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Cover photo: Women in northern Nigeria bringing maize to the market.

Contents

Tables

Figures

Acronyms and abbreviations

BOSADP	Borno State Agricultural Development Program
CBO	community-based organization
CIDA	Canadian International Development Agency
CoC	cost of calories
FGN	Federal Government of Nigeria
FGT	Foster, Greer, and Thorbecke weighted poverty index
IITA	International Institute of Tropical Agriculture
LGA	local government area
MAHE	mean per adult equivalent household expenditure
NGO	nongovernmental organization
NGS	northern Guinea savanna
PCA	Principal Component Analysis
PROSAB	Promoting Sustainable Agriculture in Borno State
RDS	Rural Development Strategy
SGS	southern Guinea savanna
SS	Sudan savanna
WI	wealth index

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Executive summary

The International Institute of Tropical Agriculture (IITA) and national partners from Borno State received funding from the Canadian International Development Agency (CIDA) to conduct the project *Promoting Sustainable Agriculture in Borno State* (PROSAB) from 2004 to 2009. The goal of the project is to contribute to improved rural household livelihoods in the project areas of Borno State in northeastern Nigeria. Therefore, an improvement in food security and the reduction of poverty incidence are major objectives of PROSAB. Food security has been defined as "access by all people at all times to safe and nutritious food needed to maintain a healthy and active life" (FAO 1989). The incidence of poverty in Nigeria increased from 65.6% in 1996 to 78.3% of the population in 2004 (FOS 2004).

The PROSAB project has used a participatory approach to promote improved varieties of cereals and legumes along with improved crop management practices. Training and linking farmers to markets were also important components of this project. This study was conducted for an early assessment of the project effects on key indicators of project success, which include rural poverty and food security. Survey results indicate that the project has been successful in increasing crop yields in the communities where it promoted the use of improved varieties and better crop management practices. Both yields and per capita production of major crops (maize, rice, soybean, and cowpea) were statistically significantly higher in PROSAB communities compared to non-PROSAB communities.

Study results suggest that PROSAB has made a significant contribution towards improving food security. In project communities, food insecurity has been reduced from 58% in 2004 to 49% in 2008, indicating a 9% improvement in food security over the 4-year period. In addition, a comparison of PROSAB and non-PROSAB communities in 2008 showed that food insecurity is higher (61%) in communities where PROSAB had no interventions compared with 49% in PROSAB communities. Probit regression technique was used to determine factors that influence household security. The regression results suggested that participation in PROSAB activities had a positive and statistically significant effect ($P = 0.05$) on household food security status. In fact, households that participate in PROSAB activities had an 18% increase in the probability of being food secure.

Also, the incidence of poverty in participating communities has decreased from 67% in 2004 to 49% in 2008, indicating an 18% reduction in the poverty level among households in the project area. Comparison of household poverty between PROSAB communities and non-participating communities in the State indicate that the incidence of poverty is lower in PROSAB communities by 14%[1]. Even though less robust than the food security case, poverty status regression results suggest that participation in PROSAB activities had a negative and significant effect on household poverty status. Therefore, participating in PROSAB activities contributed to reducing household poverty.

[1] Incidence of poverty in non-PROSAB communities is 63% (i.e., 63 – 49 = 14%)

Introduction

Background

IITA and national partners from Borno State received funding from the Canadian International Development Agency (CIDA) to conduct PROSAB from 2004 to 2009. The project aimed to contribute to improved rural household livelihoods in the project areas of Borno State in northeastern Nigeria. Therefore, an improvement in food security and reduction in poverty incidence are major objectives of PROSAB. This study was conducted to assess the project's effects on key indicators of project success, including rural poverty and food security.

Food security has been defined as "access by all people at all times to safe and nutritious food needed to maintain a healthy and active life" (FAO 1989). Food security is thus people-oriented and implies a situation in which all households have both physical and economic access to adequate food for all members and where households are not at risk of losing such access (A-shami 1996). If food security is attained, the result according to Talabi (1996), will be a contented, patriotic, and more productive populace and, therefore, an ideal environment in which to thrive.

Mustafa (1996) viewed food security as a major element in national security alongside domestic law and order as well as territorial defense and other forms of security. Furthermore, according to the checklist of fundamental human rights, the right or easy access to food means more to households who are food insecure than the right to basic education, participation in political and social life, and so on. Relating food security to the security of the State, Omole (1996) indicated that food is not an ordinary commodity, but a powerful instrument of State policy that can be employed to punish enemy and recalcitrant nations, reward friendly States, and influence the political and economic decisions of nations. According to Beer (1975), food is an instrument of power and hence Government must be concerned with how to increase its availability. If there is a shortage of food, then the power of the State becomes weak. The level of food security is, therefore, one of the indicators of the level of development. Thus, it is imperative to group the level of world economic development into high, medium, and low-income food-deficit countries (Oyakhilome 1996). Food security can, therefore, be seen to have social, economic, and political implications for any nation. Food insecurity is synonymous with not knowing where your next meal is going to come from (Wilson and Ramphale 1989). And, according to Olayemi (1998) there is often a strong interrelationship between food insecurity and poverty.

The poverty incidence in Nigeria increased from 65.6% in 1996 to 78.3% of the population in 2004 (FOS 2004). Furthermore, the distribution of extreme poverty by occupational category indicates that 67.4% of the poor in Nigeria were in agriculture (FOS 1999). The rural, traditional, and mostly private agricultural sector is characterized by small-scale, poor, subsistence and semi-subsistence farmers and informal traders. The farmers cultivate small landholdings, which are often less than one hectare in size and in fragmented plots. The traditional system of agricultural production still prevails, with its characteristically low technical base, high reliance on manual labor and, hence, low resource productivity. Agricultural production is seasonal with annual output fluctuations. Because of adverse biophysical conditions, such as erratic rainfall, marginal soil fertility, and a nonconducive policy environment, the sector is no longer able to cater to the growing population, much less to cope with unexpected shocks. Hence, farmers have been obliged to diversify their livelihood with incomes from outside the sector.

To achieve poverty reduction, it became necessary to empirically measure the poverty status and examine the determinants of poverty among the farming households. The need to investigate poverty and its determinants has also been justified by Ravallion (1998) and Bandabla (2005) who argued that "a credible measure of poverty and its determinants can be a powerful instrument for focusing the attention of policy makers on the living conditions of the poor." Poverty data can inform policies intended to reduce poverty.

Rationale

In pursuance of the goals of the project, a baseline survey was carried out in the project area in 2004 to provide sex-disaggregated baseline data on socioeconomics, resource use patterns, and market opportunities, and their effects on land degradation and agricultural productivity in potentially targeted project communities.

The major baseline indicators or criteria designed for measuring and monitoring farmers' economic status and progress included the following:

1. Agricultural production characteristics, such as farm size distribution, distribution of the number of farm plots owned, distribution of important crops grown, and so on.
2. Livelihood diversification indices, such as household engagements in nonfarming activities and enterprises.
3. Farm households' access to improved farm inputs and gender-based differentials in access.
4. Food and nonfood expenditure and consumption patterns in farm households.
5. Farm households' food security and poverty status.

Socioeconomic measurements and food security and poverty status analyses were carried out to help support and explain the various baseline indicators. These provide information on the capabilities and constraints under which farmers, their spouses, and other family members operated to achieve the goal of improved household welfare. As the project draws to an end in October 2009, it is important to evaluate the outcome of the project on food security improvement and poverty reduction among households in the project area. The study will provide the basis to present PROSAB's achievement to policy makers within and outside Borno State, IITA, CIDA, and other development partners. It will also guide the scaling up and scaling out of projects such as PROSAB in other parts of the savanna ecological zones of Nigeria. It is within this context that the study was planned.

Study objectives

The main objective of the study is to carry out a comparative household poverty and food security analysis (*before* PROSAB)[2] using the baseline report as a benchmark and the *current* period (2008). The study seeks also to compare PROSAB and non-PROSAB communities in terms of their food security and poverty status. The specific objectives were to:

a. Examine the sample households' socioeconomic characteristics.
b. Compare the households' poverty and food insecurity status against the baseline data.
c. Compare the households' food security and poverty status in PROSAB and non-PROSAB communities of Borno State.
d. Examine the determinants of household poverty and food security.

[2] PROSAB baseline study report.

Study area and the project

Borno State in northeastern Nigeria covers an area of 69,435 km^2. The state ranges from the northern Guinea savanna (NGS) in the southeast to the Sahel in the north, and a larger part of the State lies in the Sahelian zone. The annual rainfall ranges from 600 mm in the north to 1200 mm in the south and extends over a growing season of between 100 and 180 days. Annual rainfall varies from year to year, with decreasing trends during the past two decades. According to the 2006 census, Borno State has a population of 4.2 million people who depend mainly on agriculture. In the north, major crops grown are millet, sorghum, and cowpea. In the savannas of the southern part of the State, major crops are maize, sorghum, cowpea, groundnut, rice, and recently soybean.[3] In most areas, the cereal cropping systems are being intensified and new crops are replacing the old ones.

In Borno State, as everywhere in northern Nigeria, food security depends on weather and soil fertility. With erratic rainfall and marginal soil fertility, the region's food production is no longer sufficient to feed the growing population. Other major threats to rural livelihoods in Borno State are desertification and poverty. Desertification results in misery and food insecurity across the dry savannas of West and Central Africa.

Poor soil management practices, increasing soil erosion, and deforestation are decreasing the productive capacity of land that is already overcultivated. Often this has led to permanent degradation in some areas. There are many factors that trigger desertification, including the unpredictable effects of drought, unsustainable land use (overcultivation, overgrazing, deforestation), fragile soils and erosion, nutrient mining, a growing population and neglect by policy makers. This hampers food security, limits efforts to reduce poverty, and constrains human development. This environmental degradation results in low crop yields and poverty among agricultural communities where the average income is less than US$1/ day. Farmers, therefore, tend to move to new areas when crop yields are drastically reduced, thus advancing the frontiers of desertification. This may result in extreme hardship among farm families.

Soybean was introduced to Borno State, and is now fast becoming a major crop.

[3] Soybean became a major crop as a result of PROSAB's intervention in agriculture in Borno State.

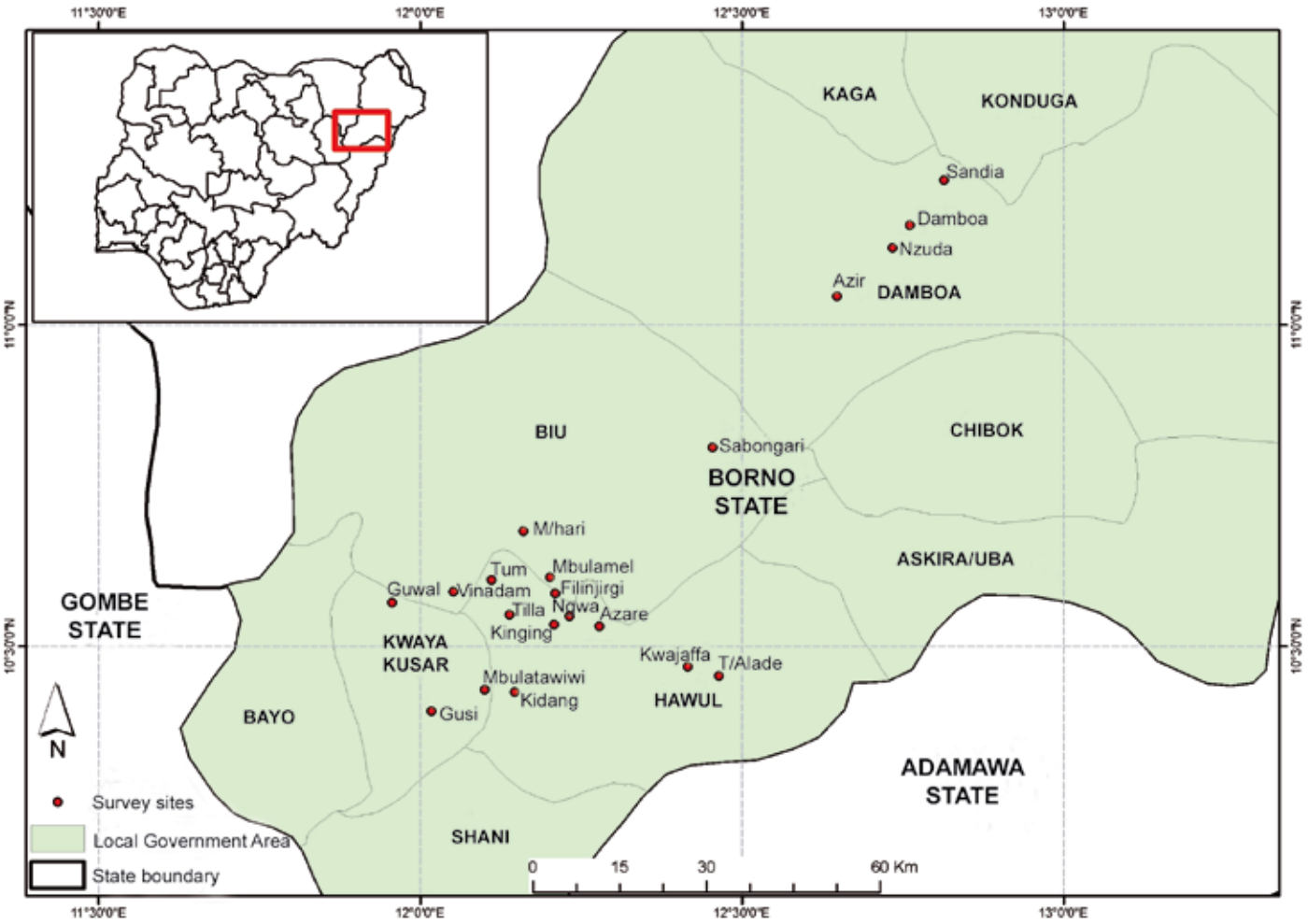

Figure 1. Surveyed communities in Borno State.

The challenge of increasing food production should thus be to develop technologies that not only enhance food production but also maintain ecological stability and preserve the natural resource base, i.e., technologies that are both economically viable and sustainable.

Cognizant of the foregoing conditions, which are also prevalent in many other parts of the country, the Federal Government of Nigeria (FGN) prepared and adopted a new national Rural Development Strategy (RDS) in 2001. Its aims are to improve livelihoods and food security through a process of community-based agriculture and rural development programs. The strategy calls for a community-driven development approach which ensures the active participation of beneficiaries and local governments at all levels of decision-making. It is within this development framework that CIDA signified, in September 2003, its assistance to the agricultural and rural development sector of Nigeria by funding a project for *Promoting Sustainable Agriculture in Borno State* (PROSAB) which was proposed by IITA.

The project is being implemented in three agroecological zones of Borno State, the southern Guinea savanna, (the SGS), the NGS, and the Sudan savanna (SS) (Fig. 1). Its goal is to contribute to improved rural household livelihoods in the project areas. The specific objectives include (1) improved food security, (2) reduced environmental degradation, (3) improved sustainable agricultural production through the transfer of improved agricultural technologies and management practices to female and male farmers, (4) improved market access, (5) a more enabling policy environment, and (6) enhanced capacity of project partners.

The project was designed in a participatory manner and took into consideration the experiences gained from past projects in northern Nigeria and especially in the project area. The project was implemented by IITA in collaboration with local and regional development partners, including nongovernmental organizations (NGOs) and community-based organizations (CBOs). Strong linkages were also forged with other donor-supported projects in the State as well as across states.

Data and methods

Data

The data for the present survey were obtained through a survey of 600 households in Borno State conducted in June 2008. The main instruments for data collection were well-structured questionnaires administered on households by trained enumerators under the supervision of the PROSAB collaborator from the Department of Agricultural Economics, University of Maiduguri.

Three agroecological areas, the SS, NGS, and SGS, which fall into four local government areas (LGAs), were covered in data collection. Data were collected from 20 communities and settlements spread across the four LGAs in the project area. (Annex 2 provides a list of the settlements and communities.) Sixteen of the communities were selected from the 30 communities where PROSAB has been directly promoting improved crop technologies and better crop management practices since 2004. The remaining four communities, although they are within the four LGAs and three agroecological areas, are not among the 30 project communities that were earlier identified and selected in preparation for project implementation activities. Non-PROSAB communities were selected for the comparative analysis of food security and poverty status with the communities where IITA has been promoting improved crop technologies and management practices among resource-poor farmers.

In each selected community, a random selection of 30 households was carried out, thus giving a total of 600 sample households (480 households in PROSAB communities and 120 households in non-PROSAB communities).

Methods

A combination of analytical tools was employed in this study. These included descriptive statistics (e.g., means, frequencies, etc.), Foster, Greer, and Thorbecke (FGT) weighted poverty index, cost of calorie (CoC) food security status estimation, and probit regression techniques.

Descriptive statistics

Descriptive statistics was used to examine the socioeconomic characteristics of the respondents' households and basic features of the existing crop production system in the study area. The need for such analysis is predicated on the fact that households' food security and poverty are largely functions of farmers' social and economic characteristics.

Estimation of food security line and status

In assessing food security at the household level, we first asked the household heads to make their own assessment of food security. We then proceeded and calculated food security for all the households and then classified them as food-secure or food-insecure households accordingly. The food security measures were carried out for the year (2008) and compared with the 2004 baseline food security data. The second component of food security analysis was to compare the food security status for communities where PROSAB is directly working in terms of promoting the use of improved crop varieties and management practices with the situation in communities where PROSAB is not directly working.

The study used the cost-of-calories (CoC) method proposed by Foster et al. (1984) to determine the food insecurity line. This method yields a value that is usually close to the minimum calorie requirements for human survival. The process involves defining a minimum level of nutrition necessary to maintain healthy living. This minimum level is referred to as the "food insecurity line" for the study area, below which households are classified as food insecure, subsisting on inadequate nutrition. Calorie adequacy was estimated by dividing the estimated calorie supply for the households by the household size adjusted for adult equivalents using the consumption factor for age–sex categories.

Women play an important role in ensuring food security in the community.

Therefore, using this method, the food insecurity line is given as

$$\ln X = a + bC \quad (1)$$

Where X is the adult equivalent food expenditure (in Naira) and C is the actual calorie consumption/adult equivalent of a household (in kcal). The calorie content of the recommended minimum daily nutrient level (L) by Gohl (1981) was used to determine the food insecurity line (S) using the equation:

$$S = e^{(a+bL)} \quad (2)$$

Where,

S = the cost of buying the minimum calorie intake (food insecurity line)
a & b = parameter estimates from equation 1
L = recommended minimum daily energy (calorie) level (2250 kcal)

Based on the S calculated, households will be classified as food secure or food insecure, depending on which side of the line they fall.

Estimation of the poverty line and poverty status

Similarly, as with the food security measures, current (2008) poverty measures were carried out and compared with the 2004 baseline poverty measures. The comparison provided information on the level of poverty reduction in the project communities since the introduction of improved crop technologies and management practices among farmers in the project areas. Secondly, poverty measures within the project communities were compared with those communities outside the project area. The estimation of poverty status involves the measurement of the standard of living of the households, estimation of the poverty line, and the computation of the poverty profile.

Table 1. Nutritional (calorie-based) equivalent scales.

Years of age	Male	Female
0–1	0.27	0.27
2–3	0.45	0.45
4–6	0.61	0.61
7–9	0.73	0.73
10–12	0.86	0.78
13–15	0.96	0.83
16–19	1.02	0.77
20 and above	1.00	0.73

Source: Adapted from FOS (2004).

Measuring the standard of living

The standard of living of households in the area was measured based on the expenditure of the households. The household expenditure was converted into per capita expenditure by dividing it by the number of members of the household. This was further converted into adult equivalents based on the nutritional requirement, sex, and age of household members, using the nutrition-based adult equivalent scales provided by FOS (2004) shown in Table 1. By multiplying the nutrition equivalent scales by the number of household members that fall in any of the age-by-sex categories, the monthly mean/adult equivalent household expenditure (MAHE) for the sampled households was calculated.

Threshing maize in Miringa, Biu, Borno State.

Estimating the poverty line

The poverty line was calculated from the MAHE of the sampled households. Two-thirds of the MAHE of the sampled households was used as the poverty line for the study. This approach was used by several researchers (World Bank 1996, FOS 1999, Omonona 2001; FOS 2004; Bandabla 2005, Kwaghe 2006, Amaza et al. 2007. This was done by ranking the MAHE of the households and then dividing the population into equal increments. For this study, the division was based on deciles or 10% increments, such that the first decile represents the bottom 10% of the sampled households in terms of expenditure (or presumably, the poorest) and the highest or the 10th decile was that increment which represents the highest 10% of the sample in terms of consumption (or presumably, the richest). The MAHE of the deciles were added and divided by 10 to get their mean. Two-thirds of the mean was then computed to arrive at the MAHE that served as the poverty line for the study area.

Estimating poverty status

As earlier reported, two methods are used to have a classification of sampled households into poor and non-poor categories. First, the weighted poverty index is used and in the second approach, several factors (capital assets) are used and categories defined using Principal Component Analysis (PCA) to determine the most important factors that distinguish the groups.

A. Weighted poverty index

The Foster, Greer, and Thorbecke (Foster et al. 1984) weighted poverty index was used for the quantitative poverty assessment. The *P-alpha* measures in analyzing poverty relate to different dimensions of the indices of poverty P_0, P_1, and P_2 and were used for head count, depth, and severity of poverty.
The three measures are all based on a single formula, but each index puts different weights on the degree to which a household or individual falls below the poverty line. This measure is also useful due to its decomposability among subgroups. To see how the measures are defined, the expenditures were arranged in ascending order, from the poorer Y_1, next poorest Y_2…. with the least poor Y_q. The poverty index is defined mathematically as follows:

$$P_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}\left(Z - \frac{Y_i}{Z}\right)^{\alpha} \qquad (3)$$

where:

α = the FGT index and takes values 0,1,2.
n = total number of households
q = number of households below the poverty line
Z = poverty line
Y_i = the MAHE of the household in which individual ith lives.

B. Principal Component Analysis method

A composite measure of the cumulative living standard or wealth status of a household is the wealth index (WI) (see details in Langyintuo 2008). The WI places individual households on a continuous scale of relative wealth. In computing this index, household capital assets were used which are generally perceived to be important indicators in defining wealth status in the study area. In this study, the following factors derived from the five livelihood capitals (human, natural, physical, financial, and social) are used: membership in a farmers' organization, number of people in the household, child dependency ratio, total land, expenditure on hired labor, remittances received, cropped land area, livestock ownership (in Tropical Livestock Units), number of poultry owned, numbers of bicycles, motorcycles, television sets and radios, and also the number of cellular handsets owned. Using the above factors, each household asset for which information is collected is assigned a weight or factor score generated through PCA, a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of "dimensions".

The PCA starts by specifying each variable normalized by its mean and standard deviation (Langyintuo 2008). This technique extracts the few orthogonal linear combinations from a set of variables that capture the common information most successfully (Filmer and Pritchett 1998, 2001, Ellis and Bahiigwa 2003, Freeman et al. 2004, Zeller et al. 2005; Langyintuo 2008). The first principal component is expressed in terms of the original (un-normalized) variables, and therefore an index for each household is based on the expression:

$$A_{1j} = f_1\ (a^*_{1j} - a^*_1)(\ s^*_1) + \ldots + f_{1K}(a^*_K\ - a^*_K)(\ s^*_K) \quad (4)$$

Technically, the procedure solves the equations (R –λI)vn = 0 for λn and vn, where R is the matrix of correlations between the scaled variables (the as) and vn is the vector of coefficients on the n^{th} component for each variable. Solving the equation yields the Eigen values (or characteristic roots) of R, λn, and their associated eigen vectors, vn. The final set of estimates is produced by scaling the vns so the sum of their squares sums to the total variance. The resulting asset scores are standardized (using assigned weights) in relation to a standard normal distribution with a mean of zero and a standard deviation of one. The assigned weights are then used to construct an overall WI, applying the following formula:

$$W_j = \sum_{i=1}^{k} [b_i(a_j\ - x_i\ ]\ / s_i \quad (5)$$

where: Wj is a standardized WI for each household; bi represents the weights (scores) assigned to the (k) variables on the first principal component; a_{ji} is the value of each household on each of the k variables; x_i is the mean of each of the k variables; and s_i the standard deviation. These standardized scores are then used to create the break points that define wealth categories. A negative index ($–W_j$) means that, relative to the communities' measure of wealth, the household is poorly endowed and hence worse-off (poor or poorly endowed) while a positive figure (W_j) signifies that the household is well-off or well-endowed (nonpoor).

Factors affecting food security and poverty

In analyzing factors that affect household food security and poverty status, the probit regression model was used. Households were classified as food secure or insecure based on estimations of the food security line. This dummy variable (1 = food secure, 0 = food insecure) was then used as dependent variable for the regression analysis to estimate the coefficient of factors that affect household food security. The same technique was used for the poverty status. However, this time the poverty status determined using the PCA technique was used as the dependent variable (1 = poor, 0 = nonpoor). Thus, the model is estimating the factors that determine the household poverty status.

Maize is the major cereal crop grown in northern Nigeria.

Results and discussion

The results are classified into four categories. First, descriptive statistics on household characteristics in the three agroecological zones and the two types of communities (PROSAB and non-PROSAB) are presented and discussed. The second category is an analysis of the households' food security status, and the third is an analysis of the poverty status in both PROSAB and non-PROSAB communities. The last section of the results focuses on assessing the effects of key socioeconomic and institutional factors on household food security and poverty.

Descriptive analysis of household characteristics

The major socioeconomic characteristics of households covered in the survey are presented. These characteristics relate to the relative frequency distribution of heads of households by gender, age, years of formal education, and marital status. Also included are household asset ownership structures, size distribution of household farms, types of land tenure, sources of farm credit, types of crops grown, the composition of household livestock (animal and poultry stock), household farm income distribution, household nonfarming employment and income distribution, and household food and nonfood consumption patterns.

Distribution of household heads by gender

The pattern of gender distribution of household heads was similar across the three agroecological zones surveyed (Table 2). However, in relative terms, the percentage of male-headed households was higher in the NGS than in the SGS and SS. The percentage was lowest in the SS. On the other hand, the percentage of female-headed households was highest in the SS and lowest in the NGS. But, on average, approximately 86% of the households covered in the survey were headed by males while 14% were-headed by females.

A vibrant market is one of the indicators of a healthy economy.

Table 2. Percentage distribution of household heads by gender.

	Agroecological zone			
	SGS	NGS	SS	Average (all areas)
Female	15.2	10.0	18.7	14.5
Male	84.8	90.0	81.3	85.5
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

Table 3. Percentage distribution of household heads by age category and gender.

	Agroecological zones							
Age category	SGS		NGS		SS		Average (all areas)	
	Female	Male	Female	Male	Female	Male	Female	Male
30 or less	4.9	16.2	5.6	15.4	14.3	20.5	8.3	17.4
31–40	24.4	23.6	22.2	32.7	25.0	29.5	23.9	28.6
41–50	12.2	31.0	44.4	20.4	21.4	23.0	26.0	24.8
51–60	51.2	14.4	16.7	15.5	21.4	21.3	29.8	17.0
Above 60	7.3	14.8	11.1	16.0	17.9	5.7	12.1	12.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

Distribution of household heads by age

The significance of age on farm output has been examined extensively by Rongoor et al. (1998) where it is revealed that the influence of age on farm productivity is very diverse. Some studies have found that age has a positive effect on productivity (Kalirajan and Shand 1985, Stefanou and Sexena 1988). Also, a study by Adubi (1992) reveals that age, in correlation with farming experience, has a significant influence on the decision-making process of farmers with respect to risk aversion, adoption of improved agricultural technologies, and other production-related decisions. Age has been found to determine how active and productive the head of the household would be. Age has also been found to affect the rate of household adoption of innovations, which in turn, affects household productivity and livelihood improvement strategies (Dercon and Krishnan 1996).

Table 3 shows the distribution of household heads by age ranges. Table 3 shows that the distribution of the age of household heads was fairly similar across the ecological zones surveyed. But on average, approximately 52% of the household heads were between 31 and 50 years of age. The mean age of household heads was 45 years (with a standard deviation of 13.4). For the sample as a whole, approximately 64% of household heads were in the active and productive age range of less than 50 years.

The predominance of active and productive heads of households in the project area has a direct bearing on (1) increased availability of able-bodied labor for primary production; (2) ease of adoption of innovations; and (3) reduction in the degree of risk aversion. All these have great potential for increasing agricultural productivity and production and, hence, for improving household livelihoods and reducing poverty in the PROSAB project area.

Household sizes

The significance of household size in agriculture hinges on the fact that the 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 size of the farm household. The pattern of household sizes was similar across the agroecological zones surveyed. But, in relative terms, the mean household size was higher in the SS than in the SGS and NGS. The mean household size in the area of study is approximately 8 persons (Table 4).

Table 4. Household size.

Agroecological zone	Mean	Std. Deviation	Maximum	Minimum
SGS	7.8	4.9	31	1
NGS	7.9	4.9	31	1
SS	8.2	4.7	29	1
All areas	7.9	4.9	31	1

Source: Survey data, 2008.

Table 5. Percentage distribution of household heads by years of formal education.

	Agroecological zones							
Level of education	SGS		NGS		SS		Average (all areas)	
	Female	Male	Female	Male	Female	Male	Female	Male
No formal education	9.8	17.5	27.8	14.8	60.7	38.5	32.8	23.6
Up to 6 yrs	34.1	38.4	44.4	44.4	25.0	39.3	34.5	40.7
7–12 yrs	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.2
Over 12 yrs	56.1	44.1	27.8	40.1	14.3	22.2	32.7	35.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100

Source: Survey data, 2008.

Household heads' level of formal education

Many studies have revealed that the level of education (years of schooling) helps farmers to use production information efficiently, as a more educated person acquires more information and, to that extent, is a better producer (Hayami 1969, Lockheed et al. 1980, Phillips 1994, Wang et al. 1996, Yang 1997).

The level of farmers' education is believed to influence the use of improved technology in agriculture and, hence, farm productivity. The level of education determines the level of opportunities available to improve livelihood strategies, enhance food security, and reduce the level of poverty. It affects the level of exposure to new ideas and managerial capacity in production and the perception of the household members on how to adopt and integrate innovations into the household's survival strategies. Table 5 shows the distribution of the levels of formal education among household heads.

In all the agroecological zones in the project area, the pattern of distribution of the levels of formal education of household heads was similar. However, the highest illiteracy level was found in the SS with about 50% of respondents having had no formal education at all, while the SGS and NGS had relatively well-educated household heads.

Household heads' marital status

Table 6 shows the distribution of the marital status of household heads in the study area. There was a high level of homogeneity in the distribution of household heads' marital status in the project area because of similarities in cultural and religious practices. The significance of marital status on agricultural production can be explained in terms of the supply of agricultural family labor. It is expected that family labor would be more available where the household heads are married.

The majority of household heads in the study area were married. On average, about 87.5% of all household heads in all the project areas were married. Only 12.5% were single.

A market in Nigeria.

Table 6. Percentage distribution of household heads by marital status.

	Agroecological zone			
Marital status	SGS	NGS	SS	Average (all areas)
Married	89.3	91.1	80.0	87.5
Single	10.7	8.9	20.0	12.5
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

Distribution of household heads by occupation

In sub-Saharan Africa, it is common for some farm household members to engage in other nonfarm occupations to complement their earnings from farming. A study by Herbert (1996) in Burundi reveals that there is a tendency towards income diversification through extra-agricultural activities which complement farming. In this survey, different farming and nonfarming occupations of household heads were identified. As practiced in many rural areas in Nigeria, the households in the project area had highly diversified income-generating activities.

Table 7 shows the major types of income-generating activities or livelihood strategies. The distribution of occupations was similar across the agroecological zones. It is also evident that farming was the most important occupation of the household heads of in the project area; a civil service job was the second most important occupation. This finding has an important implication for farm production decisions by the households. The dependence of farm families on farming as the predominant occupation may have a positive or negative effect

Table 7. Percentage distribution of household heads by main occupation.

	Agroecological zone			
Occupation	SGS	NGS	SS	Average (all areas)
Farming	67.0	62.2	80.7	69.0
Civil service	13.7	21.1	6.7	14.2
Trading	6.7	7.8	9.3	7.7
Service provision (driver)	4.1	1.1	0.7	2.3
Others	8.5	7.8	2.7	6.8
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

Table 8. Average household farm sizes (ha).

Agroecological zone	Mean	Std. Deviation	Maximum	Minimum
SGS	2.8	2.2	12.0	0.1
NGS	3.6	3.3	17.0	0.4
SS	5.1	5.0	21.0	0.4
Total	3.6	3.6	21.0	0.1

Source: Survey data, 2008.

on agricultural production, depending on the availability and allocation of household resources. In a situation where farm families have capital constraints due to low income from farming, there is likely to be heavy reliance on family labor and low input technology to carry out farming operations. Consequently, in the event of crop failure or low yields from crops, farm families are likely to be faced with the problem of food insecurity arising from unavailability or limited access to sufficient food.

Household farm sizes

Farm size in this study refers to the land area that was actually used for crop production during the survey year. The average farm sizes in the study area are presented (Table 8).

The average farm size in the project area ranged from 2.8 ha in the SGS to 5.1 ha in the SS, thus showing large disparities in farm sizes among farming households. However, many farm households operate small and fragmented plots in the project area. A striking finding shown in Table 8 is the large disparity between the minimum and the maximum farm sizes; the minimum size was 0.1 ha, while the maximum was 21 ha for all areas covered in the study. In sum, Table 8 reveals that the average farmer operated small fragmented plots that added up to an average of about 3.6 ha/household.

Farming experience of household heads (years)

Farming experience is an important factor determining both the productivity and the production level in farming. But the effect of farming experience on productivity and production may be positive or negative. Generally, it would appear that up to a certain number of years, farming experience would have a positive effect; after that, the effect may become negative. The negative effect may be derived from aging or reluctance to change from old and familiar farm practices and techniques to those that are modern and improved.

The farming experience of household heads in the project area varied widely, with a minimum of only 2 years and a maximum of 80 years (Table 9). The average farming experience, however, did not vary widely among the zones as the variation was between 21 years in the SS and approximately 26 years in the NGS. The average for all the zones was approximately 23 years. This shows that the average farm household head had had considerable experience in farming.

Table 9. Farming experience of household heads (years).

Agroecological zone	Mean	Std. Deviation	Maximum	Minimum
SGS	21.7	12.6	72.0	2.0
NGS	25.7	13.8	80.0	2.0
SS	20.9	11.2	60.0	4.0
Total	22.7	12.8	80.0	2.0

Source: Survey data, 2008.

Table 10. Percentage distribution of households by types of land tenure.

Agroecological zone				
Tenure	SGS	NGS	SS	Average (all areas)
Individually owned	65.9	80.0	38.7	63.3
Family	31.1	10.6	44.0	28.2
Gift	0.0	0.0	1.3	.3
Rented	3.0	9.4	15.3	8.0
Community	0.0	0.0	.7	.2
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

Distribution of households by type of land tenure

In traditional agriculture, land is considered to be the most important factor of production. This arises as a result of the low level of technology that accompanies agricultural production and other related problems of land tenure that are commonly found in the agriculture of developing economies. Table 10 presents the typology of land tenure practiced in the project area.

A soybean-maize rotation system provides adopters in the project area with more food to eat and sell.

Table 11. Percentage distribution of households' asset ownership.

	Agroecological zone			
Asset	SS	NGS	SGS	Average (all areas)
Radio/TV sets	21.0	28.2	27.1	25.8
Mobile phones	15.3	15.9	18.0	16.7
Extra land	18.6	16.3	14.7	16.2
Bicycles	21.9	15.1	14.4	16.5
Motor cycles	12.0	19.0	19.0	17.2
Oxen	6.3	3.2	5.5	5.1
Motor vehicles	4.6	2.2	1.4	2.5
Others (guns, etc.)	0.2	0.0	0.0	0.1
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

The typology of the land tenure system in the project area was similar across all agroecological zones. The commonest type of land tenure was individual ownership by inheritance from family or community, accounting for 63%. "Owned land" refers to land that was acquired through direct purchase or inheritance by the respective households. This owned land mode tends to promote security of tenure, as opposed to the other modes of land ownership. Hence, this factor is likely to provide an incentive for farmers to manage their land properly. Family land accounts for 28% of land ownership in the project area. Under this ownership mode, there could be fragmentation of land as a response to an increased number of family members, to give each family member a "fair" share of the right to land use. Rented/leased land accounts for 8% and communal land for 0.2% of land ownership.

Households' asset ownership

Hassan and Babu (1991) have found that the level of asset ownership in a household is an indication of its endowment and provides a good measure of household resilience in times of food crisis, resulting from famine, crop failures, or natural disasters.

This is because a household can easily fall back on its assets in times of need by selling or leasing them. Table 11 presents the assets owned by households covered in the study.

Radios/television sets were the most common asset owned by households, followed by motorcycles and mobile phones. This is indicative of improved economic welfare among the households. The small proportion of households that owned ox plows and work bulls in the project area suggests that most farming households did not practice mechanized or semi-mechanized farming. Instead, they still relied on hand implements in their farming activities.

Type of crops grown by households

The distribution of important crops grown by households was similar among all the agroecological zones in the project area (Table 12). The most widely grown crops were cereals, of which maize was the most important and most widely cultivated cereal in the NGS and SGS. In the SS, sorghum was the most important cereal. Legumes were next to cereals in terms of relative importance, as reflected in the percentage of households growing them, especially cowpea and groundnut. Soybean is an emerging important legume in the SGS and NGS[4]. On the other hand, millet was not widely grown. The dominance of maize in NGS and SGS and sorghum in SS may be explained by the local climate which favored the cultivation of cereals in the study area by the fact that they are the predominant staple food crops. Cowpea is a predominant second crop grown in association with cereal crops, such as maize and sorghum. In fact, cowpea is grown mostly as an associated crop. Farmers' dual objectives of producing most of their basic food requirements and, at the same time, generating a marketable surplus explain their preference for growing these crops.

[4]In 2003, soybean was grown by only 0.1% of sampled farmers in the project area (see Amaza et al. 2007).

Food security has improved as a result of PROSAB's interventions.

Table 12. Percentage distribution of type of crops grown by households.

	Agroecological zone			
Crops	SGS	NGS	SS	Average (all areas)
Maize	78.5	86.1	49.3	73.5
Cowpea	33.0	76.7	86.7	59.5
Sorghum	35.9	35.6	60.0	41.8
Rice	38.1	52.8	16.0	37.0
Groundnut	36.3	35.0	31.3	34.7
Soybean	19.3	13.9	0.0	12.8
Millet	3.7	8.3	4.7	5.3

Source: Survey data, 2008.

Crop production and consumption in PROSAB and non-PROSAB communities

A comparison between PROSAB and non-PROSAB communities indicates that the average household size (number of people/household) is quite similar in the two types of communities (Table 13). Total area cropped is slightly higher in PROSAB communities by about 1.4 ha, on average. The major differences appear in crop yields. For all crops, yield/ha is higher in PROSAB communities than in non-PROSAB communities.

Rice and major legume crops (cowpea, soybean, and groundnut), yield in PROSAB communities are almost double that of non-PROSAB communities. This is a result of the introduction and adoption of improved crop varieties and agronomic practices by farmers in the project area. Also, improved access to inputs, especially fertilizers, through PROSAB, contributed to these higher yields (Table 13).

Table 13. Selected household characteristics and crop yields in PROSAB and non-PROSAB communities, Borno State, 2008.

	PROSAB communities	Non-PROSAB communities
Household size	8.0 (2–31)	7 (2–18)
Total area cropped (ha)	3.7 (0.5–21)	2.3 (0.4–18)
Crop yields (kg/ha)		
Maize	887.5	508.5
Sorghum	645.8	349.6
Millet	536.7	124.5
Rice	1,304.1	653.6
Groundnut	1,262.5	598.3
Soybean	1,388.28	456.9
Cowpea	557.6	337.6

Source: Survey data, 2008.
Note: Numbers in parenthesis are minimum and maximum.

Table 14. Per capita production and consumption of major cereals and legumes in PROSAB and non-PROSAB communities, Borno State, 2008.

	PROSAB communities		Non-PROSAB communities	
	Per capita production (kg/person)	Per capita consumption (kg/person)	Per capita production (kg/person)	Per capita consumption (kg/person)
Maize	830.9	141.6	576.0	89.7
Sorghum	560.8	47.7	255.29	49.2
Millet	410.8	19.3	510	34.0
Rice	589.8	209.3	391.4	45.1
Groundnut	902.6	18.2	57.5	20.9
Soybean	850.6	40.7	152.4	7.9
Cowpea	496.1	14.0	117.9	30.9

Source: Estimations from survey data, 2008.

In terms of per capita production and consumption (Table 14), clear differences exist between the two types of communities. On average, households in PROSAB communities have produced more grain per capita for all crops except for millet which has not been promoted by PROSAB. The major gain was made in groundnut (a crop that farmers had almost abandoned) and soybean that is a relatively new crop in the area. For household consumption, PROSAB communities consume more maize, rice, soybean, and cowpea per capita than non-PROSAB communities. This is a direct consequence of the higher production levels of these crops by farmers in PROSAB communities. In general, per capita home consumption of soybean is quite low in the area as much of the soybean produced is sold to market agents and/or industrially processed through PROSAB's market linkage.

Household food insecurity

Households' own perception of food security status

The respondents were asked whether their own households had sufficient food during the previous year. Table 15 shows how households perceive food security status. The households' perception of food security was similar across all the agroecological zones. Households in the NGS have the highest perception level of food security (80%); households in the SS are least food insecure (73%). The relatively improved food security status of households in the SGS may be attributed to the more favorable weather, especially rainfall, for the production of food crops. This tends to promote crop productivity and the production of more diverse crops in the region. This is in contrast to the NGS and SS ecological areas which are relatively more prone to

Table 15. Percentage distribution of households' own assessment of food security status.

Agroecological zone				
Had access to enough food	SGS	NGS	SS	Average (all areas)
Yes	83	73	76	77
No	17	27	24	23
Total	100.0	100.0	100.0	100.0

Source: Survey data, 2008.

drought from rainfall decline (Kamara et al. 2006). Thus, drought is one of the major causes of yield loss in the Guinea savannas (Amaza et al. 2006). This has implications for food security, where, in the event of drought, households may have limited access to safe and nutritious food needed to maintain a healthy and active life.

Food security before (2004) and after PROSAB (2008) in project communities

Table 16 shows the food security status among the households in the PROSAB project area. The food security status in 2008 (with PROSAB) revealed that the cost of the minimum basic food requirement—the food insecurity line—was ₦2160.94. Using this defined food insecurity line, it was found that 44% of all sampled households were food insecure by head count. The estimated aggregate expenditure gap indicated ₦1108.35 (51.3%) as the amount by which food-insecure households were below the minimum expenditure level required to meet their basic food needs.

Analysis of the food insecurity study in the area with no PROSAB project intervention indicated that 58% of the households were food insecure (Amaza et al. 2007). The food-insecure households were below the food insecurity threshold by ₦375.74 (19.05%) (Table 16).

Improving food security to alleviate hunger and poverty is one of the underlying reasons for PROSAB.

Table 16. Food insecurity status before and after the PROSAB project5.

Measures	Before PROSAB (2004)	After PROSAB (2008)	% Change
FAO recommended daily energy level (L)		2250 Kcal	
Food insecurity line Z (cost of the minimum energy requirement/adult equivalent)/month	₦1975.01	₦ 2160.94	+ 8.6
Head count (H) food insecurity index:	0.58	0.49	– 9.0
Aggregate expenditure gap	19.02	51.27	+ 32.3
Aggregate income gap (G)	–375.74	–1108.35[1]	+ 66.1

Source: Survey data, 2008.

Table 17. Yield levels (t/ha) of food crops measured on secondary and tertiary farmers' fields in Borno State.

Crop	Improved varieties	Local varieties	% increase
Maize	2.44	1.38	77
Sorghum	2.12	1.54	38
Cowpea	1.96	1.40	40
Groundnut	2.62	1.36	93
Soybean	2.06	1.63	27
NERICA rice	2.73	1.61	70

Source: PROSAB 2008–2009 Annual Report.

A comparison of the figures for food security status indicate that the number of food-insecure households in the project area had declined[6] by 9% over the 4-year period. This implies that households food security in the project area has improved by 9%. The adoption of improved technologies and crop management practices has led to increased crop productivity with implications for improved food security, increased incomes, and improved livelihoods of households in the project communities. Recent statistics showed that agricultural productivity has increased by over 100% with the new crop varieties and management practices compared with the productivity levels prior to 2004. Yield increases on lead farmers' test plots in 2008 relative to the baseline data (2003) are 220% for maize, 160% for sorghum, 100% for cowpea, 90% for groundnut, and 60% for rice (PROSAB 2009).

The production conditions under which crops were produced in the baseline data differ considerably compared with the 2008 production figures. In the baseline survey, it was observed that there was an increasing incidence of continuous cropping, increasing intensity of land use, and planting of unimproved varieties (Amaza et al. 2007). This led to the interrelated problems of poor soil fertility and low crop yield in the project area. In fact, these problems called for measures to make fertilizers readily available to farmers and to put in place appropriate soil fertility-enhancing/ conserving farm management practices, such as the use of legumes and organic fertilizers, which subsequently led to PROSAB's intervention. Factors that seem to influence the yield increases on farmers' test plots are associated with use of improved varieties, increased use of fertilizer and improved fertilizer application methods, improved crop management practices, among others[7].

Secondary and tertiary farmers and farmers in adjoining PROSAB communities have benefited from the improved crop technologies promoted by PROSAB. Results of the crop yield survey of secondary and tertiary farmers' fields conducted recently showed significant increases in yields of improved crop varieties over the local varieties (Table 17). Improved varieties of maize, rice, and groundnut recorded over 70% increase in yields over the local varieties.

[5] After PROSAB refers to 2008, which is a year before the end of the project in 2009.
[6] Note that this statement is based on relative measure.
[7] Improved crop management practices include close spacing, drilling fertilizer, clean weeding, and at least two chemical sprays for cowpea.

Table 18. Food insecurity status in PROSAB and non-PROSAB communities.

	PROSAB communities	Non-PROSAB communities	Percentage difference
Food security line	2,160.94	1,748.99	19.1
Food insecurity status	49.00	61.00	12.0
Aggregate expenditure gap	51.29	24.53	26.8

Source: Survey data, 2008

Current food security level in PROSAB communities and non-PROSAB communities

Table 18 shows a comparison of the results of the food security measures for PROSAB and non-PROSAB communities (Table 18). Food insecurity lines of ₦2160.94 were estimated from households in PROSAB communities and of ₦1748.99 from households in the non-PROSAB participating communities. These food insecurity lines were expected to meet the minimum recommended daily energy level (2250 kilocalories) of an adult/month in the participating communities and 61% in the non-participating communities. Based on these food insecurity lines, 49% of households were classified as food insecure in the participating communities and 61% of households in the non-participating communities. The aggregate expenditure gap or expenditure shortfall of the food-insecure households is 51.3% of the food insecurity line for PROSAB communities and 24.5% of the food insecurity line for non-PROSAB communities.

Food insecurity status in the two communities reveal that the food insecurity level is relatively higher in non-PROSAB communities than in PROSAB communities by 12%. This observed difference might be associated with the adoption of improved crop varieties and crop management practices[8].

However, the percentage of aggregate expenditure shortfalls is higher in PROSAB communities. Even though the number of food-insecure households is higher in non-PROSAB communities, food-insecure households in PROSAB communities are more food insecure.

Households' poverty status

Based on the poverty status classification using the PCA and WI approach described earlier, the incidence of poverty follows the crop production potential of the different agroecological zones. The SGS with higher production potential has the lowest poverty incidence followed by the NGS and then SS. The SS, the zone with the lowest rainfall of the three agroecological zones, has the highest poverty incidence (Fig. 2). Agricultural production is higher in the SGS compared to the other zones, leading to more investments in inputs and a higher production surplus for farmers.

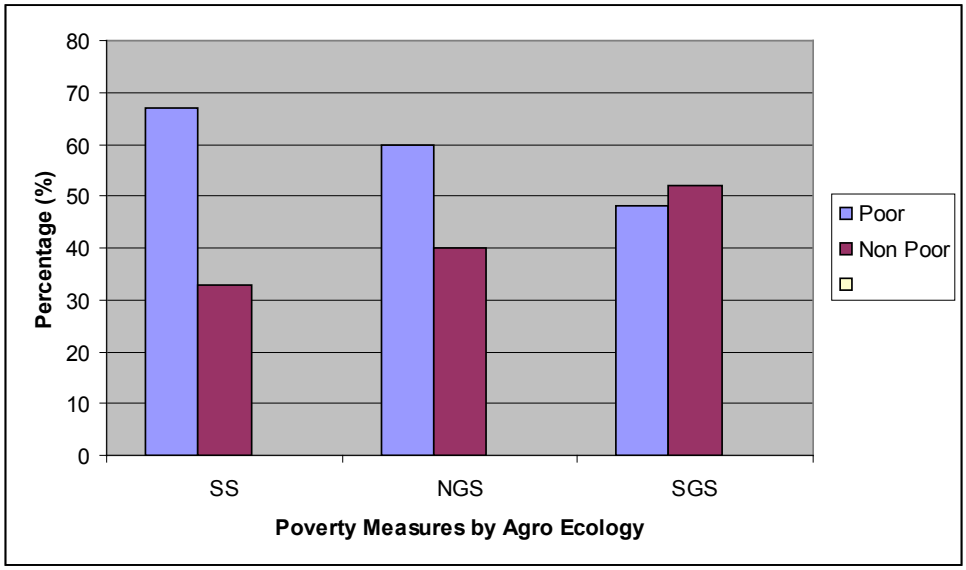

Figure 2. Poverty measures by agroecology.

[8] A direct causality link is not claimed here because the two groups might have had the same difference even before PROSAB came into the picture.

Poverty level in PROSAB communities before and after the project

The poverty line used for this study was calculated from the monthly MAHE of the sampled households. A poverty line of ₦3,508.68 based on 2008 prices, is two-thirds of the MAHE, and was expected to meet the monthly minimum basic requirements (food and nonfood) of an adult in the study area. Households with a MAHE below this poverty line were classified as poor, while those with a higher MAHE were classified as being nonpoor. Based on this poverty line, 49% of the households were classified as poor while 51% were classified as non-poor (Fig. 3).

In a baseline study by Amaza et al. (2007) prior to the implementation of the PROSAB project, a poverty line of ₦2446.67 was estimated and used to classify households into poor and non-poor. Based on this poverty line, 67% of households were classified as poor whereas the non-poor accounted for 33% of the sample households.

Analysis of the two studies revealed that PROSAB project has reduced poverty in the project area by 18% (67% – 49%). This shows that, due to improved livelihoods as a result of the PROSAB intervention, poverty was alleviated in 18% of the poor households.

Poverty level in PROSAB communities and non-PROSAB communities

Two kinds of analyses were simultaneously carried out to examine the impact of PROSAB on the poverty level of the households in the project area. To ascertain the impact of the project on the participating communities, a similar study was also conducted in non-participating communities in the project area. Table 19 shows results of the studies.

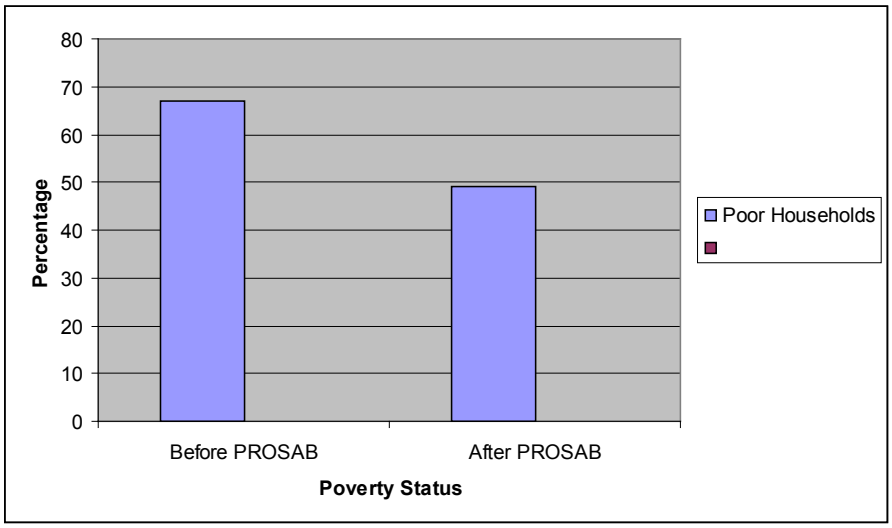

Figure 3. Poverty measures before and after PROSAB.

Table 19. Poverty status in PROSAB and non-PROSAB communities.

Poverty index	PROSAB communities	Non-PROSAB communities	Percentage difference
Poverty head count (P_0)	49.00	63.00	14.00
Poverty gap (P_1)	68.42	36.62	31.80
Severity (P_2)	25.69	21.05	04.64

Source: Survey data, 2008.

Women in the project sites show products from soybean, which was introduced by PROSAB in 2004.

The poverty lines used for these studies were calculated from the monthly MAHE of the sampled households. A poverty line of ₦3508.68 was estimated for the participating communities and ₦2849.35 for non-participating communities, which was two-thirds of the MAHE of PROSAB-participating households. These poverty lines, based on 2008 prices, were expected to meet the monthly minimum basic requirements (food and nonfood) of an adult in both participating and non-participating communities. Households with a MAHE below these poverty lines were classified as poor while those with a higher MAHE were classified as being nonpoor. Based on these poverty lines, 49% of the households were classified as poor in the participating communities and 63%

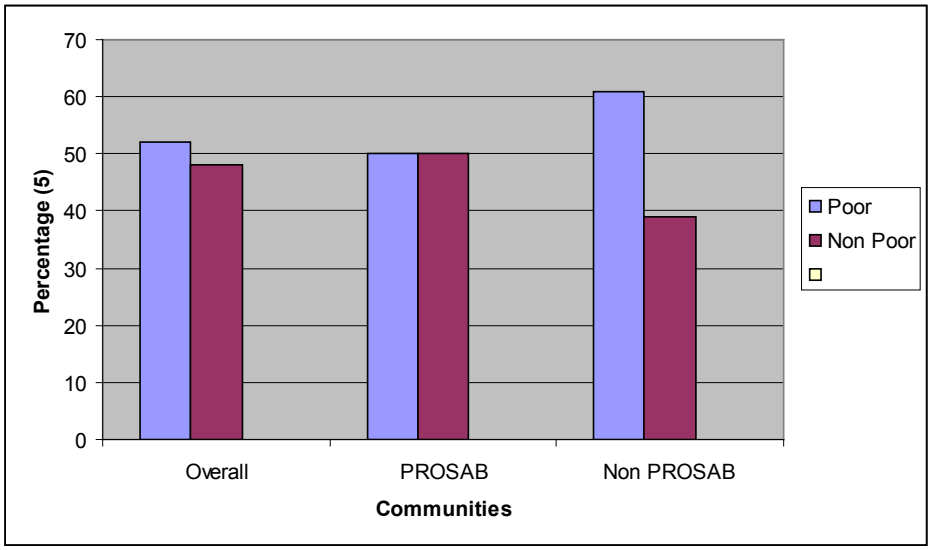

Figure 4. Poverty status in PROSAB and non-PROSAB communities.

Table 20. Differences in average yields, and per capita production and consumption of major crops in PROSAB and non-PROSAB communities, Borno State, 2008.

	Crop yields (kg/ha)	Per capita production (kg/person)	Per capita consumption (kg/person)
Maize	379 (3.710**)	254.9 (2.044**)	–51.98 (–2.593**)
Sorghum	–296.2 (–1.585)	–305.51 (–1.884)	–1.4 (0.086)
Millet	412.2 (1.257)	-99.2 (–0.567)	–14.7 (–0.830)
Rice	650.5 (2.128**)	198.4 (2.681**)	164.2 (5.355**)
Groundnut	664.2 (2.332**)	845.1 (0.491)	–2.7 (–0.199)
Soybean	931.38 (3.469**)	698.2 (2.618**)	32.8 (3.166**)
Cowpea	220 (2.464**)	178.075 (2.321**)	16.9 (1.951**)

Source: Survey data, 2008.
Note: Numbers in parenthesis are T-ratio values (assuming equal variances).
** Significant at 1%.
* Significant 5%.

in the nonparticipating communities (Fig. 4). The poverty gap or expenditure shortfall of the poor households is 68.4% of the respective poverty line for PROSAB communities and 36.6% for non-PROSAB communities. The results further reveal that 25.7% and 21.1% of the households in PROSAB and non-PROSAB communities, respectively were severely poor. Comparison of the poverty status of two communities reveals that the poverty level is higher by 14% in non-PROSAB communities than in PROSAB communities. However, the percentages of aggregate expenditure shortfalls and poverty severity are higher in PROSAB communities. Even though there are more poor households in the non-PROSAB communities, poverty is marginally more severe among the poor households in the PROSAB communities.

As discussed earlier, the households in both PROSAB and non-PROSAB communities were classified according to poverty level (poor vs. nonpoor) using a PCA approach. Using this second method of classification, we assessed the effect of the classification method on the results. The results of this second approach also compared well with those of the weighted poverty index presented in Table 19. This gives more confidence to the estimated poverty measures as both estimation methods give results that are similar and within a few percentage points of each other. Using this WI approach, we estimate that the overall incidence of poverty in the sampled communities is 52. PROSAB communities and poverty incidence is 50% while it is estimated to be 61% in non-PROSAB communities, respectively.

Factors that influence food security and poverty levels

In this section, we examine factors that determine the food security and poverty status of farming households in Borno State and the differences in crop yields, and per capita production and consumption of major food crops by households in PROSAB and non-PROSAB communities. Yields of maize, rice, soybean, cowpea, and groundnut are higher in PROSAB communities compared with non-PROSAB communities, and the differences are statistically significant (Table 20). The differences are not statistically significant for millet and sorghum, crops for which PROSAB had not been promoting any improved varieties.

At the household level, per capita production is also significantly higher in PROSAB communities for maize, rice, soybean, and cowpea (Table 20). The statistical significance of the yield levels and per capita household production for maize, rice, soybean, and cowpea in PROSAB communities is associated with the adoption of improved varieties for these crops. Recent adoption studies in the project area revealed adoption rates of these crops 53% (maize), 50% (rice), 97% (soybean), and 64% (cowpea) (Kwache 2008; Gabdo 2008; PROSAB 2009; Idrisa 2009). The per

Groundnut processing.

capita consumption of maize is lower in PROSAB communities, indicating that residents sell more maize and also consume more of other crops such as soybean and rice. Per capita consumption of rice, soybean, and cowpea is indeed statistically higher in PROSAB communities compared with non-PROSAB communities.

Determinants of food security

Determinants of food security in sub-Saharan Africa have been investigated by several authors. Olayemi (1998) categorized factors affecting food security at the household level into supply-side factors, demand-side factors, and the stability of access to food, which includes household food and nonfood production variability; household economic assets; household income variability; the quality of human capital within the households; degree of producer and consumer price variability; and household food storage and inventory practices.

Nyangwesoi et al. (2007) in a study of household food security in Vihiga district of Kenya found that household income, number of adults, ethnicity, savings behavior, and nutrition awareness significantly influence household food security. In a similar study, Kohoi et al. (2005) established that the significant determinants of food security in the Mwingi district of Kenya were participation of households in the food-for-work program, marital status of the household heads, and their educational level. Similarly, in a study of food security in the Lake Chad area of Borno State, Nigeria, Goni (2005) reported factors that influence household food security, which include household size, stock of home-produced food, and numbers of income earners in the household.

For this study, household food security status was estimated as a function of household characteristics, crop production, and participation in PROSAB activities. The estimated function is as follows:

Food security status = f (Size, Chlab, SS, NGS, PROSAB, Experience, FO, Education, Gender, Area, Credit, Extension, Distance assets, Remittances, Non-agriculture income).

Where:

Food security status = dummy dependent variable (1 if household is classified food secure and 0 = otherwise).
Size = number of persons in the household
Chlab =annual household expenses on hired labor for agricultural activities
SS = dummy variable (where 1 = household is in SS and 0 = otherwise)

NGS = dummy variable (where 1 = household is in NGS and 0 = otherwise)
PROSAB = dummy variable (where 1 if household participated in PROSAB activities and 0 = otherwise)
Experience = number of years household head has been farming
FO = dummy variable (where 1 = household has a member who belongs to an association and 0 = otherwise)
Education = number of years of schooling of household head
Gender = dummy variable (where 1 = household head is male and 0 = otherwise)
Area = area of land owned by the household in ha
Credit = dummy variable (1 = a member of the household had access to credit and 0 = otherwise)
Access to extension = dummy variable (where 1 = a member of household had access to extension and 0 = otherwise)
Distance = Distance in km from homestead to nearest input shop
Asset = 1 = household owns other physical assets and 0 = otherwise)
Remittances = total annual remittances received by household in Naira
Non-ag income = total non-agricultural income of household in Naira

The regression result indicates that household size, cost of hired labor, participation in PROSAB activities and non-agricultural income have significant positive effects on the food security status of the household. Household size had a negative effect, indicating that large households are more likely to be food insecure. This shows that households with large sizes had higher probabilities of being food insecure than those with smaller sizes, and vice versa. That is, household size is a negative factor determining the food security status of a household in the project area. The hired labor variable measure indicates the amount of extra labor investment made by a given household. It had, as expected, a positive effect on food security. Farmers who use more hired labor in food crop production tend to work for increased profit, as was reported by Amaza (2000). The profit-oriented farmers who use relatively higher proportions of hired labor are also relatively more efficient in terms of allocative and economic efficiency and, therefore, likely to be more food secure. On the other hand, farmers who mostly use family labor farm for food security, which has taken precedence over that of commercial gain.

Having additional income from non-agricultural activities also has a positive impact on the food security of the household. This variable is a proxy for the household's ability to purchase inputs, such as fertilizers and improved seeds, which are critical to increased agricultural production. Participation in PROSAB activities also had a positive effect on household food security. This variable measured household participation in terms of the research development and training activities of PROSAB and shows that participating households are more likely than others to be food secure. This suggests that the project activities, such as farmers' training on crop management practices, marketing, adoption of improved crop varieties by farmers and their links to inputs and output markets and so on, positively contributed to enhancing food security. It is estimated from the marginal effect equation that participating in PROSAB activities increases the chance (probability) of being food secure by 18%. However, an increase in household size reduces the chances of being food secure by about 8% (Table 21). This shows that households with large sizes had higher probabilities of being food insecure than those with smaller sizes, and vice versa. Household size is a negative factor determining the food security status of a household in the project area.

Determinants of poverty status

Several authors have investigated the determinants of poverty in sub-Saharan Africa. Okurat et al (2002) in a study of regional poverty reported that northern Uganda was found to be the poorest region; it has the largest depth of poverty and worst inequality. It is characterized by the poor having large mean household sizes, least education, lowest mean household incomes, lowest expenditure on health, least chance of child survival, and the highest concentration in rural areas. Similarly, Minot (2006) found that rural poverty is associated with remoteness, where poverty is higher in the remote areas of Tanzania. In a recent study that examined the determinants of poverty in Sierra Leone, Fargernas and Wallace (2007) found that almost 80% of the rural households were poor, less likely to be educated, and more likely to work in agriculture, particularly rice production. Determinants of poverty differed between rural and urban households, where urban households were found to be relatively better-off.

Table 21. Estimated coefficients of different factors affecting household food security.

Variable	Effects on food security status	Marginal effects on food security status
	Estimated coefficients	Estimated coefficients
Size of household	–0.214** (–10.97)	–0.085
Cost of hired labor	0.00001** (2.26)	6.67e–06
SS zone	–0.288 (–1.65)	–0.113
NGS zone	0.142 (0.98)	0.056
PROSAB zone	0.4703** (2.86)	0.181
Years of farming experience	0.0082 (1.51)	0.003
Membership in farmers' organization	0.271 (1.91)	0.108
Education level of household head	–0.0430 (–0.52)	–0.017
Gender	–0.310 (-1.83)	–0.123
Total area of the household farm	0.046 (1.22)	0.018
Access to credit	–0.137 (-0.84)	–0.054
Access to extension	–0.0645 (-0.44)	–0.026
Distance to nearest input shop	0.003 (0.92)	0.0011
Household assets	0.235 (0.73)	0.091
Remittances	1.16^{e}–06 (0.52)	4.62e–07
Non-agricultural income	4.26^{e}–06* (2.00)	1.69e–06
Constant	0.801 (1.80)	NA
Number of observations	600	
LR chi2(16)	212.47	
Log likelihood	–309.53	
Pseudo R-Square	0.255	

Source: Regression results, 2009.
Notes: Numbers in parenthesis are Z values for each coefficient.
** indicates statistical significance at 1% and * indicates statistical significance at 5%.
NA = Not available.

In analyzing factors that affect the poverty status of the households, a probit regression model was estimated using dummy variable (1, 0) for poverty status as the dependent variable. Household characteristics, participation in PROSAB activities, and agroecological zones were explanatory variables. The estimated function was as follows:

Poverty status = f (SS, NGS, PROSAB, Age, Experience, CDR, Education, Gender, Distance).

Where:

Poverty status = dummy variable (where 1 = household is classified as poor and 0 = otherwise) and dependent variable
SS = Sudan Savanna zone = dummy variable (where 1 = household is in SS and 0 = otherwise)
NGS = Northern Guinea Savanna zone = dummy variable (where 1 = household is in NGS and 0 = otherwise)
PROSAB = dummy variable (where 1 = household participated in PROSAB activities and 0 = otherwise)
Age = Sgears of household head
CDR = Ratio of children under 15 to total number of people in the household
Experience = Number in years of household head has been farming
Education = Number of years of formal schooling of household head
Gender = dummy variable (where 1 = household head is male and 0 = otherwise)
Distance = Distance in km from homestead to nearest input shop.

Table 22. Estimated coefficients of different factors affecting household poverty status.

Variable	Effects on poverty status Estimated coefficient (standard error)	Marginal effects on poverty status Estimated coefficient (standard error
SS zone	–0.034 (–0.24)	–0.0137
NGS zone	–0.105 (–0.81)	–0.0417
PROSAB zone	–1.243** (-8.04)	–0.424
Age of household head	–0.014** (-2.57)	–0.00562
Years of farming experience	0.0012 (0.21)	0.00048
Education level of household head	–0.352 (–0.60)	–0.0176
Gender	–0.242** (–2.22)	–0.1398
Child dependency ratio	–0.2420 (–1.16)	–0.0962
Distance to nearest input shop	–0.002 (-0.65)	–0.0008
Constant	2.225** (6.20)	NA
Number of observations		600
LR chi2(9)		83.20
Log likelihood		-373.63
Pseudo R-square		0.10

Source: Regression results.
Notes:
Numbers in parenthesis are Z values for each coefficient.
** indicates statistical significance at 1% and * indicates statistical significance at 5%.
NA = Not available.

The estimation of factors affecting poverty status is not as robust as that of food security. This is probably due to the reduced number of variables used in this regression. Nevertheless, this regression provides some indications of the potential effect of PROSAB on household poverty. The regression results (Table 22) indicate that participating in PROSAB activities, along with age of household and gender of the household head, had significant effects on poverty status. All these variables have a poverty reducing effect. As expected, the older the household head, the lower the chance of the household being poor. Male-headed households are also less likely to be poor compared to female-headed households.

Farm with improved soybean varieties and that uses IITA-introduced crop management practices.

Table 23. Soybean market linkage statistics: 2005–2009.

	2005	2006	2007	2008
Farmers linked to market (no.) (male/female)	201 (127/74)	301 (190/111)	391 (231/160)	485 (344/141)
Qty sold through market linkage (t) (male/female)	20.7 (13.1/7.6)	57.2 (36.0/21.2)	218.5 (129.1/89.4)	811.0 (754.0/57.0)
Revenue (million Naira) (male/female)	0.93 (0.59/0.34)	2.8 (2.3/0.5)	14.2 (11.4/2.8)	46.8 (43.7/3.1)
Average price/kg (Naira)	45	49	54	58

Source: PROSAB 2008–2009 Annual Report.

Participation in PROSAB activities is the third variable with a significant coefficient ($P = 0.05$). It indicates that participating in PROSAB activities had a poverty reducing effect. Households that participated in PROSAB activities are less likely to be poor compared to those that have not participated. In fact, marginal effects estimates indicate that those households that participated in PROSAB activities have a 42% reduction in their probability of being poor compared with those that have not participated. These results are associated with the improved education that farmers acquired through various training, such as crop management practices, seed production techniques, marketing, and so on. In addition, the use of improved crop varieties had increased farmers' yields considerably, leading to an increased marketable surplus, which in turn contributed to increased incomes.

A significant contributor to increased incomes is the production and sales of soybean. The major driver for poverty reduction in the project area is related to developments in the soybean market. Soybean had been introduced into the project area but, prior to 2004, its production was non-existent on a commercial scale. The project introduced the crop for improved soil fertility, control of the *Striga* parasitic weed, improved nutrition, and increased incomes through sales to industrial processors.

The market development in the soybean market from 2005 to 2008 is presented (Table 23). There has been a drastic growth in the sales of soybean by farmers. While the number of farmers who were linked to markets increased steadily over the period, the quantity sold over the period from 2005 to 2008 also increased, as has the aggregate revenue (Table 23).

The trend suggests that farmers are increasingly adopting soybean production, with more farmers planting the crop and existing producers increasing the land area under cultivation. Increased demand for soybean by industrial processors and attractive market prices, among other reasons, are major factors that motivate farmers to grow the crop. The fact that the unit price of soybean has increased by nearly 80% suggests that the market potential for soybean is high. Producers are price takers on the market and any amount of soybean produced will be sold without forcing the price down in the short term. The chain of market activities, such as the initial dissemination of price information, farmers' training on marketing techniques, and market linkage activities all cumulatively contributed to the development of the soybean market. The increased incomes realized from sales of soybean contributed to improved livelihoods and poverty reduction in PROSAB communities. The regression estimates presented in Table 23 indicate that having a male-headed household reduces the probability of being poor only by 14%.

Conclusions

The PROSAB project has used a participatory approach to promote improved varieties of cereals and legumes along with agronomic practices. Training and linking farmers to markets were also important components of this project. Survey results indicate that it has been successful in increasing crop yields in the communities where it worked. This study suggests that PROSAB has made a significant contribution to improving food security in its project areas. In project communities, food insecurity has been reduced from 58% in 2004 to 49% in 2008. In addition, the comparison of PROSAB and non-PROSAB communities in 2008 showed that food insecurity is higher (61%) in communities where PROSAB had no interventions compared with 49% in PROSAB communities. Also, regression analysis suggested that participation in PROSAB activities had a positive and statistically significant effect on household food security status. Households that participate in PROSAB activities had an 18% increase in the probability of being food secure, according to our results. With less robust regression results, the evidence from this study also suggests that the project contributed to poverty reduction in the area as shown by poverty incidence before (67%) and after PROSAB (49%). Poverty incidence has been found to be lower in PROSAB communities (49%) compared with non-PROSAB communities (63%). Furthermore, regression results indicate that participation in PROSAB activities significantly reduced the probability of a household being poor. According to these regression results, participation in PROSAB activities reduces the probability of being poor by 42%.

Several factors played a significant role in the success of PROSAB, including the IITA technologies promoted, the project approach (including partnership), collaborators and stakeholders, and support from the local people. This analysis has not tried to single out the effect of any of these components. Instead, it endeavored to measure the changes that have happened since the project started in these communities and then compared them with outcomes in non-participating communities. The full impact assessment of project activities will require more time as the project is still completing its activities in 2009.

James Buba, a lead farmer, enjoys the fruits of his labor after adopting IITA technologies.

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Annexes

1. Questionnaire on Food Security and Poverty Study in PROSAB project area of Borno State, Nigeria

A. Background information on the household head

A1. Name:_____

A2. Village:_____

A3. Local government area:_____

A4. Date of interview:…… ……2008

A5. What is your highest educational qualification?

(i) Primary certificate [ ] (ii) SSCE/GCE [ ]

(iii) NCE/OND/Nursing [ ] (iv) HND [ ]

(v) University [ ] (vi) Master's Degree [ ]

B. Social factors

B1. How long have you been farming? _____ years

B2. Did extension staff visit you last growing season to give you farm advice?

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

B3. If yes, how many times did extension staff visit you this cropping season?:_____

B4. Do you belong to any cooperative society?

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

B5. If yes, name the cooperative society:_____

C. Demographic characteristics of the household head

C1. Sex (i) Male [ ] (ii) Female [ ]

C2. Age in years…….

C3. Marital status: (i) Married [ ] (ii) Single [ ]

C4. If single, tick the one that best describes your condition

(i) Divorced [ ] (ii) Widowed [ ]

(iii) Separated [ ] (iv) Single parent [ ]

(v) Others, specify……..

C5. How many of your household members fall in the following age group?

Age group (in years)	Number of males	Number of females
0–4		
5–14		
15–64		
65 and above		

D. Health-related factors

D1. If anybody in your household is sick, which of the following places do you first contact for a solution?

(i) Clinic/Hospital [ ] (ii) Dispensary [ ]

(iii) Native doctor/traditional healer (iv) Spiritualists [ ]

(v) Patent medicine stores (vi) Others, specify:…….

D2. What is the distance between your house and clinic or hospital?.....km

D3. How much in Naira do you spend on treating members of your household?

(i) Weekly ……or (ii) Monthly……

E. Economic factors

E1 What is your (household head) primary occupation?:……

E2. Secondary occupations (Tick as appropriate)

(i) Farming [ ] (ii) Trading [ ]

(iii) Government salaried job [ ] (iv) Private salaried job [ ]

(v) Crafts and artisans [ ] (vi) Others, specify:……

E3. Are there other working members in your household?

(i) Yes [ ] (ii) No [ ]

E4. If yes, state their income in the table below

S/No	Daily	Weekly	Monthly
1			
2			
3			
3			
4			
6			

E5. Tick as many enterprises as your household is into:

(i) Staple food crop [ ] (ii) Livestock [ ]

(iii) Cash crops [ ] (iv) Tree crops [ ]

(v) Others, specify:…….

E6. Do you work off-farm? (i) Yes [ ] (ii) No [ ]

E7. If yes what type of activities do you engage in during this off-farm time?

(i) ……. (ii)……

(iii) ……... (iv)……

E8. How much does your household earn from the following sources of income?

S/No.	Income Source	Amount in Naira
1	Self-employment (trading, tailoring, carpentry, crafts, bricklaying, blacksmithing, barber's work, shoe cobbling, repairing of bicycles and motorcycles, etc.)	
2	Government employment (salary)	
3	Private employment (salary)	
4	Money earned from interest on capital lent out and rent on building or dividend on shares, etc.	
5	Remittances (money sent by children and relatives)	

E9. If you have benefited from credit last cropping season, indicate from which source and the amount given (if in kind, give the value)

i. Agric. bank (NACRDB) ₦:_____

ii. Commercial banks ₦:_____

iii. Cooperatives ₦:_____

iv. Friend/Relatives ₦:_____

v. Others, specify_____ ₦:_____

E10. Kindly indicate if you own any of the following assets.

Item	No.	Are you the sole owner of this item or do you share ownership with someone? Sole = 1; share = 2	How many years ago did you acquire this item?	Did you purchase this item or did you receive it as a gift? Purchase = 1; gift = 2
Extra land				
Bicycle				
Motorcycle				
Motor vehicle				
Radio/TV Set				
Oxen				

E11. Kindly provide information on the following crops (only on those you have purchased or produced).

	Item purchased last season for household consumption		Amount produced last cropping season (quantity/ units)	Amount consumed from last season's production (quantity/ units)	Amount consumed from last season's production (quantity/ units)	Value of prepared foods purchased outside household last week (₦)
	Quantity and units[1]	Price paid/ unit				
Maize						
Grain						
Flour						
Sorghum						
Grain						
Flour						
Millet						
Grain						
Flour						
Rice						
Imported						
Local						
Cassava						
Tubers						
Gari						
Cassava chips						
Yam						
Tubers						
Yam flour						
Cocoyam						
Corms						
Groundnut						
Shelled						
Unshelled						
Soybean						
Grain						
Flour						
Cowpea						
Okra						
Tomato						
Onion						
Pepper						
Egg plant						
Carrot						
Pumpkin						
Green leaves						
Guava						
Citrus						
Mango						
Others (specify)						
4						
5						
6						

[1] Units refers to local measures (e.g., *Mudu, Shakade, Tiya*, baskets, etc.) and kilograms (kg)

E12. Kindly indicate how many livestock you own and also provide other related information.

	Number of livestock presently owned	How many did you have last year?	How many have you sold this year?	How many have you consumed this year?	Amount of animal products consumed last week (quantity/ units)	Amount of animal products sold last week (quantity/unit)
Cattle						
Sheep						
Goats						
Pigs						
Chickens						
Ducks						
Guinea fowls						

F. Household expenditure

F1. Indicate the amount purchased of the following items for household consumption.

Item	Item purchased last week or month or last year for household consumption (please indicate whether for a week or month or year).	
	Yes = 1, No = 2	Purchased value (₦)
Salt/Potash/Maggi		
Groundnut oil		
Palm oil		
Other oils, specify 1.		
2.		
Fish (fresh/dried/smoked)		
Meat (beef/mutton, etc.)		
Sugar		
Bread		
Cigarettes, tobacco, kola nuts		
Drinks (beer, local sweet drinks, minerals)		
Shoes (leather, plastic, slippers)		
Clothing (fabric and clothing)		
Purchase of motor vehicles		
Purchase of motor cycles		
Purchase of bicycles		
Repairs of vehicles/bicycles		
Home repairs (painting, roofs, plastering)		
Kitchen utensils (pots, cups, cutlery, plates, spoons, etc.)		
Furniture (beds, tables, chairs, cartons, etc.)		
Petrol for vehicles		
Kerosene		
Detergents (soaps)		
Pomades		
Toothpaste		
Remittances/Gifts/Donations		

Item	Item purchased last week or month or last year for household consumption (please indicate whether for a week or month or year).	
	Yes = 1, No = 2	Purchased value (₦)
Festivals		
Funerals		
Agroservices (tractor hiring, spraying, threshing, etc.)		
Electricity bills		
Transportation (money spent on transport)		
Agrochemicals (herbicides, pesticides, etc.)		
Fertilizer		
Debts		

G. Farm-specific factors

G1. Kindly indicate the ownership type of the land you cultivate.

(a) Individual [ ] (b) Family [ ] (c) Community [ ]

(d) Rented [ ] (f) Other, specify:_____

G2. Kindly give a rough estimate of the total size of land cultivated by the household…….(ha)

G2. State the labor contribution of your family members during the last cropping season in the following farm operations and hired labor.

Operation	Family labor			Hired labor	
	Days used (no.)	Adult members (no.)	Children (no.)	Days (no.)	Persons hired (no.)
Land clearing					
Planting					
Weeding					
Fertilizing					
Spraying					
Harvesting					
Threshing					
Transportation					
Caring for livestock					

G4. Do you use modern farm inputs on your farm? (a) Yes [ ] (b) No [ ]

G5. If yes, which among the following farm inputs did you use on your farm last cropping season? (Tick as many as possible.)

(a) Improved seeds [ ] (b) Fertilizer [ ] (c) Agrochemicals [ ]

(d) Veterinary drugs [ ] (e) Livestock concentrates [ ]

G6. What is the distance between your village and the source of inputs?_____ km.

G7. How many times does your household eat the following food items in the past months? (Respond only on those eaten).

Item	No. daily	Or no. weekly	Or no. monthly	Or not eaten
Millet				
Sorghum				
Maize				
Rice				
Groundnut				
Beans				
Bread				
Egg				
Meat				
Fish				
Groundnut oil				
Butter				
Tea/beverages				
Fruits				
Vegetables				
Others (specify)				

2. GPS coordinates of the communities covered for Food Security and Poverty Survey, Borno State, Nigeria.

S/no	**Community**	**Latitude N**	**Longitude E**
1	Mbulatawiwi	12 05.989	10 25.974
2	Guwal	11 57.402	10 34.090
3	Vinadam	12 03.080	10 35.114
5	Tashan Alade	12 27.860	10 27.229
6	Maina hari	12 09.590	10 40.756
7	Tilla	12 08.303	10 32.977
8	Gusi	12 01.029	10 23.951
9	Kwajaffa	12 24.928	10 28.084
10.	Azare	12 16.686	10 31.927
11	Filinjirgi	12 12.559	10 34.938
12	Mbulamel	12 12.103	10 36.448
13.	Kidang	12 08.789	10 25.711
14	Ngwa	12 12.446	10 32.065
15	Kinging	12 13.852	10 32.841
16.	Damboa	12 45.613	11 09.338
17.	Sandia	12 48.793	11 13.547
18	Nzuda	12 44.019	11 07.263
19.	Azir	12 38.853	22 02.725
20.	Sabongari	12 27.268	10 48.590

[1] The gap has increased probably due to the adoption effects for those who have taken up the new IITA technologies.