The adoption of soybean in northern Nigeria: The case of Kaduna State

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Executive Summary

This study measured the level of soybean adoption in northern and southern Kaduna State. Adoption for the purpose of this study is defined as when farmers grow varieties promoted by the N2Africa project. The varieties include TGX1835 (Danwuri), TGX1951-3F, TGX1955-4F, TGX1448-2E, and TGX1904-6F. Multistage sampling was used in this study and 800 farmers were sampled for the study.

Socioeconomic characteristics

Results showed that farmers in southern Kaduna (38.5) were younger than those in northern Kaduna (40). The predominance of male-headed households was true for both northern and southern Kaduna, with the north having 91% of men heading households as against 85.5% of men in the south. Households in both regions were large sized with an average household size of eight members in southern Kaduna and an average of 8.5 in northern Kaduna. Differences in farming experience between respondents in both areas were not very high as respondents in northern Kaduna had on average 17.51 years of farming experience while those in the southern Kaduna had on average 16.4 years of experience. The results also showed that farmers in both regions had approximately 3 ha of farmland with southern Kaduna having a slightly higher farm size (3.19 ha) than those in the north (2.9 ha). Household heads in northern Kaduna had a higher rate of illiteracy (28.9%) than those in southern Kaduna (15.85%). However, in northern Kaduna and in Ikara in particular, the rate of respondents who had university education was much higher (17.25%) than those in southern Kaduna (2.8%).

Adoption of new soybean varieties

The most recent adoption rate for 2017 shows that approximately 84.85% of farmers in southern Kaduna and 72.8% of farmers in northern Kaduna have adopted varieties promoted by N2Africa. The most adopted varieties are TGX1951-3F with 26.5% adoption rate and TGX1448-2E with a 24.8% adoption rate. TGX1951-3F is the most popular in Chikun, Kajuru, and Igabi while TGX14482E is more popular in Ikara. The extent of adoption is higher in southern Kaduna as 55% of farmlands was devoted to the production of soybean in southern Kaduna while 14.85% of farmland was devoted to the production of soybean in northern Kaduna. The results reveal that the use of rhizobium inoculants was much more widespread in the southern (52%) part of the state than in the north (19.65%). The use of chemical fertilizer was much higher in northern Kaduna (45%) than in southern Kaduna (21.05%). This may be because the soils in the north have a greater deficiency of phosphorus and other essential nutrients. In both regions the lack of seeds was the greatest constraint to adoption reported by non-adopters of the varieties. According to the results of the probit component (selection or first stage) of the double hurdle model, age, membership of association, farm size, and farm experience all had a positive and significant effect on adoption. Also, the results of the Tobit component (second stage) of the double hurdle model show that gender, age, membership of association, farm experience, extension contact, and pesticide application all had a positive and significant effect on the intensity or extent of adoption.

Conclusion and Recommendations

Policymakers must do more to ensure that farmers have regular contact with extension agents. A performance-based system in conjunction with frequent monitoring of the performance of extension agents must be made. This is especially crucial just before the planting season and during the planting period. Extension agents can be made to give weekly reports on their activities supported by evidence in the form of audio recordings and GPS coordinates. Policymakers must ensure that female farmers have access to factors of production such as land and capital for them to expand their productivity, have higher farm incomes, and enable them to escape poverty. Access to credit was

an important factor that determined adoption of improved varieties. Thus, policymakers must strive to ensure that farmers with capital deficit have access to credit to purchase new seeds and other inputs. More has to be done to bring about microfinance schemes and rotating savings and credit associations. Other forms of peer-to-peer banking should also be introduced to help farmers with capital deficit.

Introduction

Background of the Study

Soybean, although a relatively new crop in sub-Saharan Africa (SSA), is increasingly becoming an important crop cultivated for the livelihood of a large population of farmers in SSA. The advantages of soybean, which make it attractive to farmers in this part of the world, are well documented. It has high market demand, thus providing a source of cash income for rural agricultural households. Soybean therefore holds considerable potential to increase farm income and reduce rural poverty in SSA. Soybean's additional importance lies in its capacity to improve the fertility of the soil. The improved soybean varieties can nodulate and, in association with native rhizobia, fix nitrogen in the soil (Onyube et al. 2003). Some varieties fix 44 to 103 kg N/ha annually (Sanginga et al. 2003). When rotated with cereal crops such as maize, substantial yield benefits are obtained from the crop. The cereal tends to copiously benefit from the surplus nitrogen left in the soil after harvesting the soybean. In addition to this, soybean can control *Striga*, a parasitic weed that poses a serious problem on cereal fields.

Soybean is an important source of protein containing high quality, affordable protein estimated at between 35 and 40% of total crop mass (Onyube et al. 2006; Greenberg and Hartung 1998). Soybean is used as human food, animal feed/fodder, oil, and an industrial crop. As human food, it is used in the preparation of diversified local recipes including soyflour, soybread, soycake, and soymilk, and some locally named recipes.

In Nigeria, soybean production is gaining increasing importance with the crop now being cultivated in almost all ecologies, but with the greatest potential in the Guinea savannas. The main growing states include Benue, Kaduna, and Katsina. Studies have revealed that Nigeria is the biggest soybean producing country in SSA in terms of both area cultivated and production level (Coulibaly et al. 2009). Between 1990 and 2007, Nigeria cultivated an average area of 564,927 ha of soybean and produced an average of 176,954 tons (t) (Coulibaly et al. 2009).

Kaduna is one of the most important states for soybean production. The State lies in the Guinea savanna where rainfall and soil conditions are suitable for soybean production. In the southern part of the State, Kaduna city offers opportunities for the marketing of grain because of the presence of many aggregators for bulk marketing. In addition, a large feed mill processing plant is located about 25 km from Kaduna City. The mill, established by OLAM Agro-chemical Company, has processed about 150,000 t of soybean per year in the last two years. This has created an unprecedented demand for soybean grain. In northern Kaduna, soybean generally yields well (Kamara et al. 2014). There are pockets of small-scale processors in Zaria such as Sunseed Company. Northern Kaduna is also close to Kano City where there are several soybean processing companies. Kano City is host to the largest grain market (Dawano Market) in West Africa and yield increasing inputs such as fertilizer and good seed are readily available in Kaduna State. All these processing and grain marketing opportunities make Kaduna among the largest producers of soybean. Despite the seeming importance of soybean production in Kaduna State, cultural differences between the northern and southern parts of the State may influence adoption of soybean production technologies. The north is largely dominated by Muslims while the south is populated largely by Christians. Access to education, family size, and age of farming population may vary between the two regions.

Despite these numerous advantages, there are several constraints that limit soybean production and adoption among small-scale farmers in the savannas of West Africa. These include poor soil fertility, pests and diseases, and drought. Other constraints are (i) lack of awareness on processing

and utilization methods, (ii) limited availability of processing equipment, (iii) low yield, (iv) lack of market linkages with processors and consumers, (v) lack of yield increasing inputs, (vi) low prices, (vii) weak policy support, and (viii) limited access to improved seed. Poor access to improved seed in terms of availability, accessibility, and quality is one of the major constraints to smallholder soybean productivity in Nigeria. Research institutions such as the International Institute of Tropical Agriculture (IITA) have, in the recent past, made tremendous efforts to develop improved soybean cultivars and release such to farmers in SSA. These varieties have been deployed alongside other yield improving inputs through diverse projects in various parts of Nigeria including Kaduna State.

The N2Africa Nigeria project

N2Africa is putting nitrogen fixation to work for smallholder farmers in Africa through enhancing the yield of grain legumes and expanding the farm area cropped with legumes to improve incomes and food and nutrition security. It is a large-scale, science-based "research-in-development" project funded by the Bill & Melinda Gates Foundation (BMGF). The project is currently being implemented in 11 countries including Nigeria. In Nigeria it is implemented in the Federal Capital Territory (FCT) and in Benue, Kaduna, Kano, Kwara, Kebbi, Niger, and Sokoto states. The mandated crops for the project are cowpea, groundnut, and soybean. In Kaduna State, N2Africa is implemented in Ckukun, Igabi, Ikara, and Kajiru local Government Areas (LGAs). The vision of N2Africa is to build sustainable, long-term, and effective partnerships to enable African smallholder farmers to benefit from symbiotic N_2 fixation by grain legumes through effective production technologies including introduction of improved crop varieties, inoculants, and phosphorus fertilizers.

Purpose of the Study

The study set out to evaluate whether the N2Africa project in Kaduna had been successful in achieving an increase in the adoption of soybean. This will provide project staff, donors, and other stakeholders with detailed information on the achievement of key project deliverables and related indicators.

Objectives of the Study

The main objective of the study was to assess the project's impact on the livelihood of farmers in southern and northern Kaduna. The specific objectives of the study are to:

- Examine the socioeconomic characteristics of soybean farmers in the study area.
- Determine the level and rate of adoption of soybean varieties by farmers in the project area.
- Examine the reasons for growing soybean varieties.
- Examine the constraints to growing soybean varieties.
- Examine the factors influencing adoption and intensity of adoption of soybean varieties.

Scope of the Study

The study covered the collection of quantitative and qualitative data on key milestones of the N2Africa Nigeria Results framework. It also comprised collecting information on the impact indicators of the project as indicated in the project results framework. Field data collection was carried out in May and June 2018. However, the data were collected to give information on the 2016 cropping season. The study area comprised Chikun, Igabi, Ikara, and Kajuru LGAs of Kaduna State, Nigeria. The main reference points of the study were the project document (project proposal), the baseline report, and the N2Africa Nigeria results framework.

Study Area

Kaduna State is located between latitudes 90 and 140 North of the equator and longitudes 70 and 100 East of the Greenwich meridian. It occupies a landmass of about 70,210 km^2 in Nigeria. Its topography is an undulating plateau that forms part of the rich tourist attractions in areas like Kufena in Zaria, Kagoro, Kwoi, and Gwantu. These areas have protruding, hard, resistant granite rocks that are attractive for sightseeing. Its main rivers are Kaduna, Gurara, Kogum, and Kubani.

Kaduna State has two distinct seasons. The dry season lasts from November to mid-April while the rainy reason, which is cool and lasts between 5 and 6 months, starts from mid-April. The State extends from the tropical grassland known as the Guinea savanna to the Sudan Savanna. Vegetation is thick with grasses about 3.6 m tall with big trees, which grow shorter as one approaches the Sudan savanna. The two climatic conditions in the State greatly influence the activities of the people, who are predominantly occupied in agriculture.

Methodology

Sampling technique and data collection procedure

A multistage sampling technique was used in this study. The first stage was the purposive selection of four LGAs Chikun, Igabi, Ikara, and Kajuru. These four LGAs were selected because interventions promoting improved agricultural technologies including soybean varieties have been undertaken there by other projects such as TLII, SG3000, USAID Markets, and N2Africa. The second stage included the random selection of 40 communities where these interventions were conducted. In each of the four local governments, 10 communities were randomly selected from a list of 50 communities. In the third and final stages there was the random selection of small-scale farmers using random numbers; 20 farmers were randomly selected from a list of 100 farmers. The summary of the sampling frame is presented in Table 1.

Table 1. Summary of sample frame and sample size.

Chikun (200)		Kajuru (200)		Ikara (200)		Igabi (200)	
Bugai (20)	Damishi (20)	Kufana (20)	Afogo Gida (20)	Bakula (20)	Furana (20)	Dinki	Amana
Kajama (20)	Kakua (20)	Shagaya (20)	Dutse Gaya (20)	Fadama Kale (20)	Japalan (20)	Jaji (20)	Dumbin (20)
Kakura (20)	Koche (20)	Madaki (20)	Kasuwan Magani (20)	Gunduma (20)	Wambai (20)	Mangi (20)	Gargai (20)
Kudansa (20)	Kujama (20)	Kallah (20)	Maraban (20)	Jampalam (20)	Sayasaya (20)	Unguwan Kanawa (20)	Fangurza (20)
Magashanu (20)	Gayab (20)	Issabe (20)	Rimau (20)	Karmawa (20)	Rumi (20)	Turunku (20)	Maimadachi (20)

Method of data collection

Data for the N2Africa Kaduna survey were obtained through a survey of 800 households in Kaduna State in May and June 2018. The main instruments for data collection were well-structured electronic questionnaires administered on households by trained enumerators under the supervision of students from the Department of Agricultural Economics, Bayero University, Kano, Nigeria; researchers from IITA; and a private consultant. Information collected included variables on sex, age, marital status, farm size, family size, quantity of input, income of farmers, awareness and adoption of soybean varieties, expenditure on food and non-food items, expenditure on productive and household assets, and crop production based on the 2016 farming season. A survey research design was employed to capture all these variables. Data were collected from 40 communities and settlements spread across the four LGAs in the project area (Table 1).

Analytical Techniques

A combination of analytical tools was employed in this study. These included descriptive statistics (means, frequencies, etc.). The Statistical Package for Social Sciences (SPSS) version 20 was used in the analysis of descriptive statistics. Using means, percentages, and frequency distribution; the level of education of household head, the age of household heads, their years of farming experience, the level of household income, and the level of awareness and adoption of soybean were all measured. Inferential statistical methods such as the logit and Tobit regression techniques were used to model the determinants of adoption and intensity of adoption respectively.

Descriptive statistics

Descriptive statistics were used to examine the socioeconomic characteristics of the respondents' households and basic features of the existing crop production system in the study area. The analysis is needed because household food security and poverty are largely functions of farmers' social and economic characteristics.

Determinants of level and intensity of soybean adoption

The adoption process begins with farmers becoming aware of a new technology by hearing about it. Afterwards they go through a time of acquiring knowledge about the technology, which would leave either a positive or negative impression about the technology and ultimately lead them to decide whether to adopt that technology. After adopting the technology, farmers may also choose to increase the intensity of use of the new technology as well or stop using it entirely (Rogers 2004). Understanding the factors that determine the adoption and intensity of adoption of soybean varieties during the adoption process is critical to knowing the factors that stimulate and hinder the adoption of these varieties. Policymakers, research institutes, and donor organizations will find this information helpful to better plan future soybean interventions and to help respond to the needs of farmers who may have been hindered by certain socioeconomic or institutional variables.

Empirical model for determinants of adoption: double-hurdle estimation of factors influencing adoption and intensity of adoption

The double-hurdle model is an improvement on the Tobit model and it has been used by many researchers in adoption studies. The double-hurdle model is used in studies involving participation decisions. The value, d = 1, is assigned for participants and nonparticipants are assigned the value, d = 0. After we determine the probability of being a participant or nonparticipant the participants will be assigned a conditional density of y given $y > 0$ is specified to be $f(y|d = 1)$, for some choice of density $f(\cdot)$.

The two-part model according to Cameron and Trivedi (2005) for y is then given by

$$f(y|x) = \begin{cases} \Pr[d = 0 \mid x] & if\ y = 0 \\ \Pr[d = 1 \mid x]\, f(y|d = 1, x) & if\ y > 1 \end{cases}$$

The Logit or Probit model is used to determine the participation decision. But a latent variable is measured against a threshold such that if the latent variable exceeds the threshold then participation takes place. A latent variable formulation is that $d = 1$ if $I = \beta + u_1$ exceeds zero. Meaning participation takes place if I exceed the threshold of zero. The act of crossing that threshold is described as a hurdle (Cameron and Trivedi 2005).

The major drawback of the Tobit model is that the choice of $y > 0$ and the value of y, given that $y > 0$, is determined by the same vector of parameters ($\boldsymbol{\beta}$). For example, this imposes that the direction (sign) of a given determinant's marginal effect will be the same on both the probability that $y > 0$ and the expectation of y, conditional or otherwise. This means that for the Tobit the same factors influencing the decision to adopt are also affecting the intensity of adoption. The double-hurdle realizes that in real life this may not always be the case. It recognizes that there are different factors affecting both the decision to adopt and the intensity of adoption. As an alternative, Cragg (1971) proposed the following, which integrates the Probit model with the Tobit to determine the probability of $y > 0$ and the truncated normal model for given positive values of y,

$$f(w, y|x_1, x_2) = \{1 - \Phi(x_1\gamma)\}^{1(w=0)}[\Phi(x_1\gamma)(2\pi)^{-\frac{1}{2}}\sigma^{-1}\exp\{-\frac{(y - x_2\beta)^2}{2\sigma^2}\}/\Phi(\frac{x_2\beta}{\sigma})]^{1(w=1)}$$

Where *w* is a binary indicator equal to 1 if *y* is positive and 0 otherwise. In Cragg's model, the probability of *y* > 0 and the value of *y*, given *y* > 0, are now determined by different mechanisms (the vectors $\boldsymbol{\gamma}$ and $\boldsymbol{\beta}$, respectively). Furthermore, there are no restrictions on the elements of $\boldsymbol{x}_1$ and $\boldsymbol{x}_2$, implying that each decision may even be determined by a different vector of explanatory variables altogether (Burke 2009).

The probabilities regarding whether *y* is positive are

$$P(y_i = 0|x_{1i}) = 1 - \Phi(x_{1i}\gamma)$$

$$P(y_i > 0|x_{1i}) = \Phi(x_{1i}\gamma)$$

The expected value of y, conditional on y > 0 is

$$E(y_i|x_{1i}, x_{2i}) = \Phi(x_1\gamma)\{x_{2i}\beta + \sigma \times \lambda\left(\frac{x_{2i}\beta}{\sigma}\right)\}$$

where $\lambda(c)$ is the inverse Mills ratio (IMR)

$$\lambda(c) = \varphi(c)/\phi(c)$$

where φ is the standard normal probability distribution function. Finally, the "unconditional" expected value of *y* is

$$E(y_i|x_{1i}, x_{2i}) = \Phi(x_1\gamma)\{x_{2i}\beta + \sigma \times \lambda\left(\frac{x_{2i}\beta}{\sigma}\right)\}$$

for a given observation, the partial effect of an independent variable, *xj*, around the probability that *y* > 0 is

$$\frac{\delta P(y > 0|x_1)}{\delta x_j} = \gamma_j \phi(x_1\gamma)$$

(Burke 2009)

Table 2 provides a list of all the independent variables used to model adoption and intensity of adoption.

Table 2. Variable for adoption models.

	Variables	Measurement	a priori expectation
Dependent variable			
Y_1	Adoption	Binary: 1 = adopted improved maize varieties, 0 = otherwise	
Y_2	Adoption intensity	Proportion of crop area allocated to improved maize varieties (ha)	
Independent variables	**Farmer/farm specific characteristics**		
GEND	Gender	Dummy: 1 = male, 0 = female	+
AGE	Age	Years	+/-
LGA	Local government area	Ordinal: 1 = Chukun, 2 = Kajuru, 3 = Ikara, 4 = Igabi	+/-
EDU	Education	Highest level of educational qualification of any household member	+
HHS	Household size	Number of persons in a given household	+
	Economic characteristics		
FARMSIZ	Farm size	Hectare	+
FARMEXP	Farm experience	Years	+
TOTINC	Total income	Naira	+
CREDIT	Access to credit	Dummy: 1 = yes, 0 = no	+
LIVE_ST	Livestock	Total number of livestock	+
COSTFERT	Cost of fertilizer	Naira	-
FERT_APP	Application of Fertilizer	Dummy: 1=yes, 0=no	+
PEST_APP	Application of pesticide	Dummy: 1=yes, 0=no	+
	Institutional characteristics		
EXT	Extension	Number of extension contacts	+
MEMASSOC	Membership of association	Dummy: 1 = member of association, 0 = nonmember of association	+
PART	Participation in soybean extension activities	Dummy: 1 = yes, 0 = no	+
PROC_MACH	Processing machine in community	Dummy: 1 = yes, 0 = no	+
DSTMARK	Distance to seed market	Kilometer	-
	Technology specific characteristics		
VAR_HIGH	Variety is high yielding	Perception of high yielding, 1 = better than other varieties, 0 otherwise	+
VAR_NON_SHATT	Variety is non-shattering	Perception of non-shattering, 1 = better than other varieties, 0 otherwise	+

Results

Household Socioeconomic Characteristics

In this section some important household socioeconomic characteristics are presented. Their statistics are represented by frequency, means, and percentages and are disaggregated by gender. Some of the variables measured include age, gender, marital status, level of education, and household size. Institutional variables measured include extension contact, access to credit, and membership of association.

Household demographic characteristics

The household demographic characteristics of respondents were measured because these characteristics can have an influence on adoption itself. Thus, differences in household characteristics may help explain differences in adoption. According to the results presented in Table 3, farmers in southern Kaduna (38.5) had an average age that was slightly younger than those of farmers in northern Kaduna (40). The predominance of male headed households was true for both northern and southern Kaduna, with the north having 91% of men heading households while 85.5% of men in the South were household heads. This is expected as Nigeria is very patriarchal across all regions and previous studies in the adoption literature have reported the high prevalence of male-headed households in Nigeria (Bamire et al. 2010; Jibrin 2010; Kamsang 2013).

Households in both regions had a large household size with an average household size of eight members in southern Kaduna and an average of 8.5 in northern Kaduna. This high household size means that farmers have the manpower and capacity to cultivate on a large scale. This, according to Bamire et al. (2010), helps in the adoption of improved technologies. In northern Nigeria previous literature (Mbavai 2013; Ndaghu 2013; and Kamara 2017) has established that household sizes are on average large. Differences in farming experience between respondents in northern and southern Kaduna are not very high as respondents in northern Kaduna had on average 17.51 years of farming experience while those in the Southern Kaduna had on average 16.4 years of experience. Farming experience can have either a positive or negative impact on farmers. While some experienced farmers may prefer their old technologies and refuse to adopt new agricultural innovations others might have witnessed the benefits of improved crop technologies on the yield of adopters and decide to adopt (Kamara 2017). The size of farmland is another important component in the adoption literature. According to Bamire et al (2010) a large farm size gives farmers the space to experiment with new varieties, which improves adoption. According to the results, farmers in both regions have approximately 3 ha of farmland with southern Kaduna farmers having a slightly larger farm size (3.19 ha) than those in northern Kaduna (2.9 ha).

Table 3. Selected household demographic characteristics.

	Southern Kaduna			Northern Kaduna		
	Chikun (N = 195)	Kajuru (N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
Age (years)	38	39	38.5	40	40	40
Male-headed households (%)	85	86	85.5	89	93	91
Household size	8	8	8	8	9	8.5
Years of farming experience	16.4	16.64	16.52	17.59	17.42	17.51
Farm Size (ha)	3.28	3.10	3.19	2.95	2.85	2.9

Education

Education is a key variable in adoption studies because education helps farmers to understand new varieties better. An improved understanding will help farmers quickly understand the benefits of the technology which encourages them to adopt (Kamara 2017). Table 4 shows the highest education level attained by the household head and the highest number of years any household member has spent being educated. Household heads in northern Kaduna had a higher rate of illiteracy (28.9%) than those in southern Kaduna (15.85%). However, in northern Kaduna and in Ikara in particular the percentage of respondents with a university education (17.25%) was much higher than that of southern Kaduna (2.8%). The percentage of household heads with university education in Ikara was particularly high (32%) while in Kajuru it was almost negligible (0.5%). At the same time a greater number of respondents in both LGAs in southern Kaduna had a higher level of attendance at a college of education compared to northern Kaduna. The highest education level achieved by household member was slightly higher in southern Kaduna (10.5) than in northern Kaduna (9.5). Although adult education was low in both regions, Ikara was once again the leader in adult education. While the level of adult education in other LGAs was approximately 2.5% on average in Ikara, 6.5% of household heads had adult education. Adult education is important as it gives respondents a second chance to improve their level of education and literacy in the event that they did not benefit from formal education as children. The difference was not much and showed that, overall, households in both regions understand the importance of a good education as investment was high in the education of at least one household member.

Table 4. Education of households.

		Southern Kaduna			Northern Kaduna		
		Chikun (N = 195)	Kajuru (N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
Highest household head education	No formal education	15.4	16.3	15.85	32.0	25.8	28.9
	Adult education	2.6	2.5	2.55	6.2	2.5	4.35
	Some primary	4.6	5.4	5	8.8	8.6	8.7
	Completed primary education	14.4	18.2	16.3	10.8	18.7	14.75
	Some vocational training	3.1	2.0	2.55	0.5	3.0	1.75
	Completed vocational training	0.5	2.5	1.5	7.2	2.5	4.85
	Some secondary education	9.2	7.9	8.55	25.8	6.1	15.95
	Completed secondary education	34.9	31.5	33.2	7.7	22.2	14.95
	College of education	10.3	13.3	11.8	1.0	8.1	4.55
	University education	5.1	0.5	2.8	32.0	2.5	17.25
	Highest education (years) achieved by any household member	11	10	10.5	9	10	9.5

Household marital status

The marital status of households is reported in Table 5. Most household heads were married with only 6.5 of household in southern Kaduna being single compared to 7.7% in northern Kaduna. Over 80% of respondents were married in either a monogamous or polygamous arrangement. The incidence of polygamous marriage was higher in northern Kaduna (38.95%) compared to southern Kaduna (30.9%). Marital status gives a general indication of how resources are transferred from one generation to another. In areas where polygamy is high resources tend to be more fragmented as they are transferred from one generation to another. When crucial resources such as land become fragmented, they shrink in size which hinders the ability of households to adopt new technologies in the long term (Ngewyo et al. 2015).

Table 5. Marital status of household head.

	Southern Kaduna			Northern Kaduna		
	Chikun (N = 195)	Kajuru (N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
Single	5.6	7.4	6.5	9.8	5.6	7.7
Monogamous marriage	70.8	62.1	66.45	54.1	43.4	48.75
Polygamous marriage	19.0	22.2	20.6	30.9	47.0	38.95
Widowed	3.1	8.4	5.75	4.1	3.5	3.8
Separated/Divorced	1.0	0.0	0.5	1.0	0.0	0.5
Other	0.5	0.0	0.25	0.0	0.5	0.25

Roofing material

Roofing material was measured and is presented in Table 6. Roofing material is an asset that can indicate household welfare. The results showed that in southern Kaduna, most farmers (89.8%) used iron sheets as their roofing material while in northern Kaduna approximately 43.55% used iron sheets. This is partially because most of the farmers in Igabi used wood planks (89.9%) instead of iron sheets. These results suggest that in Igabi the standard of life may be lower than in the other local governments. A low standard of life or welfare implies that farmers may not have enough resources to adopt new agricultural technologies.

Table 6. Roofing material.

	Southern Kaduna			Northern Kaduna		
	Chikun (N = 195)	Kajuru (N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
Straw/thatch	0.5	5.4	2.95	0.5	2.0	1.25
Mud	1.0	0.5	0.75	4.1	4.5	4.3
Wood planks	1.5	4.9	3.2	3.6	89.9	46.75
Iron sheets	94.9	84.7	89.8	86.6	0.5	43.55
Asbestos/brick/tiles	1.0	0.5	0.75	0.5	2.5	1.5
Tin	0.5	1.0	0.75	3.1	0.5	1.8
Cement	0.5	2.0	1.25	1.5	2.0	1.75
Other floors	0.0	0.5	0.25	0.0	0.0	0.0

Main source of water supply

Another key resource that was captured in the report is water supply. Water supply is a basic need for the survival of households and it is also required in periods of low rainfall to help crops escape drought. There were four main sources of water supply: river, wells, borehole, and pump (Table 7). According to the results more people relied on rivers and streams in the northern parts (5.9%) than those in the south (2.0%). Most respondents used wells as their main source of water across all local governments with Igabi having the highest figure (81.3%). The second most used source of water was the borehole in both regions.

Table 7. Main source of water supply.

	Southern Kaduna			Northern Kaduna		
	Chikun (N = 195)	Kajuru (N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
River/stream	1.0	3.0	2.0	9.8	2.0	5.9
Wells	66.7	58.1	62.4	53.1	81.3	67.2
Borehole	25.6	20.2	22.9	30.9	12.1	21.5
Pump	6.7	18.2	12.45	6.2	4.5	5.35
Others	0.0	0.5	0.25	0.0	0.0	0.0

Main source of light

The main source of light was also studied and is presented in Table 8. According to the results an overwhelming majority of respondents across both regions used lamps as their main source of light. In northern Kaduna more people were more reliant on lamps (64.9%) than in the south (51.45%). Electricity was the second most common source of light for all respondents, but the use was slightly higher in southern Kaduna (38.2%) than in northern Kaduna (31.8%).

Table 8. Main Source of light.

	Chikun (N=195)	Kajuru N = 203)	Mean	Ikara (N = 194)	Igabi (N = 198)	Mean
Lamp	46.7	56.2	51.45	72.7	57.1	64.9
Generator	10.3	3.0	6.65	2.6	2.5	2.55
Electric power	38.5	37.9	38.2	24.2	39.4	31.8
Candles	0.0	1.0	0.5	0.0	0.0	0
Solar panels	4.6	.5	2.55	0.5	0.0	0.25
Firewood	0.0	1.5	0.75	0.0	0.5	0.25
Other	0.0	0.0	0	0.0	0.5	0.25

Institutional variables

Table 9 shows some of the institutional variables that characterize households in both northern and southern Kaduna. These variables include membership of association, extension contact, and access to credit. Results show that extension contact was relatively high in both southern (61.85%) and northern (68.4%) Kaduna. While access to credit was low in both regions, northern Kaduna households had far greater access to credit (16.85%) than those in Southern Kaduna (3.3%). Membership of association was also higher among farmers in southern Kaduna (86.85%) than in northern Kaduna (83.86%).

Table 9. Institutional variables.

	Chikun (N = 195)	Kajuru (N = 203)	Southern Kaduna (398)	Ikara (N = 194)	Igabi (N = 198)	Northern Kaduna (392)
Extension contact	64.6	59.1	61.85	70.6	66.2	68.4
Access to credit	3.6	3	3.3	19.6	14.1	16.85
Membership of association	94.4	79.3	86.85	81.4	85.9	83.65

Adoption

N2Africa Nigeria promoted the use of new soybean varieties including TGX1835 (Danwuri), TGX1951-3F, TGX1955-4F, TGX1448-2E, and TGX1904-6F. These varieties are mostly early maturing and drought tolerant and were developed to help crops escape drought conditions in the Sudan and Guinea savannas. In addition to this, the project promoted complementary agronomic practices including row spacing, phosphorus fertilizer to assist the crop in fixing atmospheric nitrogen, and rhizobium inoculant. This section presents the results of the adoption of these technologies promoted by the N2Africa project.

Adoption of new soybean varieties

Table 10 and Figure 1 present a trend analysis of the adoption rate of soybean varieties promoted by N2Africa. According to the results, the most recent adoption rate in the year 2017 showed that approximately 84.85% of farmers in southern Kaduna and 72.8% of farmers in northern Kaduna had adopted these varieties. The adoption trend in Figure 2 shows a gradual increase in rate from 2009 to 2012 in all LGAs except for Igabi. Adoption in Igabi was very stagnant between these years. However, from 2013 to 2017 the adoption of these varieties increased dramatically more than doubling in all regions. The overall adoption rate in southern Kaduna (84.85%) was more than that in northern Kaduna (72.8%). This is because adoption in Igabi at 62.6%, which is much lower than for the other regions.

Table 10. Annual adoption rate trend disaggregated by LGA (2009–2017).

	Chikun (N = 195)	Kajuru (N = 203)	Southern Kaduna (398)	Ikara (N = 194)	Igabi (N = 198)	Northern Kaduna (392)
2009	20.00	23.60	21.80	29.9	13.6	21.75
2010	22.10	24.10	23.10	32.0	14.1	23.05
2011	27.2	30.5	28.85	37.6	15.2	26.4
2012	29.7	33.0	31.35	39.2	15.7	27.45
2013	34.9	39.4	37.15	46.9	23.7	35.3
2014	47.2	52.7	49.95	59.8	39.3	49.55
2015	59.5	62.6	61.05	71.1	43.4	57.25
2016	72.3	79.3	75.8	81.4	55.1	68.25
2017	80.5	89.2	84.85	83.0	62.6	72.8

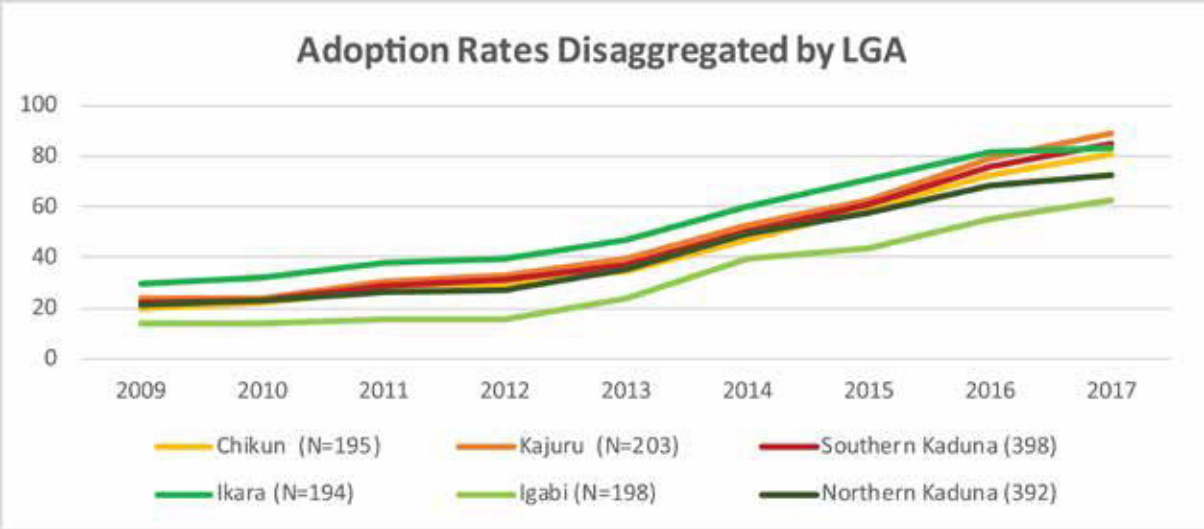

Figure 1. Adoption rates disaggregated by LGA.

Estimated adoption rate of new soybean varieties

Table 11 and figure 2 show the estimated adoption rate of new soybean varieties. The most adopted varieties are TGX1951-3F and TGX1448-2E; roughly a quarter of respondents adopted these varieties. Another variety that was adopted by many respondents is TGX1835; 14.6% of farmers use this variety. The least popular varieties were TGX1904-6F and TGX1955-4F as only 4.3% and 8.6% of respondents adopted them respectively.

Table 11. Estimated adoption rate of new soybean varieties.

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
TGX1835	4.6	3.9	4.3	4.4	6.3	9.0	11.1	12.9	14.6
TGX1951-3F	4.1	5.3	6.2	7.2	9.1	12.8	16.7	21.9	26.5
TGX1955-4F	2.5	2.8	3.7	3.9	4.4	5.1	6.5	7.8	8.6
TGX1448-2E	8.2	8.9	9.9	11.1	12.7	17.5	21.3	25.1	24.8
TGX1904-6F	2.4	2.2	2.7	2.7	3.7	3.2	3.5	4.3	4.3
Total variety	**21.8**	**23.1**	**26.8**	**29.3**	**36.2**	**47.6**	**59.1**	**72**	**78.8**
No adoption	**78.2**	**77.0**	**73.3**	**70.6**	**63.8**	**52.2**	**40.9**	**28.0**	**21.2**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

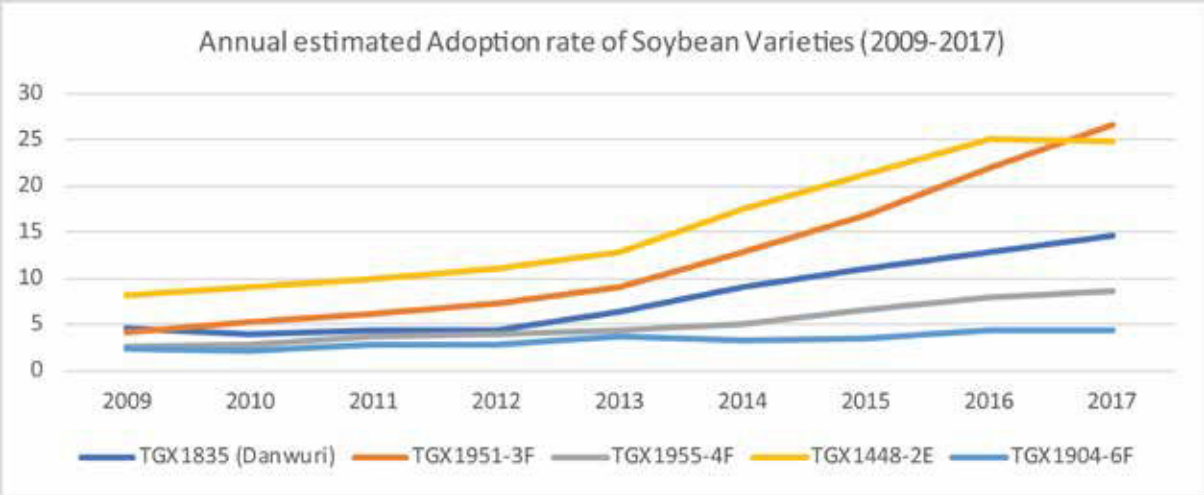

Figure 2. Annual estimated adoption rate of soybean varieties (2009–2017).

Estimated adoption rate of new soybean varieties for the 2017 season in each LGA

After finding the annual adoption rate for the varieties we also analyzed the varieties by adoption in each local government for the year 2017. The results (Table 12) show that TGX1951-3F was the most popular in Chikun, Kajuru, and Igabi while TGX14482E was more popular in Ikara. Across all LGAs both varieties were far more popular than the other varieties. A more graphical representation is described in Figure 3.

Table 12. 2017 Adoption rate of new soybean varieties disaggregated by LGA.

	Chikun (N = 195)	Kajuru (N = 203)	Southern Kaduna (N = 398)	Ikara (N = 194)	Igabi (N = 198)	Northern Kaduna (N = 392)
TGX1835 (Danwuri)	14.9	10.8	12.85	21.6	11.1	16.35
TGX1951-3F	26.2	41.4	33.8	16.0	21.7	18.85
TGX1955-4F	7.7	5.9	6.8	15.5	5.6	10.55
TGX1448-2E	27.2	28.1	27.65	24.7	19.2	21.95
TGX1904-6F	4.6	3.0	3.8	5.2	5.1	5.15
Total variety	80.6	89.2	84.9	83.0	62.7	72.85
No adoption	19.4	10.8	15.1	17.0	37.3	27.15
Total	100	100	100	100	100	100

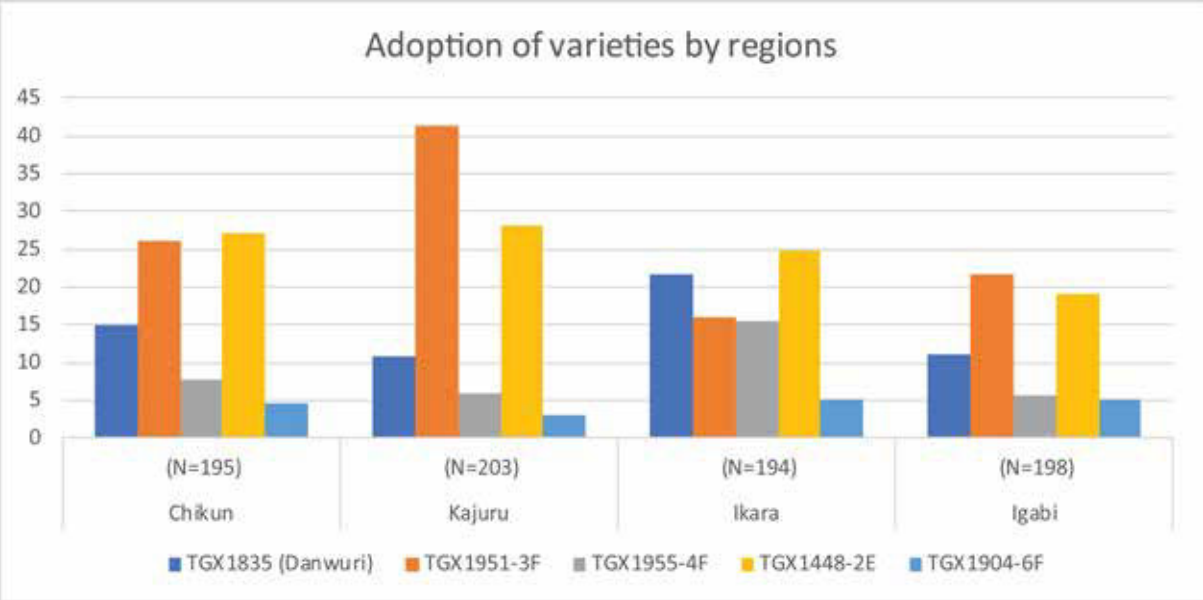

Figure 3. Adoption of varieties by region (2017).

Extent of adoption

In adoption studies it is not enough to know whether farmers adopted a variety or not. To have a complete picture one must understand the extent of adoption of improved varieties and this is measured as a ratio of total farmland devoted to the cultivation of the new soybean over the total farmland cultivated. Table 13 shows the average soybean area planted, average farm size, and the extent of adoption measured by total soybean area planted over the total farm size. The results show that southern Kaduna had a greater rate of adoption than northern Kaduna. This is because 55% of farmland was devoted to the production of soybean in southern Kaduna while 14.85% of farmland was devoted to the production of soybean in northern Kaduna.

Table 13. Total soybean plot/total farmland area (extent of adoption).

	Soybean area planted (ha)	Farm size (ha)	Extent of adoption (soybean area/total farm size)
Chikun (N = 195)	0.77	3.28	0.69 (69%)
Kajuru (N = 203)	1.00	3.11	0.41 (41%)
Southern Kaduna (N = 398)	0.885	3.195	0.55 (55%)
Ikara (N = 194)	0.69	2.95	0.22 (22%)
Igabi (N = 198)	0.96	2.85	0.077 (7.7%)
Northern Kaduna (N = 392)	0.825	2.9	0.1485 (14.85%)

Adoption of agronomic practices

The technologies in the N2Africa Nigeria project include both improved soybean varieties and the requisite agronomic practices required for these varieties to meet their full genetic potential. Key agronomic practices such as the application of rhizobium inoculants, chemical fertilizers, pesticides, and herbicides were introduced to help the varieties achieve their maximum yield. This section presents the results of the adoption of some of these agronomic practices (Table 14). The results reveal that the use of rhizobium inoculants was much more widespread in the southern (52%) part of the state than in the north (19.65%). This may be because households in southern Kaduna had more information and understanding of the use of rhizobium inoculants. The use of chemical fertilizer was much higher in northern Kaduna (45%) than in southern Kaduna (21.05%). This may be because the soils in the north had a greater deficiency of phosphorus and other essential nutrients. Herbicide and pesticide use was comparable in both regions, but more awareness is required to increase the use of herbicides.

Table 14. Agronomic practices.

	Rhizobium inoculants (%)	Chemical fertilizer (%)	Organic fertilizer (%)	Herbicide (%)	Pesticide (%)
Chikun (N = 195)	53.3	18.5	8.2	40.5	28.2
Kajuru (N = 203)	50.7	23.6	4.9	43.3	43.8
Southern Kaduna (N = 398)	52	21.05	6.55	41.9	36
Ikara (N = 194)	21.1	52.6	45.9	55.2	40.7
Igabi (N = 198)	18.2	37.4	34.8	38.9	32.8
Northern Kaduna (N = 392)	19.65	45	40.35	47.05	36.75

Constraints to adoption

Farmers' who did not adopt the technology where asked for the reason why. This was to understand farmer constraint to adoption. The majority of households reported lack of seed availability as the greatest constraint (Table 15). This was particularly so for southern Kaduna.

Table 15. Constraints to adoption.

	Chikun (N = 195)	Kajuru (N = 203)	Southern Kaduna (N = 398)	Ikara (N = 194)	Igabi (N = 198)	Northern Kaduna (N = 392)
Seed not available	49.7	43.3	46.5	33.5	37.9	35.7
Low yielding	9.7	4.4	7.05	14.9	8.6	11.75
No market	3.1	0.0	1.55	3.1	2.0	2.55
Poor taste	1.0	0.0	0.5	0.5	4.0	2.25
Low grain prices	3.1	2.5	2.8	3.1	0.5	1.8
Other, specify	0.5	0.5	0.5	1.0	2.0	1.5

Determinants of adoption and intensity of adoption

The double-hurdle model was used to model adoption and the intensity or extent of adoption. Adoption here refers to farmers growing the new varieties disseminated by the N2 Africa Nigeria project in Kaduna State and they include TGX1835, TGX1951-3F, TGX1955-4F, TGX1448-2E, and TGX1904-6F. The intensity of adoption is measured as a ratio of total farmland devoted to the cultivation of new soybean over the total farmland cultivated. The results of the modeling are described in Table 16. In the first stage of the double-hurdle model the Probit model was used to estimate the intensity of adoption. According to the results of the Probit component (selection or first stage) of the double-hurdle model, age, membership of association, farm size, and farm experience all had a positive and significant effect on adoption. The results of the Tobit component (second stage) of the double-hurdle model show that gender, age, membership of association, farm experience, extension contact, and pesticide application all had a positive and significant effect on the intensity or extent of adoption. Marital status on the other hand had a negative and significant effect on the intensity of adoption.

Table 16. Double-hurdle estimate of determinants of adoption.

Variables	Probit model		Tobit model	
	Coefficient	P-Value	Coefficient	P-Value
Intercept	–6.69	0.95	18.83***	0.00
LGA	–0.14	0.47	0.17	0.13
Gender	4.35	0.96	1.41***	0.00
Age	0.06***	0.00	0.49***	0.00
Marital status	0.18	0.61	–8.84***	0.00
Household size	1.55e-8	0.98	0.03	0.26
Education	–0.01	0.88	–0.04	0.14
Membership of association	0.99**	0.02	1.00**	0.02
Credit	0.08	0.59	0.02	0.81
Income	7.95e-08	0.78	2.72e-07	0.29
Farm experience	0.03*	0.06	0.027*	0.07
Farm size	0.10***	0.00	–0.05	0.25
Livestock	0.11	0.40	0.00	0.83
Extension contact	–0.77	0.17	0.73	0.01
Processing machine	0.09	0.81	0.04	0.87
Distance to seed market	0.03	0.38	0.03	0.27
Participation in N2 Africa	0.59	0.24	–0.31	0.11
Fertilizer cost	8.36e–06	0.95	–5E-05	0.59
Fertilizer application	1.61e–06	1.00	–8E-05	0.38
Pesticide application	1.09	0.04	0.48	0.07
Variety is high yielding	0.01	0.91	–0.02	0.64
Variety is non–shattering	0.10	0.63	–0.14	0.13
Observations	791			
LR chi2	98.04			
Prob> chi2	0.05			
Log likelihood	–1268.27			
Sigma	2.65***(0.00)			
Wald Chi2	32.55			

Conclusions and Recommendations

Conclusions

The results of the study show that extension contacts and membership of association are relatively high in both northern and southern Kaduna. Access to credit was low in both regions; but was especially lower in southern Kaduna (3.3%) compared to northern Kaduna (16.85%). Both regions have seen a substantial increase in adoption rate from approximately 21% in both regions in the year 2009 to 84.85% in southern Kaduna and 72.8% in northern Kaduna in the year 2017. The most popular varieties promoted are TGX1951-3F and TGX1448-2E with roughly a quarter of respondents adopting these varieties. TGX1951-3F was the most popular in Chikun, Kajuru, and Igabi while TGX1448-2E was more popular in Ikara. Across all LGAs both varieties were far more popular than the other varieties. Southern Kaduna had a greater extent of adoption than northern Kaduna, as 55% of farmland was devoted to the production of soybean in southern Kaduna while only 14.85% of farmland was devoted to the production of soybean in northern Kaduna. Northern Kaduna had higher adoption of the use of chemical fertilizers, herbicides, pesticides, and organic fertilizers compared to southern Kaduna. However, the use of rhizobium inoculants was more prevalent in southern Kaduna at 52% compared to 19.65% in the north. Farmers in all regions reported the lack of seed availability as being the major constraint to adoption.

The results of the double-hurdle model indicate that age, membership of association, farm size, and farm experience all had a positive and significant effect on adoption. While the results of the Tobit component (second stage) of the double hurdle model show that gender, age, membership of association, farm experience, extension contact, and pesticide application all had a positive and significant effect on the intensity or extent of adoption. Marital status on the other hand had a negative and significant effect on the intensity of adoption.

Recommendations

The N2Africa project is coming to an end and the findings of this study can guide policymakers on the achievements of the project to scale out and scale up some of the successes. It can also guide policymakers, development specialists, and donor organizations on how to improve on its limitations. Following are recommendations based on the findings of the study to guide stakeholders on how future programs can be conducted.

1. Adoption of crop technologies and management practices.
2. The project will soon come to an end and although the project has been successful in disseminating new varieties and practices, sustainability of agricultural technologies uptake needs to be maintained. For this to happen, KADP should do more in ensuring that farmers have regular contact with extension agents. A performance-based system in conjunction with frequent monitoring of the performance of extension agents must be put in place. This is especially crucial just before the planting season and during the planting period. Extension agents can be made to give weekly reports on their activities supported by evidence in the form of audio recordings and GPS coordinates.
3. Gender mainstreaming
4. Policymakers must ensure that female farmers have access to land and capital for them to expand their productivity and have higher farm incomes to enable them to escape poverty. More work needs to be done to help female farmers to access these technologies and the factors of production required for them to expand their agricultural production.
5. Access to credit was an important factor that determined adoption of improved varieties. Thus, policymakers must strive to ensure that farmers with capital deficit have access to credit to purchase new seeds and other inputs. More must be done in the future to bring about microfinance schemes, rotating savings, credit associations, and other forms of peer-to-peer banking to help farmers with capital deficit.

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Appendix 1

Questionnaire for the Adoption and Impact of Soybean among Smallholder Farmers in Kaduna State, Nigeria

1. Enumerator: _____ 2. Date of interview: _____
3.LGA: _____
4. Village/Community: _____
GPS coordinates at the house of respondent
5. Latitude: _____ 6. Longitude: _____7. Altitude: _____

1. GENERAL HOUSEHOLD INFORMATION

NB: The "household" refers to all members of a common decision-making unit (usually within one residence) that are sharing income and other resources. 2017.

Variable	Response	Codes
Demographic data		
Sex of respondent		1 = Male 2 = Female
1. Gender of household head		1 = Male 2 = Female
2. Age of household head in years		
3. Marital status of household head		1 = Single 2 = Monogamous marriage 3 = Polygamous marriage 4 = Widowed 5 = Separated/Divorced 6 = Other (Specify)
3. Education level of household head		1 = no formal education, 2 = adult education, 3 = some primary, 4 = completed primary education, 5 = some vocational training, 6 = completed vocational training, 7 = some secondary education, 8 = completed secondary education, 9 = college of education, 10 = university education
4. Highest level of education attained by any household member in years		
5. Number of children 0–5 years		
6. Number of members aged 6–15 years		
7. Number of males aged 16–64 years		
8. Number of females aged 16–64 years		
9. Number of members aged 65 and above		
10. Household size		
11a. Number of children of age 3–17		
11b. Number of children of age 3–17 who are in school		
11.c Number of household members below 18 years who are involved in agricultural labor supply to generate income		
11d. Number of household members below 18 years who are involved in nonagricultural labor to generate income		
11e. Number of household members below 18 years who live outside the household with a relative/family friend due to the households' financial constraints		

12. How long has the household head been farming as an independent household? (*Number of years*)		
13. Type of household		1 = male headed (monogamous), 2 = male headed (polygamous), 3 = female headed (husband absent), 4 = female headed (widowed), 5 = female headed (divorced), 6 = female headed (single), 7 = male headed (single), 8 = male headed (divorced), 9 = male headed (widowed), 99 = other (specify)
14.Occupancy status		1 = landlord, 2 = tenant, 3 = rent, 4 = other, specify
15. Total number of rooms in the house (minus kitchen and bathrooms)		
16. Roofing material of household's most important residence		1 = straw/thatch, 2 = mud, 3 = wood/planks, 4 = iron sheets, 5 = asbestos, bricks/tiles, 7 = tin, 8 = cement, 9 = other roofing, 10 = other walls, 11 = other floors
17. Main source of water supply to the household		1= river/stream, 2 = wells, 3 = borehole, 4 = pump, 5 = other (specify)
18. Household's main sources of light		1 = lamp, 2 = generator, 3 = electric power, 4 = candles, 5 = solar panels, 6 = firewood, 7 = other (specify)
19. Main source of fuel used for cooking:		1 = agricultural by-product, 2 = charcoal, 3 = firewood, 4 = gas, 5 = electric power, 6 = kerosene, 7 = other

2. LAND OWNERSHIP

NB: 1 ha = 2.47 acres, 1 acre = 0.405 ha, 1 ha = 10000 m^2, NB: Please use only hectares
22 plots = 1 football field= 1 ha also 1 saffiya = 1 ha

2.1 How much land this household owns now

Row	Holdings	(a) Homestead land	(b) Upland Away from home	(c) lowland (if applicable)	(d) Total
1	Owned				
2	Sharecropped				
3	Borrowed in				
4	Rented out (for money)				
5	Lent out (for free)				
6	Under crop cultivation (2016/17)				
7	Total land under other uses (fallow, pasture, etc.) (2016/17)				

2.2 Household soybean plots/fields

Soybean plot(s)	**Area**	**Seed planted (30–50 mudu is one ha)**	**Yield harvested**
1. Main soybean plot			
2. Second soybean plot			
3. Third soybean plot			
4. Fourth soybean plot			
5. Fifth soybean plot			

3.0 AWARENESS AND ADOPTION OF SOYBEAN VARIETIES AND SOYBEAN PRODUCTION TECHNOLOGIES

3.1 Access to Extension Service

Variable	Response	Codes
1. Have you ever participated in any soybean related extension activities?		1 = Yes, 0 = No
2.If yes, indicate the extension activities		1 = Training in soybean production (training in row planting and pests and diseases management) 2 = Training in soybean processing 3 = Fertilizer application, 4 = Soybean varietal demonstration trials 5 = Other (specify)
3. If yes, with which extension institution or agency?		1 = N2AFRICA, 2 = KADP, 3 = Ministry, 4 = TLII 5 = SG3000/Sasakawa 6 = USAID Markets, 7 = Other (SPECIFY please)
4. Do you have extension contact?		1 = Yes, 0 = No
5. If yes, from which institution (s) or source (s)? (multiple answers)		1 = N2AFRICA, 2 = KADP 3 = NGO, 4 = Ministry, 5 = Other (specify)
6. How often were you visited by extension agents in the last cropping season?		1 = Weekly, 2 = Bi-weekly, 3 = Monthly, 4 = Quarterly, 5 = Other (specify)
7.How would you rate the usefulness of your contact with extension activities?		1 = Very useful, 2 = Useful, 3 = Not useful, 4 = Can't tell

8. Did you get any kind of assistance or information from the Extension Agents on: **1 = Yes, 0 = No……**		9. Which kind of assistance or information did you receive from the Extension Agents?
	a. Use of fertilizer	
	b. Use of improved varieties	
	c. Pest and disease management	
	d. Soil management	
	e. Weather information	
	f. Marketing advice	
	g. Credit	
	h. General crop production advice	
	i. Other (specify)	

3.1.2. Membership of Associations/Social Capital

Do you belong to any association? **1 =** Yes; 0 = No

If yes, which of these association?

Voluntary Organizations, Groups, Networks, or Associations	Indicate if you are a member of any of this type of group: **1 = Yes; 0 = No**
1. Village committee	
2. Village NGO or civic group	
3. Political group or movement	
4. Agricultural association	
5. Finance, credit, or savings group	
6. Health group	
7. Education group	
8. Religious or spiritual group	
9. Cultural group or association	
11. Sports group	

3.1.3. Access to Credit

Do you have access to any of the following sources of credit? Yes = 1, No = 0

If yes source?

Source of borrowed money	Have you ever borrowed?	Amount borrowed in the last 12 months	Purpose of borrowing[1]
1. Relative and friends			
2. Informal savings and credit group			
3. Money lender			
4. Government credit schemes			
5. NGO/Mosque/Church			
6. Bank or microfinance institution			
7. Input and output dealers			

Purpose of borrowing: 1 = Purchase of food, 2 = Purchase of household assets, 3 = Payment of fees, 4 = Cover medical costs, 5 = Agricultural production, 6 = Other (specify)

3.1.4. Interaction with other Farmers and Farmer Groups

1. In the last 12 months, has a member of your household participated in any of the following?

Aspect	1 = Yes, 0 = No
1. Participated in community development activity	
2. Made financial contribution for community activities or collective problems	
3. Been involved in settling conflicts or disputes among people	
4. Visited other farmers within your community to learn about agriculture	
5. Visited other farmers outside your community to learn about agriculture	
6. Visited a research station to learn about agriculture	

3.2 Growing New Soybean Varieties

	Variable	Response	Codes
1.	Do you grow soybean?		1 = yes, 0 = no
2.	Number of years of growing soybean		
3.	Are you aware of new soybean varieties?		1 = yes, 0 = no
4.	If aware, do you grow new soybean varieties?		1 = yes, 0 = no
5.	If yes, do you receive information on new soybean varieties?		1 = yes, 0 = no
6.	What are the sources of information on varieties?		1: bulletins or handbooks, 2: radio, 3: extension agent from KADP, 4: NGO, 5: neighbor, 6: market, 7: village or community organization, 8: IITA, 9: seed company, 10: other (specify)
7.	Did you grow new soybean variety in		1 = yes, 0 = no
		2008	
		2009	
		2010	
		2011	
		2012	
		2013	
		2014	
		2015	
		2016	
		2017	
8.	Which of the new varieties did you grow from 2008 to 2017? 1. TGX1835 (*Danwuri*) 2. TGX1951-3F 3. TGX1955-4F 4. TGX1448-2E 5. TGX1904-6F Others (specify)……..	2008	
		2009	
		2010	
		2011	
		2012	
		2013	
		2014	
		2015	
		2016	
		2017	

9	Will you grow in future? 1. TGX1835 (*Danwuri*) 2. TGX1951-3F, 3. TGX1955-4F, 4. TGX1448-2E, 5. TGX1904-6F Other (specify)……..		
10	If no to 9, give reasons for your answer 1. TGX1835 (*Danwuri)* 2. TGX1951-3F 3. TGX1955-4F 4. TGX1448-2E 5. TGX1904-6F Other (specify)……..		Codes 1 Seed not available 2 Low yielding 3 No market 4 Poor taste 5 Low grain prices 6 Yther, specify
11	In 2017, how many *mudus* did you plant?		
12	How many bags did you harvest in 2017?		
13	Unit of bag harvested (check key for code)		
13.	Which of the farming system is commonly practiced by your household? 1 = monocropping/solecropping: 2 = mixed cropping 3 =. mixed farming: 4 =. livestock/pastoral		
14	Which of the following cropping pattern is commonly practiced in soybean production in your household? 1 = soybean as sole crop: 2 = soybean as a major crop in mixture: 3 = soybean as a minor crop in mixture:		

Tiya = 2.50 kg, Mudu = 1.25 kg, 100 bag kg = 80 mudu, Unit for bags harvested: 1 = 100 kg, 2 = 50 kg 3 = 25 kg

3.2.1: Reasons for growing new soybean varieties in 2017

Reasons	**Please tick**
1. High yield	
2. Large seed size	
3. Less shattering	
4. Resistance to disease (s)	
5. High fodder yield	
6. High oil content	
7. High cash income/profit	
8. Drought resistant	
9. Early maturity	
10. Less labor inputs	
11. Resistance to pest	
12. Soil fertility improvement	
13. Makes better local foods/utilization	
14. *Striga* control	
15. Food security in the home	
16. Less fertilizer required to grow	
17. Others (specify)	

3.3. Do you keep Livestock? **----------(**1 = Yes, 0 = No)

1. If yes, state the five-major livestock kept in your household, their number, purpose, and ownership

Livestock		Number	Ownership: 1 = mainly men, 2 = mainly women, 3 = men and women equally	Purpose 1 = for food, 2 = cash income, 3 = both cash and food, 4 = work, 5 = social prestige, 6 = transport, 7 = others (specify)---
1.				
2.				
3.				
4.				
5.				

1 = Goat, 2 = Ram/Sheep, 3 = Cow 4 = Poultry 5 = Pig 6 = Rabbit 7 = others

3.4. Soybean Production and Processing Technologies

3.4.1. Use of crop management, soil conservation, and other land management options (Technology/Management Practice)

NB. Technology refers to any practice including traditional and improved agricultural practices

Did you use this technology during the 2017 season?	1 = Yes 0 = No	Did you use this technology during the 2017 season?	1 = Yes 0 = No	Did you process into? :	
1. Organic manure		9. Fungicide		17. Processing into:	
2. Cover crops		10. Herbicide		(a) Soymilk	(h) Soy bread
3. Crop rotation		11. Varietal selection		(b) Dadawa	(i) Others
4. Intercropping		12. Drying		(c) Awara (soybean cake)	
5. Rhizobia inoculation		13. Threshing/shelling equipment		(d) Kunu	
6. Chemical fertilizer		14. Improved storage facilities		(e) Tum brown	
7. Row planting		15. Pest control		(f) Soup	
8. Plant spacing		16. Grading		(g) Soy flour	

KEY	**SA = Strongly agree, A = Agree, U = Undecided, D = Disagree, SD = Strongly disagree**					
	Section B2. Level of technology(ies) acceptance and adoption of soybean production technologies **Ease of Usage**					
		SA	**A**	**U**	**D**	**SD**
	Use of new soybean varieties increases my production					
	Saves time of production (earliness)					
	High yielding					
	Non-shattering					
	Intention to continue usage					

	Disease resistant					
	Perceived Usefulness	**SA**	**A**	**U**	**D**	**SD**
	Improves access to qualitative soybean					
	Increases productivity					
	Enhances our effectiveness on large-scale production					
	Raises our chances to increase profit					
	Increases amount of locally processed soybean products in the state					
	Attitude	**SA**	**A**	**U**	**D**	**SD**
	Introducing may fail as past interventions					
	Fear of the unknown					
	Conservativeness (resistant to change)					
	Success would be achieved if availability of new variety is sustained					
	Consumer preference					
	More producers would emerge if the availability of new variety is extended					
	Beneficial to all actors along the soybean value chain.					
	Access and use of new variety are only beneficial to selected/influential members of the community					
	Nutritional value and health benefits of the new soybean variety					
	Intention to Use	**SA**	**A**	**U**	**D**	**SD**
	I will frequently use the soybean production technologies in future					
	I will recommend others to use soybean production technologies					

Technology Acceptance Model

3.5: Traits and Preferences

What are your three most preferred new soybean varieties (in order of importance)?	**Rating**	What are the three main characteristics (in order of importance) that make the variety a preferred variety for you? (***WRITE CODE***) 1. Earliness, 2. High yield, 3. Grain size, 4. Disease resistant, 5. Non-shattering
1. TGX1835 (*Danwuri*)		
2. TGX1951-3F		
3. TGX1955-4F		
4. TGX1448-2E		
5. TGX1904-6F		
Others (specify)……..		

1 = most preferred, 2 = preferred 3 = least preferred

4. SOYBEAN PRODUCTION FOR THE LAST SEASON (2017)

4.1 Land preparation and weeding cost for soybean in 2017 (This should be consistent with the Page 3 soybean plot table)

	Land preparation for soybean					**Weeding-soybean**					
Row (Farm)	Total family labor for land preparation (days)		Total hired labor for land preparation (days)		Total cost of land preparation including hired labor (₦)	Number of weedings	Total family labor for weeding (days)		Total hired labor for weeding (days)		Total cost of weeding including hired labor (₦)
	Days	No. of people	Days	No. of people			Days	No. of people	Days	No. of people	
1.											
2.											
3.											
4.											
5.											

	Fertilizer application for soybean					**Harvesting soybean**					
Row (Farm)	Total family labor fertilizer application (days)		Total hired labor fertilizer application (days)		Total cost of fertilizer application (₦)	Number of harvesting	Total family labor for harvesting (days)		Total hired labor for harvesting (days)		Total cost of harvesting labor (₦)
	Days	No. of people	Days	No. of people			Days	No. of people	Days	No. of people	
1.											
2.											
3.											
4.											
5.											

4.1.2: Which of the following methods did you use for land preparation, weeding, and harvesting in the last cropping season? ***Use CODE below***[1]

Land preparation	**Weeding**	**Harvesting**

[1] **Methods:** 1 = hand hoe; 2 = oxen; 3 = tractor/mechanized; 4 = chemical; 5 = tractor and oxen; 6 = slash and burn; 7 = Sickle; 8 = other (specify)

4.2. Inorganic and Organic Fertilizers Inputs in Soybean Production (2017)

	Fertilizer									
Row	Used chemical fertilizer? 1 = yes 0 = no	Type of fertilizer used [2]	Amount used (kg)	Did you buy it? 1 = yes 0 = no	Total value (₦)	Used organic fertilizer? 1 = yes 0 = no	Did you buy it? 1 = yes 0 = no	Type of organic fertilizer [3]	Amount in (kg)	Total value (₦)
1.										
2.										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

[2] **Chemical fertilizers:** 1 = NPK (*Kamfa*), 2 = SSP (*super*), Urea = 3

[3] **Type of organic fertilizer:** 1 = Green manure, 2 = Animal manure, 3 = Compost, 4 = Leaf litter, 5 = Crop residue, 99= other (specify)

4.3. Seed cost: soybean 2017

	Seed		
Plots/fields	kg	Mudus	Total value (₦)
1. Main soybean plot			
2. Second soybean plot			
3. Third soybean plot			
4. Fourth soybean plot			
5. Fifth soybean plot			

4.4. Soybean yield in 2017

Plots/fields	**Yield in Mudus Harvested**	**Yield in 100 kg bag**
1. Main soybean plot		
2. Second soybean plot		
3. Third soybean plot		
4. Fourth soybean plot		
5. Fifth soybean plot		

4.4.1. Assess your soybean yield vis-a-vis quantity of seeds used in the past 3 years (2013–2017) (*QTY = Quantity Planted*), (*YLD = Yield Harvested*) **(EVERY MEASUREMENT SHOULD BE IN MUDU)**

Varieties	**2017**	**2015**		**2013**		
	QTY	YLD	QTY	YLD	QTY	YLD
1. TGX1835 (*Danwuri)*						
2. TGX1951-3F,						
3. TGX1955-4F,						
4. TGX1448-2E,						
5. TGX1904-6F						
Others specify…….						

4.4.2. Have you received or given out new seeds of soybean? ----------(1 = Yes, 0 = No)

If yes, please state quantity received or given out and year?

Varieties	Received 1. KADP/Ministry, 2. N2AFRICA, 3. EAs, 4. Other farmers, 5. Seed dealer, 6. Relatives, 7. Friends, 8. Cooperatives, 9 = NGO 99=Others (specify)			Given Out 1. CBO members, 2. EAs, 3. Other farmers, 4. Seed dealer, 5. Relatives, 6. Friends, 7. Cooperatives, 99:Other (specify)		
	FROM	QTY(mudu)	YEAR	TO	QTY (mudu)	YEAR
1. TGX1835						
2. TGX1951-3F						
3. TGX1955-4F						
4. TGX1448-2E						
5. TGX1904-6F						
Others						

4.5. Soybean Production Constraints

1. What are the priority constraints to soybean production?

Constraints to crop production	**Rank the top three constraints (1 being the topmost constraint)**
1. Low soil fertility	
2. Pests and diseases	
3. Lack of new varieties	
4. Low access to inputs	
5. High cost of inputs	
6. Insecure land tenure	
7. Lack of land	
8. Lack of labor during peak season	
9. Lack of/expensive agricultural equipment	
10.Lack of market for soybean	
11. Distance to market	

5. ACCESS TO INPUT/OUTPUT MARKETS FOR SOYBEAN

5.1. Access to Market Information

Variable	Response	Codes
1. Do you regularly have information on market price for soybean?		1 = Yes, 0 = No
2. If yes, indicate the source (s) of your market information.		1 = Market visits, 2 = Media (TV/Radio), 3 = Other farmers, 4 = Middlemen, 5 = Friends/relatives, 6 = extension agents, 99= Others(specify)
3. Did you receive information on:	**1 = Yes, 0 = No**	
	a: Soybean prices in different markets	
	b: Soybean demand in different markets	
	c: Soybean supply in different markets	
	d: Availability of services, e.g., transport	
4. What is your assessment of the market price of soybean over the past 12 months?		1 = good market price, 2 = not so good, 3 = low market price

5.2. Access to Inputs and Machineries

Variable	**Response**	**Codes**
1. Do you have any agrochemical dealer in this village? (fertilizer, insecticide, etc.)		1=Yes, 0=No
2. If no, what is the distance to the nearest agrochemical dealer? (km)		
3. Do you purchase agrochemicals for soybean production?		1 = Yes, 0 = No
4. Where do you purchase your agrochemicals? 1 = open market, 2 = KADP, 3 = input dealer, 4 = Other farmers, 5 = friends/relatives, 6 = farmer cooperative, 7 = seed company, 99 = Others (specify)		

5. Which of the chemicals do you purchase?		**1 = Yes, 0 = No**	
		NPK	
		SSP	
		Urea	
		Fungicide	
		Herbicide	
		Seed dressing	
7. Is there an improved seed dealer in this village?		1 = Yes, 0 = No	
8. If no, what is the distance to the nearest seed dealer? (km)			
9. What are the sources you get seeds from for your household?		1 = own produced, 2 = open market, 3 = seed company, 4 = community seed producers, 5 = neighbour/friends, 6 = seed aid, 99=other (specify)	
10. Do you have food processing machines for soybean in this village?		1 = Yes, 0 = No	

5.3. General Access to Inputs: 1. Indicate your access to the following inputs

Variables	**Ever heard** **1 = yes 0 = no**	**Ever used** **1 = yes 0 = no**	**Used in 2017?** **1 = yes 0 = no**
Improved cowpea varieties			
Improved groundnut varieties			
Improved maize varieties			
Improved sorghum varieties			
Improved millet varieties			
Fertilizer			
Herbicide (Pre and/or post emergence)			
Inoculants			
Insecticide			
Treated seed (fungicide)			

5.4. Marketing strategies and linkage with agricultural traders (Soybean)

1. If soybean is sold in more than one form, enter each form on a separate row

2. Price is to be given in Naira

3. Please leave every unit used in mudu or 100 kg bag

		Market 1 (main market)				Market 2 (in case of other market)				
Soybean Forms[2]	(a) Did you sell? 1 = Yes 0 = No	(b) If yes, quantity sold (100 kg bag)	(c) Type of market[1]	(d) Price per unit in market[1]	(e) How did you sell?[3]	(f) Did you sell? 1: Yes 0: No	(g) If yes quantity sold (100 kg bag)	(h) Type of market[1]	(i) Price per unit	(j) How did you sell?[3]
Form 1										
Form 2										
Form 3										

[1] **Type of market:** 1 = on the farm, 2 = middlemen, 3 = local/village market, 4 = distant market,
[2] **Form** 1 = grain, 2 = seed, 3 = processed into food products
[3] **How?** 1 = Individually, 2 = Collectively

5.5. Constraints to Soybean Marketing

Constraints to Soybean Marketing	**Rank (1 being the topmost constraint)**
1. Low quality of produce	
2. Low market prices at the time of selling	
3. Unavailability or limitations of markets	
4. Lack of market information	
5. Difficulties in processing	
6. Difficulties in storage	
7. Transport to the market	
8. Farmers are not organized to market collectively	
9. Difficulties in setting prices	
10. others (specify)	

6. IMPACT OF PROJECT ACTIVITIES ON FARMER INCOME, POVERTY

6.1. Household Major Sources of Income

1. What are your priority sources of income and what is the income estimate from these sources for the last 12 months?

Row	**Income source**	Do you get income from this source? Yes = 1 No = 0	How regularly do you get income from this source? **(see codes) *****	Estimated amount from this source in the last 12 months (Naira)	What is the importance of this source to total household income? **(Codes)****
1.	Sale of soybean				
2.	Sale of cowpea				
3	Sale of groundnut				
4.	Sale of maize				
5	Sale of sorghum				

6	Sale of millet				
7	Sale of rice				
8	Sale of other products, e.g., firewood, trees				
9	Regular employment				
10	Casual employment (agricultural related)				
11	Casual employment (nonagricultural related)				
12	Running own business				
13	Remittances from family members				
14	Remittances from non-family members				
15	Other (specify)				
.	**TOTAL INCOME**				

******Regularity of income source** 1 = Do not get at all, 2 = Occasionally, 3 = Regularly 4 = All the time*
*****Importance of source**: 1 = Not important, 2 = Moderate importance 3 = High Importance 4 = Very High Importance*

6.2. Household Food Security

1. Were there any month (s) (January to December 2017), in which you did not have enough food to meet your family's needs? This includes any kind of food from any source, such as own production, purchase or exchange, food aid, or borrowing. 1 **= Yes, 0 = No: ----------**

Month	Which month (s) in the last 12 months did you not have enough food to meet your family's needs? Record 1 in identified month. 1 = Yes, 0 = No	Why? List up to 3 major reasons. **See codes*****.**
January 2017		
February 2017		
March 2017		
April 2017		
May 2017		
June 2017		
July 2017		
August 2017		
September 2017		
October 2017		
November 2017		
December 2017		

CODE**** *1 = drought; 2 = flooding; 3 = pest/diseases; 4 = irregular rain; 5 = high food price; 6 = high cost of agricultural input; 7 = loss of employment; 8 = illness of household member; 9 = death of household member; 10 = theft of productive asset; 11 = erosion/landslide; 12 = livestock disease; 13 = large family size; 14 = insecurity; 15 = others (specify)*

6.3 Coping Strategy for Food Shortages

1. If you faced any food shortage in the past 12 months, what coping strategies did you use?

Coping mechanism	Did it happen? 1 = Yes, 0 = No	If you used a coping strategy, how often did you use it?
1. Borrowed money to buy food or got food on credit		
2. Reduced the number of meals		
3. Mother ate less		
4. Father ate less		
5. Children ate less		
6. Substituted commonly bought foods with cheaper kind		
7. Modified cooking method		
8. Mortgaged/sold assets		
9. Borrowed from neighbours		

Code****1 = regularly; 2 = occasionally

6.4. Household Expenditure or Household Dietary Diversity

(*Here, the person involved in purchases should be the principal respondent/s)*

No.	Item3	**Unit**: 1 = kg, 2 = liter, 3 = packet, 4 = bundle, 5 = number, 6 = basket, 7 = mudu, 8 = cup, 9 = tuber, 10 = bag, 11 = others (specify)	**Consumed in the last 7 Days (One week)**				
			Frequency of buying	Average quantity each time (e.g., 2 kg; 4 bundles etc.)	Total quantity per week	Average price per unit **(Naira)**	Total cost of purchases **(Naira)**
1	**2**	**3**	**4**	**5**	**6 = 4 × 5**	**7**	**8 = 6 × 7**
Root crops & products							
1	Yam						
2	Cassava/product						
3	Potatoes						
4	Sweetpotatoes						
Cereals and products							
5	Maize						
6	Wheat						
7	Barley						
8	Rice						
9	Sorghum						
10	Millet						
Grain legumes & products							
11	Beans						
12	Cowpea						
13	Soybean						
14	Groundnut						

15	Bambaranut						
16	Leaves						
Fruit staples							
17	Bananas						
18	Plantain						
19	Other, specify.....						
20	Other, specify.....						
Beverages and drinks							
21	Tea (leaves)						
22	Tea (liquid)						
23	Coffee (liquid)						
24	Soft drinks						
25	Juices						
26	Drinking water						
27	Coffee beans						
28	Coffee powder						
29	Other drinks						

6.5 Household Assets

Which of the following assets do you have?

Code	Equipment	Does your HH own Yes = 1 No = 0	If yes Total Number	Estimated average NAIRA value for one item
A				
a1	Hoes, cutlasses			
a2	Ox-ploughs			
a3	Draft cattle			
a4	Draft donkeys			
a5	Tractor/tractor plough			
a6	Wheelbarrows			
a7	Threshing machine			
a8	Water pumps			
a9	Sprayers			
a10	Grinding			
a11	Milling			
B				
b1	Sewing machine			
b2	Ox-cart			
b3	Car			
b4	Bicycle			
b5	Motorcycle			
b6	Radio			
b7	Television			
b8	Water well			
b9	Mobile phone			
b10	Paraffin stove			
b11	Sofa chairs			
b12	Others			

7. IMPACT OF SOYBEAN ADOPTION ON FOOD CONSUMPTION AT HOUSEHOLD LEVEL

7.1. How many times did your household eat the following food items?
(if eaten = 1, not eaten = 0).

Item	Yes = 1 No = 0	No. daily	No. weekly	No. monthly
Soybean related meals				
Cereal related meals (maize, millet and sorghum				
Cowpea/groundnut Related Meals				

7.2. In what form is soybean consumed in your household? **Use CODE (Yes = 1; No = 0)**

Form	**Response**
1.Soybean cake (fried bean cake, kuli kuli)	
2.Soy flour	
3.Soy tum-brown	
4.Soy milk	
5.Soy cheese (awara)	
6.Soy daddawa	
7.Soy bread	
8.Soy kunun	
9.Soy oil	
10. Soy soup	