Vol.15(2), pp. 84-94 April-June 2023
DOI: 10.5897/JAERD2022.1355
Articles Number: 87991CC70731
ISSN: 2141-2170

http://www.academicjournals.org/JAERD

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Journal of Agricultural Extension and Rural Development

Full Length Research Paper

Determinants of adoption of short season soybean (*Glycine max*) (*L.*) varieties in the Sudan Savannas of Northern Nigeria

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Received 18 October 2022; Accepted 14 March 2023

This study assessed the level of adoption of short season early-maturing soybean varieties in the Sudan savanna agro-ecological zones of the Nigeria savannas. The study identified determinants of adoption of short-season early maturing soybean varieties. It was conducted on a sample of 600 farming households from 20 communities in Bunkure and Shanono Local Government Areas in Kano State. Descriptive (frequencies and graphs) and inferential (Regression) statistics were used for analysis. Results revealed high level of adoption in 2015 (73.5%) compared with adoption level of less than 20% in 2008. The determinants of adoption of improved soybean varieties using both Probit and Tobit regression analysis revealed household size, keeping of livestock, access to market information at p<0.01, participation in Sudan Savanna taskforce project at p<0.05, extension contact, distance to soybean seed, yield, shattering, disease resistance, high cash earned as a result of sale of crop and earliness at (p<0.10) were revealed as factors influencing probability and extent of adoption. It was therefore recommended that farmers should be encouraged to participate fully in projects' activities implemented by any development partner to allow them to take ownership and for easy uptake of technology packages that benefits them.

Key words: Adoption, determinants, short season soybean, sudan savannas.

INTRODUCTION

Soybean is one of the most important legumes grown in most tropical countries. Its cultivation is increasing in the savannas of Nigeria because it is a major cash crop widely used in food and feed (Sanginga et al., 2002). The crop provides opportunity to diversify the cereal cropping systems in the savannas of West Africa. According to Arioğlu (2007), soybean seeds contain 40% of protein, 20–24% of oil, 26% of carbohydrate and other minerals, so they are called the wonderful plant of the century. Because of these highly valuable nutrients (Cober et al., 2009), soybean can be used in oil and protein processing industry by both humans and for

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animal production (Arioğlu, 2007). Also, 20% of the world's vegetable oil production is obtained from soybeans, which has made soybean production a massive industry (Bakhsh et al., 2021). Soybean oil contains the different types of oil acid such as linoleic acid, palmitic acid, etc. (Wilson, 2004) which is made it one of the healthiest oil for human consumption (Cober et al., 2009).

According to report by Horizon International (2011) in Kormawa et al. (2018), soybean-fortified products not only have more protein and minerals than their non-fortified counterparts, they are considerably cheaper than other sources of high-quality protein such as fish, meat, milk and other protein-rich legumes. It was stated in a report that soybeans are about 40% protein - more protein-rich than any of the common vegetable or animal food sources found in Africa (Horizon International, 2011) in Kormawa et al. (2018).

Soybean also contributes to improving soil fertility and reducing Striga infestation on farmers' fields (Sanginga et al., 2002; Franke et al., 2004). According to Ugbabe et al. (2017), there are good prospects for expanding production in the savanna areas of Nigeria, where it shows significant economic and soil fertility restoration benefits over other crops especially cereals. Potential soybean grain yields are as high as 3615 kg ha-1 in tropical Africa (11). The promiscuous soybean lines that are now available produce about 2.5 t of grain and 2.5 - 4 t of forage ha^{-1} and there is every indication that further progress can be made. Despite the popularity of soybean in northern Nigeria, yields are low. The yield is on average less than one tons/ha, which is below the potential yield of over 3 tons/ha (Ronner et al., 2016). Biophysical constraints, such as pest and diseases, drought, poor soil fertility, high pod shattering, poor agronomic practices and market-related constraints contribute to the low soybean yields (Khojely et al., 2018; Kamara et al., 2014; Sanginga et al., 1999). In Nigeria, soybean is traditionally grown in the Guinea savannas where rainfall amount and length of growing period are sufficient for the cultivation of the largely medium to late maturing varieties. Because of the cash value and potential for home consumption, farmers in the drier Sudan savannas around Bauchi, Borno, Kano, Katsina, Kebbie and Zamfara States are increasingly growing soybean (Ugbabe et al., 2017). They however, mostly grow the available late maturing varieties which has a high risk of failure if the rains stop earlier in the season because the Sudan savannas have short growing seasons and high temperatures.

The International Institute of Tropical Agriculture (IITA) and partners had developed a range of early maturing soybean varieties that are suitable for cultivation in the Sudan savanna zones of northern Nigeria. Through diverse projects IITA and partners have disseminated among smallholder farmers in the Sudan savannas, the early maturing short-season varieties along with other soybean production technologies including crop management and protection techniques between 2008 and 2015 (Ugbabe et al., 2017). The projects trained lead farmers drawn from several community based organizations (CBOs) in Bauchi, Kano and Katsina States in northern Nigeria to grow soybean using improved production techniques. The varieties were sourced from the IITA and distributed to the CBOs through the Agricultural Development Programs in the three States. To drive production, the farmers were also linked to industrial processors and local buyers so that soybean can be sold at farm gate at acceptable prices. To promote local consumption, women from the selected communities were provided training in the processing of soybean into various local food products. Despite these interventions there is limited information on the level and extent of adoption of the short-season soybean varieties in the Sudan savanna zones of the Nigeria savannas.

Several studies have documented the adoption and intensity of adoption of improved agricultural technologies in Nigeria (Manda et al., 2020; Wossen et al., 2019; Mbavai et al., 2015; Abdoulaye et al., 2014; Mbavai 2013, Amaza et al 2007b, Awotide et al., 2015). The focus of the previous studies is largely on maize, cassava, and cowpea. The few studies on the adoption of soybean have been largely in the derived and Guinea savannas. For example, Sanginga et al. (1999) reported that 75% of farmers in Benue largely adopted the improved soybean varieties TGX 1448. Analysis of a study by Adebayo et al. (2018) shows that household size, education, experience, membership of association, extension contact and output significantly affected farmers' decision to adopt improved soybean production technologies in Benue State. Tufa et al. (2021) reported that in Malawi, that 32% of the sample households adopted improved soybean varieties and agronomic practices. The adoption benefits were higher for female-headed households and increased with the household head's education and cultivated land areas. Ojiako et al. (2007) reported 60.91% adoption of improved soybean technology in selected communities in Kaduna and Kano States. They reported that 62.57% of the adopters devoted over 80% of their soybean farm fields to the improved cultivars. While these studies were mostly conducted in the Guinea savannas, very few farmers in very few communities in the targeted areas were sampled which make it difficult to draw conclusions on their adoptions in a wider population. The promotion of early maturing soybean cultivars such as TGX 1835-10E and TGX1951-3F has spurned interest of farmers in the Sudan savannas in the cultivation of soybean. The early maturing cultivars complete their growth cycle in 90 days and are harvested before the cessation of the rains at the end of September when planted in late June-early July. These varieties are also resistant to diseases like leaf rust, frogeye leaf spot disease caused by *Cercospora sojina Hara,* which can reduce the grain yield of susceptible cultivars by 40-60%.

Past investigation has shown that these varieties have low cases of severity and incidence of bacteria pustule disease caused by *Xanthomonas campestris, pv. Glycines (Nakano)* and do not shatter after physiological maturity (Omoigui et al., 2020). There is an urgent need to understand the adoption and the underlying factors that influence the adoption of these early-maturing short season soybean varieties in the Sudan savannas of northern Nigeria where the growing period is about 105 days. The choice of improved and adapted crop varieties by farmers is an important factor affecting productivity of a crop (Neupane et al., 2002; Rogers 2003). The efficiency of technology diffusion programs depend mostly on the factors influencing adoption by the farmers. In order to deliver effective programs, extension agents need to be aware of the factors influencing technology adoption (Abebaw and Belay, 2001). To identify factors influencing a farmers' decision to adopt or not to adopt a new technology, the theory of adoption and diffusion of technologies has been extensively used (Rogers, 2003). Information for improving agricultural research efficiency, food policy and extension services as well as for drawing implications for government involvement thus reducing the cost of non-adoption and enabling a rapid technical change can be derived from adoption studies (Mmbando and Baiyegunhi, 2016).

The objective of this study was i) assess the level of adoption of short season early-maturing soybean varieties in the Sudan savanna agro-ecological zones of the Nigeria savannas, ii) identify the determinants of the adoption and intensity of adoption of the short-season early maturing soybean varieties.

METHODOLOGY

Study area

Shanono Local Government Area (LGA) is located in Kano State of the Federal Republic of Nigeria. The LGA headquarter is in the town of Shanono. It has a total land area of 697 km^2 (269 sq mi). The LGA is predominantly Muslim Hausa with a smaller Fulani population as well. The language most spoken in the local government is Hausa but also English is spoken. The population census of 2006 puts the population of the LGA at 140, 607 which has up to 70% of the population said to be involved in farming or being involved with one aspect or the other of farming. It is situated in the Sudan Savanna zone of West Africa. The main soil types found in this zone are classified as Entisols, Inceptisols and Alfisols (Ogungbile et al., 1998).

In Shanono, land uses also comprise ruminant-based livestock activities. The average farm size is 1.3ha and the cropping systems are mainly based on maize, sorghum, millet, groundnut and cowpea. The cultivation of groundnut and cowpea are the major cash crops regardless of the geographical position (Ogungbile et al., 1998). According to Ogungbile et al. (1998) due to the absence of fallow, both chemical fertilizer and organic manure are used to maintain and improve soil fertility. The high cost and scarcity of fertilizers owing to poor distribution systems in recent years have forced farmers to use more animal manure, which is now applied at an average rate of about 535 kg ha-1 (51).

Bunkure LGA is located between Latitude 110 34' 02''N to Latitude 110 46' 05''N of the Equator and between Longitude 80 26' 36''E to Longitude 80 46' 43''E of the Prime Meridian. It comprises of fifteen wards (Ahmed et al., 2015), with an aerial extends 9911.22 Km2 and is bordered with Dawakin kudu and Kura LGAs by the North, Wudil and Garko LGA by the East while Kibiya at the South Western part (Ahmed et al., 2015). The area experiences four distinct seasons, long wet (*damina*) and dry (*rani*) seasons and short autumn (*kaka*) and spring (*Bazara*) seasons. The mean annual Rainfall is about 884mm varying greatly from the northern and southern parts of the Region (Maryam et al., 2014; Usman, 2014).

Sampling and data collection

A survey was carried with a sample size of 600 farming households specifically from 10 communities in Bunkure and 10 communities in Shanono Local Government Areas (LGAs) respectively in Kano State of Northern Nigeria. The communities were purposively selected as the Sudan Savanna Taskforce project mainly targeted these areas. Second, households were randomly selected with 30 households from each community. Data were collected using a well-structured survey questionnaire and trained enumerators and extension agents from Kano State Agricultural Development Programme.

Conceptual framework

Social change processes in the adoption of short season soybean varieties

Social change processes as employed by SSTF explains that climate change is influenced by drought and short or erratic rainfall. These have adverse effects on rural farmers whose major livelihoods depend largely or solely on agriculture. Food insecurity, low income and malnutrition among under-five children are among the major effects of climate change among rural communities in the Sudan Savannas. Farmers in this region therefore prefer crops that are drought resistant and can be cultivated within a short period. These conditions influenced the inception of the Sudan Savanna Taskforce project to introduced short season or early maturing soybean varieties with its management practices demonstrated to farmers in the project areas. As a leguminous crop, its adoption has the potential to contribute to health and income of farmers.

This study assumed that the adoption of the short season soybean varieties are based on: Farm / Household Characteristics (Gender, Age, Marital status, Education level, Farming Experience, Off-farm Income, Farm size, Household size, Access to Land etc.); Technology Perception or characteristics (Early maturing, Availability of seed, Yield, Seed size, Colour, Resist to pests / diseases, Drought resistance, High market price, Diverse utilization ability, Fertilizer requirement, Food security, Less shattering, Good germination, Improve soil fertility) and Institutional Factors (Participation in Project, Extension contact, Market access and information, Credit Access, Membership of CBO / FA, Availability of fertilizer). An illustration of the social change process is presented in Figure 1.

Analytical framework

Specification of the Probit model

The Probit regression model was used to determine the factors influencing the adoption of short season soybean varieties in the study area. This model was employed because it accommodates two categories in the dependent variable. According to Bamire et al.

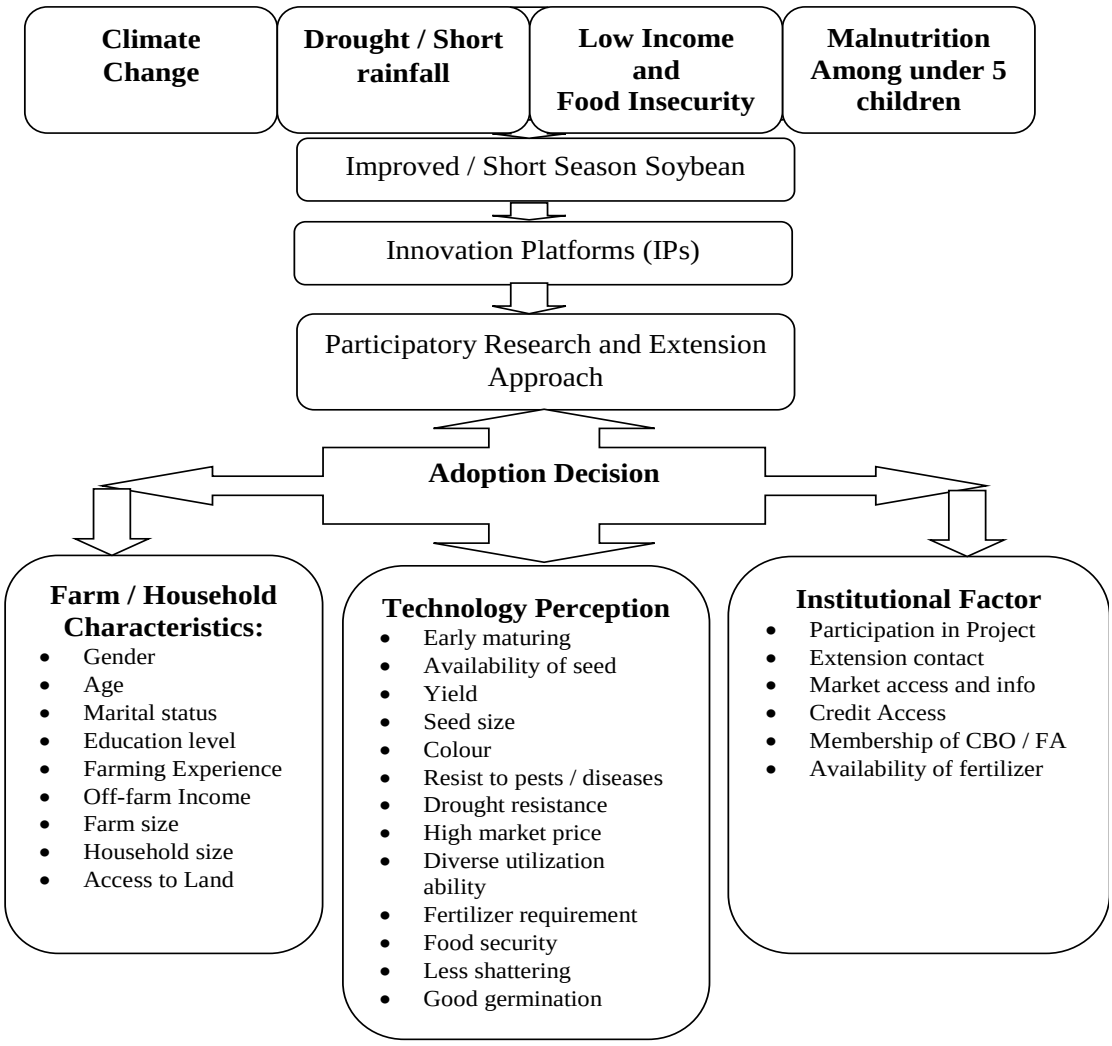

Figure 1. Adoption of short season soybean varieties.
Source: Field research; Mbavai, 2015).

(2002), the model has the ability to resolve the problem of heteroscedasticity and it satisfies the assumption of cumulative normal probability distribution. We specify the Probit model as follows;

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu \quad (1)$$

Where,
Y = level of adoption measured as a percentage (%) of technologies adopted
X_1 = Gender of farmer (Male=1, Female=0)
X_2 =Age of farmer (years)
X_3= Educational level of farmer (Years)
X_4 =Short Season Soybean production experience (Years)
X_5 = Extension contact (Contact=1, No contact=0)
X_6 = Membership of association (Member=1, Non-member=0)
X_7 = Participation in project activities (Participate =1, Not participate=0)
X_8 = Livestock ownership (Own livestock=1, Don't own livestock=0)
α = constant term
μ = disturbance term or error term
β_1 to β_8 are the regression coefficients of the independent variables.

Specification of the Tobit model

The adoption decision may not simply be a yes/no decision that is, farmers may decide to adopt a certain innovation but only apply it on a part of their land. To assess the intensity of use of the short season varieties, a Tobit model was used (Tobin, 1958). The Tobit model enables us not only to determine the probability of adoption but also the intensity of adoption once the adoption decision has been made (36). Following Shiyani et al. (2002) the Tobit model can be specified as;

$$Y_i = X_i\beta \quad \text{if } i^* = X_i\beta + U_i > T \quad (2)$$
$$Y_i = 0 \quad \text{if } i^* = X_i\beta + U_i < T \quad (3)$$

Where Y_i is the probability of adopting and intensity of use of short season varieties, $I^*$is a non-observable latent variable, T is a non-

Table 1. Percentage distribution of farming households according to socioeconomic characteristics.

Variable	Bunkure		Shanono		Overall	
	Frequency	%	Frequency	%	Frequency	%
Gender						
Male	296	98.7	299	99.7	595	99.2
Female	4	1.3	1	0.3	5	0.8
Marital status						
Not married	20	6.3	57	19.0	77	12.7
Married	280	93.7	243	81.0	523	87.4
Educational level						
Quranic education	145	48.3	107	35.8	252	42.1
Vocational training	8	2.7	8	2.7	16	2.7
Adult education	6	2	4	1.4	10	1.7
Formal education	141	47	180	60.1	321	53.5
Extension contact						
Had contact	228	76	280	93.3	508	84.7
No contact	72	24	20	6.7	92	15.4
Membership of association						
Member	246	82.0	290	96.7	536	89.4
Non-Member	54	18.0	10	3.3	64	10.7
Access to credit						
Access	105	35.0	153	51.3	258	43.2
No Access	195	65.0	147	49.0	342	57.0
Livestock keeping						
Keep Livestock	227	75.7	236	78.7	463	77.2
Do not Keep Livestock	73	24.3	64	21.3	137	22.8
Participation in project						
Participate	156	52.0	192	64.0	348	58.0
Did not Participate	144	48	108	36	252	42.0

Freq = Frequency.
Source: Field Research (2015)

observed threshold level, X_i is the vector of independent explanatory variables determining the adoption decision of *i*th farmer, β are the regression coefficients of the independent and U_i is an independently normally distributed error term with zero mean. The equation is a simultaneous and stochastic decision model. If the non-observed latent variable *i** is greater than *T,* the observed qualitative variables *Yi* that indexes adoption becomes a continuous function of the explanatory variable and zero otherwise. The Tobit Model uses a maximum likelihood method to estimate the coefficient of the equation. The regression coefficients are asymptomatically efficient, unbiased and normally distributed.

RESULTS AND DISCUSSION

Socio-economic characteristics of the sampled households

Table 1 revealed that majority of the household heads (99.2%) was male, and mainly married (87.4%). The educational level of farmers revealed that 53.5% of the farmers had formal education while 42.1% had Quranic education. Farmers' access to extension services is considered by many an important factor in adoption process. Results revealed that 84.7% of household farmers had extension contact showing that the Sudan Savanna Taskforce project's extension service delivery system was very effective. Farmers' membership of association revealed that majority (89.4%) of the farmers belong to associations, 43% of had access to credit and 77.2% keep livestock. Participation in the project activities revealed that 58.0% of the farmers participated in the project's activities.

Adoption of short season improved soybean varieties

Figure 2 showed that the percentage of households who

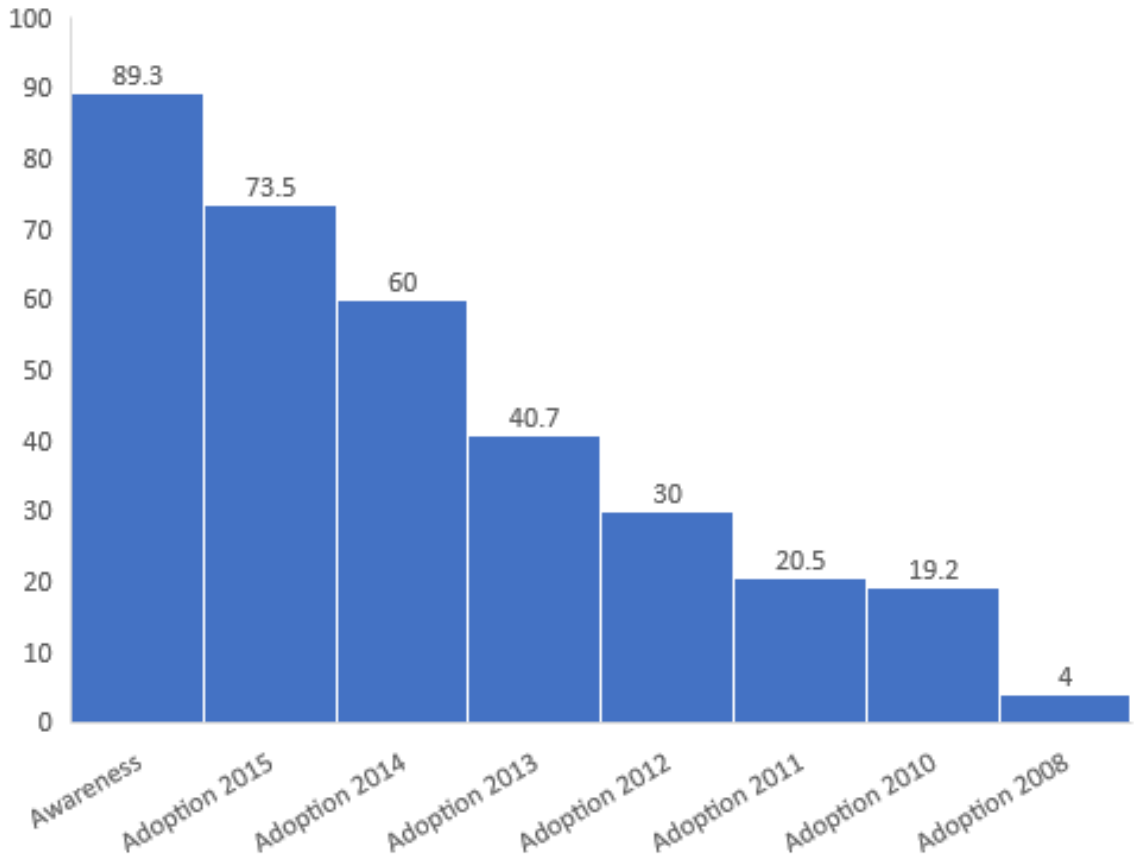

Figure 2. Adoption of short season soybean varieties between 2010 and 2015.
Source: Field research (2015).

Table 2. Percentage distribution of households according to reasons for growing short season soybean varieties.

Reason	Bunkure		Shanono		Overall	
	Frequency	%	Frequency	%	Frequency	%
High yield	122	64.9	213	84.2	335	74.6
Large seed size	96	51.1	210	83.0	306	67.1
Less shattering	86	45.7	206	81.4	292	63.6
Resistance to disease (s)	94	50.0	204	80.6	298	65.3
High fodder yield	86	45.7	201	79.4	287	62.6
High cash income/profit	92	48.9	211	83.4	303	66.2
Early maturity	95	50.5	215	85.0	310	67.8
Food security in the home	95	50.5	202	79.8	149	65.2

Source: Field research (2015).

adopted short season soybean varieties in 2015 compared with the baseline study of 2008 adoption level result reported in 2011 revealed that there was high level of adoption in 2015 (73.5%) compared with adoption level in 2008 which was less than 20% as reported by Ayanwale et al. (2011).

Determinants of adoption of improved soybean varieties

Results in Table 2 revealed reasons why farmers grow short season soybean varieties and these include: high yielding (74.6%), early maturing (67.8%), large seed size

Table 3. Probit regression results determining factors influencing adoption of short season soybean varieties.

Variable	Coef.	*t*-value	P>|t|
Age of farmer	0.002	0.12	0.904
Household size	0.005	1.88	0.061*
Marital status	0.029	1.28	0.201
Education	0.004	1.18	0.239
Participation in Sudan Savanna Taskforce project	0.107	3.27	0.001**
Agricultural association	0.007	0.42	0.675
Access to market information	0.076	7.10	0.000***
Extension contact	2.383	1.68	0.092*
Exchange of seed	0.005	0.66	0.511
Access to agro chemicals	0.029	0.97	0.335
Access to soybean seed	0.000	0.01	0.994
Distance to Soybean seed	0.002	1.71	0.088*
High yielding	3.928	2.08	0.038*
Keeping of livestock	0.395	1.59	0.10
Non-shattering	1.772	1.66	0.097*
Disease resistance	3.038	2.22	0.027*
High cash	1.457	1.86	0.062*
Earliness	3.438	1.68	0.093*
Constant	5.211	2.11	0.035

***p<0.01; **p<0.05; *p<0.10.
Source: Field Research (2015)

(67.1%), high cash income / profit (66.2%), resistance to diseases (65.3%) and food security in the home.

Using the regression analyses on factors influencing the probability and intensity of adoption of short season soybean varieties, eighteen (18) variables (Tables 3 and 4) were hypothesized as factors influencing both probability and intensity of adoption of short season soybean varieties. Of the eighteen variables, eleven were revealed as factors influencing adoption of short season soybean varieties. These variables include: household size, keeping of livestock, access to market information at p<0.01, participation in Sudan Savanna Taskforce project at p<0.05, extension contact, distance to soybean seed, yield, shattering, disease resistance, high cash earned as a result of sale of crop and earliness at (p<0.10).

Adoption of short season soybean varieties increased with household size. It has significant effect on the adoption decision of short season soybean varieties as well determines the intensity of adoption, measured as the area under short season soybean varieties. Households with large family sizes have more mouths to feed and more members to take care of in the family. They therefore rely on crops that are high yielding with income generation potential to take care of their responsibilities. This also confirms the reasons given why they adopted the short season soybean varieties to include: high yield and high cash income / profit. The size of the household is also a proxy for labour endowment; hence larger households may be more willing to try out new technologies. According to Amaza et al. (2007b), the availability of labor for farm production, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption and marketable surplus are all determined by the size of the farm household. This is consistent with other studies by Chiputwa et al. (2011), Doss (2006) and Marenya and Barreta (2007). It is however contrary to the findings of Yanguba (2004), Amaza et al. (2007b), Bamire et al. (2010) and Umar et al. (2014), who all found negative relationship between household size and adoption.

This study indicated that adoption of short season soybean varieties is positively related to participation in the Sudan Savanna Taskforce and the result was significant at (p<0.05). During the implementation stage of the Sudan Savanna Taskforce project, they organized trainings, demonstrations and field days for farmers were organized showcasing certain agronomic practices, and farm management practices. Participation in project's activities has been found to be a significant factor in determining improved agricultural technology adoption across study areas and this is in line with, Mbavai (2013) and Shitu et al. (2014) and Morris et al. (1999). Farmers who are involved in projects' activities especially gearing toward improving agricultural activities which is among the major livelihood activities of the rural populace tend to adopt the technologies introduced to them than those who do not participate. This is because they often have first-hand information relating to such technologies.

Table 4. Tobit regression results determining factors influencing the extent / intensity of adoption of short season soybean varieties.

Variable	Coef.	*t*-value	P>|t|
Age of farmer	0.001	1.06	0.291
Household size	0.013	7.41	0.000**
Marital status	0.019	-1.04	0.301
Education	0.001	0.27	0.784
Participation in Sudan Savanna Taskforce project	0.019	0.74	0.463
Agricultural association	0.662	3.053	0.481
Access to market information	0.020	2.25	0.025*
Extension contact	0.012	0.34	0.735
Exchange of seed	0.007	1.18	0.238
Access to agro chemicals	0.005	0.22	0.824
Access to soybean seed	0.014	0.98	0.326
Distance to soybean seed	0.000	0.48	0.632
High Yielding	0.132	2.39	0.017*
Keeping of livestock	0.019	8.60	0.000**
Non-shattering	6.906	0.88	0.409
Disease resistance	0.008	0.15	0.878
High cash	0.267	3.88	0.186
Earliness	0.004	0.06	0.949
Constant	0.040	0.43	0.671

***p<0.01; **p<0.05; *p<0.10.
Source: Field Research (2015)

Farmers' participation in agricultural activities promoted by agricultural institutions, exposes them to new farming techniques and this in return improve on their production yields to enhance better standard of living. According to Mbavai et al. (2015, this is very crucial especially for the adoption of new technologies, as it will help farmers to have first-hand experience with the new technologies.

Access to market information was significant (p<0.10) and positively related to adoption of short season soybean varieties and as well determines the intensity of adoption. Market information is sometimes a major constraint facing rural farmers. According to Amaza et al. (2009), middlemen are likely to make greater profits from transactions between them and farmers due to the weak bargaining position of farmers who often lack access to market information (Msheliza et al., 2005). Majority of farmers do not have knowledge of prices of their produce at the time of sale, as such they are not in better position to take informed decisions about their produce. This result corroborates findings of Okuthe et al. (2007) who reported that farmer's access to market and inputs have significant and positive effect on the likelihood of adoption. .

Contact with extension at a given time is an indicator of exposure to information. Good extension and training programs increase farmers' ability to adopt short season varieties successfully. Extension is an important component in adoption process. Most information and training on new varieties are transmitted to farmers through extension services. Extension service guarantees farmers' confidence to uptake new technologies. This finding is therefore consistent with Pattanayak et al. (2003), Simtowe et al. (2012), Jones (2005), Mbavai (2013), Uaiene (2011), Owens et al. (2001), Doss et al. (2002), Chikaire et al. (2011), and Onu (2006), who all reported that contacts with extension agents increase the possibility of adoption.

High yield, less shattering, disease resistance, high cash earned as a result of sale of crop and earliness is technology related characteristics found to significantly and positively influence the adoption of short season soybean varieties in the study area. High yield also determines the intensity of adoption. This is in line with Negatu and Parikh, (1999), who posited that the technology characteristics, socioeconomic characteristics of potential user and institutional factors are necessary for adoption. That is to say if the outcome of any technology is not within the expectation of the end user, it cannot be adopted. Farmers are selective especially when they have alternative varieties. Preferring one variety over the other should be based on special characteristics present in such varieties. It is therefore important for breeders to consider these characteristics especially yield as it both influence probability and intensity of adoption, when developing any improved crop varieties for farmers if they are to be adopted. Non

shattering disease resistance, high cash income and early maturing are characteristics present in short season soybean varieties. Most varieties carry one or two of these characteristics but not all. If short season soybean varieties are to be adopted, it is therefore important that extension agents and agronomists emphasize the varietal characteristics to breeders. The finding is consistent with Yanguba (2004) and Adesina and Zinnah (1993).

Livestock owners were among the major adopters of the short season soybean varieties. This is not surprising because keeping livestock demands animal feeds. Soybean serve as both human and animal feeds apart from its income generation potential. Livestock production is an important enterprise in rural areas which may serve as a means of diversification and support to soybean production. The implication of this is that income obtained from keeping livestock can be used for inputs procurement in soybean production as well as taking care of household expenditure for food, shelter, clothing, schooling etc. Dashiell et al. (2001) found similar results. They stated that soybean fetches high income because it is a cash crop used by the food industry to extract cooking oil and animal feeds.

This corroborates Dugje et al. (2009) who reported that the stems are good for animal feeds. Chiputwa et al. (2011) found similar result in Zimbabwe.

Livestock owners (77.9%) are among the major adopters of the short season soybean varieties. Keeping livestock demands animal feeds. Soybean serve as both human and animal feeds apart from its income generation potential. It is a significant factor influencing adoption. Livestock production is an important enterprise in rural areas which may serve as a means of diversification and support to soybean production. The implication of this is that income obtained from keeping livestock can be used for inputs procurement in soybean production as well as taking care of household expenditure for food, shelter, clothing, schooling etc. Keeping of livestock may avail the farmers more manure for their mostly intercropped soybean farms. Farmers rearing livestock are therefore more inclined to increase area under soybean production.

Conclusions

This study was carried out to investigate factors influencing adoption of short season soybean varieties in the Sudan Savannas of Northern Nigeria introduced by the Sudan Savanna Taskforce project in Bunkure and Shanono Local Government Areas of Kano State in Northern Nigeria. The study was carried out on 600 farming households as sample.

Results show that the major reasons why farmers adopted the short season soybean varieties include: high yielding, early maturing, large seed size, high cash income/profit, resistance to diseases and food security in the home.

Household size, participation in Sudan Savanna Taskforce project activities, access to market information, extension contact and distance to soybean seed markets were among the factors influencing the probability of adoption of short season soybean varieties. Also, factors influencing the intensity of adoption included household size, access to market information, high yield and livestock ownership.

RECOMMENDATIONS

Farmers should be encouraged to participate in projects' activities such as those implemented by federal government through states ADPs which allows them to take ownership of such projects and creates avenue for easy uptake of technology packages introduced as this will increase and sustain adoption. It is also important that soybean breeders incorporate farmer's preferences with regards to the soybean characteristics in their breeding programmes. Finally, there is need to increase funding for government agricultural development Programmes (ADPs) for the recruitment of more extension agents so as to have frequent and close contacts with farmers.

FUNDING

The research was funded by the Bill & Melinda Gates Foundation through the project Putting Nitrogen Fixation into Use for Smallholder farmers in Africa with Grant No. OPP1020032

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests in this research.

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