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ANALYSIS OF FACTORS THAT INFLUENCE ADOPTION OF N2AFRICA SOYBEANS TECHNOLOGIES AMONG SMALLHOLDER FARMERS IN KADUNA STATE

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ABSTRACT

The study aimed at analysing the factors that influenced adoption of N2Africa Soybean technologies among smallholder farmers in Kaduna State. Primary data were collected using structured questionnaires and interview schedules with the assistance of trained enumerators. Three hundred (300) soybean farmers were selected using multistage sampling technique. The N2Africa soybean technologies analysed were seeds, inoculant and fertilizer. The collected data were analysed using descriptive and inferential statistics (Tobit regression model and factor analysis). The findings of the study revealed that the respondents accepted the N2Africa soybean technologies highly, their socio-economic characteristics had influence on the rate of soybean technology adoption and the factor analysis result implies that most of the factors encourage farmers to risk trying new innovations and its eventual adoption. The study recommended that soybean technologies (seed, fertilizer and inoculant) should be made readily available; N2Africa should focus on expanding area of intervention in Kaduna and other soybean producing states, and other non-governmental organizations (NGOs) should complement the efforts of N2Africa for farmers to easily access the soybean technologies.

Keywords: N2Africa soybean; technologies; smallholder farmers

INTRODUCTION

Soybean (*Glycine max L.*) is an important crop produced mainly in the southern and northern Guinea savannas of Nigeria where rainfall is more than 700 mm (although short-duration varieties can thrive in much drier Sudan savanna). 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 Savannahs. Nigeria is Africa's largest producer of soybean, and Benue State is Nigeria's largest soybean producer, producing about 175,000 metric tons. Nigeria's soybean output increased from 480,000 metric tons (MT) in 2010/11 to 510,000 MT in 2011/2012 (Abate, 2012). Soybean is one of the crops in the world import list of agricultural products based on value, indicating that it is one of the most agricultural products traded and consumed globally as it is an alternative protein source to the rural families and can be utilized at home in various forms (FAOSTAT, 2013). It has long been recognized primarily to improve nutrition of farm families and diversify income sources. Besides nutritional advantage, the crop has a great significance in improving soil fertility when grown solely or in combination with cereal crops (CDI, 2010). Thus, several projects/programs exist that work towards production and promotion of soybean one of such projects is N2Africa, which developed, tested and promoted new improved soybean variety and its associated management practices. The promoted soybean technologies include the use of inputs such as seeds, inoculants and fertilizers as well as other good recommended agricultural practices.

More so, considering the recent societal problems; malnutrition and soil fertility problems faced due to frequent cultivation, the adoption and diffusion of soybean among small holder farmers may be regarded as a good option especially for Sub-Saharan African countries that are characterized by high population growth, large family size, high child mortality, malnutrition and food shortage (Samuel & Wondaferahu, 2015). Many donor countries through their international development agencies and in cooperation with international research centres have invested substantial resources in agricultural technologies but have not fully achieved their desired goals (such as high rate of adoption) (Faltermeier & Abdulai, 2009). Adoption of recommended technologies implies that technologies are relevant to the farmers' circumstances. If farmers become aware of technologies or modifications in the use of resources that are relevant to their circumstances and can improve their farm production and thus their welfare, they will most likely adopt these changes (World Bank, 2011). These technical changes are needed to sustain smallholder agricultural growth in Africa. Minten and Barrett (2008) argued that agricultural technology adoption and productivity improvements have the potential of increasing food security. Most agricultural households earn the food they consume and the cash they need to cover other expenses only from farming activities so that improvement of agricultural productivity is very important to them (CSA, 2011) and may result in a change in their livelihood pattern.

N2Africa is putting nitrogen fixation to work for smallholder farmers in Africa through enhancing the yield of grain legumes and expanding the farm area with cropped legumes to improve incomes, food and nutrition security. It is a large scale, science-based "research-in-development" project funded by Bill and Melinda Gates Foundation with a vision of building sustainable, long-term partnerships to enable smallholder farmers to benefit from symbiotic N2-fixation by grain legumes through effective production technologies, including inoculants and fertilizers. The project aims to enhance legume yields of sequential crops, and to diversify cropping patterns from mono-cropping of cereals to rotation or intercropping with legumes. The project has currently been implemented in 11 countries including Nigeria. In Nigeria, its implementation is being coordinated by International Institute of Tropical Agriculture (IITA), and it was implemented in four states; Niger, Kaduna, Kano and Borno States. The program focuses on adoption of grain legumes (cowpea, soybean and groundnut) and some associated technologies. These associated technologies include the use of purchased inputs such as seeds, inoculants and fertilizers as well as other good recommended agricultural practices. These recommended practices include seeds planting, appropriate spacing (inter and intra-row spacing) and good management among others for better productivity (N2Africa, 2012). Thus, the project developed, tested and promoted improved soybean variety and its associated management practices which can enhance production of soybean.

The agricultural production system in Kaduna state is characterized by small-scale producers dependent on low adoption of improved inputs and practices resulting in low productivity of resource use (KSDP, 2013). The low output realized by smallholder farmers is an indication that resources needed in the production of crops are not at optimal levels, (Nweze, 2002; Panwal, 2006; Adinya *et al.*, 2008). One of the critical problems hindering improvement in productivities of legumes is the traditional practices of cropping systems used by majority of the farmers (Halliru, 2015). Despite stronger national research systems, agricultural productivity remained low as a result not only of the lack of appropriate technologies and lack of access to those technologies, inputs, credit and access to markets and rural infrastructure, but also because of gaps in information and skills that prevented rural producers from effectively utilizing and adopting technologies (Miriam *et al.*, 2011). (Ogunniyi & Kehinde, 2015). There are different factors influencing the adoption of technologies that is believed to bring change in smallholder farmers' production. An important aspect of the dynamics of adoption is the study of factors that influenced adoption and this study seek to examine the factors that conditions the adoption of the promoted soybean technologies.

The study intends to determine the factors that influence the rate adoption of soybeans technologies among smallholder farmers; analyse the effects of socio-economic characteristics of the soybean farmers on adoption of soybean technologies; and describe the constraints militating against the adoption of soybeans technologies.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Kaduna State, Nigeria. Kaduna state is located at the centre of Northern Guinea savannah and it lies between latitudes 9˚ 03 and 11˚ 32 north of the Equator and longitudes 6˚ 05 and 8˚ 38 east of the Greenwich Meridian. Kaduna State shares common borders with Zamfara, Katsina, Niger, Kano, Bauchi, Nasarawa, Plateau States, and the Federal Capital Territory, Abuja. The total land mass of the State is estimated at 46,053 square km which is about 5% of the total land area of Nigeria. The state experiences a tropical continental climate with two distinct seasonal climates, dry and rainy seasons. The wet season (May to October) is very much heavier in the Southern part of the State, which has an average of over 1,524 mm, than in the Northern part, which has an average of 1,016mm. The average annual rainfall and humidity are 1,272.5 mm and 56.64% respectively. The population of the State according to 2006 census stands at 6,113,503, using 3.18% growth rate as allowed by the National Population Commission, the projected population of Kaduna State stands 8,835,235 by the year 2020. Agriculture is the main stay of the economy of Kaduna State with the majority of the people actively engaged in farming. The study was conducted in Kajuru and Ikara, Local Government Areas of Kaduna State where N2Africa activities were carried out and the two LGAs have a good access to soybean market and processing plants.

Sampling Procedure

Multi stage sampling procedure was used in this study. The study considered the three (Southern, Northern and Central) zones in Kaduna State purposefully in specific areas where

N2Africa project was implemented. One local government area (LGA) each from Central and Northern zones of Kaduna state was conveniently selected due to security reasons. The next stage employed purposive selection of six communities from each local government area (60% from each LGA) where N2Africa project was carried out making a total of 12 communities. Systematic quota sampling of 25 respondents from 100 participating farmers in each of the communities was employed making a total of 150 respondents from each LGA and a total of 300 respondents for the study.

Table 1 : Sampling frame summary

LGA's	Communities under the Project	Sampled Communities	Sample Frame	Sampled Farmers
Ikara	Furana,Wambai, Unguwan Barau,	Furana	100	25
		Wambai,	100	25
	Marabar Rido, Magashanu,	Unguwan Barau	100	25
	Saya-saya,Gunduma,Rumi,	Jampala	100	25
	Bakula, Jampala.	Bakula	100	25
		Saya-saya	100	25
Kajuru	Kallah, Rimau, Kasuwan magani, Issabe, Dutsen gaiya, Sabon-garin Afogo, Maraban Kajuru, Sabon garin Kufana, Kufana, Kyemara.	Kallah	100	25
		Rimau	100	25
		Kasuwan	100	25
		magani	100	25
		Issabe	100	25
		Kyamara	100	25
		Kufana		
Total	20	12	1200	300

Data Collection and Tools of Analysis

Data were collected from primary sources. Primary data were collected through the use of structured questionnaires (for respondents with considerable level of literacy) and interview schedules (for non-literate respondents) with the assistance of trained enumerators. Descriptive and Inferential statistics were used for the study. Descriptive statistical tools such as frequency, percentages, was used for the analysis of household socio-economic characteristics and constraints militating against the adoption of soybeans technologies. Tobit model was used to establish relationship among factors responsible for the adoption of the technologies.

Tobit Model

The Tobit model was used to analyse objective I that is the rate of adoption of the soybean technologies by the farmers. The advantage of the Tobit model over the dichotomous choice models such as the Probit and Logit model is that it permits determining the rate of adoption of the technology once adoption has taken place. The model assumes that the rate of adoption of a technology by a farmer is a function of a vector of explanatory variables, X and an unknown parameter vectored. The model is implicitly represented as;

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots B_nX_n + e$$

Where:
Y = rate of adoption (measured in percentage of soybean technology(ies) adopted)
X_1 = Age of respondents (measured in years).
X_2 = Marital status (dummy variable)
X_3 = Educational level (measured in years spent in formal schooling)
X_4 = Household size (measured in number of persons living under the care of the respondent)
X_5 = Income per annum (₦)
X_6 = Primary occupation (binary)
X_7 = Farming experience (measured in number of years spent as a soybean farmer)
X_8 = Farm size (hectares)
X_9 = Access to credit (Dummy variable)
X_{10} = Extension contact (measured in number of visits by extension agents to farmers)
X_{11} = Membership of association (dummy variable)
X_{12} = Yield (physical output of improved variety measured in kg)
B_0 = intercept
B_1 - B_n = estimated parameters
e = error term

The use of the tobit model for this analysis is consistent with the literature on adoption see for instance Idrisa *et al.* (2012) in logit and tobit analyses of the determinants of likelihood of adoption and extent of adoption of improved soybean seed in Borno state, Nigeria. The Tobit regression model was used to establish the relationship between the extent of adoption of soybean technologies and the various factors affecting it.

Factor Analysis

Factor analysis will be used to determine objective II. Factor analysis could be described as orderly simplification of interrelated measures. It seeks to resolve a large set of measured variables in terms of relatively few categories known as factors. Karl Pearson was the first to explicitly define factor analysis as a statistical tool which looks at the relationship between observed, correlated variables in terms of potentiality with lower number of unobserved variables otherwise called factors. Factor analysis is a generic name used to describe a number of techniques that are used to decompose a correlation matrix when strong assumptions are made about the nature of variation in the variables of the data set (Farinde and Alabi, 2015). This technique allows the researcher to group variables into factors (based on correlation between variables).

Exploratory Factor Analysis (EFA) Model Specification

The model for EFA is generally specified as follows:

$X_1 = l_1F_1 + l_{1,2}F_2 + l_{1,3}F_3 + \ldots\ldots\ldots + l_{1,4}F_4 + e_1$
$X_2 = l_2F_1 + l_{2,2}F_2 + l_{2,3}F_3 + \ldots\ldots\ldots + l_{2,4}F_4 + e_2$
$X_{25} = l_{25}F_1 + l_{25,2}F_2 + l_{25,3}F_3 + \ldots\ldots\ldots + l_{25,4}F_4 + e_4$

Where;
F_1= First component
F_2= Second component

F_3= Third component
F_4= Fourth component
X_1 = Age of respondent
X_2 = Marital status
X_3 = Educational level
X_4 = Household size
X_5 = Income per annum
X_6 = Primary occupation
X_7 = Farming experience
X_8 = Farm size
X_9 = Access to credit
X_{10} = Extension contact
X_{11} = Membership of association
X_{12} = High yield
X_{13} = Large seed size
X_{14} = Less shattering
X_{15} = Resistance to disease (s)
X_{16} = High fodder yield
X_{17} = High oil content
X_{18} = High cash income/profit
X_{19} = Drought resistant
X_{20} = Early maturity
X_{21} = Less labour inputs
X_{22} = Resistance to pest
X_{23} = Soil fertility improvement
X_{24} = Striga control
X_{25} = Food security in the home
l_1 - l_{25} = Factor loading
$e_1 - e_4$ = error terms

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Soybean Farmers

Sex is an important variable in agricultural production. Majority (87.3%) of the soybean farmers were males, while females constitute 12.7%. This implies that male dominated soybean production in the study and the sex of a farmer influences the decision he/she makes concerning new technologies. In most cases, males have better access to information on improved technologies and are more likely to adopt new technologies than female. Melesse (2018) in a review on "Factors Affecting Adoption of Agricultural New Technologies in Ethiopia" revealed that in most parts of rural Ethiopia women are disfavoured groups of the society who couldn't easily access technology information. Thus, numerous adoption studies had come up with results showing that being a female negatively influences technology adoption decisions.

Also, majority (84.6%) of the respondents were married. This implies that soybean production was dominated by married people in the study area and this served as income generating activity that help in improving the living conditions of the people in the area. This finding is in line with that of Haruna (2011) who reported that men and women with responsibilities are willing to try new innovations that will improve their standards of living.

It is evident from the results that, 25.3% of the respondents had no formal education at all. This implies that majority (74.7%) of the respondents had at least one form of education or the other and are in a better position to adopt the soybean technologies. Therefore, in this study education was expected to positively influence adoption of soybean technologies. The findings are consistent with that of Degu (2012) who found that education has a positive relationship with the adoption of improved potato varieties in eastern Ethiopia. The level of education among the respondents differs (that is either adult education, primary, secondary or post-secondary) and this might have an effect on their ability to understand and thus, adopt the N2Africa soybean technologies.

Extension contact is the frequency of extension agents' interactions with the respondents. The result showed that 33.3% of the respondents had no extension contact while majority (66.7%) of the respondents had extension contact. Farmers who are regularly visited by extension workers and those who attend field days or host demonstration/trials are likely to adopt modern agricultural technologies due to their increased exposure and awareness. Farmers can only adopt modern agricultural technologies if they are aware of the availability and benefits of these technologies and their inherent characteristics (Adegbola & Gardebroek, 2007). Similar results were also found for adoption of improved maize varieties in studies such as Mekonnen (2007) and Taha (2007) which reveals that access to extension service increases farmers' adoption decision of improved technologies.

The results also revealed that majority (80.7%) of the respondents belonged to one association group or another while 19.3% claimed not belong to any association/group. Farmers who get the chance to acquire timely and vital information from associations are more likely to adopt new innovations. Thus, being a member of a farmer association was expected to affect adoption of soybean technology positively. Similarly, it was also found that cooperative membership had a strong positive impact on income and on the adoption of fertilizer and improved seed in Kenya and Ethiopia, respectively as found by (Abebaw & Haile, 2013; Alene *et al*., 2008; Fischer & Qaim, 2012).

It was also found that majority (80.7%) of the respondents were within the age bracket of 20-50years, which is an active, innovative, motivated and adaptive age bracket. This is in agreement with the findings of Wakawa *et al*., (2015) in their study on Impact of Soybean Technology Adoption on Income of Farming Households in Borno and Kaduna States, Nigeria. Their study revealed that the Soybean farmers comprised relatively young and active farmers between the ages of 30 and 40 years and they are likely to be more productive, have higher degree of risk aversion and can participate in new agricultural projects.

From the result, 42.3% of the soybean farmers had a household size of between 7-9 persons which is above the national average of five (5) and six (6) persons in urban and rural areas per household as reported by (NBS, 2016). It is assumed in some parts of Nigeria that large household size is a source of pride, a compelling force that contributes a lot to the family labour. This is in line with Shuaib *et al.* (2017) in their study in Kano state which revealed that having large household size is a source of pride and a compelling force to produce more output by the household head in the farms. The minimum (9%) respondents had a household size of 1-3. Large family size is an indicator for availability of labour, since the main source of labour in most African communities are from immediate family.

Effects of Socio-economic Characteristics of Soybean Farmers on the Rate of Adoption of Soybean Technologies

The results of tobit regression (Tables 2a, 2b and 2c) revealed the socio-economic characteristics that influenced the rate of adoption of N2Africa soybean technologies. The results also indicated the relevance of the model for estimating the relationship between the dependent and at least one independent variable. A positive coefficient indicated that a higher value of the variables tends to increase the likelihood of adoption rate. Similarly, a negative value of coefficients implied that higher value of the variables would decrease the rate of adoption. Model output indicated that most of the socio-economic characteristics positively influenced the rate of adoption of soybean technologies by smallholder farmers.

Table 2a: Tobit regression result for the effects of socio-economic characteristics on adoption of soybean technology (seed)

Variables	Coeff.	Std. Err.	T	P>|t|	[95% Conf.	Interval]
Age	0.127653	0.0358442	3.56***	0.000	0.0571032	0.1982027
Marital status	0.0933083	0.0379706	2.46**	0.015	0.0185731	0.1680434
Educational level	0.0458709	0.0118522	3.87***	0.000	0.0225431	0 .0691988
Household size	0.5793527	0.2404961	2.41**	0.017	0.1059999	1.052706
Income per annum	0.0189372	0.0280844	0.67	0.501	-0.0363403	0.0742148
Sex	0.8099287	0.3341752	2.42**	0.016	0.1521837	1.467674
Farming experience	0.2664681	0.0953642	2.79***	0.006	0.0787192	0.454217
Farm size	0.5389294	0.1965623	2.74***	0.007	0.1519461	0.9259127
Access to credit	0.7410098	0.2004449	3.70***	0.000	0.3464871	1.135533
Extension contact	0.2435046	0.0825752	2.95***	0.003	0.0809772	0.406032
Membership of association	0.1983632	0.1603954	1.24	0.217	-0.1173373	0.5140637
Yield	1.549316	0.0201631	76.84***	0.000	1.50963	1.589003
_cons	0.5972257	0.2511246	2.38	0.018	0.1029534	1.091498
/sigma	0.7247836	0.0323865			0.6610383	0.7885288

***, **, * show significance at 1%, 5% and 10% levels respectively

Table 2b: Tobit regression result for the effects of socio-economic characteristics on the rate of adoption of soybean technology (fertilizer)

Variables	Coeff.	Std. Err.	T	P>|t|	[95% Conf.	Interval]
Age	0.1811946	0.0419038	4.32***	0.000	0.0987169	0.2636724
Marital status	0.5143498	0.0137735	37.34***	0.000	0 .4872399	0.5414597
Educational level	0.2991035	0.0881409	3.39***	0.001	0 .1256189	0 .4725881
Household size	2.868337	0.1196448	23.97***	0.000	2.632844	3.103829
Income per annum	0.1813696	0.0418809	4.33***	0.000	0.0989382	0.263801
Sex	0.1452088	0.0492565	2.95***	0.003	0.048259	0.2421587
Farming experience	0.1386647	0.0587653	2.36**	0.019	0.022999	0.2543303
Farm size	0.7175297	0.0847058	8.47***	0.000	0.5507647	0.8842947
Access to credit	0.2982037	0.0878364	3.39***	0.001	0 .1253209	0.4710865
Extension contact	0.1756285	0.4737846	0.37	0.711	-0.756891	1.108148
Membership of association	0.423137	0.5403476	0.78	0.434	-1.486668	0.6403943
Yield	0.4543021	0 .2061869	2.20**	0.028	0.0484719	0.8601324
_cons	4.997431	1.511117	3.31	0.001	2.023198	7.971664
/sigma	2.476391	0.1112342			2.257456	2.695326

***, ** show significance at 1%, and 5% levels respectively

Table 2c: Tobit regression result for the effects of socio-economic characteristics on the rate of adoption of soybean technology (inoculant)

Variables	Coeff.	Std. Err.	T	P>|t|	[95% Conf.	Interval]
Age	0.1128296	0.0516887	2.18**	0.030	0.0110671	0.214592
Marital status	0.1964664	0.0916246	2.14**	0.033	0.0160799	0.3768529
Educational level	0.0560534	0.0242253	2.31**	0.021	0.0083597	0.1037471
Household size	0.4955762	0.21017	2.36**	0.018	0.0836504	0.9075019
Income per annum	0.4835809	0.2498137	1.94**	0.053	-0.006045	0.9732068
Sex	0.1276507	0.2427106	0.53	0.599	-0.350164	0.6054652
Farming experience	0.3238066	0.1988632	1.63	0.105	-0.067603	0.7152162
Farm size	0.1523974	0.080109	1.90**	0.058	0.3101047	0.00531
Access to credit	0.1897566	0.0924849	2.05**	0.041	0.0076853	0.3718279
Extension contact	0.594172	0 .070378	8.44***	0.000	0.4556148	0.7327291
Membership of association	0.1305422	0.1155601	1.13	0.260	-0.096956	0.3580406
Yield	0.3150498	0.1480617	2.13**	0.034	0.0235524	0.6065472
_cons	1.223685	0.3796614	3.22	0.001	0.4762247	1.971146
/sigma	0.5034363	0.025867			0.4525129	0.5543596

***, ** show significance at 1%, and 5% levels respectively

Age: Age of the respondents was a very important factor that influenced the rate of N2Africa soybean technologies. The result of the Tobit Regression Model showed that age of the respondents influences adoption of soybean production technologies positively at 1% level of significance for both seed and fertilizer and positively significant at 5% for inoculant. Indicating that an increase in farmer's age increases the adoption of these soybean production technologies. The positive and significant relationship between age and adoption in this study disagrees with earlier studies of Bethuel & Edward (2017) on "the impact of agriculture technology adoption on farmers' welfare in Uganda and Tanzania" where they found that as the age of the farmer increases, there are chances of developing resistance to the adoption of new technologies.

Marital status: Marital status is significant at 5% for seeds and inoculant and it is significant at 1% for fertilizer, implying that it positively affects the adoption of N2Africa soybean technologies and signifying the likelihood of adopting technologies by married individuals than the unmarried. This is in agreement with Sahbong (2013) whose study revealed that marital status of the farmers was significant at 5%, indicating that adoption is likely to occur when a farmer is married than when he/she is not. This could largely be due to the fact that the married farmers tend to have more responsibilities to shoulder in terms of providing basic needs of their families and food being the most important. Thus, any technology that will increase the production of food or ensure food security among households will be adopted.

Level of education: Level of education was significant at 1% for both the seeds and fertilizer and significant at 5% for inoculant. This indicated that the higher the farmers level of education, the higher their rate of adopting soybean technologies. An increase in literacy level will most likely result in an increase in the farmer's level of adoption of innovations. This is in line with the studies of Atman *et al.* (2008) which reported that literacy status of respondents is necessary to explain the strength or weakness observed in their management ability and adoption of innovation. Mamudu *et al.* (2012) revealed that the maximum level of education within the household was found to have a positive relationship with the probability of adoption, also implying that farming households with well-educated members are more likely to adopt modern agricultural production technologies than those without.

Household size: From tables 4a, 4b and 4c above, the soybean technologies (seed, fertilizer and inoculant) were significant at 5%, 1% and 5% respectively. This indicated that the larger the household size the higher their rate of adopting new technology. Danso-Abbeam *et al.*, (2017) in a study on "Adoption of improved maize variety among farm households in the northern region of Ghana" opined that large households tend to have free labor supply toward the adoption of the innovation than the smaller households.

Sex of respondents: Sex was found to be positively related to the adoption of soybean technologies by respondents. This was found to be significant at 5% and 1% for seed and fertilizer, revealing the possibility of male farmers adopting new technologies than the female farmers. This is in line with Mamudu *et al.* (2012) who found that male farmers were more likely to adopt modern agricultural production technologies than their female counterparts. The reason for this is that men are responsible for making production decisions and also control resources such as land, labour and capital which are critical for the adoption of new technologies. Thomson *et al.*, (2014) also reported that sex of the household head is important in explaining adoption of improved maize varieties where the adoption was in favour of male households.

Farming experience: This is positively significant at 1% and 5% for seed and fertilizer and negatively significant for the inoculant. This could also mean that farmers with more years' in farming experience are more likely to adopt soybean production technology than those farmers with a smaller number of years of farming experience. The implication is that experience in farming can encourage a farmer to adopt new technologies and understand the benefits of the technology.

Farm size: The size of the farm is positively related to rate of adoption of soybean technologies (Tables 2a, 2b, and 2c.). Farm size was found to have a positive relationship with the probability of adopting modern agricultural production technologies. This finding is consistent with some studies that large-scale farmers are more inclined to adopting new technologies than small scale farmers (Kasenge, 1998). Idrisa *et al.* (2010) also revealed that farm size affects the adoption of soybean seed negatively which is in contrast to this study where the farm size affects the adoption of soybean seed positively at 1% level of significance.

Access to credit: Access to credit was found to have a positive relationship with the adoption soybean technologies. This was found to be significant at 1% level and also at 5%. This means that credit is an important factor of agricultural production technology adoption. This is consistent with the view that high poverty levels among farmers and lack of access to credit make it almost impossible for them to afford technologies (Ministry of Food and Agriculture, Ghana 2010).

Extension contact: Extension contact was found to be significant at 1%. Access to extensions services creates the platform for acquisition of relevant information that promotes technology adoption. Mamudu *et al.* (2012) found access to extension services to be positively related to the adoption of modern agricultural production technologies and was found to be significant at 10% level. This means that farming households are more likely to adopt modern agricultural production technologies if they have access to extension services.

Yield: The yield of soybean affects the likelihood of adoption of soybean technologies positively at 1% and 5% levels of significance. Thus, indicating that the higher the adoption of soybean technologies the higher the yield.

Membership of association: The result from tables 4a, 4b and 4c revealed that membership of association is the only variable that is not significant at 1% and 5% for the N2Africa soybean technologies. Hence indicated that belonging to a farmer group/association had little influence on farmers' decision to adopt agricultural technologies.

Factors Influencing the Adoption of Soybean Technologies

Table 3: Computed Eigen values of the factors that influence adoption of soybean technologies (n=300)

Factors	Eigen value	Percentage variance	Cumulative % of variance
Institutional factors	3.594	14.377	14.377
Socio economic factors	2.145	8.579	22.956
Sociological factors	2.029	8.115	31.071
Technological factors	1.918	7.671	38.742

Table 3 showed the result of component factor extraction of the variables based on four factors namely; Institutional, Socio-economic, Sociological and Technological factors. The table further showed the respective Eigen values of the component factors. Eigen value is the sum of squared correlation for each factor, it is the overall strength of relationship between a factor and a variable. Eigen values over (>1) are stable. The table showed that institutional factor had an Eigen value 3.594, socio-economic 2.145, sociological 2.029, and technological 1.918.

The sum of all Eigen values equals the correlation, equals total variance of the variables. The proportion of variance in each variable which can be explained by the factors is called the explained variation due to factor or communalities. Proportion of variance > 0.5 shows that the factor extracted, explain most of the variance in the variables analyzed. If < 0.5, it means there is considerable variance unexplained by the factor extracted. The table also illustrated the percentage of variance and the cumulative percentage of variance of the component factors as institutional factor had 14.377% (14.377%), socio-economic factor had 8.579% (22.956%), sociological factor had 8.115% (31.071%) and lastly technological factor had 7.671% (38.742%). This indicates that most of the variables of the component factors were significant determinants of adoption of soybean technologies among the respondents in the study area.

Factor Loadings

After constructing the factors, it is possible to determine the factor loadings by calculating the correlations between the original variables and the newly obtained factors or components, (it is the correlation of the variable and the factor). Factor loadings give an idea about how much the variable had contributed to the factor. If factor loadings are large, it means the variable has contributed to the factor. Factor loadings in the range of ±0.3 to ±0.4 are considered to meet the minimal level for interpretation of structure. Absolute value loading of 0.5 or greater are considered practically significant. Absolute value of loadings 0.7 or greater are considered indicative of well-defined structure. The larger the absolute size of factor loading the more improvement the loading in interpreting the factor which is the goal of factor analysis. In principal factor analysis, the first factor that account for the maximum part of the variance is the one with high loading. Factor rotation alters the pattern of the factor loading and hence can improve interpretation.

Table 4: Factor loadings result obtained of rotated varimax

Factors	Variables	Factor loading
Socio-economic factors	Age	0.550
	Marital status	0.691
	Educational level	0.560
	Household size	0.655
	Income per annum	0.992
	Sex	0.668
	Farming experience	0.648
	Farm Size (ha)	0.656
Institutional factors	Access to credit	0.316
	Extension contact	0.580
Sociological factors	Membership of Association	0.650
Technological factors	High yield	0.992
	Large seed size	0.596
	Less shattering	0.640
	Resistant to diseases	0.480
	High fodder yield	0.506
	High oil content	0.572
	High cash income/profit	0.462
	Drought resistant	0.658
	Early maturity	0.605
	Less labour inputs	0.733
	Resistance to pest	0.740
	Soil fertility improvement	0.688
	Striga control	0.763
	Food security in the home	0.373

Source: field survey, 2018

Factor Loadings Obtained of Rotated Varimax

The factor loadings for each of the 25 variables were thus revealed. Under socioeconomic factors, all the variables had high loading with income per annum having the highest thus all these variables (age, sex, marital status, educational level, household size, income per annum, farming experience and farm size) are considered as socio economic factors. These factors are important factors that can influence adoption of technologies. This implies that the factors can encourage farmers to risk trying a new innovation and can lead to eventual adoption of improved farming technology hence the capacity of farmers to know about new farming system is developed.

Under the second factor, the variable loading with the highest is extension contact (0.580). The second factor was thus termed institutional factor. This implies that farmer's contact with extension agents help educate and inform farmers about improved technologies, can encourage communication, sharing and transferring of technologies and knowledge effectively.

Variables with high positive loadings under factor 3; Sociological factor was membership in associations (0.650). This indicate that membership in associations can play a role in information exchange, networking and dissemination of improved crop and livestock technologies. Belongingness and participation of farmers in associations widens access to and dissemination of information, create peace, unity and will give one the advantage of being heard and assisted by the government and other organization.

Factor 4 named technological factors, all had high positive loadings except food security in the home (0.373). This implies that technological factors influence the adoption of soybean technologies in the study area.

Constraints to Adoption of Soybean Technologies among Smallholder Farmers

Constraints are factors that can influence the innovation process negatively. Adoption of N2Africa soybean technologies is associated with certain constraints as reported by the soybean smallholder farmers. Table 5 below presents the constraints faced by soybean smallholder farmers which affected the adoption of N2Africa soybean technologies.

Table 5: Constraints to Adoption of Soybean Technologies among Smallholder Farmers.

Constraints	Frequency	Percentage	Rank
Inadequate inoculants	72	24.3	2nd
Pest and diseases	27	9.0	5th
Low access to fertilizer	34	11.3	4th
Low yielding	13	4.3	7th
Inadequate seed	73	24.5	1st
Insecurity problem	4	1.3	11th
Lack of land	6	2.0	10th
Low market for newer soybean variety	18	6.0	6th
Lack of capital	36	11.7	3rd
Insecure land tenure	9	3.0	8th
Poor taste	8	2.6	9th

Table 5 presents constraints faced by respondents using the N2Africa soybean technologies. Inadequate seed was ranked the 1st (24.5%) constraint faced by the farmers, no access to inoculant was ranked 2nd (24.3%) this is in line with Ibrahim *et al.*, (2016) in a study on factors influencing level of adoption of cowpea production technology in Askira/Uba LGA of Borno State, which revealed that most of the respondents (48.32%) indicated that they had input constraints. Lack of capital (11.7%) was ranked as constraint number three (3) which agrees with the findings of Agbamu (2006) who observed that lack of capital was one of the major constraints to adoption of maize production technologies among farmers in Kwara State, Nigeria. Low access to fertilizer was ranked 4th, pest and diseases was ranked 5th. Other constraints include low market for soybean, low yield, insecure land tenure, poor taste, lack of land and insecurity problems.

CONCLUSION

Conclusively, the socioeconomic characteristics of the respondents revealed that a great percentage (80.7%) of the respondents are youths aged between 20-50 years. Although, majority (87.3%) of the respondents were male and also married (84.6%), over 66% of them had extension contact with 74.7% that had one form of education or the other. Majority of the respondents (89%) has no access to credit and the soybean production technology package was highly accepted by the respondents. The factors that influenced adoption of the soybean technologies promoted by N2Africa were grouped into four main factors viz; socioeconomics, sociological, technological and institutional factors. The rate of adoption of the technology was analysed for each technology in the N2Africa package (seed, fertilizer and inoculant).

Based on the findings of this study, the following recommendations were considered; N2Africa should focus on expanding area of intervention on soybean production activities in Kaduna and other soybean producing states. Also, soybean technologies (seed, fertilizer and inoculant) should be made readily available to the farmers; additional support/intervention from government and other non-governmental organizations (NGOs) is needed to compliment the efforts of N2Africa by helping the small holder farmers to easily access the soybean technologies and raise the adoption level; from the findings of the study, association membership can facilitate farmers' participation in intervention programmes and adoption of technologies. Thus, smallholder farmers should step up efforts to form groups/associations which are geared towards diffusing the soybean technologies to other farmers and achieving total acceptance in the study area; KARDA in conjunction with other relevant stakeholders in the soybean production sector should closely work together towards meeting the challenges of adoption of new agricultural technologies, create new ideas or improve on existing ideas.

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