
# Impact on household food security of promoting sustainable agriculture among farming households in Borno State, Nigeria

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*This paper evaluates the impact of the project Promoting Sustainable Agriculture in Borno (PROSAB) on the livelihoods of farming households in Borno State, Nigeria. Specifically, the paper identifies and provides information on farmers' adoption of improved crop varieties introduced by PROSAB, measures their adoption rates and food security levels, and analyses the factors that affect the households' food security status. The study used mainly primary data collected from a sample of 693 farming households in the study area. The analysis of data was carried out using descriptive statistics, Cost of Calorie calculations, and Logit regression techniques. The study results suggest that PROSAB has made a significant contribution towards improving the food security of households. In project intervention communities, food insecurity has been reduced from 58% in 2004 to 30% in 2015, indicating a 28% improvement in food security over the 11-year period. The paper clearly demonstrates how the adoption of crop technologies and crop management practices with linkages to markets has significantly contributed in improving households' food security. The paper recommends increased promotion of improved crop technologies, trainings delivered to farmers on such technologies, and policies that enhance farmers' access to inputs, credit, and output markets.*

*Acknowledegment: The authors acknowledge the following; i) Canadian International Development Agency (CIDA) for funding the research (2004-2009); ii) financial assistance from the funded N2Africa project; iii) the contribution of IITA as an institution for providing a conducive environment and various Scientists from IITA that were involved in delivering research for development technologies and farmers' training in the PROSAB project area, which had significantly increased crop yields, farmers' income and enhanced household food security and iv) the contribution of Scientists from the University of Maiduguri and Borno State Agricultural Development Programmes who are Collaborators in implementing the PROSAB project.*

**JEL Codes:** O13, C83

#1330

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## Abstract

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**Key words:** household; food security; sustainable agriculture; Nigeria

## 1. Introduction

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 (PROSAB), Nigeria from 2004 to 2009 with an objective of contributing to improving rural household livelihoods and food security in Borno State, Nigeria. This was implemented through the promotion of improved agricultural technologies and management practices, and capacity building of farmers in the use of technologies for sustainable agricultural production. The project's operational areas were *Biu, Damboa, Hawul, and Kwaya Kusar* Local Government Areas (LGAs). This study was conducted to assess the impact of the project's interventions on household food security. Food security has been defined in several ways with shifting paradigms over the years. According to Food and Agricultural Organization (FAO, 2009) food security is defined as a situation where, "everyone at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Definitions of food security have continued to evolve as concerns emerge over inequitable distribution and access to food not only within countries, but within households (Jones *et al.*, 2013). Food security is thus people-oriented and implies a situation in which all households have access both physical and economic to adequate food for all members and where households are not at risk of losing such access (World Bank, 2007; 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.

Food security is a global phenomenon, where about 852 million people are considered to be chronically hungry, while about 2 billion of the population lack food security intermittently, 6 million children die of hunger every year, and 17,000 everyday (Garnah *et al.,* 2013). In Nigeria, more than 65 per cent of the Nigerian population is said to be food insecure (Osagie, 2013). The most vulnerable group in Nigeria are the rural smallholder farmers, especially women and children in the marginal areas who don't have access to adequate quality of food they want. However, Household food security depends substantially on household income and asset (or wealth) status. Food security can, therefore, be seen to have social, economic, and political implications for any nation. Food insecurity is synonymous with not knowing from where your next meal is going to come (Wilson and Ramphale 1989). And, according to Slopen et.al. 2010; Bhattacharya et.al. 2004 and Olayemi, 1998 there is often a strong interrelationship between food insecurity and poverty.

Smallholder farmers constitute a majority of the working population in much of the developing world and tend to be stuck in patterns of semi-subsistence farming, unable to generate sufficient income to obtain access to key services to further their pathways out of poverty (Fowler and Dan 2015). One of the ways of increasing the welfare of farmers is the effective application of agricultural technologies in production. Technology adoption has a direct effect on the farmer's income, usually resulting from higher yields, higher prices, or both. According to the World Food Program (1998), the prospect of enhanced production offered by improved agricultural technologies is recognized as essential to improving the household food security of small-scale farmers. The promotion and adoption of improved agricultural technologies therefore offers an opportunity to increase production and income substantially and reduce food insecurity (Nata et al. 2014). Studies by (Diagne and Demont 2007; Dontsop-Nguezet et al. 2011) have shown the positive impact of technology adoption on household well-being and food security.

Following the inception of PROSAB in 2004 and its conclusion in 2009, it is important to evaluate the impact of the project on the improvement of food security among households in the project area. It will also guide the scaling up and scaling out of projects such as PROSAB in other parts of the savannah ecological zones of Nigeria. It is within this context that the study was planned.

The main objective was to carry out a comparative household food security analysis (*before* PROSAB)[1] using the baseline report as a benchmark and the *current* period (2015). The study also compared PROSAB and non-PROSAB communities in terms of their food security status. The specific objectives were as follows: examine the sample households' socioeconomic characteristics; compare their food insecurity status against the baseline data; compare the food security in PROSAB intervention with non-intervention communities of Borno State; and examine the determinants of household food security.

## 2. Study Methodology

### *The Study Area*

Borno State in north-eastern Nigeria covers an area of 69,435 km$^2$. The State ranges from the northern Guinea savannah in the southeast to the Sahel in the north, and a larger part of the State lies in the Sahelian zone.

[1] PROSAB baseline study report.

The annual rainfall ranges from 600 mm in the north to 1200 mm in the south and the growing season is 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 (Amaza et al. 2007, 2009). In the north, the major crops grown are millet, sorghum, and cowpea. In the southern savannahs, major crops are maize, sorghum, cowpea, groundnut, rice, and recently soybean.[2]

In Borno State, as in most places in northern Nigeria, food security depends on agricultural production. 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 this State are desertification and poverty. Desertification results in low yields from crops and the consequent food insecurity and misery which are common 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 over-cultivated. This has led often to permanent degradation in some areas. There are many factors that trigger desertification, including the unpredictable effects of drought, unsustainable land use (over-cultivation, overgrazing, and deforestation), fragile soils and erosion, nutrient mining, a growing population, and neglect by policymakers. 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 (Amaza et al. 2007).

The challenge 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.

***Sampling procedure, methods of data collection and analysis***

A multi-stage sampling technique was used to select respondents for the study. In the first stage, three local government areas (LGAs) in the PROSAB intervention communities were purposively selected as PROSAB project operational areas[3]. In these selected LGAs 17 PROSAB beneficiary communities and their corresponding non-beneficiaries (17 communities) were selected. The non-intervention (counterfactual) communities were selected for comparative analysis to assess the impact of the PROSAB intervention in promoting improved crop technologies and management practices among resource-poor farmers.

The stratified random sampling technique was used to select PROSAB and non-PROSAB participants in each LGA. Data were obtained through a random survey of 693 households in the selected communities (293 households in the PROSAB area and 400 households in the counterfactual area) in May/June 2015.[4] The main instruments for data collection were well-structured questionnaires administered on households by trained enumerators under the supervision of an Agricultural Economist from the Department of Agricultural Economics, University of Jos, Nigeria. Thus, the quality of data collected is good with desirable implications for data analysis.

[2] Soybean became a major commercial crop as a result of PROSAB's intervention in Agriculture in Borno State.
[3] Three LGAS (Biu, Hawul, and Kwaya Kusar) are PROSAB areas. Data were not collected from Damboa LGA because of insecurity.
[4] Data could not be collected in Damboa LGA due to the insecurity.

The baseline data and the *ex-post* assessment data were both collected for the same season (May/June) in 2004 and 2015, hence, variation in seasonality is plausibly minimal or non-existence. The questionnaire contained information on farm and farmer characteristics, market, credit, extension, and awareness/adoption of crop technologies. The pre-tested questionnaire was administered in June 2015 by trained enumerators. Data collected were entered using SPSS spreadsheet, while STATA version 10 was used for analysis. Data were analysed using descriptive statistics and the Logit regression model. Frequency counts, percentages, and mean computations were used to describe the variables in the study such as farm and farmer characteristics, as well as awareness and adoption rates of improved crop technologies.

***Estimation of the food insecurity line of households***

The food security measures were carried out for 2015 and compared with the 2004 baseline food security data to assess the impact of crop technologies, management practices, and market linkages delivered by the PROSAB project on households' food security. The second component of food security analysis was to compare the food security status for PROSAB communities where the use of improved crop varieties and management practices were directly promoted and with the situation in non-intervention communities.

For household food insecurity analysis, a combination of analytical tools was used. To analyse the food security status of households, a Cost-of-Calorie index was constructed, followed by the use of a Logit regression model to identify the major determinants of household food insecurity.

1. **Cost-of-Calorie Index**

The Cost-of-Calorie (COC) method proposed by Foster, Greer, and Thorbecke (1984) was used in this study to determine a threshold food security line. The cost-of-calorie intake as a measure of food security has been describe as time consuming and expensive as a measure of food security (Maxwell and Coates, 2013). Despite this limitation, the cost-of-calorie index has been used by many researchers (Burchi and De Muro, 2016; Maxwell, Coates and Vaitla, 2013; Smith and Subandarro, 2007) in recent years to assess household food security. The method yields a threshold value that is usually close to the minimum calorie requirement for human survival. Two steps, identification and aggregation, were involved in constructing the index. Identification is the process of defining a minimum level of nutrition necessary to maintain healthy living. This minimum level is referred to as the "food insecurity line". In the context of this study, the food insecurity line is the calorie level below which people are classified as being food insecure or are subsisting on inadequate nutrition in the study area. Calorie adequacy was estimated by dividing the estimated calorie supply for each household by the household size, adjusted for adult equivalent, and using the consumption factors for various age-sex configurations. This method has been applied in several studies with a main focus on food security (Hasan and Babu 1991)

Following the method, the food insecurity line is given as:

$$LnX = a + bC \quad (1)$$

Where, X is the adult equivalent food expenditure and C is the actual calorie consumption per adult equivalent in a household. The recommended minimum daily calorie requirement per adult equivalent (see FAO (1982) was used to determine the food insecurity line, using the equation:

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

Where,

S = the cost of buying the minimum calorie intake requirement (i.e., the food insecurity line);

a and b = parameter estimates in equation 3 above; and

L = recommended minimum daily calorie intake level[5]

Based on the calculated S, households were classified as being food-secure or food-insecure, depending on which side of the line they fell. But due to differences in household composition in terms of age and sex, there was a need to calculate the levels of expenditure required in households with different age-sex compositions. The approach used to achieve this was to divide household expenditure by household size to get the per capita expenditure as used by the World Bank (1996) and in several other studies (Hassan and Babu, 1991; Goni, 2005 and Amaza, et.al. 2007). The household expenditure was then decomposed on a per adult equivalent basis, using the conversion factor developed as adapted by Storck et al. (1991).

2. **Determinants of Food Insecurity**

The determinants of food insecurity of households were also analysed. For this, a Logit regression model was used. The model is presented as follows:

$$Y_i = g(I_i) \qquad (3)$$

$$I_i = b_o + \sum_{j=1}^{n} b_j X_{ji} \qquad (4)$$

Where $Y_i$ is the observed response for the $i^{th}$ household, it is a binary variable in which $Y_i = 0$ for a food secure household and $Y_i = 1$ for a food insecure household. $I_i$ is an underlying and unobserved stimulus index for the $i^{th}$ household. Conceptually, there is a critical threshold, $I_i^*$ for each household. If $I_i < I_i^*$, the household is observed to be food secure, but if $I_i \geq I_i^*$, the household is observed to be food insecure. Equation (3) states the functional

[5] The FAO-recommended minimum daily calorie requirement per adult equivalent is 2250 kcal.

relationship between the response ($Y_i$) and the stimulus index ($I_i$) which determines the probability of being food insecure. Equation (4) states that $I_i$ is, in turn, determined by a vector of explanatory variables ($X_i$).

The Logit model assumes that the underlying stimulus index ($I_i$) is a random variable which predicts the probability of being food insecure. Therefore, for the i[th] household,

$$I_i = \ln\frac{P}{1-P_i} = b_o + \sum_{j=1}^{n} b_j X_{ji} \qquad (5)$$

The relative effect of each explanatory variable ($X_{ji}$) on the probability of being food insecure is measured by differentiating $P_i$ with respect to $X_{ji}$, using the quotient rule (Green and Ng'ong'ola 1993).

Where;

P = is the probability that a household being food insecure equals the linear combination of the explanatory variables, and

$P_i$ = the probability of an i[th] household being food insecure.

That is:

$$\frac{dP_i}{dX_{ji}} = \left[\frac{e^{I_i}}{\left(1+e^{I_i}\right)^2}\right]\left[\frac{I_i}{X_{ji}}\right] \qquad (6)$$

Where,

| | | |
|---|---|---|
| $X_{i,}$ | = | which is the vector of explanatory variables in equations (6-8) is defined as follows. |
| AGE | = | Age of head of household (in years) |
| Mstatus | = | Marital status of household head |
| EDUC | = | Level of farmer's education (in years), assuming the farmer is the head of the household |
| HHSZ | = | Farmer's household size |
| CDR | = | Child dependency ratio |
| INCOME | = | Income of a household (in naira per annum) |
| ADOPTION | = | Adopted new maize crop technology, a binary variable where; D=1 if adopted and D=0 otherwise. |
| TRAINING | = | Received training on new crop management practices under PROSAB (D=1 if trained D=0 otherwise). |
| EXPERINCE | = | Years of farming experience |
| FARMSIZE | = | Farm size of a household (in ha) |
| PLOTS | = | Number of farm plots owned |
| INPUTS | = | Distance to input source (in km). |
| MARKET | = | Distance to nearest market (in km) |
| CREDIT | = | Household head's access to credit facilities (D=1 if there is access; D=0 otherwise). |

## 3. Results and Discussion

### 3.1 Access to and Control of Productive Resources

The respondents' access to and control of productive resources is presented (Table 1). On average, respondent household heads had an average of 22 years farming experience and owned an average of 4 farm plots with a total farm size of 4 ha. The number of farm plots owned by their spouses was relatively lower at approximately 3 plots, all presently under cultivation.

**Table 1: Access to and control of productive resources (2014)**

| **Variables** | PROSAB Intervention Area (n=292) | Non-intervention Area (n= 398) | Mean Difference (Intervention and Non-intervention) |
|---|---|---|---|
| No. of farm plots (mean) | 3.9 | 3.9 | 0.07 |
| Mean no. of farm plots under cultivation | 3.5 | 4.2 | -1.32 |
| Total farm size (ha) | 4.3 | 4.9 | 0.09*** |
| No. of farm plots owned spouse(s) | 2.5 | 1.4 | 1.07*** |
| No. of farm plots owned by spouse(s) presently under cultivation | 2.5 | 1.3 | 1.15*** |
| Mean farming experience (no. years) | 21.7 | 23.2 | -1.55 |

*** Significant at 0.01 level.
**Source:** Survey data, 2015.

However, significant differences exist in terms of total farm size, number of plots owned by spouse(s), and number of plots owned by spouse(s) currently under cultivation in the PROSAB intervention area compared with the non-PROSAB area (counterfactual). The significantly higher figures under PROSAB might have been influenced by the project intervention[6]. Increased yields of crops under PROSAB, as will be examined later, seem to have encouraged farmers to acquire and/or rent more land for crop production. In addition, under the PROSAB gender mainstreaming strategy, women farmers were empowered to have access to more productive resources, especially land. This had increased the average number of farm plots owned by women in PROSAB area which is twice as many as that of women in the non-intervention areas.

### 3.2 Type of crops grown

The type of crops grown by farmers and their average yields in kg/ha in the surveyed areas are presented (Table 2). The proportion of farmers that grew crops in in the intervention area had significantly increased between

[6] The PROSAB project focused on smallholder farmers that cultivated ≤5ha of farmland, excluding larger farms.

the time periods (i.e. 2004 and 2014). Similarly, there was significant differences in cowpea, maize and rice crops grown between groups of farmers in intervention and non-intervention areas. Maize is the most popular crop grown by farmers (96% in the PROSAB area and 88% in non-project areas). While among legumes, cowpea is the most favoured crop grown by 94% in the PROSAB areas and 87% in non-project areas.

**Table 2: Percentage Distribution of Crops grown in 2004 and 2014**

| **Crops** | **Baseline (Intervention area) 2004** | | **Intervention area (2014)** | | $\chi^2$ **test±** | **Non-intervention area (2014)** | | $\chi^2$ **test¥** |
|---|---|---|---|---|---|---|---|---|
| | **n** | % | **n** | % | | **n** | % | 0.087 |
| Cowpea | 30 | 2 | 274 | 94 | 0.000** | 347 | 87 | 0.043* |
| Groundnut | 627 | 31 | 175 | 60 | 0.043** | 289 | 72 | 0.953 |
| Soybean | 2 | 0.1 | 158 | 54 | 0.000** | 138 | 39 | 0.076 |
| Maize | 1,457 | **73** | 279 | **96** | 0.000** | 352 | **88** | 0.002** |
| Sorghum | 468 | 23 | 95 | 33 | 0.000** | 230 | 57 | 0.086 |
| Rice | 66 | 3 | 114 | 40 | 0.002** | 131 | 38 | 0.003** |
| Millet | 14 | 0.7 | 42 | 15 | 0.052** | 82 | 20 | 0.087 |

± Statistical significance over time (i.e. 2004 and 2014)
¥ Statistical significant difference between groups (Intervention area in 2014 and Non-Intervention area in 2014).
** Significant at 1%. * Significant 5%.
**Source:** Survey data, 2015.

The popularity of maize stems from the fact that this cereal is a basic staple in the surveyed areas. Hence, farmers grow the crop largely for household food security requirements. Cowpea is also a food crop that has a lot of commercial value, thus it is grown for subsistence consumption but largely for the market. Groundnut and soybean, the third and fourth important crops in the PROSAB area, are industrial crops mainly grown for commercial sales. The emergence of soybean as an important legume was largely influenced by the PROSAB project[7]. Prior to 2004, its production was non-existent on a commercial scale. The project however introduced the crop for improved soil fertility, control of the parasitic weed, *striga,* improved nutrition, and increased incomes through sales to industrial processors.

The increased popularity of cowpea, groundnut, and soybean might be attributed to the dissemination of improved varieties by the PROSAB project. In addition to sales most women add value to the groundnut and soybean they grow by processing them into oil and cake from groundnut and a range of other food products, such as soy milk and soy cake, from soybean. These are further sold and/or consumed by the households. Food processing accelerates agricultural production and promotes sustainable agricultural intensification (Ihekoronye and Uzomah, 2011). It offers opportunities for enterprising people to generate income and employment using locally available resources (Onwurafor and Enwelu, 2013).

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

### 3.3 Crop production and consumption in surveyed areas

The total area cropped is similar in all the surveyed areas (Table 3). However, there are major differences between crop yields in PROSAB and the counterfactual areas. Generally, yields in kg/ha are higher in the PROSAB area and significantly higher for cowpea, groundnut, maize, and rice than in non-PROSAB areas. The significantly higher yield may be as a result of the introduction of improved crop varieties and agronomic practices and their adoption by farmers in the PROSAB project area. Since the end of PROSAB in 2009, farmers in the PROSAB area continued to use improved crop varieties and crop management practices and these are reflected in the observed higher yields[8].

**Table 3: Selected household characteristics and yield of crops in kg/ha (2014)**

| | PROSAB Project Area | Non-PROSAB Project Area | % Difference (PROSAB and Non- Project Area) |
|---|---|---|---|
| Total area cropped (ha) | 4.3 | 4.2 | 2.3 |
| **Crop yield in kg/ha** | | | |
| Cowpea | 877 | 704 | 19.3** |
| Groundnut | 906 | 603 | 33.4** |
| Soybean | 1,022 | 942 | 7.7 |
| Maize | 1,325 | 1066 | 258** |
| Sorghum | 1,068 | 1024 | 19.5 |
| Rice | 1,101 | 762 | 30.8** |
| Millet | 959 | 937 | 2.3 |

** Significant at 1%. * Significant 5%.

**Source:** Survey data, 2015.

### 3.5 Awareness of crop technologies and management practices

In the adoption process, farmers must first of all be aware of the new technology, including its advantages, before they accept and adopt it. The frequency distribution of farmers' awareness of crop technologies and management practices promoted by PROSAB is presented (Table 4). The levels of awareness of most of the crop technologies are significantly high with over 70% among sampled farmers in PROSAB areas (with the exception of improved groundnut varieties).

**Table 4: Percentage distribution of farmers' awareness of crop technologies and management practices (2014)**

| Crop technologies and practices | PROSAB Area (n=292) | Non-PROSAB Area (n= 398) | $\chi^2$ test |
|---|---|---|---|
| Improved cowpea varieties | 87.4 | 58.8 | 0.05* |
| Improved groundnut varieties | 73.1 | 52.3 | 0.76 |
| Improved soybean varieties | 87.8 | 58.3 | 0.002** |
| Improved maize varieties | **92.5** | 52.3 | 0.001** |
| Cereal/legume rotations | 81.0 | 38.8 | 0.001** |
| Cereal/legume intercropping | 81.0 | 35.5 | 0.002** |
| Drilling fertilizer application | 90.5 | 0 | |
| Legume utilization | 61.0 | 0 | |

** Significant at 1%. * Significant 5%.

**Source:** Survey data, 2015.

[8] Average yields realized by farmers in the survey.

On the other hand, in the non-PROSAB areas, the proportions of farmers that were aware of crop technologies and management practices were considerably lower, generally ranging from 36% to 59% among sampled farmers. The level of awareness of these farmers could have been created through farmer-to-farmer sharing of information by farmers in PROSAB intervention communities with farmers in non-PROSAB communities. Farmer-to-farmer extension is an informal system in which an individual farmer in a community assists other farmers by sharing information on improved technologies. Such information sharing is critical to adoption and facilitates the use and therefore the adoption of technologies. This factor plausibly influenced the awareness of the crop technologies and management practices in the non-intervention project areas.

In the intervention area, the rates of adoption are significantly higher, as expected, for all the crop technologies and management practices adopted by males, females, and the youth (Table 5). There are generally high adoption rates of improved groundnut (76%), soybean (83%) and legume specific fertilizer (71%) by female farmers. Improved maize was adopted by males (87%), both females and young people (91%). These high adoption rates, for example, of improved maize, are in conformity with an adoption rate of 84% in 2008 reported by Ellis-Jones et. al. (2009) in the PROSAB area. However, in most cases the adoption rates for the other improved crop varieties in the 2015 survey exceed adoption rates for improved soybean (63%), improved rice (50%), improved cowpea (28%), improved groundnut (25%), and improved sorghum (8%) as reported by Ellis-Jones et. al. (2009). This suggests that since the end of the project in 2009, farmers in PROSAB areas have increasingly adopted improved crop varieties and have been sustainably planting them. The sustainable use of the improved varieties hinges on the fact that farmers had access to these improved varieties largely through JIRKUR Seed Producers Cooperative domiciled in the project area[9].

The relatively high rates of adoption of cereal/legume rotation and cereal/legume intercropping, especially by women, are associated with the farmers' preferred cropping system of growing legumes, especially cowpea and groundnut, as an intercrop with cereals such as maize, sorghum, or millet.

The project had a gender mainstreaming strategy to address the many constraints facing women in Borno with the aim of reducing gender inequalities (Tegbaru et al. 2010). During the 5 years of implementation, the project created gender awareness among the project staff and participants, including the technical capacity to undertake gender analyses, planning, and implementation. Female-led community-based organisations, lead farmers, and seed producers emerged and support from the project strengthened the capacities of women as leaders. The project went beyond simple quantification of participation and produced clear evidence of women's innovation as well as indications of reductions in gender inequality in terms of income distribution, engagement, and participation in development, access to property rights and leadership (Gurung et al. 2009).

[9] The seed cooperative emerged from a group of seed farmers that was trained by PROSAB.

**Table 5: Comparison of adoption rates of improved crop technologies and management practices among PROSAB and non-PROSAB farmers disaggregated by gender (percentage of farmers) (2014)**

| **Crop technologies** | **PROSAB Area** | | | | **Non-PROSAB Area** | | | | **All** |
|---|---|---|---|---|---|---|---|---|---|
| | Male | **Female** | Youth | $\chi^2$ **test** | Male | **Female** | Youth | $\chi^2$ **test** | $\chi^2$ **test** |
| Improved cowpea varieties | 59.7 | 73.8 | 60.8 | 0.076 | 13.7 | 16.0 | 9.5 | 0.067 | 0.001** |
| Improved groundnut varieties | 45.1 | 76.2 | 43.2 | 0.054* | 5.7 | 6.0 | 5.2 | 0.087 | 0.000** |
| Improved soybean varieties | 53.4 | 83.3 | 59.5 | 0.032* | 19.7 | 14.0 | 14.7 | 0.0876 | 0.000** |
| Improved maize varieties | 87.4 | 90.5 | 90.5 | 0.867 | 12.3 | 10.0 | 8.6 | 0.0654 | 0.000** |
| Improved rice varieties | 48.2 | 76.2 | 44.6 | 0.56 | 7.1 | 6.0 | 6.0 | 0.45 | 0.000** |
| Improved sorghum varieties | 28.9 | 42.9 | 25.7 | 0.096 | 3.1 | 0.0 | 2.6 | 0.54 | 0.000** |
| Legume-specific fertilizer | 39.5 | 71.4 | 29.7 | 0.056* | 4.9 | 2.0 | 4.3 | 0.543 | 0.000** |
| Cereal/legume rotations | 61.3 | 78.6 | 55.4 | 0.075 | 5.4 | 2.0 | 4.3 | 0.765 | 0.000** |
| Cereal/legume intercropping | 62.5 | 78.6 | 60.8 | 0.0765 | 7.4 | 6.0 | 4.3 | 0.654 | 0.000** |
| Drilling fertilizer application | 24.9 | 54.8 | 21.6 | 0.056 | 2.3 | 4.0 | 0.0 | 0.54 | 0.052* |
| Legume utilization | 26.5 | 61.9 | 18.9 | 0.076 | 2.3 | 2.0 | 2.6 | 0.65 | 0.050* |

** Significant at 1%. * Significant 5%.

**Source:** Survey data, 2015.

In the non-intervention areas the adoption rates were generally considerably lower, ranging from zero to 20%. The significantly low rates are not unexpected, given the relatively lower levels of awareness about crop technologies among farmers in the non-project areas. It is highly plausible that the adoption rates of the respective technologies and management practices in the non-intervention areas, without any PROSAB promotional efforts, might have been influenced by farmer-to-farmer technology transfer to farmers outside the project area or non-intervention communities.

### 3.6 Household Food Security

This section presents the results of the household food insecurity carried out in the study, based on the model developed and earlier presented in section 2. It begins by presenting the food security statistics and impact of crop technologies, management practices, and market linkages delivered by PROSAB on households' food security in the study areas.

***Household Food Insecurity Statistics***

The summary statistics on the food insecurity status of households are presented (Table 6). Based on the FAO-recommended daily energy level (L) of 2250 kilocalories, the food insecurity threshold or line (S) was found to be ₦2814 for the households in the PROSAB area per month per adult equivalent and ₦1996 for the non-intervention area. Using the defined food insecurity line, it was found that 30% of all households sampled in the PROSAB areas and 62% in non-intervention areas were food insecure by headcount or population (H). Furthermore, the estimated aggregate income gap (G), the amounts by which food insecure households were below the minimum expenditure level required to meet their basic food needs were ₦400 in the PROSAB areas and ₦586 in non-intervention areas.

**Table 6: Summary statistics on food insecurity among households in the PROSAB and non-PROSAB areas (2015)**

| **Measures** | **PROSAB** | **non-PROSAB** | Mean Difference (Intervention and Non-intervention) |
|---|---|---|---|
| FAO recommended daily energy level (L) | **2250 kcal** | | |
| Food insecurity line Z (cost of the minimum energy requirement/adult equivalent)/month | ₦ 2,814 | ₦1,996 | 818.00** |
| Head count (H) food insecurity index: | 0.301 | 0.616 | -0.32* |
| Food insecure households (%) | 30 | 62 | -32.00** |
| Food secure households (%) | 70 | 38 | 32.00* |
| Aggregate income gap (G) | -399.78 | -585.52 | 185.74** |

** Significant at 1%. * Significant 5%.
**Source:** Survey results computation, 2015.

**Impact of project intervention on household food security**

The impact of improved crop technologies, management practices, and linkages to inputs and output markets promoted by the PROSAB project is examined with regard to food security. This was done by first comparing households' food security status before the start of the PROSAB project (2004) and after the end of the project (2015). The eleven (11) years' time lag is long enough for this impact factor to be assessed.

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

The first component of the food security impact analysis was to compare the food security status of households in PROSAB area (i.e., with intervention) with households in non-intervention area (i.e., without intervention). A comparison of the results of the food security measures for PROSAB and non-PROSAB communities in 2015 are presented Table 6. Food insecurity lines of ₦2,814 were estimated from households in PROSAB communities and of ₦1,996 from households in the non-PROSAB 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 of 62% in the non-participating communities. Based on these food insecurity lines, 30% of households were classified as food insecure in the participating communities and 62% of households in the non-participating communities. The 62% food insecurity status of households in the non-intervention area is marginally higher than the estimated 61% food insecurity status reported in the earlier study of the impact of PROSAB by Amaza et al. (2009). This suggests that over the past six years, households in non-intervention project area have experienced only slight changes in their food security status. This is plausible as households in non-intervention areas have largely been using local crop technologies and traditional crop management practices which have limited contribution to their improved food security.

**Table 7: Food insecurity status before and after the intervention.**

| **Measures** | **Before PROSAB (2004)** | **PROSAB (2008)** | **After PROSAB (2015)** | **% change (2004-2015)** |
|---|---|---|---|---|
| FAO recommended daily energy level (L) | | **2250 Kcal** | | |
| Food insecurity line Z (cost of the minimum energy requirement/adult equivalent)/month | ₦1975 | ₦ 2161 | ₦ 2,814 | +30.9 |
| Head count (H) food insecurity index: | 0.58 | 0.49 | 0.30 | -18.0 |
| **Food insecure households (%)** | 58 | 49 | 30 | -28.0 |
| **Food secure households (%)** | 42 | 51 | 70 | +28.0 |
| Aggregate income gap (G) | –375.74 | –1108.35 | -399.78 | +6.0 |

**Sources:** Amaza et al. 2009.
Survey results computation 2015.

***Food security before, during PROSAB and after PROSAB intervention in project communities***

The second level of analysis was to assess and compare food security measures among households in the intervention area in 2004 (i.e. before PROSAB), during PROSAB implementation (2008) and six years after PROSAB has ended (2015) as presented in Table 7. The results for the comparison of food security measures revealed progressive positive changes in levels of food security. The cost of the minimum basic food requirement–the food insecurity line–which was ₦1,975/month per adult equivalent in 2004 had risen to ₦2,161/month (2008) and to ₦ 2,814/month (2014). Using the defined food insecurity lines it was found that the number of all sampled households that were food insecure by head count (58% in 2004) had declined to 49% in 2008 with a further decline to 30% in 2015. This suggests that the proportion of households in the PROSAB intervention area that were food secure had increased by 28% over the period between 2004 and 2015.

***Determinants of Household Food Insecurity***

The various variables included as the determinants of household food insecurity in the Logit regression model used were as defined earlier. The results of the Logit regression analysis are presented (Table 8).

**Table 8: Result of the Logit regression analysis of household food security status (2015)**

| **Variable** | **Effects on food security status** | **Marginal effects on food security status** |
|---|---|---|
| | Estimated Coefficients | Estimated Coefficients |
| Constant | 8.174** | NA |
| Participation in PROSAB | 3.093*** (6.62) | 0.179 |
| Gender | 0.0208 (0.70) | 0.193 |
| Age | 0.822** (2.76) | 0.060 |
| Education | 1.536** (2.50) | 0.083 |
| Household size | -0.926** (2.17) | -0.052 |
| Child dependency ratio | 2.947** (2.03) | 0.166 |
| Annual income | 1.497** (2.56) | 0.069 |
| Adoption of new maize crop technologies | 3.299** (2.14) | 0.207 |
| Received training on new crop technologies | 1.836** (2.85) | 0.097 |
| Farming experience | 1.942***(4.34) | 0.715 |
| Farm size in ha | 1.308** (2.14) | 0.118 |
| Number of plots owned | 2.971** (2.07) | 0.098 |
| Distance to source of inputs | 1.572** (2.87) | 0.166 |
| Distance to market | 0.822** (2.76) | 0.646 |
| Access to credit | 1.118*** (3.02) | 0.337 |
| Number of observations | 693 | |
| LR Chi2 (14) | 402.54 | |
| Log likelihood | -106.51 | |
| Pseudo R-square | 0.654 | |

Source: Regressions results, 2015.

**Notes**: Numbers in parentheses are Z values for each coefficient.

*** Statistical significance at 1%; ** at 5%; NA = Not available.

From the Logit analysis, 14 regression coefficients were found to be statistically significant at $p \leq 0.05$ (i.e., at 5% level or below). However, some variables which were earlier included in the model were dropped from the analysis because of the problem of multicollinearity.

The result shows that the significant determinants of household food insecurity in the PROSAB area were participation in the PROSAB project, age, level of formal education, household size, child dependency ratio, annual income, adoption of new maize crop technologies, received training on new crop technologies, farming experience, household farm size, number of farm plots owned, distance to source of inputs, distance to market and household's access to credit.

**Participation in PROSAB**: The coefficient of participation in PROSAB project is highly significant ($P<0.01$) with a marginal effect of 18%, implying that as household heads that participated in PROSAB project, there is a probability that their food security will increase by 18%. Households that participated in PROSAB activities are less likely to be food insecure compared to those that have not participated. These results are associated with access to improved crop technologies, 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 availability of food and increased incomes.

**Age:** The coefficient of age had a positive effect, indicating that older household heads tend to be more food secure. Such households tend to have larger household sizes that contribute to household production and incomes that tend to have a positive influence on the level of food security.

**Education:** The coefficient of education variable is statistically significant ($P<0.05$) and carries a positive sign, thus suggesting that the higher the educational level of the head of a household, the more food secure (or less food insecure) the household tended to be, and vice versa. This is expected, since level of education should positively affect income-earning capacity and the level of efficiency in managing household food resources.

**Household size**: This had a positive effect on food security. 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.

**Child dependency ratio:** Similarly, the child dependency ratio was found to have positively affected the food security status of the households in the area. The coefficient of this variable was positive (2.747) and significant ($P<0.05$). The positive coefficient implies that one unit increase in the child dependency ratio would improve the probability of food security by approximately 2.7 in an average household in the area. This is unexpected *a priori*. However, it suggests that children contribute to household food security by contributing their labour in farming activities such as planting, weeding, harvesting of crops, and so on. This is plausible as the survey was carried out at a time when public schools at both primary and secondary levels in Borno State were closed owing to the insecurity problem caused by *Boko haram* insurgency[10]. This situation implies that children who hitherto were in schools became available to work on farms, thus contributing to household food security.

**Household annual income:** This also has a positive impact on the food security of the household. The coefficient of this variable was positive (1.497) and significant at $P<0.05$. The positive coefficient implies that 1-% increase in household income would improve the probability of food security by approximately 1.5 in an average

[10] Public schools at primary and secondary levels have been closed for 2 years in the State.

household in the area. 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.

**Adoption of new maize crop technologies**: This variable also had a positive effect on household food security. The survey results revealed that over 93% of households in the PROSAB areas and 52% in non-intervention areas have adopted improved maize in particular and maize is commonly consumed by households in the survey areas. The adoption of new maize crop varieties tends to increase crop yield/ha thus improving household food security. Similarly, households that received training on the new technologies would be likely to be food secure. This suggests that the project's activities, such as training farmers on crop management practices, marketing, farmers' adoption of improved maize crop varieties and their links to inputs and output markets and so on, positively contributed to enhancing food security.

**Farming experience**: The coefficient of this variable is statistically significant ($P<0.05$) and carries a positive sign, thus suggesting that the greater the farming experience of the household head, the more food secure the household tended to be, and vice versa. This is as expected since the level of experience of the household head is expected to position the household's farming activities in forecasting the future in the face of changing climate/weather variability. Also, these farmers that have more years of farming experience and have accumulated knowledge through learning-by-doing and this tends to have a positive effect on productivity leading to increased output and improved food security.

**The total farm size of a household:** This is another significant determinant of food security status. The coefficient of the variable is positive and statistically significant at 5% level, meaning that farm size exhibits a positive relationship with the food security status of a household. That is, households with larger farm sizes tend to be more food secure than those with smaller sizes, and vice versa. As household farm size increases, the probability of household food security tends to rise.

**Number of plots owned:** The coefficient of number of plots owned by the household is positive and significant ($P<0.05$). This imply that the more plots owned by the household the more food secure the housed tended to be, and vice versa. Households who have more farm plots are prone to grow diverse crops for both own household food consumption and for market sales. This tend to enhance their household food security and food diversity.

**Distance to source of inputs:** The coefficient of distance to inputs market is positive and significant at 5% level. This underscores the importance that inputs have in improving household food security. The distance to the source of inputs, such as fertiliser, has implications for expenditure on food production. The positive coefficient suggests that farmers who have a longer travel distance to the source for inputs tend to be more food secure and vice-versa.

**Distance to output market:** The distance to output markets has shown strong positive significance with food security at 5% level. The longer the distance to output markets, the more food secure the household. This is plausible as households that are further to output markets (mostly urban and semi-urban markets) have relatively higher commodity prices than found in rural markets. Consequently, farmers who travel longer distances to such markets earn higher net incomes from the sales of crops with greater potential to purchase more and/or produce diversified food for household consumption.

**Household head's access to credit:** The coefficient is positive and highly significant (P<0.01). Households whose heads had access to credit facilities had a higher level of food security than those whose heads did not. This might be due to the fact that those households with access to credit were able to acquire more productive resources for their enterprises. This would subsequently enhance income-generating ability and household welfare. This variable has an intercept dummy of 1.118, meaning that the autonomous food security status of households whose heads had access to credit facilities was, on average, higher by 1.118 than that of households without access.

## 4. Conclusion

The PROSAB project has made a significant positive impact on a number of outcomes among households in the project communities. These include improvement in crop productivity, incomes, and food security. PROSAB used a participatory approach to promote improved varieties of cereals and legumes along with agronomic practices that had a positive impact on crop yields and incomes. The survey results indicated that PROSAB has been successful in significantly increasing crop yields and farmers' incomes in the communities where it worked.

This study reveals that PROSAB has also made a significant impact to improving food security. In project communities, food insecurity has been reduced by 28% from 58% in 2004 to 30% in 2015. In addition, the comparison of PROSAB and non-PROSAB communities in 2015 showed that food insecurity is higher (62%) in communities where PROSAB had no interventions compared with PROSAB communities (30%). These positive changes in the food security status of households are attributed to the gains derived from intervention, especially the increases in the levels achieved in crop productivity and household incomes.

Also, regression analysis suggested that participation in PROSAB activities had a positive and statistically significant effect on household food security status. Households that participated in PROSAB activities had a 28% increase in the probability of being food secure, according to our results.

Several factors played a significant role in the success of PROSAB, including the IITA technologies promoted, the trainings delivered to farmers, the links between farmers and markets, especially output markets for the sales of crops, 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 endeavoured to measure the impacts since the project started in these communities eleven years ago and then compared them with outcomes in non-participating communities.

Based on the findings of this study, a number of policy recommendations are suggested. The adoption of new crop technologies and the trainings delivered to farmers on such technologies were found to have a strong influence in improving household food security. This underscores the importance of promoting improved crop technologies and strengthening farmers' education. Other significant policy interventions included enhancing farmers' access to inputs, credit, and output markets that facilitated the adoption of crop technologies, increasing crop yields and the availability of food for household consumption and the market.

**Acknowledgement**

The authors acknowledge the following; i) Canadian International Development Agency (CIDA) for funding the initial research in PROSAB project area (2004-2009); ii) financial assistance for the study from the funded N2Africa project by the Bill and Melinda Gates Foundation; iii) the contribution of IITA as an institution for providing a conducive environment and various Scientists from IITA that were involved in delivering research for development technologies and farmers' training in the PROSAB project area, which had significantly increased crop yields, farmers' income and enhanced household food security and iv) the contribution of Scientists from the University of Maiduguri and Borno State Agricultural Development Programmes who are Collaborators in implementing the PROSAB project

**Conflict of Interest:**
**There is no potential conflict of interest from publishing this article.**

**REFERENCES**

A-shami, H. G. (1996). *The attainment of national and global food security*, FAO experience, Abuja, Nigeria.

Amaza, P. S., Olayemi, J. K. Adejobi, A. O., Bila, Y., Iheanacho, A. (2007). *Baseline socioeconomic survey report: agriculture in Borno State, Nigeria*. IITA, Ibadan, Nigeria. 84 pp.

Amaza, P., Abdoulaye, T., Kwaghe, P., Tegbaru. A. (2009). *Changes in household food security and poverty status in PROSAB area of Southern Borno State, Nigeria.* IITA, Ibadan, Nigeria. 51 pp.

Bhattacharya, Jayanta; Janet Currie, and Steven Haider *(2004)* Poverty, food insecurity, and nutritional outcomes in children and adults, *Journal of Health Economics,* 23, (4) 839–862

Burchi, Francesco and De Muro, Pasquale (2016) From food availability to nutritional capabilities: Advancing food security analysis, *Food Policy,* 60, 10-19

Diagne, A., and Demont, M. (2007). Taking a new look at empirical model of adoption: average treatment effect estimation of adoption rates and their determinants. *Agricultural Economics*, 37: 201–210.

Dontsop-Nguezet, P. M., Diagne, A., Okoruwa, V.O., Ojehomon, V.E.T. (2011). Impact of improved rice technology adoption (NERICA varieties) on income and poverty among rice farming households in Nigeria: A Local Average Treatment Effect (LATE) Approach. *Quarterly Journal of International Agriculture,* 50 (3), 267–291.

Ellis-Jones, J., Amaza, P., Abdoulaye, T. (2009). An early assessment of adoption and impact of PROSAB's activities. In *Proceedings of a Stakeholder Conference, Sharing Experiences,* 1-2 September 2009. Maiduguri, Borno State, Nigeria. PROSAB.

FAO (Food and Agriculture Organization) (2009). Declaration of the World Food Summit on Food, Rome, 16-18 November FAO, Rome, Italy.

FAO (Food and Agriculture Organization) (1982). Food Consumption Tables for the Near East. *Food and Nutrition Paper 20.* Rome, Italy. FAO.

FAO. (1995). *A fairer future for rural women.* Rome, Italy. FAO.

Food Basket Foundation International. (1995). Nutrient Composition of Commonly Eaten Foods in Nigeria-Raw, Processed and Prepared.

Foster, J., Greer, J., Thorbecke, E. (1984). A class of decomposable poverty measure, *Econometrica,* 52, 761–766.

Fowler, B., & Dan, W. (2015). Scaling impact: improving smallholder farmers' beneficial access to output markets. *USAID. LEO Report No. 19*

Green, D.A.G. and Ng'ong'ola, D.H. 1993. Factors Affecting Fertilizer Adoption in Less Developed Countries: An Application of Multivariate Logistic Analysis in Malawi, *Journal of Agricultural Economics*, vol. 44, No. 1. Pp 611-25

Gernah, D. I., Ukeyima, M. T., Ikya, J. K., Ode, F. K., and Ogunbande, B. J. 2013. Addressing Food Security Challenges through Agro Raw Materials Processing. *Agricultural Science Research Journal 3: 6-13*

Gurung, B., Adamu, M., Samuel, M., Tegbaru, A., Gadzama, R., Gayya, I., Pindar, H. (2009). *Assessing the Gender mainstreaming Strategy for Promoting Sustainable Agriculture in Borno State (PROSAB).* Ibadan, Nigeria, IITA. 20 pp.

Gwary, M. (2008). Evaluation of the effectiveness of Participatory research and extension approach in promoting sustainable agriculture in Borno State, Nigeria. Department of Agricultural Economics & Extension, University of Maiduguri. 197 pp.

Hassan, R. M., & Babu, S. C. (1991). Measurement and Determinants of Rural Poverty: Household Consumption Patterns and Food Poverty in Rural Sudan. *Food policy,* 16, (6), December.

Ihekoronye, A. I., & Uzomah, A. (2011). Manual on small-scale food processing. A guide to opportunities for enterprise development in small scale food processing. Springfield publishers Ltd, P.3

Jones, A. D., Francis. M., Ngure, G. and Young, S. L. 2013. What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics1, 2 *American Society for Nutrition. Adv. Nutr. 4: 481–505; doi:10.3945/an.113.004119*

Smith, Lisa C., and Ali Subandoro. 2007. Measuring Food Security Using Household Expenditure Surveys. Food Security in Practice technical guide series. International Food Policy Research Institute, Washington, D.C.:

Maxwell, Daniel, Jennifer Coates and Bapu Vaitla (2013).How do different indicators of household food security compare? Empirical evidence from Tigray, Feisten International Centre, Tufts University, Somerville, USA.

Mohammed, I., Wojciech, J. F., Shashidhar K. (2012). The Determinants of Farmer Adoption of Improved Peanut Varieties and their Impact on Farm Income: Evidence from Northern Ghana. Agricultural and Applied Economics Association Annual Meeting, Seattle, WA, August 12-14, 2012

Nata, J. F., Mjelde, J. W., Boadu, F. O. (2014). Household adoption of soil-improving practices and food insecurity in Ghana. *Agriculture & Food Security* 3(1), 17

Nweke, F. L., & Akorhe, I. A. (2002). Adoption behaviour of farmers towards yam mini sets technology in Imo State Nigeria. 25th annual conference of Agricultural Science Society of Nigeria. Federal University of Technology Owerri, pp 18–21.

Olayemi, J. K. (1998). Food security in Nigeria. *Research Report No. 2*. Ibadan, Nigeria. Development Policy Centre. 85 pp.

Onwurafore, U. I., & Enwelu, I. A. (2013). Rural women entrepreneurship in agro-food processing in Enugu State, *Nigeria International Journal of Research in Applied, Natural and Social Sciences,* 1 (2), 13–30.

Osagie, C. (2013), "Fear of Food Insecurity Grips Nigeria," Saturday This Day, November 8, P. 24.

Slopen, Natalie; Garrett Fitzmaurice, David R. Williams, Stephen E. Gilman (2010) Poverty, Food Insecurity, and the Behavior for Childhood Internalizing and Externalizing Disorders, *Journal of the American Academy of Child and Adolescent Psychiatry,* vol. 49, 444-452

Smith, Lisa C., and Ali Subandoro. 2007. Measuring Food Security Using Household Expenditure Surveys. Food Security in Practice technical guide series. International Food Policy Research Institute, Washington, D.C.

Storck, H., Emana, B., Adenew, B., Borowiecki, A. W/Hawariat, S. (1991). Farming Systems and Farm Management Practices of Small Holders in the Hararghe Highlands". In Doppler, W. (ed). *Farming Systems and Resource Economics in the Tropics*.

Talabi, A. E. (1996). Implementation of national food security programme: experience so far. Pages 67–73 *in* Proceedings of the Strategic Grains Reserve Programme: Nucleus for National Food Security. Abuja, Nigeria. Federal Ministry of Agriculture

Tegbaru, A., Fitzsimons, J., Gurung, B., Hambly Odame, H. (2010). Change in gender relations: Managerial and transformative approaches of gender mainstreaming in agriculture. *Journal of Food, Agriculture and Environment.* 8 (3&4), 1024–1032.

Wilson, F., & Ramphele, M. (1989). Uprooting poverty: the South African Challenge. David Philip, Cape Town, Republic of South Africa.

World Bank (2007). World Development Report. Von Braun, J. (2007). *The world food situation: new driving forces and required actions*. Intl Food Policy Res Inst.

World Bank. (1996). *Nigeria: Poverty in the Midst of Plenty. The Challenge of Growth with Inclusion*. A World Bank Poverty Assessment. Population and Human Resources Division, West Africa Department, Africa Region. Report No. 14733 UNI.

World Food Programme. (1998). Food aid to support technology adoption among small scale Agriculturists. Rome, Italy, WFP,