IMPACT ASSESSMENT OF IMPROVED COWPEA VARIETIES ON WOMEN FARMERS IN SOUTHERN PART OF BORNO STATE, NIGERIA

By

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CERTIFICATION

We certify that this thesis entitled "**Impact Assessment of Improved Cowpea Varieties on Women Farmers in Southern Borno State, Nigeria",** has been duly presented by **Binta Ali Zongoma (PGA/06/06108)** of the Department of Agricultural Economics, Faculty of Agriculture, University of Maiduguri and has been approved by the examiners.

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DEDICATION

This study is dedicated to my beloved husband and children Adama, Adam and Muhammad.

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ABSTRACT

The study examined the impact of improved cowpea varieties on the income and the food security status of women farmers in Southern Part of Borno State, Nigeria. The specific objectives were to describe the socio-economic characteristics of women cowpea farmers in the study area; identify the changes in income as a result of using improved cowpea seeds by the respondents; analyze the impact of the improved cowpea varieties on the food security status of the respondents; analyze the determinants of technical efficiency of the respondents; estimate the technical efficiency of the respondents in using improved cowpea and identify the constraints associated with the use of improved cowpea varieties. Both primary and secondary data were used for the study. The primary data were collected by use of structured questionnaires administered to 240 participants and 60 non-participants to give a total of 300 respondents who were selected using a random sampling technique. Descriptive statistics, Double Difference (DD), Cost-of-Calorie index and the Stochastic Production Frontier Function were the analytical tools used to analyse the data collected. The results of the descriptive statistics indicated that the respondents were mostly within the age group of 31-40 years implying they are in their active age. Majority are married (68% participants and 75% non-participants), 38% participants and 35% non-participants have household of 6-8 people. An average of 66% participants and 62% non-participants were educated with mean farm sizes of 1.2 and 0.8 hectares respectively. Findings from the Double Difference estimates indicated that the annual income of the participants increased by N143, 495.20 which was higher than that of the non-participants which increased by only ₦58, 500.00.This indicates that there was a positive impact on income as a result of using the improved cowpea varieties. The Cost-of-calorie index showed that based on the daily energy level of 2250Kcal recommended by Food and Agriculture Organization, the food security line per adult equivalent per month was N2,743.81 and N2,076.69 for the participants and non-participants respectively. The result also showed that 66% of the participants and 33% of the non-participants were food secure. The Maximum Likelihood Estimates revealed that the coefficients of the production parameters were all positive and significant at one percent. The inefficiency variables affect efficiency in improved cowpea production. The values of sigma square is 3.293 and gamma is 0.997.The estimated mean technical efficiency was 0.7993 which indicates that the improved cowpea farmers could improve their present level of output by 20.4 % given their present resources. The cowpea farmers were constrained by diseases and pests, high cost of labour and inadequate access to markets. It was recommended that policies should be formulated to encourage women farmers in the study

area to adopt and sustain the use of improved varieties of cowpea, women farmers in the study area should be given adequate enlightenment on how to control pests and diseases and improved cowpea varieties and other inputs should be made readily available and accessible to the women farmers at affordable prices, on time and in adequate quantities.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Cowpea (*Vigna unguiculata*) is an annual leguminous crop indigenous to Tropical Africa. It is adapted to the tropics with temperatures between 28 ^{o}C and 30 ^{o}C and rainfall between 500 and 1200 mm per annum (Dugje *et al.,* 2009). It performs well on well drained sandy loam to clay loamy soils with pH between six and seven. It is of vital importance to the livelihood of millions of people providing nutritious grain and an inexpensive source of protein for both rural poor and urban consumers (Agwu, 2004). In Africa, women farmers produce process and sell snack foods made from this nutritious legume. The fodder is used as animal feed and can be sold during dry season to provide income to farmers. Cowpea can contribute significantly to increased food security and sustainability of crop-livestock systems. The high protein content of cowpea, its adaptability to different types of soils, drought tolerance, ability to improve soil fertility and prevention of erosion makes it an important economic crop.

With the popular view that crop-livestock integration provides some of the best options for sustainable productivity, the trends in human and livestock population and the imperative agricultural intensification point to the fact that cowpea is likely to become more popular and to play an important role in agricultural production systems in the near future.

About 12.76 million hectares of land is cultivated annually with cowpea in the world and total worldwide production of cowpea was estimated at 7.56 million metric tonnes with sub Saharan Africa accounting for about 75% (i.e. 5.67mmt) of the total production (International

Institute of Tropical Africa, IITA, 2009). This gives an average annual yield per heactare of just 0.59 metric tonnes.The principal cowpea producing countries are largely from West Africa and these are Nigeria, Niger, Senegal, Ghana, Mali and Burkina Faso. Nigeria is the largest producer of cowpea in the world today with an estimated production index of 3.15 million metric tonnes per annum which constitute about 42% of world production (Gabdo and Amaza, 2010). However, with a large population; Nigeria is also the largest consumer of cowpea in the world and the domestic supply of cowpea is not adequate to meet demand (Gomez, 2004).

Over the years, the production figure of cowpea in Nigeria has been increasing as a result of increase in total area under cultivation; however, the overall productivity is still very low (Lawal and Oluyole, 2008). The problem of this low productivity has been traced to the use of local varieties of the crop, poor management practices, lack of sufficient inputs, inefficient extension services and lack of or inadequate use of modern technologies (Olajide, 2011). Thus, there is the need to increase farmers' productivity and efforts have been made to boost production by introducing improved technologies.These have the potential to increase yields to about 1.5 - 2.0 metric tonnes per hectare (Aboki and Yuguda, 2013).

In line with this, the Canadian International Development Agency (CIDA) funded a project titled Promoting Sustainable Agriculture in Borno State (PROSAB), which was implemented in the southern part of Borno state in 2004. The project was aimed at improving food security, reducing environmental degradation and improving sustainable agriculture through the transfer of improved agricultural technologies and management practices to farmers. Improved varieties of crops like maize, rice, sorghum, cowpea and soyabeans were introduced in the study area. These improved varieties were introduced along with their associated management practices which include seed rate, planting distance, weeding, fertilizer application,

e.t.c. The improved cowpea varieties introduced by PROSAB (see Appendix I) include IT89KD-288, IT89KD-391, IT90K-277-2, IT97K-131-2, IT97K-499-35 and IT97K-568-18 (Onyibe *et al*., 2006). The improved cowpea varieties introduced have the potentials to increase grain and fodder yields per hectare in addition to enhancing the productivity, sustainability of crop-livestock systems and food security thus, responding to the food, feed as well as the soil fertility needs of the region.

Women have been found to provide about 60-80 percent of food in most developing countries and they are responsible for half of the world's food production (Sulo *et al*., 2012). However, most of what the women produce at most times is being consumed by the household with very little or no marketable surplus. Food insecurity and poverty are serious issues ravaging the female population and when ccompared to men, women have a higher incidence and severity of poverty (Doss, 2001). The introduction of improved cowpea varieties has indeed brought about high hopes for increased productivity and reduction of poverty. However, the extent to which improved cowpea varieties contribute to increase productivity and income among women farmers needs to be addressed.

1.2 Statement of the Problem

Agriculture plays a major role in the economy of many developing countries. It is a significant source of food security for the people and a means of livelihood for the most vulnerable citizens of these countries. Consequently, raising agricultural productivity is an important policy goal for governments and development agencies and this is central to growth, income distribution, improved food security and poverty alleviation among practitioners. Important actors in this endeavor are the rural women who play vital roles in agricultural

production and they are crucial to the overall success of the efforts directed at agricultural development in rural areas.

Women farmers mostly grow cowpea to provide food security and it is an important source of income for a large number. With growing potential market for cowpeas both within and outside the country, women can be encouraged to increase their production by using improved cowpea varieties. Over the years, efforts have been made to provide women farmers with efficient and appropriate improved technologies and agricultural statistics have begun to show positive indices in family welfare. The improved agricultural technologies have changed women's efficiency, productivity, resultant welfare and sustainable livelihood.

The PROSAB project had promoted the use of improved agricultural technologies among farmers. There is need therefore to assess how the project has impacted on the livelihood of women farmers in the study area. There is the need to assess the improved cowpea varieties now, ten years after being introduced, especially on women farmers who had actively participated in the project. This study is thus, specifically aimed at evaluating the impact of the improved cowpea on women farmers' income and food security in the study area. To achieve this, an attempt was made to answer the following research questions:

i. What are the socio-economic characteristics of women cowpea farmers in the study area?
ii. What is the impact of the improved cowpea varieties on the income of the respondents in the study area?
iii. What is the impact of the project on the food security status of the respondents?
iv. What is the level of technical efficiency of the respondents?
v. What are the determinants of technical efficiency of the respondents?
vi. What constraints do the respondents face in the production of improved cowpea?

1.3 Objectives of the Study

The main objective of this study was to analyse the impact of improved cowpea varieties on the income and the food security status of women farmers in Southern Borno State, Nigeria. The specific objectives were to:

i. describe the socio-economic characteristics of women cowpea farmers in southern part of Borno state;
ii. identify the changes in income as a result of using improved cowpea varieties by the respondents;
iii. analyze the impact of the improved technology on the food security status of the respondents;
iv. analyze the determinants of technical efficiency of the respondents;
v. estimate the level of technical efficiency of the respondents and
vi. identify the constraints associated with the use of improved cowpea.

1.4 Hypotheses

The following hypotheses were tested:

1. There is no significant difference between the income level of farmers before and after introduction of the improved cowpea varieties.
2. The respondents are technically inefficient in improved cowpea production.

1.5 Significance of the Study

The findings of this study will serve as a crucial policy instrument to government and other policy makers in judging the intrinsic merits of the improved cowpea varieties on the target population and to design effective policies and programs that will integrate gender concerns

towards upgrading women farmers' production capacity and improving their living standards. Thus, contributing to overall agricultural production and food security in the country.

The results will provide information to CIDA/PROSAB and other agencies who participated in the promotion and dissemination of the improved cowpea varieties about the impact on the farmers and whether there is need for improvement or not. In addition, information on impact assessment will augment the findings of earlier ex-post studies by the donors. This will assist such donors to decide whether to continue funding other similar projects in the same area and even be encouraged to expand to other areas too where such projects have not been implemented.

The findings of this study will also be useful to non-governmental organizations and other interested agencies in providing information to assist them in advocating and planning programmes that are gender responsive. This study will in addition, provide information on the constraints facing women farmers after adopting the improved cowpea and how these can be overcome to improve their production. Finally, the study will enrich existing literature and open room for further research by students and other researchers.

1.6 Scope and Limitations of the Study

This study focused on the impact of improved cowpea varieties on women cowpea farmers in the southern part of Borno State. The PROSAB project was implemented in four LGAs. These are Biu, Damboa, Hawul and Kwaya-kusar LGAs. However, only three were selected for this study. Damboa LGA was not included in the study as the inhabitants had been displaced by insurgents as at the time of collecting the data. The indicators used to measure impact of improved cowpea varieties in this study were income level, food security and technical efficiency of women farmers which was used to measure production efficiency of the women

cowpea farmers. Data were collected for 2014 cropping season and compared with the baseline data of 2004.

The limitations encountered during the study include the insecurity in the state which prolonged the period of data collection. That notwithstanding, the data were painstakingly collected and collated with the assistance of trained field assistants.

CHAPTER TWO

LITERATURE REVIEW

2.1 Empirical Review

2.1.1 Socioeconomic Characteristics of Farmers

2.1.1.1 Age

Age has been found to affect the mental attitude of an individual to new ideas. In addition, it is also an important factor influencing the use of improved agricultural technologies and farmers productivity (Amaza, 2000; Ironkwe and Madu, 2014).The rate at which women farmers have been found to adopt improved technologies is affected by their age and this in turn affects the household productivity and livelihood. Amaza *et a*l. (2007), in their Baseline Socioeconomic survey report on agriculture in Borno state found majority (61%) of the women farmers to fall within the age group of 30-40 years. This agrees with the findings of Atibioke *et al*. (2012) in their study on effect of demographic factors affecting adoption of technologies in Kwara state Nigeria where 75% of respondents engaged in farming are within the age range of 30-50 years.

In a study by Idrisa *et al.* (2010) on Influence of Farmers' Socioeconomic and Technology Characteristics on Soyabean Seeds Technology Adoption in Borno State, the farmers were found to have an average age of 41 years. Some other studies (Okunade, 2006; Adofu *et al*. 2008; Lawal and Oluyole, 2008; Ironkwe and Madu, 2014) have also shown that majority of farmers were found to have an average age of 40 years. These findings imply that the farmers were in their productive and economic ages and more inquisitive to try out new technologies and continue growing the improved varieties compared to older farmers. The younger farmers will also be willing to and readily apply the associated management practices like seed rate on their farms unlike the older people who may be reluctant in using them. Age

has also been found to affect the rate of household usage of improved technologies which in turn, affects household productivity and livelihood improvement strategies (Dercon and Krishnan, 1996). It is expected that higher yields as well as higher incomes will be obtained among younger farmers.

2.1.1.2 Education

The productivity of farmers can be increased with education as the level of education of the farmer can influence his use of improved technology and hence, farm productivity. Education can also improve access to agricultural information and farmers' ability to evaluate new production techniques. This will also aid them in understanding how to apply the associated management practices and also understand the importance of doing so. Rahman (2007) in a study on Adoption of Improved Technologies by Farmers of Aizawi District of Mizoram, India, revealed that education was positively and significantly associated with the use of improved technology by farmers. Education improves human capital, farm management capacity and ability to understand and use new agricultural technologies (Ojiako *et. al*., 2007). This shows that as the educational level of farmers increase, their use of improved technology also increase. Studies have shown that women farmers are usually characterized with low level of education which has subsequently affected their production and thus leading to their low level of productivity. A report by the International Food Policy Research Institute (IFPRI, 2000), indicated that in Kenya, if women farmers were given the same levels of education, experience, and farm inputs as their male counterparts, they could increase their yields for maize, beans, and cowpeas by 22 percent. Data from women farmers in Kenya suggest that yields could increase by 25 percent if all women attended primary school (IFPRI, 2000) Educating women is thus, a key method for boosting agricultural productivity in Sub-Saharan Africa.

Ironkwe and Madu (2014) have shown in their study on Gender Factors Influencing Technical Efficiency of Cassava Farmers in Akwa Ibom State, Nigeria, that the bulk (40%) of the women farmers only had primary education with only about 10% having tertiary education. Adofu *et al*. (2008) have shown in their study on the Economic Impact of Improved Agricultural Technology on Cassava Productivity in Kogi State, Nigeria that about 39% of their respondents had only primary education and only 10% had tertiary education. This shows that the level of education is low and this may influence their production especially their use of improved technologies. Thus, it can be concluded that women farmers generally have low level of education and so prone to low productivity.

2.1.1.3 Farm Size

Majority of the farmers in rural areas are small scale farmers with less than one hectare of land. The size of the farm determines the farmers' level of output and tendency to have several crop enterprises on the farm. There is also the tendency of using improved technologies on such farms. Sulo *et al*. (2012) showed that the farm size had a positive relationship with the uptake of improved technologies like improved seeds. Farmers with larger farm size tend to be more willing to bear the risk in using part of their farms to try the improved seeds unlike those with smaller farms who have to be very sure before trying any new seeds. Inaizumi *et al.* (1999) studied the impact of Dry season dual purpose cowpea in semi-arid Zone of Nigeria and revealed that majority (84%) of the farmers who are small-scale farmers had less than one hectare of arable land.

Various studies (Bamire and Manyong, 2003; Kolawale, 2006; Mignouna *et al.*, 2011 and) have shown that farmers in developing countries have an average farm size of 0.7 hectares indicating they are small scale farmers. Farm size is positively significant with farm productivity.

An increase in farm size by one hectare could increase yield by about 0.073%. This finding is consistent with earlier studies (Sharma *et al*. 1999; Lundvall and Battese, 2000; Alvarez and Arias, 2004) which have all reported a positive relation between average land productivity and land size. The larger the farm size, the higher the tendency of farmers to use improved varieties which will in turn raise their productivity leading to higher incomes.

However, women, who form the bulk of the population in rural areas, have been shown to have smaller land holdings and this greatly affects their production. Hyuha *et al*. (2005) in studying the Impact of Rice Production on Food Security and Women in Uganda have shown that women farmers had farm sizes of only 0.1-0.3 hectares. Similarly, a study on Determinants of Gender Productivity Among Cowpea Farmers in Borno State by Ojo *et al*.(2013), also showed that most (54%) women farmers had only about 0.5-1 ha while the men had up to 3- 4 ha. Thus, the tendency for them to use improved technologies will be low and this will lead to their low productivity.

2.1.1.4 Household Size

Small scale farmers who are resource poor depend on family labour for their agricultural production. Farmers that have large household sizes can provide the needed labour required for their farm activities. However, this is possible only if the adult-child ratio is high. The household size, as well as its composition, is one of the most important factors conditioning the level of production and the productivity of small scale farmers especially women.

According to Amaza *et al*. (2009) availability of labor for farm production, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the marketable surplus are all determined by the household size. Several studies (Hyuha, *et al*., 2005; Kolawole, 2006; Awoniyi and Awoyinka, 2007; Idrisa, 2009;) have

also shown that farmers in Nigeria have an average household size of 8.5. This indicates that farmers have family labour available for production. This will also encourage them to employ new technologies on their farms which lead to increased yields resulting in the supply for additional labour required for the production of improved varieties thus, leading to more income. However, female headed households have been shown to have smaller sizes thus, having low labour supply which may discourage them from using improved technology (Hyuha, *et al.,* 2005). In cases where they adopt the improved varieties, they may not be able to hire the additional labour required for efficient production. They also do not have control over the available family labour in the household as this is under the control of the husbands.

2.1.1.5 Farming Experience

Agwu (2004), Kolawole (2006) and Amaza *et al.* (2007) have all shown that farmers have mean farming experience of 23, 18 and 25 years respectively. The number of years spent in farming can boost knowledge of farming activities and farmers with more years of experience are expected to perform better in their agricultural activities. Farming experience is an important factor determining both the productivity and the production level in farming and its effect may be positive or negative. It could have a positive effect up to a certain number of years, after which it may become negative. The managerial know-how of farmers is being affected by their farming experience and they are better able to assess the importance of new technologies. They could apply the management practices associated with the improved varieties and achieve better results. The negative effect may be derived from aging or reluctance to change from old and familiar farm practices and techniques to improved practices. The older farmers tend to have problem in using the improved varieties along with the recommended practices which differs from the ones they have been using over the years.

2.1.1.6 Access to Credit

Improved technologies are usually cash intensive. Most technologies such as improved seeds require complementary inputs such as fertilizers for their optimum yield. Thus, access to credit is important to resource poor farmers to enable them access improved technologies along with their associated inputs like fertilizer. As a result they can obtain the desired output and improve their productivity. However, majority of farmers do not have access to credit especially women. Despite their contribution to agricultural production, women's productivity is constrained by lack of access to credit (World Bank, 2008; Ojo, 2011).

A study on Kenya, Zimbabwe, Malawi, Zambia and Sierra Leone found that women received only 10% of the credit for smallholder farmers and 1% of total credit to agriculture (Wikipedia, 2010). Lack of access to credit reduces a woman's efficiency and productivity on her plot. Another constraint is the inability of the women farmers to obtain credit without a male guarantor or without husband's assistance. Having access to credit could enable her to secure fertilizer, improved varieties of seeds and other technology on farms thus, enabling her to produce more output for increased welfare.

2.1.1.7 Contact with Extension Services

Extension services influence farmers' attitudes, knowledge and skills which have positive influence on their production. Regular visits by extension agents expose the farmers to information on new ideas and technologies. Availability of information stimulates farmers to adopt new technologies which will raise their productivity. Elias *et al*. (2013) have studied the Effect of Agricultural Extension Program on Smallholders' Farm Productivity in Ethiopia and

the results revealed that participation in extension has increased farmers' productivity by six per cent. Bamire *et al.* (2010), stated in their study on Impact of PROSAB on adoption of improved crop varieties in Borno state, that farmers must have information about the characteristics of an improved variety before they can consider adopting it or not. Their study showed that households in the Sudan savannah who had more access to extension services (84%) as a result of the activities of the PROSAB project had higher rate of adoption of the improved varieties like cowpea (57%) and hence had higher yields and income.

Idrisa (2009) has shown that access to extension services had a positive and significant influence on the uptake of improved soyabean seed. Similarly, the result of the study on influence of socio-economic factors influencing adoption of alley farming technology in Imo state by Onu (2006), revealed that farmers who had access to extension services are 72% higher in adopting the technology than those who are not. Ayaode (2012), in her study on the attitudes of women farmers towards agricultural extension services in Osun state has also shown that extension services have positive effects on the women by increasing their production and output level by 67% as well as their income and revenue (69%) .These studies have shown that extension services are important in increasing women's productivity and incomes

2.1.2 Impact of Adopting Improved Technologies on Farmers' Income

Various studies have shown that when farmers adopt improved technologies, along with the recommended management practices, the level of their output is increased and consequently their incomes. According to Adofu *et al*. (2008) in their study on the economic impact of improved agricultural technology on cassava productivity in Kogi state, improving productivity through improved agricultural technology leads to increase in income. Their result showed

however that farmers incurred higher costs of production of ₦22, 500.00 after adopting the improved technologies as against the cost of ₦17, 500.00 when using the local varieties. They obtained higher yields and consequently higher incomes of about ₦43, 750.00.

In a farmers Guide to Increased Productivity of Improved Legume-Cereal Cropping Systems in the savannah, Nigeria, Ajeigbe *et al*. (2010) indicated that farmers using improved systems earned a gross income/ha ranging from ₦102,000.00-₦167,000.00, compared with ₦24,000 - ₦52,000 in those that used traditional systems. On the average, participating farmers had 24 - 31percent more income compared with those that did not participate.

Awoniyi and Awoyinka (2007) in their study on Economic Analysis of the Impact of Improved Yam Variety on Farm Income of Farming Households in Guinea Savannah, Nigeria, showed that even though farmers that are cultivating new improved yam variety incurred more costs compared to farmers that cultivated traditional varieties. They earned gross margin and farm income between ₦ 21,500 and ₦ 19,450. Those with traditional variety got income of only ₦ 4,103 and ₦ 3,352 respectively. Thus, farmers with improved yam variety have enhanced income which invariably enhances their purchasing power and therefore their household welfare status improved, compared to their counterparts that cultivated traditional yam varieties.

Simonyan and Omolehin (2012) analyzed the impact of Fadama II Project on beneficiary farmers' income in Kaduna State using a Double Difference approach. Their findings established the fact that income of the beneficiary farmers increased significantly more than before the project (i.e. from ₦ 302,971.56 before to ₦ 709,492.52 after) and also more than the non beneficiary income of ₦ 478,564.73. The results also proved that the increase in income realized by the beneficiary farmers was attributed to their participation in the Fadama II project based on the positive mean income value obtained which was significant at 10% level of probability.

Iheanacho *et al.* (2007) also carried out a similar study in Adamawa State using baseline and household survey data. They computed the percentage change in average net income of beneficiaries and non beneficiaries and the findings showed that the net increase on income of the beneficiaries and non beneficiaries have resulted in improvement in their incomes and subsequently on their standard of living and social welfare. These results show that such projects also have spillover effects on unintended beneficiaries.

In a study on impact of Fadama Field Schools on Agricultural Productivity and Poverty in East Africa, Davis *et al. (*2010) reported that participation in farmers' field schools increased farmer's production, productivity and incomes in the countries studied. Crops in Kenya and agricultural income in Tanzania shows significant increases of 80% and more than 100% respectively. In Uganda, female headed households benefited significantly more than men headed households

Nguezet *et al.* (2011) studied the Impact of Improved Rice Technology on Income and Poverty among Rice Farming Household in Nigeria. The findings indicated that farmers' incomes and per capita expenditures were raised as a result of using improved varieties thereby increasing their probability of escaping poverty. This confirms the widely held view that productivity-enhancing agricultural innovations can contribute to raising incomes of farm households, poverty alleviation, and food security in developing countries.

2.1.3 Impact of Improved Technologies on Food Security Status of Farmers

Catherine and Jeffrey (2014) studied the Impacts of Improved Bean Varieties on Food Security in Rwanda and their results showed that food consumption is influenced through channels in addition to the farm profitability channel. For example, some of the new improved varieties have shorter production cycles, which can free up labor, and allow household members

to be engaged in additional income-generating activities. Higher productivity can also allow households to reallocate resources to other crops, increasing agricultural production diversity and thus food consumption diversity, as household food consumption is mainly derived from home production. The impact pathway from adoption to food security is influenced by gender and this contributes additional food security impacts especially on women. In Rwanda, bean is mainly a woman's crop and the improved varieties will enable them to improve their productivity and have better control over the income gains and thus, be in a stronger position to influence household nutrition outcomes.

Nyangena and Juma (2014) studied the Impactof Package Adoption of Inorganic Fertilizers and Improved Maize Seed Varieties on Yield among smallholder households in Kenya using a quasi-experimental difference-in-differences approach. Their findings showed that inorganic fertilizers and improved maize varieties significantly increased maize yields when adopted as a package, rather than as individual elements. This has resulted in households having more food available for their consumption thus becoming more food secured.

2.1.4 Levels and Determinants of Technical Efficiency among farmers

Okoruwa *et al*. (2006) used a stochastic efficiency decomposition methodology to derive technical efficiency measures for a sample of rice farmers located in Niger State, Nigeria. The results obtained indicated an average technical efficiency of 0.82 from upland rice and 0.77 for lowland rice and this implies that there is considerable room for improvement in the productivity of farms in the lowland area. This shows that farmers could increase output and household income through better use of available resources given the state of technology.

Ajibefun (2006) carried out a study on linking Socio-economic and Policy Variables to Technical Efficiency of traditional Agricultural Production in Nigeria. His results showed that

technical efficiency of farmers varies across farms and farming systems and education has the highest marginal effect on technical efficiency. The highest (0.77) mean technical efficiency occurs among group of farmers within 7-12 years of schooling and the least (0.54) mean technical efficiency occurs among groups with 1-6 years of schooling. This shows that farmers need to acquire basic education necessary to read, write and understand instructions on application and adoption of new farming innovations.

Analyzing the technical efficiency in Male and Female Managed Farms in Kenya, Marinda *et al.* (2006) indicated that the main factors that tended to contribute significantly to technical efficiency are education, access to credit, fertilizer use and distance of the farm to the main road. Women farmers had low level of education and this placed them at a disadvantage. Similarly, access to credit was a constraint to the female farmers and this affected their technical efficiency.

Amaza *et al. (*2005) carried out a study of technical efficiency in the Guinea Savannah of Borno State using a Stochastic Frontier Production Function. The result showed that farmers mean technical efficiency index was 0.68. The variations in the farmer efficiency were caused by differences in their age, education, credit, and extension contacts and crop diversification. This implies that the production could be increased by 32% if the available resources were effectively utilized given the current state of technology.

In another study identifying the factors that influence technical efficiency of food crop production in West Africa with empirical evidence from Borno State, Amaza *et al. (*2006) used a stochastic frontier production function of the maximum likelihood estimation techniques and showed that the mean technical efficiency index of farmers was 0.86, showing that there has been an improvement in crop production. The significant factors that account for the observed

level of efficiency among farmers are age of farmers, education, credit, extension contact and crop diversification. It can be seen that there was an increase in the technical efficiency index and this shows that the technical efficiency has increased over time.

Musaba and Bwacha (2014) studied the Technical Efficiency of Small scale maize production in Zambia using a stochastic Frontier Approach. Their findings indicated that maize land size and fertilizer have significant positive effect on maize production. Labour and seed were however, insignificant. The technical efficiency score ranges from 52.2 percent to 93.2 percent with a mean of 79.6 percent. This implies that farmers will have to reduce inefficiency by 20.4 percent in order to operate on the frontier.

2.1.5 Constraints Associated with Use of Improved Technologies

Shashekala *et al*. (2012) in their study of Small Farmers Constraint to Agricultural Development found out that the small scale farmers are faced with the constraint of non availability of improved seeds (62%), lack of easy credit facilities (61%), untimely availability of improved production inputs(58%), high costs of production inputs (57%) and lack of technical guidance (40%) when required

A study by Singh, *et al.* (2011) found that the probability of a farmer adopting a resource conserving technology depends upon ‘‘increase in net income due to adoption of technology, education level of household- head, total irrigated cropped area, source of information, and possession of tractor by farm household and ability of the technology to save resources like labor’ According to Kassie *et al.* (2009) in their study on adoption of organic farming techniques in Ethiopia, the adoption decisions can be significantly influenced by land

rights and the future security of tenure among farmers. A farmer might reject the use of technology at any time during or after the adoption process when he/she questions the right of land ownership.

The failure of a new technology in its early stage is an important determinant in the use of improved technologies (Khan and Hall, 2003). This is because the failure of the new technology at its first stage may create doubt and even total rejection by the farmers who may question the reliability of the new technology and may decide not to continue using it.

Morris, *et al. (*1999) in their study on Adoption and Impacts of Improved Maize Production Technology in Ghana, revealed that gender differences in the use of different technologies may arise as the men head most of the households and are often the decision makers when it comes to agricultural managements. Women's participation in the technology uptake decision is often not significant. In addition to that, accessibility to resources is also another factor that influences the use of improved technologies by farmers. Men usually have better access to resources than women and the women's use and sustainability of technology depends on access to land, labor, or other resources. Thus, improved technologies do not benefit men and women farmers equally.

Modu *et al*. (2010) in their study on the Economic Analysis of Cowpea Production among Women Farmers in Askira/Uba Local Government Area, Borno State Nigeria have shown that the major constraints of the women are inadequate capital and lack of access to credit. Others include the absence of formal credit institutions, lack of market outlets, transportation, management difficulties during the production period, storage and problem of pest and diseases. Amaza (2011) in his study on Early Adoption of Improved Cowpea in

northern Nigeria identified the major constraints to use of improved cowpea to be lack of adequate seeds, poor quality seeds and inadequate information about the improved seeds.

In a study on Impact of Improved Yam Varieties on Farm Income of Farming Households in Guinea Savannah, Awoniyi and Awoyinka (2007) revealed that untimely access to fertilizer and high production costs are the major constraints facing farmers in using improved varieties. Sabo *et al*. (2014) investigated Constraints on Production and Adoption of Inorganic Insecticides and Spraying regime in Management of Cowpea in Mubi, Nigeria. The results indicated that high seed yield is consequent upon high yielding varieties and use of insecticides. The use of insecticides is constrained by high cost of insecticides and health hazards on the farmer and his household, and environmental pollution associated with use and misuse of inorganic insecticides. Another concern with pesticides use is lack of safe handling procedures. Farmers eat, drink or smoke without washing after spraying. Other constraints include high cost of spraying kit, farm size, high cost of control methods and illiteracy.

Kasirye (2012) in his paper on Constraints to Agricultural Technology Adoption in Uganda has shown that dis-adoption of agricultural technology occurs regularly in developing countries and this is attributed to life cycle effects, changes in the profitability of agricultural products and the increasing presence of adults in the household. This is because older household heads are more likely to abandon the use of fertilizers. With increase in the availability of organic fertilizer/manures as a result of owning more livestock on farms, households are more likely to abandon fertilizer use after some time. Moreover, animal manure is less amenable to supply side constraints than chemical fertilizers.

In a study on Realigning Research and Extension to Focus on Farmers' Constraints and Opportunities, Snapp *et al*. (2003) have indicated that the most common constraints to greater

use of inputs by small holders are production risks (where skilled fertilizer and manure management is required), price risks (as a result of financial commitment in buying inputs and high variation in output prices) and resource availability.

Idrisa *et al.* (2010) have identified the constraints facing farmers in Southern Borno state to include the technicality of agronomic practices, poor access to extension services, inadequate markets and poor access to improved seeds. Peterman *et al*. (2010) have emphasized that accessibility of inputs, not propensity to use inputs is the major constraint for many women farmers

2.2 Concept of Impact Assessment

The term impact simply refers to a marked effect or influence. It is the broad, long-term economic, social and environmental effects resulting from research. It is a measure of the changes made or the effect on an individual or group directly or indirectly which may be positive or negative, intended or unintended, primary or secondary long-term effects produced by a development intervention (OECD/DAC 2002). Assessment or Evaluation, on the other hand, is the judging, appraising, or determining the worth, value or quality of research, in terms of its relevance, effectiveness, efficiency, and impact (FAO, 2000).

Impact assessment has been defined as the systematic analysis of lasting or significant effects – positive or negative, intended or unintended of an intervention (FAO, 2008).The World Bank has defined impact assessment as an attempt to determine whether a programme of intervention had caused the desired effects on individuals, households, and institutions; and

whether those effects are attributed to the programme of intervention. Social impacts have been defined as the net effect of an activity on a community and the well-being of individuals and families. According to Sanginga *et al. (1999)* Social Impacts are changes that have occurred for an individual farmer at household or farm level or in the community at large as a result of the adoption of improved technologies. They showed that Social Impact Assessment (SIA) is concerned with finding out how far the introduction of an improved technology has been successful in meeting socioeconomic objectives, and how well improved agricultural technologies have satisfied the needs and priorities of households and other units in the target population.

Impact assessment has been used to identify the effects of an agricultural research on people's lives. This study defined impact assessment as the influence of improved cowpea varieties on income, food security and livelihood of women farmers.

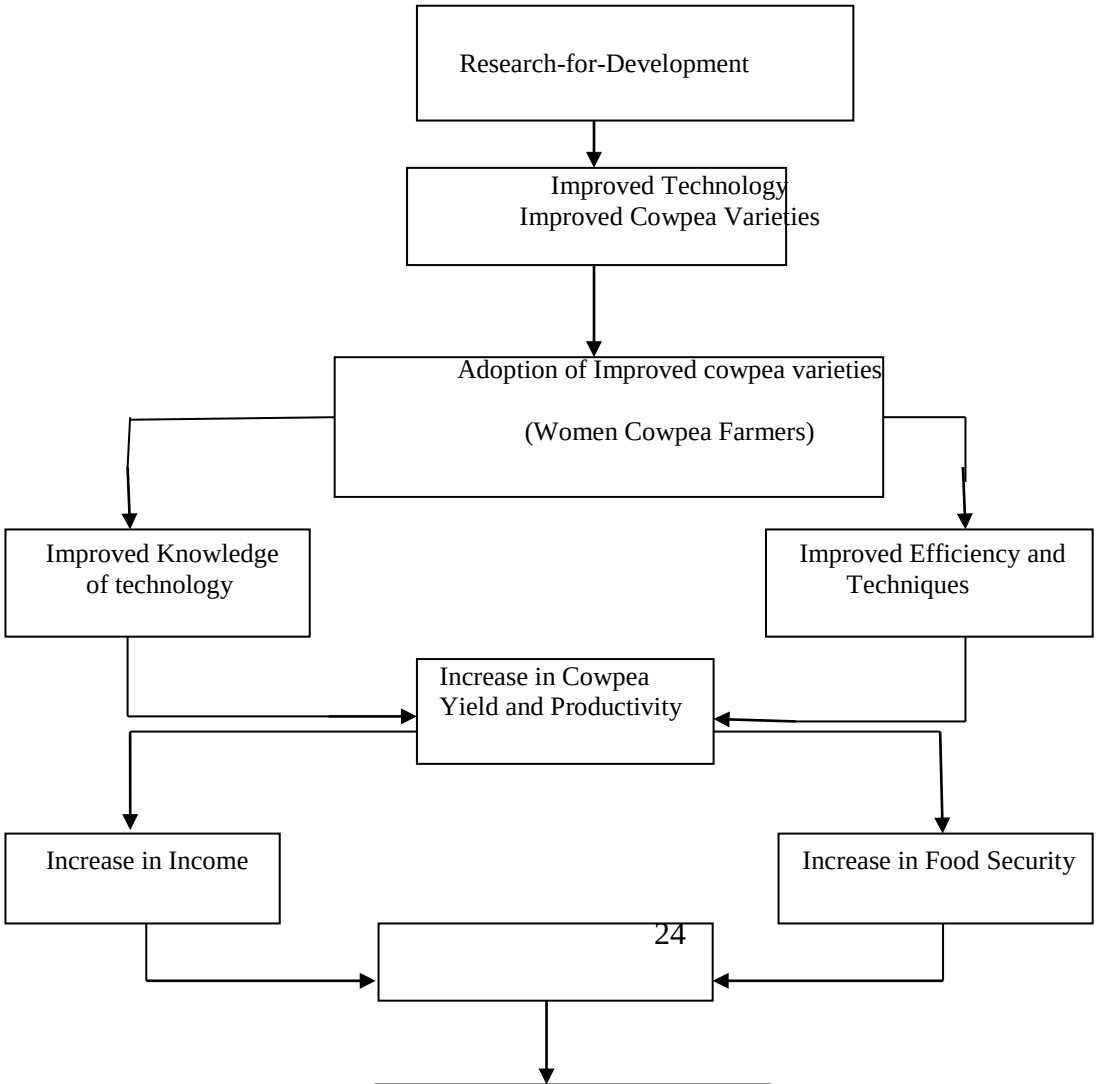
2.3 Conceptual Framework

In assessing the performance of any agricultural research project, it is important to know the extent to which technologies generated by a project have spread throughout the target population. The improved cowpea varieties introduced into Southern Borno state by PROSAB include IT89KD-288, IT89KD-391, IT90K-277-2, IT97K-131-2, IT97K-499-35 and IT97K-568-18. Figure 1 shows the conceptual framework of the impact of improved cowpea varieties on the women farmers in the study area.

When improved varieties are developed, farmers require human capital, financial and social capital to be able to adopt them. The human capital is concerned with the educational status of the farmer, his/her skills, knowledge, health and nutrition. The financial capital involves their cash at hand in form of savings (and also liquid assets), credit as well as transfers and

remittances. Social capital involves their ability to work together, membership of associations and access to opportunities. Women farmers have adopted the improved cowpea varieties introduced into the area of study and this has influenced their knowledge of the improved technology and their efficiency in production. This has consequently resulted in an increase in women farmers' yield and overall productivity.

Women farmers' increase in yield and productivity resulted to increase in their incomes which enable them to be able to access food in adequate quantities and quality, thus ensuring their food security and improving their livelihood. Improvement in their livelihoods involve generating more income, improving gender relations in households, improving nutrition especially in children and thus reducing household members' vulnerability to disease and finally reducing vulnerability to poverty.



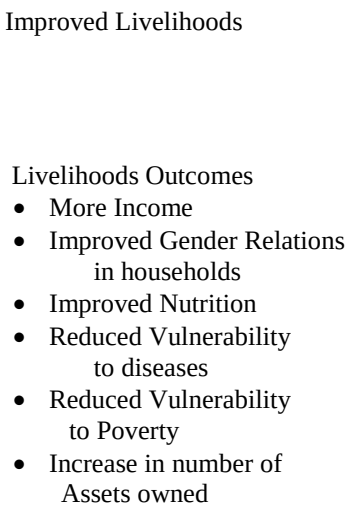


Figure 2.1: A Framework for Impact of Improved Cowpea variety
Source: Own Formulation

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

This study was conducted in the southern part of Borno State, Nigeria, where the PROSAB project promoted the production of improved cowpea among other crops. The state falls within the Savannah Zone of Nigeria. It comprises of the Northern Guinea Savannah, Southern Guinea Savannah and Sudan Savannah. The PROSAB project covers two of these Agro Ecological Zones i.e. the Northern and Southern Guinea Savannas. The state lies between latitudes 10°30'N and 14°30'N and longitudes 11°30'E and 14°13'E. However, the study area which comprises three Local Government Areas namely Biu, Hawul and Kwaya Kusar lies between latitudes 10°30'N and 11°30'N and longitudes 12°23'E and 13°13'E.(Google Earth World Map, 2005). The study area has a total population of 173,830 people with female making up 48 per cent of the population (NPC, 2006). It is expected that the population in 2014 was 224,947

based on an annual growth rate of 3.2 per cent. Within the state, the study area is bordered by Damboa, Chibok and Askira Uba LGAs to the north and Bayo and Shani LGAs to the South. The study area is also bordered by Adamawa State to the South East, Gombe State to the South West and Yobe State to the North West (Figure 3.1).

The study area has annual rainfall ranging from 600mm-1200mm which lasts for five Months i.e. June to October (Iloeje, 2001). The vegetation consists of tall trees and thick shrubs. The area is very productive in terms of crop and livestock production and is suitable for cowpea production. Majority of the population earn their living mainly from farming and farming is characterized by both crop and livestock-based production systems. Major crops grown include maize, groundnut, sorghum, cowpea, rice and soyabean. However, with increase in population and the consequent pressures from demands for land and other resources, there is high level of poverty and food insecurity especially among women. Cowpea being a cash crop could enhance women's income and empower them to acquire and own assets.

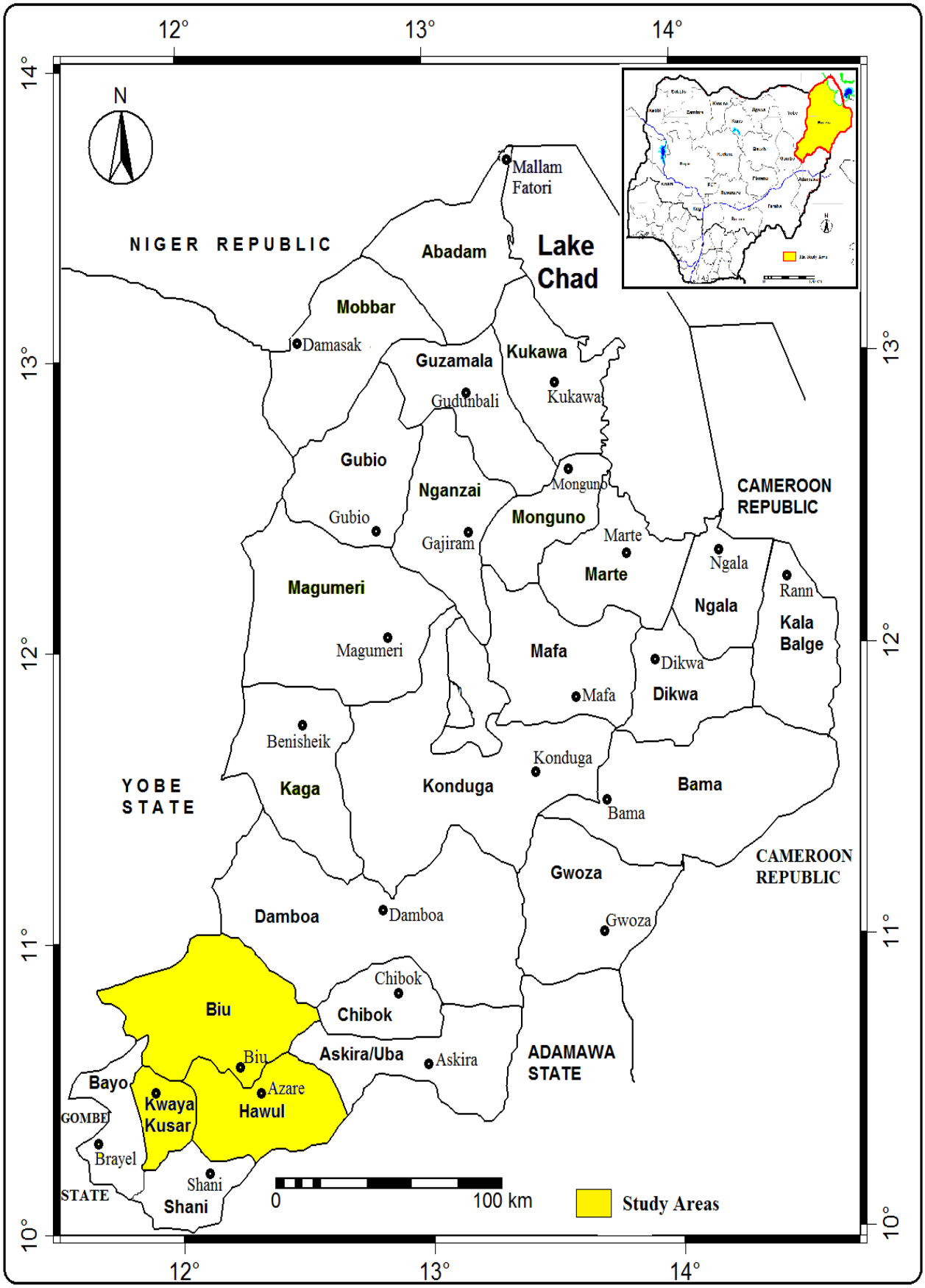


Figure 3.1: Map of Borno State showing Study Areas
Source: GEONETCast, Dept. of Geography, University of Maiduguri, 2005

3.2 Sampling Procedure and Sample size

Multi-stage sampling procedure was used to select the respondents for this study. In the first stage, three Local Government Areas (LGAs) were purposively selected from the four LGAs where PROSAB project was implemented. This is because the fourth LGA, Damboa, had been displaced by insurgency in the state. The selected LGAs are Biu, Hawul and Kwaya-kusar. A list of all the women used in the baseline survey (total of 506 women) was then obtained and used as the sampling frame for this study. A proportionate random sampling using a ratio of 3:2:1 was used based on the population of the LGAs to select the respondents for the study. For the participants, 120, 80 and 40 women were selected from Biu, Hawul and Kwaya-kusar LGAs respectively making up a total of 240 women who participated in the PROSAB project (participants). Similarly, 30, 20 and 10 were also selected respectively to make up 60 women who did not participate (non-participants). This gives a total of 300 respondents for this study(Appendix 5).

3.3 Sources of Data

Both primary and secondary data were used for this study. The primary data were collected through the use of structured questionnaire to obtain information from the respondents. Field assistants who were trained specifically for this research were used to help administer the questionnaires. Secondary data were obtained from a baseline study conducted by PROSAB in 2004 and from published materials like books, journals, reports and gazettes, unpublished projects and also from the internet.

3.4 Analytical Techniques

The analytical techniques that were used to analyze the data are the descriptive statistics and inferential statistics. The descriptive statistics, like frequencies, percentages and means were

used to organize and summarize the data. They were used to examine the socio-economic characteristics of the respondents, changes in assets owned, level of technical efficiency and constraints to cowpea production in the study area. They were specifically used to achieve objectives (i), (iii), (v) and (vii). The inferential statistics that were used include the Double Difference (Difference-in-Difference), Cost-of-Calorie index and the Stochastic Frontier Production Function.

3.4.1 Double Difference Model

The Double-Difference analytical tool is used to measure the short term or long term program effects or impacts on participants (Verner and Verner, 2005). It is a quantitative method often used to estimate and compare changes in outcome before and after programs for participants and non-participants (Chen *et al.,* 2006). In order to use the estimator in question, there must be information on both participants and non-participants and all individuals must be observed both before and after the program (Verner and Verner, 2005).

The baseline data collected at the beginning of the PROSAB project were used to provide data for 'before' while the data collected from the field survey in 2015 provided data for 'after' the project. The differences between the average income of participants and non-participants were estimated using the simple form of the Double Difference.

. The simple version of the Double Difference model is specified as follows:

$$DD^{S} = \left(\frac{1}{P} \sum_{i=1}^{P} (Y_{lia} - Y_{lib}) \right) - \left(\frac{1}{C} \sum_{j=1}^{C} (Y_{oja} - Y_{ojb}) \right)$$

Where:

DD^{s} = Change in iincome between the respondents (₦)

Y_{1ia} = Income variable of participants after PROSAB project (₦)

` Y_{1ib} = Income variable of participants before PROSAB project (₦) Yoj_a = Income variable of non-participants after PROSAB project (₦) Y_{ojb} = Income variable of non-participants before PROSAB project ₦)

P = Number of participants in the project

C = Number of individuals in the control group (non-participants)

The Double Difference has the advantage of netting out the effects of additive factors that have fixed (time-invariant) impacts on income indicator. If the mean Double Difference in income is positive, it indicates that the project has a positive impact (increase) on the income of the participants while if it is negative, it means the project has not increased the income of the participants (Bosede, 2009; Simonyan and Omolehin,2012; Wakawa, 2014). It was expected *a priori* that the respondents will have higher incomes after the PROSAB project.

3.4.2. Cost-of-Calorie (COC) Index

The Cost–of-Calorie proposed by Greer and Thorbecke (1984) was used to determine the food security status of the respondents. Various studies (Amaza, *et al.*, 2004; Amaza, *et al*., 2006; Babatunde *et al*., 2007; Ahmed, 2014) on food security have used this method. Following their approaches, the food security line is given as:

$$\text{Ln } X = a + bC \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Where

X = adult equivalent food expenditure (in naira)

a = intercept

b = coefficient of the calorie consumption

C = actual calorie consumption per adult equivalent of a household (in Kilo cal)

The FAO recommended a minimum daily calorie requirement per adult equivalent (L) of 2260 kcal (FAO, 2009). The food insecurity line is calculated using the equation:

$$S = e^{(a+bL)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

Where:

S = Cost of buying the minimum calorie taken (food insecurity line)

L = FAO recommended minimum daily calorie intake level of 2260Kcal.

a and b are as defined in equation (3.2)

Based on the calculated food insecurity line (S), respondents were classified as food secure or food insecure, depending on which side of the line they fall. This tool was used to achieve objective (v).

In order to calculate the food security status of the households in the study area, the food security line was drawn based on the recommended daily calorie required approach. The adult equivalent food expenditure was obtained from households' expenditure on food. A 24-hour recall of food consumption was undertaken and each type of food mentioned was analyzed for caloric content. Households whose daily per adult equivalent calorie intake was up to 2260Kcal as recommended by the FAO were regarded as food secure while those below 2260Kcal were regarded as food insecure.

Households have different compositions in terms of age and sex. To calculate the levels of expenditure required by these categories, the household expenditure was divided by household size to get the per capita expenditure, as used by the World Bank (1996); Agboola (2005); Babatunde *et al,* (2007) and Ahmed (2014). The household expenditure was then decomposed on per adult equivalent basis using the conversion factor adapted by Babatunde *et al.* (2007)

(Appendix 3). The household expenditure was divided by the adjusted family size to obtain the adult equivalent expenditure,

The household's calorie intake was obtained through the household's consumption and expenditure data. From the data, the quantity of every food item consumed by the household as provided by the households was estimated. The quantities were converted to kilogrammes and the calorie content was estimated using the food conversion table of commonly eaten foods in Nigeria (Appendix 4). Per adult equivalent calorie intake was calculated by dividing the estimated total household calorie intake by the household size after adjusting for adult equivalent using the consumption factors for age-sex categories (Appendix 3).

3.4.3 The Stochastic Frontier Production Function

The Stochastic Frontier Production Function (SFPF) was used to estimate the technical efficiency of the women farmers and the determinants of technical efficiency (Objectives iv and v). Aigner *et al*. (1977) and Meeusen and Van den Broeck (1977) introduced the use of the SFPF to estimate individual efficiency scores. The model is explicitly expressed as:

$$\ln Yi=\beta_o+\beta_1 \ln X_{1ij}+\beta_2 \ln X_{2ij}+\beta_3 \ln X_3 ij+\beta_4 \ln X_4 ij+\beta_5 \ln X_5 ij+\beta_6 \ln X_6 ij+\beta_7 \ln X_7 ij+V-U \quad (3.4)$$

Where:

Y_i = Quantity of output of the ith farmer (Kg)

X_1 = Area of farm planted with cowpea (Ha)

X_2 = Quantity of improved cowpea seed (kg)

X_3 = Family labour (man days)

X_4 = Hired labour (man days)

X_5 = Quantity of fertilizer used (Kg)

X_6 = Quantity of Herbicides used (L)

X_7 = Quantity of Insecticides used (L)

β_o = constant

β_o-β_7 =estimated parameters;

i = 1, 2, 3, ……..n, farmers

j = 1, 2, 3, …….m, production inputs

V_i = random variable assumed to be independently and identically distributed as μ (0, σ^2) and independent of U_i; that represent the stochastic effect outside the farmer's control.

U_i = one sided error ($U_i \geq 0$) efficiency component that represent technical inefficiency in production which is assumed to be independently and identically distributed at truncation (at zero) of the normal distribution with mean, $Z_i\sigma$ and variance σ_u^2 (| $\mu Z_i \sigma$, σ^2 |).

It was expected *a priori* that the coefficients of quantity of seeds, labour, area planted with cowpea, fertilizer and chemicals used will be positive.

The U_i was estimated as:

$$\mu = \delta_0+\delta_1 lnZ_{1ij}+\delta_2 lnZ_{2ij}+\delta_3 lnZ_{3ij}+\delta_4 lnZ_{4ij}+\delta_5 lnZ_{5ij}+\delta_6 lnZ_{6ij}+\delta_7 lnZ_{7ij}+\delta_8 lnZ_{8i}+W_i \quad \text{..... (3.5)}$$

Where:

Z_1= age (years)

Z_2= level of education (years)

Z_3= farming experience (years)

Z_4= household size (number of people)

Z_5= membership in association (Dummy = 1 if member, 0 otherwise)

Z_6= off-farm income (₦)

Z_7= extension contacts (no of visits)

Z_8= access to credit (Dummy = 1 if accessed, 0 otherwise)

δ = constant

δ_1-δ_8 = Vector of unknown parameters to be estimated

W_i = random variable defined by the truncation of the normal distribution with zero mean and variance σ^2_u such that the point of truncation is $Z_i \sigma_i$ i.e. $W_i \geq Z_i \sigma$

The inefficiency component of the SFPF comprised the socio-economic and institutional variables that are expected to be negatively related with technical inefficiency. It is expected *a priori* that the coefficients of all the variables will be negatively related to technical inefficiency. The technical efficiency of the i^{th} farmer, denoted by TE was expressed as:

$$TE_i = \exp(-U_i)$$

$$= y_i / f(X_i \beta) \exp(V_i)$$

$$= y_i / y^* \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

Where:

y_i = observed output

y^* = frontier output

if $y_i = y^*$, then $TE_i = 1$, and this shows 100% efficiency.

The difference between y_i and y^* is embedded in U_i. If $U_i = 0$, it implies that production lies on the stochastic frontier i.e. the farm obtains its maximum attainable outputs given its level of inputs. If $U_i > 0$, the production lies below the frontier and this indicates inefficiency.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1Socio-economic Characteristics of Respondents

The major socio-economic characteristics of the respondents were analysed and discussed in this section. The socio-economic characteristics considered in this study were age, marital status, household size, education, farm size, years of farming experience, primary occupation, secondary occupation and income. Summary of socio-economic characteristics of respondents considered are presented in Table 4.1.

4.1.1 Age of Respondents

Table 4.1 shows the age distribution of the respondents which varied among different age groups for both the participants and non-participants in the PROSAB project. Participants (43%) and non-participants (40%) were found to be within the age group of 31-40 years which shows that the cowpea farmers were mostly young women who are in their active ages. Only 6% of participants and 10% of non-participants were less than 20 years. The results reveal that the mean age of both the participants and non participants were 42 and 43 years respectively.

The result shows that the farmers who are mostly youths are likely to sustain the use of new technologies than the older ones who tend to be more conservative. This implies that there is the availability of able bodied women for primary production and this shows great potential for higher outputs leading to higher productivity. This will ensure more food supply, higher incomes and improved livelihoods. The finding conforms to the findings of Musa *et al*. (2010) where they found that 49% of cowpea farmers in Donga Local Government Area of Taraba State also fall within the age group of 31-40 years.

Table 4.1: Socio-economic Characteristics of Respondents

	Participants (n=240)			Non-Participants (n=60)		
Variables	**Frequency**	**Percentage (%)**	**Mean**	**Frequency**	**Percentage (%)**	**Mean**
Age (Years)						
<20	06	02.50	**42.10**	-	-	**43.50**
20-30	21	08.75		06	10.00	
31-40	102	42.50		24	40.00	
41-50	76	31.70		14	23.30	
51-60	29	12.10		15	25.00	
>60	06	02.50		01	01.70	
Marital status						
Single	10	04.20		02	03.30	
Married	163	67.90		45	75.00	
Divorced	24	10.00		02	03.30	
Widowed	43	17.90		11	18.30	
Household size						
<3	13	05.40	**08.00**	05	08.30	**07.00**
3-5	31	12.90		16	26.70	
6-8	92	38.30		21	35.00	
9-11	66	27.50		12	20.00	
>11	38	15.80		06	10.00	
Education						
No Education	82	34.20		23	38.30	
Primary	58	24.20		13	21.70	
Secondary	47	19.60		14	23.30	
Tertiary	53	22.10		10	16.70	
Farm Size						
<0.5	43	17.9	**1.2**	12	20.3	**0.8**
0.5--1	72	30.0		26	44.1	
1--1.5	105	43.8		7	11.9	
1.6-2	12	5.0		8	13.6	
>2	8	3.3		6	10.2	
Farming Experience						
<5	14	05.80		02	03.30	
6-10	87	36.20		32	53.30	
11-15	85	35.40		14	23.30	
>15	54	22.50		12	20.00	
Primary Occupation						
Farming	216	90.00		58	96.70	
Trading	06	02.50		10	01.70	
Civil service	12	05.00		-	-	
Agro Processing	06	02.50		10	01.70	
Other Occupation						
Trading	91	37.90		18	30.00	
Civil Service	23	09.50		02	03.30	
Agro processing	13	05.40		03	05.00	
Craftsmanship	05	02.10		01	01.70	
Others	16	07.60		08	13.30	
None	92	38.30		28	46.70	
Income (₦)						
<100,000	21	08.80	**256,430.54**	18	30.00	**112,233.21**
100,001 -200,000	43	17.90		21	35.00	
200,001 -300,000	98	40.80		08	13.30	
300,001 -400,000	65	27.10		09	15.00	

> 400,000	13	05.40	04	06.70

Source: Field Survey Data, 2015.

4.1.2 Marital status of Respondents

The results showed that majority (68% participants and 75% non-participants) of the respondents were married, 18% each of both groups were widowed with only 4% and 3% of participants and non participants respectively being single. This implies that the women tend to have more responsibilities and thus will be more serious with their farm work because they need to supplement the food supply to their household members and earn more income to provide for other needs of the family. Thus, they will be willing to continue using the new technologies to increase their production, secure the food needs of their household and earn more income.

4.1.3 Household size of Respondents

The results revealed that a large number of participants (38%) and non-participants (35%) have household size of 6-8 people. The mean household size was 8 people for the participants and 7 for the non-participants. Only 5% and 8% of participants and non-participants have less than 3 people as household sizes respectively. Household size is very significant in agriculture as it determines the availability of labour for farm production, the total area to be cultivated for different crop enterprises, the quantity of farm produce to consume within the households and the surplus to be marketed. The result implies that there may be availability of labour for agricultural production. This situation induces the possibility of using improved technologies especially improved cowpea, which requires a lot of labour for land clearing, weeding and harvesting.

However, since most of the respondents were married, it is expected that the household head is to be the primary decision maker on how and when the available labour is allocated.

Thus, the women farmers may not have access to the available family labour. On the contrary according to Amaza, (2000) household size could have a negative effect if it is comprised of large number of children or a large number of dependants which means more mouths to feed. A large household size could worsen the food security status of the households and reduce farmers' incomes.

4.1.4 Education level of Respondents

The use of improved technology in agricultural production is influenced by the level of the farmer's education and these will subsequently influence his productivity (Binam *et al., 2*004). The results showed that a large proportion of both groups of the respondents (66% of the participants and 62% of the non-participants) have attempted one form of education or the other although they may not necessarily have completed the desired levels. However, 34% of the participants and 38% of the non-participants have no education at all respectively.

This implies that the respondents were educated (i.e. can at least read and write) and this means that they are expected to be able to read and understand how to use the improved technologies. The participants who are more educated have been able to efficiently make use of the improved cowpea with the associated management practices thus, producing more output and becoming more food secure. They are also able to sell more of their surplus output as they are able to access more market outlets. Thus, they earn more incomes and can own more assets. This conforms to the findings of Wakawa (2014) where she showed that educated farmers can explore opportunities of other markets and can take risk to participate in the TL II project in Borno State.

4.1.5 Farm Size

The results showed that a large number (44%) of both the participants and non-participants have farm sizes of 1-1.5 hectares and 0.5 – 1 hectare respectively. Only about 3% of the participants and 10% of the non-participants have more than 2 hectares of land. The participants have a mean farm size of 1.2 hectares while the non-participants have 0.8. This implies that the respondents are small scale farmers which are a characteristic feature of women farmers in developing countries (World Bank, 2008). The introduction of the improved cowpea varieties has gone a long way in increasing the yields of the participants from their small farms thus improving their food security status and welfare.

4.1.6 Farming Experience of Respondents

The results showed that a large proportion (Participants 36% and non-participants 53%) of the respondents have modal years of 6-10 years farming experience. However, it can be seen that 35% and 23% of the participants have 1-15 years and more than 15 years experience, which is higher than the non-participants. It is expected that farmers with more years of experience may have acquired more resources or authority that may give them the courage and confidence to try new ideas. Longer years of being exposed to farming could reduce farmers' uncertainty level in their production and may also likely enhance the probability of adopting new technologies (Bamire *et al*., 2010). This is because over the years, the farmer is able to assess his achievements and challenges and also learns to correct his mistakes. Thus, the participants tend to understand the importance of improved technologies in farming and could be willing to use the improved cowpea with the accompanying management practices.

4.1.7 Primary Occupation of Respondents

The results showed that almost all the respondents in the two groups (90% of participants and 97% of non participants) have farming as their primary occupation. The remaining 10% and

3% respectively engaged in trading and civil service or agro processing as their primary occupation. Farmers who have agriculture as their primary occupation tend to be more interested in adopting improved agricultural technologies in order to boost their productivity since their livelihood depends on incomes from farm (Idrisa, 2009). This implies that the women being farmers with small land holdings (less than 2 hectares) may be willing to try out improved cowpea varieties to boost their yields, increase their incomes and food security. However, in the event of crop failure or poor harvests, they are likely to be faced with the problem of food insecurity and low incomes.

4.1.8 Other Occupation of Respondents

The results showed that a large number of the respondents (38% of participants and 30% non-participants) were engaged in one form of trading or the other. This could be attributed to the fact that the women who form the bulk of small scale farmers cannot produce enough to last them for a year. With majority of the respondents being married, they need to provide for the needs of their family members especially children and as such they engage in other occupations especially during off season of production. This enables them to earn more income which can be used to buy food and other needs of the household members. Thus, this ensures that the household is food secure all year round. However, more of the participants (63%) were involved than the non-participants (56%). This shows that their income is more guaranteed and so could afford to spend part of it to acquire the improved cowpea technologies.

4.1.9 Income of Respondents

The distribution of annual income of the respondents showed that 35% of the non-participants fall within the income group of ₦100,0000 – ₦200,000 per annum while 41% of the

participants fall within the income group of ₦200,000 – ₦300,000 per annum. The participants have a mean income of ₦256,430.54 while the non-participants have a mean of ₦112,233.21. This showed that there is a difference in the mean incomes of the respondents of about ₦144,197.33. This shows that the improved cowpea technology and could have resulted in the higher incomes of the participants. In addition, their participation in the PROSAB project could have enhanced their capacity to effectively use the improved cowpea along with the associated management practices.

4.2 Impact of Improved Cowpea on Participants' Income

The result of the Double Difference impact analysis is presented in Table 4.2. It shows the average income level of the respondents before and after the PROSAB project and the differences within and between the respondents.

Table 4.2: Average Household Income (₦) from Cowpea Before and After the PROSAB Project

	Before PROSAB (₦)	**After PROSAB (₦)**	**Difference (₦)**	**Percentage Difference (%)**	**Double Difference (DD) (₦)**	**T-Value**
Participants	56,004.80	199,500.00	143,495.20	256.20	**84,995.20**	8.43***
Non-Participants	31,000.00	89,500.00	58,500.00	188.70		

Source: Field Survey Data, 2015.
Note: *** significant 1%

The results show that the average income of the participants before PROSAB was ₦56,004.80. This increased to ₦199,500.00 after the project ended. For the non-participants also their income increased from ₦31,000.00 before PROSAB to ₦89, 500.00 after PROSAB. This

shows that the improved cowpea technology has caused an increase in the income of the participants. However, it can be seen that the income of the non-participants has also increased but the percentage increase in the income of the participants (256%) was greater than that of the non-participants (188%). The increase in the income of the non-participants could be attributed to spillover effect. Farmers interact with one another and information about the activities of PROSAB could have been passed to the non-participants who may adopt the technologies when they see that the productivity and incomes of the participants have increased. The Double Difference result revealed a positive average income of about ₦84,995.20. This implies that there was a positive impact of the project on the participants' income. The difference in income with respect to the participants after introduction of the improved cowpea was significant at 1 % level of probability as shown in Table 4.2.

The percentage difference (256%) in income is enough justification for the non-participants to be motivated to adopt the improved cowpea technologies. This will increase their output leading to increase in their food supply and at the same time increase their marketable surplus. Thus, their food security will be enhanced and their incomes increased. This further justifies the investment being made by the financing agency in the study area. These results will also encourage potential donors to introduce more improved technologies to boost agricultural production in the country.

These findings could be attributed to the advantages derived by participating in the PROSAB project. These include having access to information on improved cowpea varieties and also access to inputs like fertilizer. These lead them to improve their productivity and obtain higher outputs from their farms and thus, become more food secure and earn higher income.

This result conforms to the findings of Simonyan and Omolehin (2012) in their study of the Impact of FADAMA II on beneficiaries' income in Kaduna State. The study reported that beneficiaries were better off than their non-beneficiary counterparts in terms of income and productivity. It also conforms to the results of the study by Abudu *et al.* (2014) on the "Impact of NAPEP on Rural Livelihood in Edo State" which indicated that the level of living of participants was significantly increased as a result of increase in their income. As a result of the findings of this study, the hypothesis which stated that there is no significant difference between the income level of farmers before and after adopting the improved cowpea varieties was rejected.

4.3 Impact of Improved Cowpea Technology on Food Security Status of Households

The food security status of the respondents before the PROSAB project was implemented (2004) and after the PROSAB project ended (2014) were presented in Table 4.3. The food insecurity line, Z, which is the cost of the minimum energy requirements per adult equivalent, was determined as ₦1, 975.01 per month before PROSAB. This was based on the daily energy level of 2260 Kcal recommended by FAO (2009).With a head count of 0.58, it indicates that 58% of households were food insecure while 42% were food secure. The aggregate income gap (G) of -375.74 indicates that N375.74 was the minimum amount needed by the food insecure households to meet their basic food needs.

Table 4.3: Food Security Measures among Households in PROSAB Area

	After PROSAB

Variable	Before PROSAB	Participants DD	Non-Participants	
Cost-of-calorie equation	lnX=a + bC	lnX=a + bC	lnX=a + bC	
Constant	4.154	4.4510	3.2506	
	(0.534)*	(60.972)*	(21.963)*	
Slope coefficient	0.0019	0.0000144	0.0004221	
	(0.0004)	(12.496)	(16.234)	
FAO recommended daily energy Levels (L)	2260Kcal	2260Kcal	2260Kcal	
Food insecurity line (Z)	₦ 63.71per day	₦88.51per day	₦ 66.99per day	₦ 21.52
	₦1,975.01per month	₦2,743.81per month	₦ 2076.69per month	₦ 667.12
Head Count (H)	0.58	0.3433	0.673	-0.3297
Percentage Food Insecure	58%	34%	67%	-33%
Percentage Food Secure	42%	66%	33%	33
Aggregate income gap (G)	-375.74	-412.43	-783.91	371.48

Source: Field Survey Data, 2015.

* Figures in parenthesis are t-values

For the participants, the results of this study showed that the food insecurity line was ₦2, 743.81per month after PROSAB. The results also showed that the food insecure among the participants were 34% while 66% were food secure. In the case of the non-participants, their food insecurity line was ₦ 2,076.69 per month after PROSAB. Only about 33% were food secured and 67% were food insecure The aggregate income gap was -412.43 for the participants and -783.91 for the non-participants. This implies that the participants need only ₦412.23 while the non-participants need ₦783.91 to meet their basic food needs. This implies that food

insecurity among the participants could have been reduced as a result of the PROSAB intervention. It has been revealed that the productivity of cowpea has increased by over 100% in the study area (Amaza, *et a*l., 2009). The DD indicates a positive difference of ₦667.12 between the participants and non-participants. This shows that the improved cowpea technology has had an impact on food security of the respondents.

4.4 Determinants of Technical Efficiency among the Cowpea Women Farmers

The Maximum Likelihood Estimates of the Stochastic Production Frontier which show the best practice performance i.e. the efficient use of the improved cowpea technology by the women farmers are presented in Table 4.4.

The results showed that the variance parameter for sigma square (σ^2) was 3.293 and was significant at 1% level. The sigma square indicates the systematic variance that is unexplained by the production function and is the dominant source of random errors (Umoh, 2006). The result indicates a good fit and the correctness of the specified distributional assumption. The gamma (γ) which is the variance ratio was 0.997 and also significant at 1%. This indicates the correctness of fit of the model and the presence of inefficiency in improved cowpea production.

The estimates of the maximum likelihood showed that the coefficients of the production parameters were all positive. This conforms to the *a priori* expectations that they will be positive. The coefficient of farm size (0.025) was positive and significant at 1%.

Table 4.4: Maximum Likelihood Estimate of the Stochastic Frontier Production Function for Women Cowpea Farmers

Variable	Parameter	Coefficient	t-value

Constant	β_0	4.838	32.2***
Ln farm size (X_1)	β_1	0.250	2.2**
Ln seed qty (X_2)	β_2	0.281	5.1***
Ln family labour (X_3)	β_3	0.431	2.4**
Ln hire labour(X_4)	β_4	0.734	3.9***
Ln fertilizer qty (X_5)	β_5	0.018	2.1**
Ln herbicide qty (X_6)	β_6	0.030	9.8***
Ln insecticide qty (X7)	β_7	0.505	4.7***
Inefficiency	α_1	-0.994	-5.0***
Ln age (Z_1)			
Ln Level of formal Edu (Z_2)	α_2	-0.543	-15.0***
Ln. Farming experience(Z_3)	α_3	-0.353	-6.0***
Ln household size(Z_4)	α_4	-1.361	-3.7***
Ln M/ship of Farmers' Ass. (Z_5)	α_5	-4.745	-6.3***
Ln Off-farm income(Z_6)	α_6	-0.718	-18.1***
LnNo. Ext. Contact (Z_7)	α_7	-0.422	-16.6***
Ln Credit Avail. (Z_8)	α_8	-0.951	-16.9***

Sigma Square	δ^2	3.293	7.2***
Gamma	γ	0.997	95.4***
Log likelihood ratio	-29.093214		

Source: Computed from Field Survey Data, 2015.

Note: **, *** Significant at 5% and 1% level, respectively.

This means that a 1% increase in farm size (i.e. area of farm devoted to improved cowpea production) could increase the cowpea output by 0.025. This could be attributed to the fact that farmers with large farms tend to have advantage of attaining economies of scale since fixed costs could be spread over more land and output, and farmers could get discounts when they purchase inputs in large quantities. This conforms to the findings of Marinda *et al*. (2006) in their study of technical efficiency of farmers in maize production in Kenya.

Similarly, a 1% increase in family labour, hired labour, quantity of fertilizer, herbicides and insecticides used could lead to an increase of 0.431, 0.734, 0.018, 0.03 and 0.5 respectively. The results shows the importance of labour in cowpea production which is labour intensive and the use of agrochemicals in agricultural production especially when using improved crop varieties`especially in the study area which has high incidence of pests and diseaes.

In the inefficiency model, a negative coefficient means an increase in efficiency or a positive effect on productivity, while a positive coefficient means an increase in inefficiency or a negative effect on productivity. The estimates of the inefficiency model revealed that all the variables were significant at 1% and have negative coefficients showing a decrease in inefficiency in improved cowpea production by the women farmers and a positive effect on their productivity.

A unit increase in the inefficiency variables i.e. age, level of education, farming experience, household size, membership of association, off-farm income, extension contact and credit availability will cause inefficiency in improved cowpea production to decrease by 0.994, 0.543, 0.353, 1.361, 4.745, 0.718, 0.422 and 0.951 respectively. Generally, farming experience increases with age of the farmer and his ability to make use of improved technology. He will be willing to try new improved cowpea variety and with his experience easily apply the associated management results and get optimum yield. Education raises the level of awareness of farmers about improved technologies and its adoption. They can easily understand the need to use the improved cowpea varities along with the associated management practices. On their own, they can efficiently utilise the inputs when producing and minimise mistakes that can affect their productivity. They can read manuals or instructions on how to use the improved cowpea like seed rate and quantity of fertilizer to apply. The educated farmers could have more opportunities of accessing information about improved technologies, farming inputs and marketing facilities to enhance their production, leading to improved yields and income. This conforms to the findings of Obwona (2006) in his study on the Technical Efficiency Differential of Small and Medium Scale Farmers in Uganda where he showed education has a positive and significant relationship with farmers' technical efficiency.

4.5 Level of Technical Efficiency of the Women Farmers

The level of technical efficiency of the women farmers is presented in Table 4.5. The results showed that the technical efficiency scores range from 0.0065 -0. 98 with a mean of 0.80. This shows that the participants have high level of efficiency in their production. However, their inability to produce on the frontier indicates the possibility of further raising their output with the same inputs being used in the current production process.

The mean technical efficiency of 0.799 indicates that on average, the farmers were efficient implying that the participants could increase output by about 20 percent when they operate on the frontier. For the most inefficient farmer, with the minimum technical efficiency of 0.0065, to be on the frontier she will need to increase her output by 93 percent.

Table 4.5: Distribution of Technical Efficiency among the Participants (Improved Cowpea Farmers)

Efficiency Level	Frequency	Percentage (%)
< 0.50	8	3.3
0.50-0.60	19	7.9
0.71-0.80	37	15.4
>0.80	164	68.3
Total	240	100.0
Mean	**0.7993**	
Min	**0.0065**	
Max	**0.9837**	

Source: Computed from Field Survey Data, 2015.

In the case of the most technically efficient farmer, with a maximum technical efficiency score of 98 percent, she needs to reduce inefficiency by only two percent to be on the frontier.

A large proportion (68 percent) of the of the women cowpea farmers were found to be more than 80 percent technically efficient, 23 percent of the farmers had between 50-80 percent

technical efficiency while only 3 percent were less than 50 percent technically efficient. The estimated mean technical efficiency of 0.799 percent indicates that the cowpea farmers have the potential to increase their present level of output by 20 percent given their present resources when the significant factors are addressed. This conforms to the findings of Binam, *et al.* (2014) in their study of technical efficiency of cowpea production in Niger State.

4.6 Constraints Associated with Use of Improved Technologies.

The various constraints faced by the respondents were examined and the results were presented in Table 4.6. The results showed that the participants were mainly constrained by pests and diseases (87%), high cost of labour (35%) and inadequate access to markets (25%). The improved cowpea which has an early maturity period has a high susceptibility to pests and diseases. The crop matures when the rains are still on and the farmers are usually too busy with their other crops to harvest the matured cowpea. This encourages infestation by pests and diseases and these affect both the quantity and quality of cowpea produced and consequently affect the marketability of the cowpea and subsequently leads to reduced incomes from sale of the cowpea.

The high cost of labour also affects the production of improved cowpea varieties. Cowpea is labour intensive and with majority of the respondents being married, they may not have access to the available family labour and thus, may need to hire labour. This in turn affects their potential productivity leading to lower outputs produced; lower incomes obtained and reduced food security. Without adequate markets, the farmers may not be encouraged to market their products and where they do; they cannot get good prices and thus, sell at low prices, earning low incomes. This will not encourage them to expand their production of improved

cowpea. The women farmers are also faced with inadequate extension visits (38%) and land tenure problem (38%). In most cases do not actually own the farms they cultivate. As a result they cannot easily expand their land to cultivate more improved cowpea varieties and at the same time grow other crops to increase their yields and consequently their incomes.

Table 4.6: Constraints Faced by Women Farmers in Improved cowpea Production.

	Participants		Non-participants	
Constraint	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Inadequate Seeds	29	12	54	90
High cost of seeds	17	7	46	76
Inadequate access to market	60	25	52	87
Inadequate extension visits	38	16	56	93
Inadequate of fertilizer	24	10	41	68
Tenure problem	38	16	7	12
High cost of labour	84	35	8	13
Diseases and pests	209	87	59	98
Low yield	34	14	46	76
Inadequate information on improved seed	5	2	58	97

Drought	31	13	39	65

Source: Computed from Field Survey Data, 2015.

Other constraints include low yield (34%) but this has more to do with the grain size which are smaller than the indigenous varieties although they still obtained higher quantities with the improved varieties; inadequate seeds (29%) and inadequate fertilizer (24%). Being resource poor, the women farmers cannot afford to buy more fertilizer which is required when using higher quantities of seeds or growing larger farm areas in order to increase their yields and incomes.

The non-participants on the other hand were also faced with the problem of pests and diseases but with a higher percentage (98%). This could be as a result of Their low usage of pesticides as they earn low incomes and cannot afford to buy them. Inadequate information (98%) is another constraint facing them. Their non-participation in the PROSAB project has led to their inability to access the information they require about the improved cowpea varieties and this has influenced their use of the improved cowpea varieties especially how to access the seeds. In addition, they are also constrained with inadequate seeds (89%), high cost of seeds (76%), low yields (76%), inadequate access to markets (87%) and inadequate fertilizers (69%).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study examined the impact of improved cowpea varieties on the livelihood of women farmers in Southern Borno State, Nigeria. The specific objectives were to describe the socio-economic characteristics of women cowpea farmers in the study area, identify the changes in income as a result of using improved cowpea seeds by the respondents, analyze the impact of the improved cowpea varieties on the food security status of the respondents, analyze the determinants of technical efficiency of the respondents, estimate the technical efficiency of the respondents in using improved cowpea and identify the constraints associated with the use of improved cowpea.

The study was carried out in the southern part of Borno State where the PROSAB project was implemented. Both primary and secondary data were used for the study. The primary data were collected by use of structured questionnaires and the secondary data were obtained from the baseline survey. Multi stage random sampling technique was used to select 300 respondents spread across three LGAs. Data were collected through the use of questionnaires administered with the aid of trained enumerators. Descriptive statistics, Double Difference, Cost-of-Calorie index and the Stochastic Production Frontier Function were the analytical tools used to analyse the data collected.

Results of the study showed that the women cowpea farmers were mostly young and in the active age group of 31-40 years. Majority of them were married (68% participants and 75% non-participants), with household size of 6-8 people (38% participants and 35% non-participants). Most of the women cowpea farmers (66% participants and 62% non-participants) have attempted one form of education or the other but may not have necessarily completed it. A sizeable number of the participants (34%) and non-participants (38%) have no education at all. The respondents are small scale farmers with a large proportion (44%) having farm sizes of 1-1.5 hectares and 0.5-1 hectare respectively. Their primary occupation is farming (90% participants and 98% non-participants) although they also engage in other occupations mainly trading (90% participants and 97% non participants). Their mean annual incomes are ₦256, 430 for the participants and ₦112, 233 for the non-participants.

The Double Difference estimates indicated that the annual income of the participants, as a result of growing the improved cowpea varieties has increased by N143, 495.20 which was higher than that of the non participants which increased by only ₦58, 500.00. This indicates that there was a positive impact on income as a result of using the improved cowpea varieties which will cause their welfare to improve. This result could motivate the non-participants to adopt improved cowpea varieties.

The Cost-of-Calorie index showed that based on the daily energy level of 2260Kcal recommended by FAO, the food security line per adult equivalent per month was N2,743.81 and N2,076.69 for the participants and non-participants respectively. The results also showed that 66% of the participants and 33% of the non-participants were food secured. This leaves only 34% of the participants and up to 67% of the non-participants being food insecure. The estimated aggregate income gap was -412.43 for the participants and -783.91 for the non-participants and

this is the amount by which an average food insecure household is below the minimum monthly expenditure required to meet its basic food needs. Thus, the improved cowpea varieties can be said to have enhanced food security of participants.

The Maximum Likelihood Estimates revealed that the coefficients of the production parameters were all positive and significant at one percent. The inefficiency variables such as level of education, farming experience, household size, membership of association, off-farm income, and number of contact with extension agents have a positive effect on efficiency in improved cowpea production. The value of sigma square is 3.293 and gamma is 0.997.The estimated mean technical efficiency was 0.7993 or 79% which indicates that the improved cowpea farmers could improve their present level of output by 20.4 % given their present resources. Both the participants (87%) and non participants (98%) are constrained by diseases and pests. This could be attributed to the high susceptibility of cowpea to pests and diseases. Other constraints faced by the participants include high cost of labour (35%), inadequate access to markets (25%), inadequate extension visits (16%) and tenure problem. The non-participants on the other hand were faced with inadequate information (97%), inadequate extension visits (93%), inadequate seeds (90%) and inadequate access to market (87%).

5.2 Conclusion

The socio-economic characteristics of the participants and non-participants were similar and trading is the second most important economic activity after farming. The results conclude that the income obtained by the participants increased by ₦84, 995 at the end of the PROSAB project. The food security of households has increased with 66% of the participants now been food secure indicating that the improved cowpea varieties have a positive impact on the

participants of the project. They now obtain higher outputs leading to enhanced income which leads to improved welfare.

The improved cowpea varieties have improved the food security status of the farmers. Based on the daily energy level of 2260 Kcal recommended by FAO, the cost of the minimum energy requirement per adult equivalent per month is N2, 743.81 and N2, 076.69 for the participants and non-participants. This indicates the minimum amount needed to maintain healthy living among the respondents. Thus, 66% of the participants and 33% of the non-participants were food secure. The food insecure respondents require an aggregate income gap of N412.43 and N783.91 for the participants and non-participants respectively to overcome their food insecurity.

The study also concluded that the determinants of technical efficiency among the women cowpea farmers were all positive and significant at one percent. The inefficiency variables such as level of education, farming experience, household size, membership of association, off-farm income, and number of contact with extension agents were also positive and the women were 80% efficient in using the improved cowpea varieties. It was also shown that they have the potential to increase their present level of output.

The use of improved cowpea varieties by the women farmers is associated with many constraints which includes high incidence of pests and diseases, high cost of labour, inadequate access to markets, inadequate seeds, inadequate information on the improved cowpea technology and inadequate fertilizers

5.3 Recommendations

Based on the findings of this study, it was recommended that:

1. The government should formulate policies to encourage women farmers in the study area to adopt and sustain the use of improved varieties of cowpea which will lead to higher yields and as result lead to higher incomes. Earning higher incomes will enable the women to have better control over the income gains and thus, be in a stronger position to influence household nutrition outcomes.
2. Following the FAO recommended daily energy level of 2260Kcal, the results have shown that food security status of the respondents (66% participants and 33% non-participants) still need to be improved. More efforts need to be put in by the government, in terms of formulating policies to enhance food security; and by IITA and other research institutes to produce and disseminate more improved varieties to farmers especially the women.
3. The high efficiency (80%) of the women cowpea farmers has shown that women farmers are capable of using improved agricultural technologies. As a result, more improved technologies should be produced and made available and easily accessible to women farmers. The government should provide incentives specifically to the women farmers like ready market and fixed prices for their outputs. Adequate market infrastructure and facilities should be provided to the women so that they can easily sell their increased cowpea yields.
4. The improved cowpea varieties and other inputs should be made readily available and accessible to the women farmers at affordable prices, on time and in adequate quantities
5. Pests and diseases were major problems of both participants and non participants and as such farmers in the study area should be given adequate enlightenment on how to control them. The IITA should also improve the cowpea varieties to increase their resistance to pests and diseases**.** Extension service should be intensified to enhance the women's knowledge

transfer and their access to extension services and number of contacts with extension agents should be increased especially for the non-participants.

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APPENDIX 1:

Brief Description of Improved Cowpea Varieties introduced by PROSAB

Varieties	Colour	Characteristics
IT89KD - 391	Brown	Early maturing, non-phptosensitive, medium sizes, good grain size, some level of resistance to aphids, thrips, viruses and several other diseases, needs 2-3 sprays.
IT89KD – 288	White	Semi-erect, medium maturing, photosensitive, medium sized seeds, requires 2-3 spraying, excellent for relay with cereals .
IT90K277 – 2	White	Erect, medium maturing, medium sized seeds, some level of resistance to aphids, thrips, viruses and several other diseases, needs 2-3 sprays during flowering and podding.
IT97K – 131 - 2	Brown	Erect, medium maturing, medium sized seeds, very high yielding, non-photosensitive
IT97K– 499 - 35	White	Erect, medium maturing, medium sized seeds, requires 2-3 sprays, striga resistant.
IT97K –568-18	Brown	Erect, medium maturing, medium sized seeds, very high yielding, non-photosensitive

Source: Onyibe, *et al*. (2006)

Appendix 2

Regression Analysis

logit lny lnage lnmstatus lneducation lnyrfarming lnhhsize lncdr lnassociatn ln_income lnno_e
> xtention lncredit

Iteration 0: log likelihood = -132.71843

Iteration 1: log likelihood = -129.39243

Iteration 2: log likelihood = -129.35728

Iteration 3: log likelihood = -129.35727

Logistic regression **Number of obs = 240**

LR chi2(11) = 140.21
Prob > chi2 = 0.0000
Log likelihood = -51.436123 **Pseudo R2 = 0.72621**

lny	Coef.	Std. Err.	z	P	>|z|	[95% Conf. Interval]
lnage	.3341875	.0390834	8.55	0.000	.2554694	.4129056
lnmstatus	1.516429	.8003933	1.89	0.058	-.0523129	3.085171
lneducation	.2708202	.1088122	2.49	0.017	.0516612	.4899791
lnyrfarming	.3285019	.0410493	8.00	0.000	.2457724	.4112313
lnhhsize	.5894841	.1381388	4.27	0.000	.3140431	.8649251
lncdr	.2708202	.1088122	2.49	0.017	.0516612	.4899791
lnassociatn	1.301028	.204034	6.38	0.000	.8900829	1.711974
ln_income	.1767304	.0648013	2.73	0.009	.0458615	.3075994
lnno_exten	.2965743	.1398933	2.12	0.039	.0159839	.5771647
lncredit	.0530753	.6426563	0.08	0.934	-1.206508	1.312659
_cons	.4768661	3.872318	0.12	0.902	-7.112737	8.066469

APPENDIX 3:

Adult Equivalent Scale for adjusting the Household Size

Age category	Male	Female
0-1	0.33	0.33
1-2	0.46	0.46
2-3	0.54	0.54
3-5	0.62	0.62
5-7	0.74	0.70
7-10	0.84	0.72
10-12	0.88	0.78
12-14	0.96	0.84
14-16	1.06	0.86
16-18	1.14	0.86
18-30	1.04	0.80
30-60	1.00	0.82
>60	0.84	0.74

Source: Babatunde *et al.* 2007

APPENDIX 4:

Calorie Content for Some Commonly Eaten Foods in Nigeria

Food item	Kcal/kg	Food item	Kcal/kg
Staple foods			
Cassava tuber	1500	Garlic	1310
Cassava flour	3870	Cucumber	270
Cassava chips	3000	Spinach	220
Garri	3840	Bitter leaf	220
Yam tuber	1100	Water leaf	180
Yam flour	3810	Cabbage	230
Sweet potato tuber	1100	Pumpkin	440
Sweet potato chips	900	Fruits	
Irish potato	1200	Mango	590
Cocoyam tuber	3830	Pawpaw	300
Maize grain	4120	Pineapple	320
Maize flour	4120	Coconut	580
Sorghum grain	3450	Guava	730
Sorghum flour	3450	Sugar cane	360
Millet grain	3488	**Meat and Meat product**	
Millet flour	3488	Cow meat	2370
Rice	3544	Goat meat	2370
Wheat grain	3410	Sheep meat	2370
Wheat flour	3310	Bush meat	2380

Cowpea	3390	Chicken	2380
Groundnut	5950	Fish	2230
Soybeans	4050	Snail	2245
Soybean flour	2600	Crayfish	2200
Sugar	3870	Eggs (pieces)	1400
Mellon (shelled)	5670	Duck meat	2380
Plantain	770	Guinea fowl	2380
Banana	960	**Dairy Products**	
Whole bread	2440	Milk	4900
Locust bean	3850	Cheese	4000
Macaroni	3400	Yoghurt	4100
Spaghetti	3640	Beverages	
Indomie	3200	Tea (leaves)	1200
Vegetables		Coffee (powder)	1200
Okra	4550	**Oils**	
Tomato	880	Groundnut oil	9000
Pepper	3930	Palm oil	9000
Onion	440	Ghee (manshanu)	9000
Carrot	400		
Egg plant	440		
Drinks		**Condiments and spices**	
Soft drinks	620	Maggie	220
Orange juice	400	Salt	180
Apple juice	550		
Pineapple juice	560		

Source: Olomu, (1995) and Babatunde *et al.* (2007)

APPENDIX 5:

Proportionate Selection of respondents for the Study based on a 3:2:1 Ratio

LGA	Total Population of Women	Participants		Non-participants		Grand Total
		Ratio	Total	Ratio	Total	
Biu	85,840	3/6*240	120	3/6*60	30	150
Hawul	60,319	2/6* 240	80	2/6*60	20	100
Kwaya-kusar	27,435	1/6*240	40	1/6*60	10	50
TOTAL			**240**		**60**	**300**

APPENDIX 6:

Change in Cowpea income of Participants and Non-participants (₦/ha)

change in Cowpea income (₦/ha)				
	Before	**After**	DID	T-Value
Participants	56,004.80	199,500.00	143,495.20	8.43***
Non-Participants	31,000.00	89,500.00	58,500.00	
Difference between groups	25,004.80	110,000.00	**84,995.20**	

Note: *** significant 1%

APPENDIX 7:

Food Security Measures Among Households

Food security measures among households from baseline Study

Variable	Value
Cost-of-calorie equation	lnX=a + bC
Constant	4.154 (0.534)
Slope coefficient	0.0019 (0.0004)
FAO recommended daily energy Levels (L)	2260Kcal
Food security line Z:Cost of the minimum energy requirements per adult equivalent	₦ 63.71 per day
	₦1975.01 per month
	₦ 23700.12 per year
Head Count (H)	0.58

Aggregate income gap (G)	-375.74

Participants

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.451	.073		60.972	.000
	lx	.0000144	.0000012	.709	12.496	.000

a. Dependent Variable: lnc

Non-participants

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.2506	.148		21.963	.000
	lnnon_x	.0004221	.000026	.263	16.234	.000

a. Dependent Variable: lnnon_c

Summary Statistics and Food Security Measures Among Households in PROSAB Area

Variable	**Value**
Cost-of-calorie equation	lnX=a + bC
Constant	4.4510(60.972)
Slope coefficient	0.0000144(12.496)
FAO recommended daily energy Levels (L)	2250Kcal
Food security line Z:Cost of the minimum energy requirements per adult equivalent	N88.51 per day

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.2506	.148		21.963	.000
	lnnon_x	.0004221	.000026	.263	16.234	.000

Head Count (H)	0.34
Aggregate income gap (G)	-412.43

Summary Statistics And Food Security Measures Among Households In NON PROSAB Area

Variable	**Value**
Cost-of-calorie equation	lnX=a + bC
Constant	3.2506(21.963)
Slope coefficient	0.0004221(16.234)
FAO recommended daily energy Levels (L)	2250Kcal
Food security line Z:Cost of the minimum energy requirements per adult equivalent	N66.99 per day

Head Count (H)	0.673
Aggregate income gap (G)	-783.91

Questionnaire

Department of Agricultural Economics
Faculty of Agriculture
University of Maiduguri

QUESTIONNAIRE ON IMPACT OF IMPROVED COWPEA TECHNOLOGY ON WOMEN IN SOUTHERN BORNO STATE, NIGERIA.

A. BACKGROUND INFORMATION

Q1. Serial No: ……

Q2. Enumerator:……

Q3. Date of Interview: ……2014

Q4. L.G.A.: …….

Q5. Latitude: …….

Q6. Longitude: ……

B FARMERS' SOCIO-ECONOMIC CHARACTERISTICS

S/No.	Characteristics	Options	Code
1.	Age (Years)	……..	
2.	Marital Status	a) Single (1) b) Married (2) c) Divorced (3) d) Widowed (4)	
3.	How many of your household members fall within the following age groups? :	No of males < 15 yrs No of males >15 yrs No of females < 15 yrs No of females > 15 yrs	
4.	Education	No Education (0) Primary (NC) (1) Primary (C) (2) Secondary (NC) (3) Secondary (C) (4) Tertiary (5)	
5.	What is your primary occupation?	Farming (1) Trading (2) Civil Service (3) Agro processing (4) Others (Specify)……(5)	
	If farming, for how many years?	1-3 (1) 4-6 (2)	

6.		7-9 (3)	
	Do you have another source of income?	>10 (4)	
		Yes (1)	
	If yes, what activity?	No (2)	
7.			
		Craftsmanship (1)	
		Trading (2)	
8.		Civil Service (3)	
		Agro processing (4)	
	What is the total area under production (Ha)?	Others (Specify)……(5)	
		< 0.5 (1)	
		0.5 -1.0 (2)	
9.	Do you have contact with extension?	1.0 – 1.5 (3)	
		1.5 -2.0 (4)	
		> 2.0 (5)	
	If yes, what is the frequency of extension visits?	Yes (1)	
		No (2)	
10.	Do you belong to any co-operative society?		
		Once a week (1)	
		Twice a week (2)	
11.	What is the name of the co-op. association?	Once per month (3)	
		Less than once (4)	
	If yes for how long?		
		Yes (1)	
	What is your estimated annual income?	No (2)	
12.			

13. 14. 15.		…… …… < 10,000 naira (1) 11,000 -15,000 (2) 15,001 -20,000 (3) 20,001- 25,000 (4) >25,000 (5)	

C. COWPEA PRODUCTION

1. For how long have you been farming? _____

2. How many plots of land do you own and what crops did you grow in 2014?

Plot	Crop Grown	Size of Plot

3. What is the source of farm land
    a. Inherited
    b. Rented
    c. Borrowed
    d. Purchased
    e. Gift
    f. Others (Specify)_____
4. What variety of the improved cowpea technology did you plant in 2014?
    a.

b.

c.

d.

e.

5. Where did you hear about this variety for the first time?

   a.

   b.

   c.

   d.

   e.

6. Where did you get the seed for the improved cowpea variety for the first time?

   _____

7. Did you abandon the variety? Yes ( ) No ( ). If yes when _____

8. What is the source of the improved cowpea variety you planted?

   a. PROSAB (1)

   b. Ext. Agents (2)

   c. Seed Producers (3)

   d. Other farmers (4)

   e. Others (specify)_____ (5)

9. What qualities did you like in the varieties you planted?

   a.

   b.

   c.

   d.

   e.

   f.

10. What qualities did you not like in the varieties you planted?

    a.

    b.

    c.

    d.

    e.

    f.

11. Which management practices of the improved cowpea technologies did you apply on your farm?

    a. Land Preparation ( )

    b. Choice of variety ( )

c. Seed cleaning and preparation ( )
d. Cowpea germination test ( )
e. Date of planting ( )
f. Seed rate ( )
g. Seed dressing ( )
h. Spacing and sowing ( )
i. Weed control ( )
j. Pest and diseases control ( )
k. Post harvest operation ( )
l. Trashing ( )
m. Storage ( )

12. How do you dispose your cowpea after harvesting?
    a. In mudus
    b. Bags/kg
13. What other crops did you produce apart from cowpea and the yields obtained?

Plots	Crops Grown	Yield Obtained (Bags or Mudus)	Income (₦)

14. What crops are you no longer producing and why?

Crop	Reason

15. Do you keep livestock? Yes ( ) No ( )
16. Distribution of livestock own before and after PROSAB

Type of livestock	Before PROSAB (No.)	After PROSAB (No.)
Cattle		
Sheep		
Goat		
Chickens: Layers		
Broilers		
Cockerel		
Chicks		
Guinea Foul		
Ducks		

17. Do you sell these livestock? Yes ( ) No ( )

What is the yield of cowpea obtained viz-a-viz the quantity of seed used in the past years.

Yield	Variety	Seed (kg)	Yield (kg)
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010			
2011			
2012			
2013			
2014			

18. Utilization of improved cowpea technology

Name of cowpea variety	Years of awareness	Source of information	How many years ago did you first use this variety	Did you abandoned the variety, if yes what year	What is the area cropped (Ha)

19. Did you use improved storage technologies to store your cowpea varieties? Yes ( ) No ( ) If yes what type _____ and if no what other method did you use _____
20. How do you use your cowpea after storage?
    a. Consumption
    b. Seeds
    c. Sales
    d. Others Specify _____
21. How often did you consume cowpea in your household? _____

D. CHANGES IN INCOME AND ASSETS

22. What was the yield obtained in the form of improved cowpea in the last cropping season? _____ bags or mudu
23. How much of this is consumed in the household, sold or given as gift?

Variety	Total yield obtained	Quantity consumed	Quantity sold	Quantity given as gift

24. When selling, at what price did you sell your cowpea?
    a. Price/Mudu _____
    b. Price/bag _____
25. What is the total income received from sell of cowpea? _____
26. Do you work off-farm? Yes ( ) No ( ). If yes, what type of activity do you engage in?
    a. Petty trading ( )
    b. Farm labour ( )
    c. Food processing ( )
    d. Marketing of agricultural products ( )

e. Civil service ( )

f. Tailoring ( )

g. Others (Specify)_____

What is the income received from these activities?

Activity	Income Received

27. Are there other income earners in your household? Yes ( ) No ( ), If yes how much do they earn

S/N	Relationship	Daily income	Weekly income	Monthly income

28. How much do you earn from the sells of these livestock? _____

29. Which of the following assets do you own?

Asset	Age	Sole owned	Shared
Bicycles			
Keke Napep			
Jega (Tricycle)			

Car			
Radio/TV			
Mobile Phone			
Wheel Barrow			
Ox-plough			
Work bull			
Donkey			
Empty drums			
Silver trinket			
Others (Specify)			

30. Did you have any access to any source of credit? Yes ( ) No ( ) if yes name the source of the credit _____
31. Was the credit in cash or in kind? _____
32. If in cash how much did you received _____
33. If in kind, what items did you received_____

E.

1. Which of the problems *listed* below mostly affects cowpea production in the last ten (10) years:

a) Lack of Seeds [ ]
b) High cost of seeds [ ]
c) Lack of fertilizer [ ]
d) High cost of labour [ ]
e) Diseases and pests [ ]
f) Low yield [ ]
g) Lack of information on improved seed [ ]
h) Drought [ ]
i) Lack of access to market [ ]
j) Lack of extension visits [ ]
k) Tenure problem [ ]
l) Others (specify)…… [ ]

F. FOOD SECURITY STATUS

No.	Food Item	Food Availability	Frequency of consumption

		All year round	Less than six month	≤ 3 months	No. of days per week	In the last 24 hours	
		3	2	1	0-7	Yes (1)	No (0)
1.	**Cereals**						
	Maize						
	Wheat						
	Sorghum						
	Millet						
	Other Specify						
2.	**Roots and Tubers**						
	Yam						
	Cassava						
	Sweet potato						
	Irish potato						
	Coco yam						
	Others specify						
3.	**Legumes**						
	Groundnuts						
	Cowpea						
	Soya bean						

	Melon						
	Others Specify						
4.	**Meat**						
5.	**Fish and Fish product**						
6.	**Leafy Vegetables**						
7.	**Non Leafy vegetables**						
	Tomatoes						
	Okro						
	Cabbage						
	Pumpkin						
	Cardin egg						
	Carrots						
	Others Specify						
8.	**Fruits**						
	Orange						
	Mango						
	Paw-paw						
	Guava						
	Pineapple						
	Others Specify						

9.	**Fat and Oil**						
	Palm oil						
	Groundnut oil						
	Soya bean oil						
	Cotton seed oil						
	Butter						
	Others Specify						
10.	**Poultry**						
	Turkey						
	Chicken						
	Guinea foul						
	Duck						
11.	**Eggs**						
12.	**Beverages**						

G. HOUSEHOLD CONSUMPTION EXPENDITURE

No.	Food Item	Quantity cooked in last 24 hours (specify unit)	Source	Proportion from own production (Specify Unit)	Proportion from own from the market (Specify unit)	If own production, please estimate market value (₦)	If market purchased, please state cost of purchase (₦)
1.	Cereals						
2.	Roots and Tubers						
3.	Legumes						
4.	Meat						

5.	Fish and Fish product						
6.	Leafy Vegetables						
7.	Non Leafy vegetables						
8.	Fruits						
9.	Fat and Oil						

H. Average Quantities of food consumed by households (kg/months)

Food Items	Own produced	Purchased	Total Quantity consumed
Maize (Green)			
Maize (grain)			
Maize (flour)			
Rice(local)			
Rice(Imported)			
Millet(grain)			
Millet(flour)			
Sorghum(grain)			
Sorghum(flour)			
Cowpea			
Groundnut (shelled)			
Groundnut(unshelled)			
Soyabean			
Cassava(roots)			

Cassava(flour)			
Cassava(garri)			
Yam			
potatoes(Sweet)			
Potatoes(irish)			
Cocoyam			

Average household nonfood Consumption Expenditure (₦month)

Nonfood Items	Amount		
Clothing			
Shoes			
Education			
Health facilities			
Fuelwood			
Kerosene			
Furniture			
Detergent			
Kitchen equipment			
Vehicle Fuel			
Vehicle Maintenance			
Home repairs			
Donations			

Ceremonies & festivals			
Others(Specify)			

I. COST AND RETURNS

Costs of Inputs Used For Cowpea Production:

Cowpea Variety	Seed		Fertilizer		Herbicides		Chemical insecticides		Labour	
	Quantity used kg/ha	Cost (₦)	Quantity used (kg/ha)	Cost (₦)	Quantity /ha	Cost (₦)	Quantity /ha	Cost (₦)	Quantity /ha	Cost (₦)

J. RETURNS OBTAINED FROM COWPEA PRODUCTION

Cowpea Variety	Yield obtained	Quantity consumed		Quantity Sold	
		Quantity used	Amount (₦)	Quantity(kg)	Amount (₦)

	(Kg)	(kg/ha)			