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Determinants of Adoption Rate of Improved Cassava Production Technologies among Smallholder Farmers in Southwest Nigeria

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Abstract
Cassava production in Nigeria is increasing but it is constrained by a number of factors (biotic and abiotic) among which adoption of improve technologies is vital. This study therefore, investigated the determinants and challenges to adoption of improved cassava production technology in southwest, Nigeria. Cross sectional data obtained from 360 cassava farmers through random sampling techniques were used to analyse the set objectives. The sample size had been pre-determined through a confidence interval approach. Both descriptive statistics and probabilistic (Tobit) regression model were employed to analyse the information collected. The findings revealed that most of the farmers in the study area adopted the cassava production technologies such as use of improved varieties, planting new varieties and fertilizer application. Tobit regression result revealed that the years of experience ($P<0.1$), farm organization ($P<0.05$), high market demand ($P<0.01$), resistance to diseases ($P<0.01$) and increased yield ($P<0.01$) were significant determinants of cassava production technologies. In addition, high cost of agrochemicals, improved planting materials, capital, and technical-know-how were among the identified challenges. However, the study suggested improvement in awareness campaign of available technologies and proper education through training of the farmers about the technical knowledge of the technologies.

Keywords: Adoption, Cassava, Determinants, Production, Technologies

INTRODUCTION

Agricultural production has been the bedrock of Nigeria's economy before the advent of crude oil. Even till today, it still remains an important component of a national economy (Singh-Peterson and Iranavolaivalu 2018). Crop production, livestock farming, fishery, ornamental and aesthetic production and so on form major livelihood activity of many citizens (Nsoanya and Nenna 2011) and it is an important factor in national economic development.

Cassava is widely grown in West Africa especially in Nigeria for its root. Sitko (2008) reported that the crop came to Africa with Portuguese slave traders during the 17th century. The cassava crop (*Manihot esculeta*) was originated from Brazil and the Portuguese introduced it to West Africa and it was considered the most productive crop in the tropics (Edeh *et. al.,* 2009). Additionally, cassava is a popular root crop grown in West Africa especially in Nigeria. It is easy to cultivate and cultural practices should be employed. The soils in this region have low organic matter, poor structure, and poor buffering capacity and caution exchange capacity (Ajayi and Onuche 2005).

According to Food and Agriculture Organization (FAO), cassava is the third most important source of calories in the tropics, after rice and corn (FAO, 2004). Moreover, Chitundu *et al.,* (2006) opined that cassava produces more calories per unit of land and per unit of labour than does maize and it is accessible to the poorest families. It is rich in carbohydrate, especially starched consequently multiplicity of has an end user (International Institute of Tropical Agriculture [IITA], 2006). It is available all year round, which makes it to be preferable to other more seasonal crops (Akoroda and Teri 2004). Thus cassava production in Nigeria has not yet reached a maximum production level.

Incomes of rural households that are derived from cassava plays a vital role in the livelihood of the farmers (Son *et al.,* 2016). Bakut (2013) reported that the adoption of recommended cassava processing

practices resulted in an increase in total production by improving yield and income of farmers. If the demand for cassava and income generated from cassava production increase, farmers will be motivated to adopt productivity-enhancing technologies to increase yields and to expand cassava production even further (FAO Statistics, 2012). Despite the advantages of improved technologies such as; pre-planting and planting operation management, fertilizer and the use of hybrid seeds/planting materials, farmers are not quite to invest in them because of high purchase cost, inadequate knowledge on the technology itself, and cultural belief of the farmers and biological and environmental characteristics of the technology location. A number of studies (Bakut 2013; Muzari *et al.,* 2012; Nguluu *et al.,* 1996; Nsoanya, and Nenna 2011, Ojo 2009) in have worked on adoption of farming technologies, but in considering the adoption rate, we have few or none. This study strictly considered smallholder cassava farmers and it is on this account we specifically examine the adoption rate of available technologies among the farmers in the study area, various challenges faced by the farmers and determinants of adoption of the technologies.

LITERATURE REVIEW

This research focuses on adoption of improved cassava production technologies among the smallholder farmers and the key factors influencing their decision to adopt. We anchored the work on the adoption-diffusion theory – which provides explicit dynamic process of adoption and implementation of new innovations/invention by individuals, organization or regulatory authorities (Rogers, 2003). Sociologist traced the innovation adoption and diffusion to the 1900's especially the study carried out on imitation behavior by Tarde in1903. Ryan and Gross (1943) reported the interest of social scientist in the diffusion of agricultural innovations and/or technologies to farmers through education and public health network. The assertion has led to many fields of science and social science (economics, agricultural extension, marketing, anthropology, sociology, psychology, public health and so on) embracing the theory. Adoption of innovations is belief to relate to social values which spread through social system with the channel refers to as diffusion.

Traditionally, adoption-diffusion simply means access to vital information about innovation by the potential adopters. This forms the principal in the adoption decision making (Hooks *et al.,* 1983). This is pivoted on the assumption that adopters of innovation will make rational decisions on the advantages and disadvantages of information received about the new innovation. The simple model can be subjected to review and re-evaluation whenever changes occur or there is new information. There are number of factors that hinder adoption of new innovation or the totality of package by smallholder farmers. When farmers are introduced to new innovations, studies (Nguluu *et al.,* 1996) have found out that only those that are useful and economically within the reach of the farmers are the ones they pursue. Innovations that will further expose farmers to more economic hardship receive no adoption or discontinuity in it use.

Economic implication of new technology is not only the factor that could inhibit its adoption. Studies (Muzari *et al.,* 2012; Meinzen-Dick 2002) have shown some factors that constraint adoption of new technologies. Factors inform of the socioeconomic, farm-level and institutional such as age, household size, tenure security, cost of technology, off-farm income, shocks and other associative risk and uncertainty plays pivotal role in adoption of new technologies. Some authors (Olayiwola 2008; Tionenji 2011) identified external factors that contributed to the farmer's adoption of cassava includes information on cassava, access to planting material, market access and the price of cassava access to processing equipment. High cost of fertilizer, insufficient agricultural information and extension services, transportation problems and lack of capital have been considered to be the greatest problems faced by all farmers.

MATERIALS AND METHODS

The study was carried out in southwest Nigeria, the zone comprises of six states – Oyo, Osun, Ogun, Ondo, Lagos and Ekiti State. Cross sectional data through multistage sampling techniques was used to select 372 respondents for the study. The sample size had been pre-determined through a confidence interval approach. In the first stage of the selection, Oyo, Osun and Ogun states were purposively selected out of the six states in the region. The selected states were known to be highest producers of cassava in southwest Nigeria. The second stage require the random selection of the Agricultural Development Project (ADP) zones in each of the selected state, the third stage involve random selection of Local Government Area (LGA) from each of the ADP selected and proportionate sampling was used to select the cassava farmers based on the provisional list obtained from the ADP offices in each states. The respondents were interviewed with the use of questionnaire. Information on both the demographic and farm-level variables and this were analysed using both descriptive and inferential (Tobit regression) statistical analysis.

Model specification

This study used tobit regression model as employed by (Olagunju and Salimonu (2010). The tobit model is defined as;

$y_i^* = x_i\beta + \varepsilon_i$……..(i)

$y_i = y_i^*$ if $y_i > 0$ ……..(ii)

$y_i = 0$ if $y_i \leq 0$……..(iii)

where $y_i$is the latent dependent variable, y_i is the observed dependent variable, xi is the vector of the independent variables, β is the vector of coefficients, and the εi 's are assumed to be to be independently normally distributed: $\varepsilon i \sim N(0, \sigma^2)$ and therefore ($y_i \sim N(x_i\beta, \sigma^2)$).

The functional form of tobit regression could be expressed in linear combination of observable explanatory variables as;

$y_i^* = x_i\beta + \varepsilon_i$…….. (iv)

This can be represented algebraically for the i^{th} adopters of cassava production technologies

$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \varepsilon_i$…….. (v)

Where Y_i is the dependent variables (adoption rate), X_i are the explanatory variables i.e. Age (years), Gender (male = 1, otherwise 0), Education (years), Years of experience (years), Marital status (married = 1, otherwise 0), Farm organization (dummy), Credit access (dummy), Farm size (acres), Disease resistance stems (dummy), Farm size (acres), Extension contact (dummy), Market demand (dummy), increased yield (dummy) and Income (dollar value).

RESULTS AND DISCUSSION

Socio-economic Characteristics of respondents

Table 1 indicated that the mean age was found to be 50 years. The implication of the overall mean age for the farmers is that cassava farming is dominated by mid-age people who are tending towards unproductive age. The age is expected to have a significant effect on their productivity and according to Olarinde *et al.,* (2020), there will be improvement in technical efficiency of smallholders' farmers with increase in age. It was observed that majority (77.2%) of the cassava respondents were male and this was in conformity with the findings of Saka and Lawal (2006). Lack of women access to productive asset might be responsible for the dominance of male farmers in cassava production enterprise.

Moreover, 83.1% of the respondents were married while 4.2% of the respondents were divorced. Also 61.4% of the cassava respondents had their household size between 6 and 10 members with the mean household size of 7 members. The implication is that large household size is maintained to ensure adequate supply of family labour for cassava production activities. In addition, the result of the analysis revealed that more than 80% of the respondents had formal education which implies that cassava farmers in the study area were literate.

Finally, majority (60.6%) of the respondents claimed farming as their primary occupation while 7.2% are civil servant. This implies that majority of the farmers are into farming system.

Table 1: Distribution of socio-economic characteristics of respondents

Variables	**Frequency**	**Percentage**
Age		
≤ 30	32	8.9
31-40	65	18.1
41-50	105	29.2
51-60	97	26.9
Above 60	61	16.9
Mean = 50.5 years		
Gender		
Male	278	77.2
Female	82	22.8
Marital status		
Single	24	6.7
Married	299	83.1
Divorce	15	4.2
Widow/widower	22	6.1
Household size		
≤ 5	124	34.4
6-10	221	61.4
Above 10	15	4.2
Mean = 6.5		
Educational level		
No formal Education	66	18.3
Primary Education	160	44.4
Secondary Education	99	27.5
Tertiary Education	35	9.7
Primary Occupation		
Farming	218	60.6
Artisan	37	10.3
Trading	29	8.1
Civil servant	26	7.2
Others	50	13.9
Total	**360**	**100.0**

Source: Authors compilation

Farm-level Characteristics

From the result presented on Table 2, the farmers were operating on a small-scale as the average farm size of the farmers was 7 acres. This also affirmed that most of the rural farmers were smallholder farmers who cultivate less than 5 hectares of land and on a fragmented piece of land. It was further revealed from the table that about 55.8% of respondents cultivate inherited piece of land while few (0.3%) among the farmers produces from community land. The used of inherited land for cassava production can be possibly connected to low scale operation. Most of these lands

are fragmented, leading to an increase cost of production and at the same time efficiency of production might not be optimum or hampered as a result of this. The average farming experience of 24 years, it shows that the respondents were resourceful (Abdoulaye *et al*., 2014) in cassava production. Both family and hired labour were used for the production in the study area.

Table 2: Distribution of the farm-level characteristics

Variables	**Frequency**	**Percentage**
Farm size (acres)		
≤ 2	74	20.6
2-4	42	11.7
3-6	89	24.7
6-8	99	27.5
Above 8	56	15.6
Mean = 7		
Farm Acquisition		
Inheritance	201	55.8
Lease	29	8.1
Personal	75	20.8
Rented	54	15.0
Communal land	1	0.3
Farming Experience		
≤ 5	31	8.6
6-15	106	29.5
16-25	84	23.4
26-35	55	15.3
Above 35	83	23.1
Mean = 24.4 years		
Labour utilization		
Family	76	21.1
Hired	48	13.3
Both family and hired	236	65.6
Total		

Source: Authors compilation

Improved cassava production technologies adoption

Cassava production has been of age and the traditional method of production has been constrained biotic and a biotic factors which plague it with low yield, and low resistance to disease ((Ugwoke, 2005; Ojo, 2009 and Alabi, 2011). There is need to adopt and use new production technologies (from land preparation, inputs used, planting and post planting operations to the harvesting of the produce) to increased yield and productivity, add to the market value and prevent pests and diseases (Nsoanya and Nenna, 2011). The result presented on Table 3 shows that 72.2% of the farmers adopt new varieties of cassava i.e. they cultivate vitamin A fortified cassava varieties while 22.8% are still cultivating old varieties of cassava. In addition, 89.7% applied manure to their farms. With the use of herbicides, the result showed 87.8% of the farmers practicing the used of herbicides to control weed on their farm while only 12.2% control weeds on their farm employing traditional means such as hand picking. Furthermore, for row planting technology, 63.1% of the farmers adopted this and about 99% of them used the technology intensively. The recommended spacing for planting received the adoption from 56.4% of the farmers.

Table 3: Distribution of adoption and use of improved cassava production technologies

Variables	**Adoption**		**Frequency of use**		
	Yes	**No**	**Intensive**	**Rarely**	**Discontinue**
New varieties (vitamin A fortified cassava)	260 (72.2)	100 (22.8)	257 (98.8)	3 (1.2)	0 (0.0)
Manure application	323 (89.7)	37 (10.3)	301 (93.2)	19 (5.9)	3 (0.9)
Use of herbicides to control weed	316 (87.8)	44 (12.2)	316 (100.0)	0 (0.0)	0 (0.0)
Row planting	227 (63.1)	133 (36.9)	225 (99.1)	0 (0.00)	2 (0.9)
Spacing	203 (56.4)	157 (43.6)	203 (100.0)	0 (0.0)	0 (0.0)

Source: Authors compilation

Determinants of Adoption Rate of Cassava Production Technologies

Table 3 showed that the censored Tobit model was used to assess adoption of improved cassava production technologies. The log likelihood for the fitted model was 111.67 and significant at 1%, meaning that the explanatory variables included in the model jointly explain the probability of farmers deciding to adopt cassava production technologies. The estimate sigma (6^2) for cassava farmers was 21% - the value was small and significantly different from zero which indicates a good fit of the model and the correctness of the specified distributional assumptions. Results of the tobit analysis presented in Table 3 showed that years of experience, farm organization, market demand, resistance to diseases and high yield were significant variables affecting adoption of cassava production technologies.

Number of year's involvement in cassava production technologies had a negative effect on the proportion of the pooled data at 10% significance level.

A unit increase in years of involvement leads to a decrease in probability level of adopting improved cassava production technologies through pooled data by 0.2%. The result negated the a-priori expectation. This means that the more the number of years involvement in cassava production technologies, the less the chance of proportion of adoption through the pooled data. Farm organization had a positive influence on the proportion of adoption through the pooled data at 5% significance level. A unit increase in the level of farm organization will lead to increase in probability of adopting improved cassava production technologies through pooled data by 7.4%. This implies that an increase in the level of farm organization will increase the chance of adoption of improved cassava production technology. Also high market demand had a positive influence on the proportion of adoption through the pooled data at 1% significance level. A unit increase in high market demand of cassava produce will lead to an increase in probability level of adopting improved cassava production technologies through pooled data by 6.8%. This implies that an increase in high market demand will increase the chance of adoption level of improved cassava production technology.

Additionally, concerning resistance to diseases; adoption influenced proportion of cassava production technology positively at 1% significance level. A unit increase in resistance to diseases of cassava produce will lead to an increase in probability of adopting improved cassava production technologies through pooled data by 20.1%. This implies that an increase in resistance to diseases will increase the chance of adoption of improved cassava production technology. In addition high yield was significant at 1% level in the pooled data and influence the proportion of cassava production technologies positively.

A unit increase in high yield of cassava produce will lead to an increase in probability of adopting improved cassava production technologies through pooled data by 13.6%. This implies that an increase in high yield will increase the chance of adoption intensity of improved cassava production technology. The result was in line with the suggestion of Abdoulaye *et al.*, (2014).

The results also showed that number of years of experience in cassava production technologies, was significant at 10% level, farm organization was significant at 5% level, high market demand was significant at 1%, resistance to diseases was significant at 1% and high yield was significant at 1%.

Table 4: Result of Tobit analysis showing factors affecting adoption of cassava production technologies.

Variables	**Coefficient**	**Standard Error**	**t-ratio**
Constant	0.5339***	0.0656	8.14
Socioeconomic variables			
Age	0.0002	0.0012	0.19
Gender	-0.0123	0.2028	-0.43
Education	-0.0004	0.0027	-0.13
Years of experience	-0.0018*	0.0010	-1.71
Household size	0.0005	0.0057	0.09
Marital status	0.0337	0.0324	1.04
Institutional-based variables			
Extension contact	0.0131	0.0286	0.46
Credit access	0.1106*	0.0719	1.79
Farm Organization	0.0735**	0.0307	2.39
Farm-level specific variables			
Market demand	0.0684***	0.0242	2.82
Resistance to diseases	0.2012***	0.0322	6.24
Income	1.68e-08	5.50e-08	0.31
Farm size	0.0019	0.0034	0.56
Increased yield	0.1364***	0.0284	4.80
Diagnostics			
Number of observation	360		
LR chi2(13)	111.67		
Prob> chi2	0.0000		
Pseudo R^2	1.2817		
Log likelihood	12.26990		
Sigma	0.21399	0.00837	0.19754

Source: Authors compilation

***, **, * shows significance of the coefficients of 1%, 5% and 10% levels respectively

Production Challenges Faced by Cassava farmers

It is evident from the result showed on Table 5 that cassava farmers in the study area are faced with a number of challenges. The table revealed that 81.4% of the respondents indicated their challenges with resistance to diseases; this made some of the farmers to adopt varieties which can resist common diseases affecting cassava within their locality. About 66% of the respondents show that the fluctuating cost of agro-chemicals for production is a problem. These farmers identify the increasing trend of the price of most of the agro-chemicals used for production which either lead to non-use or application(s) below recommendation. In addition to the above, most (73.3%) of the cassava

farmers encounter the problem of transportation and 68.6% identify insufficient improved planting material. Although, the study of Ayoade *et al.,* (2012) supported lack of marketing information by cassava farmers but it we can never ignore how crucial it is in the supply chain of cassava. Cassava stems usually get rotten in the presence of excessive rainfall and at this instance many farmers sells their product at the time when there are influx of the produce in the market as most of the farmers have common problem. The demand in the market sometimes pushes farmers into sales of their product at the wrong time. The technical know-how of some of these farmers (77.8%) is very low which make production difficult sometimes and lastly most (84.1%) of the farmers identify access to credit as a problem facing production.

Table 4: Distribution of Respondents based on Challenges faced by farmers

Variables	Yes		No	
	Frequency	Percentage	Frequency	Percentage
Cost of agro-chemical	237	65.8	123	34.2
Lack of improved planting material	247	68.6	113	31.4
Transportation problems	264	73.3	96	26.7
Lack of market information	258	71.7	102	28.3
Lack of technical know-how	280	77.8	80	22.2
Resistance to diseases	293	81.4	67	18.6
Market demand	214	59.4	146	40.6
Lack of capital	302	84.1	57	15.9

Source: authors compilation

CONCLUSIONS AND RECOMMENDATION

It was evident from the result discussed that most of the farmers were male and married with a fairly large household size. Cassava farmers in the study area were smallholder farmers – cultivate less than 5 hectares of land. Due to the challenges they are facing, a quite number of the farmers does not adopt some of the improve production technologies presented to them – prominent among these technologies include; improve cassava stems with better yield and early maturity, weed control technologies and new system of planting. Education, years of experience, farm organization, credit access, and market demand and resistance to diseases were significant determinants of cassava production technologies. The study however recommends intensive awareness campaign and or education through training such as field demonstration for the farmers. This will help the farmers in adopting and practicing the technologies.

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