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Research Paper

Adoption Intensity Determinants for Improved Sweet Potato Varieties among Farmers in Nigeria

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Abstract

Sweet potato (*Ipomoea batatas*) is one of the stable tuber crops consumed by many households in Nigeria. It can be found in different varieties and exist in many colours of skin and flesh. The production of this important crop is still very low, thereby compromising food security. Sweet potato is one of the target commodity crops under the Nigerian Agriculture Sector Investment Opportunities. However, improved sweet potato production has not been widely adopted among farmers Oyo state hence, the need to investigate factors affecting the adoption of improved sweet potato varieties among farmers in Oyo state. Data were collected from 350 farmers randomly selected from two agricultural zones in the state. The data collected were presented using descriptive statistics and analysed using Tobit regression model. Results showed that farm size, age, years of formal education, early maturing, high yield potential, market availability, resistant to pests and diseases and availability of vines significantly influenced the adoption of improved sweet potato varieties. Availability of vines of improved varieties, high yield potential, early maturity, resistant to pests and diseases and market availability were the technology-specific attributes that influenced both the adoption of improved sweet potato varieties and its use intensity. The study, therefore suggests that attribute preferences of farmers need to be integrated into the development of improved sweet potato varieties by the researchers to enhance its adoption and use intensity.

Keywords:
Adoption, factors, Tobit, varieties, transformation

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INTRODUCTION

Sweet potato (*Ipomea batata L.*) is an important staple crop grown in all parts of the country by small-scale farmers. It can be found in different varieties and exist in many colours of skin and flesh. Sweet potato ranks seventh in the world among the most important food crop after wheat, rice, Irish potato, barley and cassava (CIP, 2000). In 2016, Nigeria was ranked second after China with global output of about 3.92 million metric tons of sweet potato annually (FAO, 2018). Sweet potato is a food security crop as it is grown and consumed by resource-poor households coupled with its characteristics of being able to give satisfactory yields under adverse environmental conditions (Bergh et al., 2012). Even though Nigeria is the second largest producer of sweet potato in the world, it only exports about 2,401 MT of sweet potato which represented 0.1% of the total world export in 2011 (ITC, 2012). Most farmers in Nigeria generally grow sweet potatoes for household consumption, animal feed and various industrial uses. Sweet potato vines, leaves and roots are good sources of animal feed for sheep, goats and rabbits. According to Bergh et al. (2012), consumption of sweet potato had increased significantly in Nigeria from 143,000 MT in 1990 to 2,746,000 MT in 2010.

In Oyo state, the white-coloured type of sweet potato varieties that is characterised by low yields is generally grown by farmers. For instance, the yields of white-coloured sweet potato varieties planted in southern guinea savannah of Nigeria vary from 3,000 - 9,000 kg/ha [Benue State Agricultural and Rural Development Authority (BNARDA, 2007)]. Environmental conditions, crop husbandry and varieties planted play a significant role in yield improvement. Yields of sweet potato have been declining over the years with a yield of 12.4 MT/ha recorded in the 1960s dwindling down to 5.1 MT /ha in 1990 and an average yield put at 2.9 MT/Ha in 2011 from farmers' plots (FAO, 2011).

Studies on factors affecting the adoption of agricultural innovations have been conducted in developing countries over the years and results showed that adoption decisions are influenced by some socioeconomic, demographic, ecological and institutional factors coupled with the mismatch between technology characteristics and technology preferences (Wale & Yallew, 2007).

This study used a Tobit model to identify farmers' characteristics, and technology attributes that are important for adoption of improved sweet potato varieties and its use intensity. Literature is very scanty on factors that determine the adoption and use intensity of improved sweet potato varieties in the study area, the knowledge of which is essential to accelerate technology adoption effectively. It is envisaged that the findings of this study will be of interest to several development stakeholders in agriculture.

Empirical model

It is appropriate to use logit and probit models in determining factors influencing the adoption of agricultural technology. However, the models do not indicate Ordinary Least Square (OLS) regression and thus, likely to render the estimates to be biased (Feder et al., 1985). Moreover, probit models are incapable of determining the intensity of adoption though it is adapted for dichotomous dependent variables whereas the intensity of adoption is a continuous dependent variable. This kind of information can be obtained if the dependent variable is partly binary and partly continuous hence, the need for some authors to combine probit and Tobit in determining adoption behaviour and intensity based on a two-stage decision argument. For instance, Fufa and Hassan (2006), used probit to determine the factors influencing adoption probability and Tobit for determinants of adoption intensity. However, Berhanu and Swinton (2003) argue that the decision to adopt a technology and its extent may take place at the same time. Therefore, if adoption and intensity decisions are assumed to be taken at the same time, the

one stage Tobit model can be used based on the assumption that there is no selection bias. Tobit model has the advantage of providing both the influence of exogenous factors on the probability of adoption and the intensity of adoption in addition to estimating the marginal effects of the factors (Chukwuji & Ogisi, 2006).

METHODOLOGY

The study was conducted in Oyo State Nigeria. The state is located between latitudes 7 ^{0} 3′ and 9 ^{0} 12′ north of the equator and longitudes 2 ^{0} 47′ and 4 ^{0} 23′ east of the Meridian, with a land mass area of about 27, 249 square kilometres. Oyo state is made up of thirty-three Local Government Areas grouped into four agricultural zones (Ibadan/Ibarapa, Oyo, Ogbomoso and Saki zones). The state has an equatorial climate with bimodal rainfall and relatively high humidity. The dry season lasts from November to March while the wet season starts from April and ends in October.

A multi-stage random sampling procedure was used in selecting respondents for this study. Two out of four agricultural zones in Oyo state namely, Ibadan/Ibarapa and Ogbomoso zones were randomly selected for the study. Three Local Government Areas (LGAs) were randomly selected from each of the zones. In Ibadan/Ibarapa zone the selected LGAs were Akinyele, Lagelu and Ido while Orire, Surulere and Ogo-Oluwa were randomly selected from Ogbomoso zone (Figure1). Three villages were selected randomly from each of the selected LGAs. Based on the number of registered farmers in each village by the OYSADEP, 356 respondents were selected proportionate to size using 5% of the registered farmers in a village. However, data from 350 respondents were used for the analysis due to some uncompleted questionnaires. Data were obtained through the use of a structured interview schedule and questionnaires for non-literate and literate respondents respectively.

The data for this study include the age of the farmers; farm area under sweet potato cultivation, farmers' years of formal education. Farmers' perceived attributes of the adoption included in the model were early maturity (EARMAT), high yield potential, resistance to pests and diseases (RESTPESTDISE), vines availability (VINAVALAB) and market availability (MKTAVALB). Frequency and percentages were used to describe the data and Tobit regression model was used to estimate the parameters of adoption and its intensity. Table 1 shows the description of variables used in the empirical modelling as well as related hypotheses.

Model specification and analysis: Based on the empirical approach earlier discussed the variables hypothesised to influence the adoption intensity of improved sweet potato varieties (Table 1) are presented in the form of a model as below. The empirical specification was used to examine the influence of explanatory variables on the adoption and intensity (Y) of improved sweet potato varieties in the study area. This is based on the assumption that the two decisions (adoption and intensity) were taken at the same time (Nkonya et al., 1997; Chukwuji & Ogisi, 2006; Akinola et al., 2010; Nchinda et al., 2010). The Tobit model is represented below:

$$Y = \beta_0 + \beta_1 AGE + \beta_2 FARMSIZE + \beta_3 EDUC + \beta_4 EARMAT + \beta_5 RETPESTDISE + \beta_6 VIAVALAB + \varepsilon_i$$

where;

Y= adoption intensity (area under improved sweet potato varieties cultivation as a percentage of total sweet potato farm size).

B_0 is a constant.

βi, i = 1, 2 ... and 6 are parameters associated to dependent variables to be estimated.

ε_i is the error or disturbance term with zero mean and constant variance (0, σ^2).

The latent variable Y= 1 if Y*>0 and Y=0 if Y*≤0.

The independent variables are as defined in Table 1.

The data were analysed using LIMDEP 7.0 version

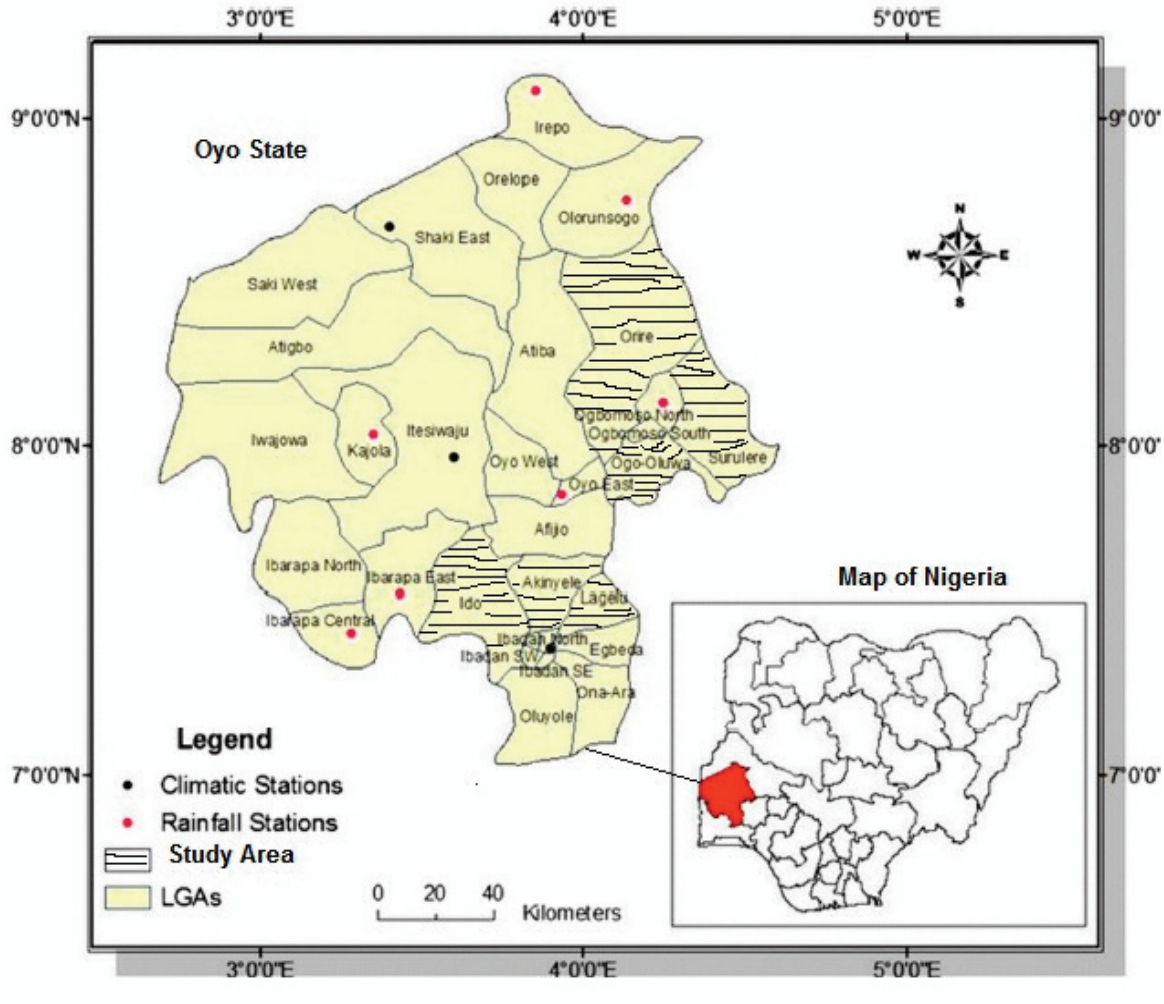

Figure 1. Map of Oyo State showing the study area.
Source: Adapted from Ayoade (2017)

Table 1
Variables Used In the Empirical Model and Hypotheses

Variable	Definition and measurement of variables	Hypotheses
Dependent Intensity of adoption	Proportion (%) of land under adopted improved sweet potato varieties cultivation as a percentage of sweet potato farm area cultivated (censored at zero)	
Independent AGE	Actual age in years	*
FARMSIZE	Farm size allocated to sweet potato cultivation (hectares).	*
EDUC	Years of formal education (Actual number)	*
HYPOTENT	If perceived as an attribute for adoption (=1) and otherwise (0).	*
EARMAT	If perceived as an attribute for adoption (=1) and otherwise (0).	*
MKT AVALB	If perceived as an attribute for adoption (=1) and otherwise (0).	*
RESTPESTDISE	If perceived as an attribute for adoption (=1) and otherwise (0).	*
VINAVALAB	If perceived as an attribute for adoption (=1) and otherwise (0).	*

NB: *Hypothesized to positively (+) influence the adoption and intensity of improved sweet potato varieties.

RESULTS AND DISCUSSION

Farmer and farm characteristics of sweet potato farmers

Table 2 shows that the average age of sweet potato farmers was 49.6 years with an average of 6 years of formal education. The mean farm size allocated to sweet potato cultivation was 3.2 hectares, and only 0.8 hectare of the farm size was planted with improved sweet potato varieties on the average.

Farmers' adoption rates of improved sweet potato varieties

Table 3 shows the adoption rates of improved varieties of sweet potato among farmers in the study area. TIS 87/0087 was adopted by 64.5% of the farmers while 47.4% of the farmers adopted TIS 8164 and 32.6% reported the adoption of TIS 2532 OP 1.13. Orange-fleshed (01/1371 and 01/1368) sweet potato varieties were least adopted by 27.7% of the farmers. The improved varieties of sweet potato identified in this study were introduced to the farmers in the study area by the Oyo State Agricultural Development Programme (OYSADEP).

Table 2
Farmer and Farm Characteristics of Sweet Potato Farmers

Characteristics	Mean	SD*
Age (years)	49.6	9.3
Education (Average number of years spent in school)	6.0	5.3
Average farm size allocated to sweet potato cultivation (hectares).	3.2	2.9
Average area under improved sweet potato varieties (hectare)	0.8	1.2

* Standard deviation

Table 3
Farmers' Adoption Rates of Improved Sweet Potato Varieties

Varieties	*Frequency	Percentage
TIS 87/0087	229	64.5
TIS 2532 OP 1.13	114	32.6
TIS 8164	166	47.4
Orange-fleshed (01/1371 and 01/1368)	97	27.7

*Multiple Responses

Adoption intensity of improved sweet potato varieties

Table 4 provides the results of the Tobit model of adoption intensity of improved sweet potato varieties regressed on the explanatory variables. Most of the variables hypothesised to positively influence improved sweet potato varieties adoption intensity in the model presented were positive and significant as expected at various levels except age (AGE) and farm size (FARMSIZE). The negative coefficient of age signifies that an increase in farmer's age will reduce their adoption intensity that is; old farmers have a lower intensity of adopting improved variety of sweet potato and vice versa. Because of the

risk-averting nature, older farmers are more conservative than the younger ones in adopting an improved technology. Adoption of improved technology (ies) is generally difficult for the aged because they are less likely to bear the risk of trial associated with adopting new technologies (Bello et al., 2012). Similar negative results were obtained by Kaguongo et al. (2012) and Amengor et al. (2018) in their studies on adoption intensity of orange-fleshed sweet potato in Kenya and adoption of improved sweet potato varieties in Ghana respectively. This similar to the findings of Ehirim et al. (2016) who opined that increase in the age of the farmers reduced their efficiency in sweet potato production.

It was hypothesised that farm size would positively influence the adoption intensity of improved sweet potato. However, the negative coefficient of farm size signifies that the larger the farm size, the lower the intensity of adopting improved sweet potato varieties and vice versa. It implies that an increase in farm size may be due to other factors such as a preference for other crops rather than an intention to increase sweet potato. Idrisa, et al. (2012) also concluded that farm size had a negative and significant influence on the adoption of improved soybean variety in Nigeria. The negative coefficient of farm size is however contrary to a priori expectations as it is believed that size of land will positively affect the decision to adopt new technologies (Akinola et al., 2010). On the other hand, the coefficient of educational status was positive and significant at 1% level of probability. The significant and positive coefficient of educational status is a sign that it has a direct relationship with the adoption intensity of improved sweet potato varieties. This implies that an increase in educational status will also increase adoption level among sweet potato farmers. The more educated farmer is expected to be more efficient to understand and adopt new technologies within a short period than uneducated people. This finding agrees with the earlier studies of Kudi et al. (2011) and Idrisa et al. (2012) in Nigeria that literacy level positively influenced the adoption of improved maize and soybean varieties respectively.

Perceived technology-specific attributes influencing the likelihood of adoption of improved sweet potato varieties

Table 4 shows all the perceived technology-specific attributes considered for the study had significant influence on the adoption in-

Table 4
Adoption Intensity Determinants of Improved Sweet Potato Varieties

Variable	Coefficient	SE[a]	t-values
Constant	0.502	0.655	7.665
AGE	-0.844	0.310	-2.719**
EDUC	0.509	0.634	8.028**
FARMSIZE	-0.142	0.203	-7.010**
VINAVALAB	0.824	0.149	5.515**
HYPOTENT	0.822	0.212	3.881**
EARMAT	0.567	0.178	3.191**
RETPESTDISE	0.609	0.171	3.555**
MKTAVALB	0.395	0.159	2.487*
Sigma	0.125	0.574	

* $P<0.05$, ** $P<0.01$
[a] Standard error

tensity of improved sweet potato varieties. Vines availability (VINAVALAB) had a positive and significant influence on the intensity of adoption of improved varieties of sweet potato (P<0.01). As hypothesised, this result suggests a direct relationship between vines availability and the adoption intensity. Farmers who have access to vines are more likely to adopt the improved varieties. Given that farmers may be constrained to access vines if they are unable to preserve planting materials from the previous season or get it from their fellow farmers. Hence, the need for inclusion of preservation techniques of vines in any intervention programme that will encourage the adoption of improved varieties of sweet potato. The estimated coefficient for the early maturity (EARMAT) variable was statistically significant at 1% level and had a positive sign as hypothesised. Early maturity variety will enable farmers to plant the crop in two seasons and likely to attract more revenue. As a result, the probability of adopting improved sweet potato increases as the maturity period decreases (Idrisa et al., 2012). High yield potential (HYPOTENT) was also an attribute found to be positive and significant at 1% level of probability. This implies that yield has a direct relationship with the probability of adoption and a high yielding crop variety is more likely to be adopted by farmers. This finding is consistent with that of Idrisa et al. (2012). These authors found and concluded that the yield of soybean was significant in influencing the adoption of improved soybean in Nigeria. Resistance to pests and diseases (RESTPESTDISE) also had a positive and significant influence on the adoption of improved sweet potato varieties (P> 0.01). It is a known fact that problems of pests and diseases can lead to a reduction in the yield of sweet potato and thus, any crop variety with this attribute would go a long way in helping farmers to control these problems and thus enhance adoption. Market availability (MKTAVALB) was found to be a positive and significant factor in the adoption intensity of improved varieties of sweet potato (P< 0.05). Farmers' access to a market where they can sell their produce plays a significant role in the production system and thus favours the adoption of improved varieties.

CONCLUSION AND RECOMMENDATIONS

The study investigated determinants of adoption intensity for improved sweet potato varieties among farmers in Nigeria. The result showed the farmers were still in their active years with at least basic formal education. TIS 87/0087 variety was the most adopted by majority of the farmers.

Educational status positively and significantly influenced the adoption and use intensity of improved varieties. However, farm size and age had negative but significant influence on the adoption and use intensity of improved varieties. For age, the older the farmers, the lower they adopt the improved variety of sweet potato. This might be because older farmers are often afraid to try new things for the fear of losing what they have before. Also, as the farm size of the farmers increase the less they are likely to adopt probably because they have preference for other crops. Availability of vines, high yield potential, early maturity, resistance to pests and diseases and market availability were the technology-specific attributes that influenced both the adoption of improved sweet potato varieties and its use intensity.

The study suggests that the attribute preferences of farmers need to be integrated into the development of improved varieties by the researchers to enhance adoption and its use intensity. Availability of vines as planting material is an important factor that needs to be addressed. Extension programme should ensure that farmers have adequate access to vines through the establishment of a sustainable network of multipliers. All these could be achieved through the inclusion of sweet potato in relevant government programmes.

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