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SOCIO-ECONOMIC DETERMINANTS OF ADOPTION OF BIO-FORTIFIED CASSAVA VARIETIES AMONG FARMERS IN ANAMBRA AGRICULTURAL ZONE OF ANAMBRA STATE, NIGERIA

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ABSTRACT: *The study analyzed the socio-economic determinants of adoption of bio-fortified Cassava among cassava farmers in Anambra State, Nigeria. Specifically, the study examined the socio-economic characteristics of the farmers, types and varieties of yellow cassava obtainable in the study area and the influence of socio-economic factors on the adoption of the bio-fortified cassava among the farmers. Multi-stage, purposive and simple random sampling techniques were used to select one hundred and twenty (120) Cassava farmers used for the Study. Data for the study was collected by administration of pre-tested questionnaire to the respondent farmers and analyzed using both descriptive (frequencies and means) and inferential statistics (maximum likelihood probit regression model). Among other results, the probit regression analysis of factors that influence the adoption of bio-fortified cassava among farmers reveals that education (3.1160) and access to planting material (5.0162) were positively significant at 1%, farm size(1.1114) at 10% and membership of cooperative society (1.3424) and extension contact (3.134) were significant at 5% level. This implies that increases in these factors will lead to more adoption of bio-fortified cassava among the farmers in the study area. Based on the findings, the researchers recommend among others that government should endeavour to increase the multiplication of the planting material, make it available to farmers for production and create a sustainable market out let if optimum production is desired.*

KEY WORDS: determinants, bio-fortified cassava, socio-economics, probit regression

INTRODUCTION

Cassava (*Manihot Esculenta*) is a woody shrub of spurge family, *Euphorbiaceae*. It is extensively cultivated as an annual crop in tropics and sub-tropical regions for its edible starchy tuberous root, a major source of carbohydrates. Cassava when dried and grinded to powdery form called cassava flour serves as a major diet in different part of the Country. It is one of the most drought tolerant crops capable of growing on soils with limited nutrients. According to Nwike, Okoli, Oghenehogagame, and Ugwumba (2017) .Cassava products have many uses apart from food. Some of the uses are animal feeds production, pharmaceutical and industrial production. In specific terms, the International Institute of Tropical Agriculture (IITA) (2011) identified important areas where cassava products are playing leading role

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nationally and globally. The areas are medical and industrial alcohol, flour for bakery industries, sweeteners from cassava glucose and fructose for fruit juice industries. Other areas of use according to Nwike (2010) are distillation for beverage, cassava chips and as fillers in manufacturing of pharmaceutical tablets

Several initiatives with regards to technological improvement were enacted to address the critical threat of Cassava production in Nigeria. Particularly, the International Institute of Tropical Agriculture (IITA), Nigeria's National Root Crop Research Institute (NRCRI) and some other national partners developed and disseminated high yielding resistant cassava varieties. Between 2002 and 2010, IITA implemented a research for development project called Integrated Cassava Project (ICP) to support the presidential initiative (PI) for cassava launched in 2002, to boost cassava production and processing. Through this project, IITA successfully introduced and promoted cassava varieties via the National Agricultural Research Services (NARs) and Agricultural Development Programs (ADPs). Furthermore, in a research spanning 12 years, the IITA, in partnership with the NRCRI, developed three bio-fortified cassava varieties which were released by the Federal Government in December, 2011, using traditional breeding method in a Harvest Plus-funded project (IITA, 2011).

The bio-fortified cassava is a vitamin A-enriched yellow cassava variety that could provide more vitamin A in the diets of more than 70 million Nigerians who eat the root crop every day (IITA, 2011). The yellow colour (cassava is generally white) is due to the higher vitamin A content. Vitamin A deficiency (VAD) is widely prevalent in Sub-Saharan Africa, as it afflicts almost 20% of pregnant women and about 30% of children under- five in Nigeria (IITA, 2011). VAD can lower immunity and impair vision, which can lead to blindness and even death. Children and women will be the main beneficiaries of the yellow varieties, which could provide up to 25% of their daily vitamin A needs, as asserted by IITA (Ayinde, Adewumi, Ajewole and Ologunde (2017). Since cassava is a major staple food crop in Nigeria, consumption of this vitamin A-enriched yellow cassava can help in combating vitamin A deficiency, which is a serious public health challenge in many parts of the World. Formulation of different food products from these cassava varieties will also help to enhance its consumption (Bai, Remadevi, Bala, Janard, 2010) and Omodamiro, Oti, Egesi, Ukpabi, Etudaiye, Chijioke, U. (2011). Since the presence of pro-vitamin A (β-carotene) in the new cassava could improve the nutritional status of the consumers, there is therefore a need to evaluate the adoption of these newly bred crops (Ayinde, et.al. 2017). Technology adoption by farmers is an essential pre-requisite for the economic prosperity in Nigeria.

The definition of adoption varies across studies, and the appropriateness of each approach depends on the particular context. Bekele, Verkuijl, Mwangi, and Tanner (2000) used a simple dichotomous approach and defined a farmer as an adopter if he or she was found to be growing any improved materials. Thus, a farmer may be classified as an adopter and may still grow some local materials. This approach is most appropriate when farmers typically grow either local varieties or improved varieties. Where farmers are increasingly devoting more land to improved varieties while still growing some local varieties, a continuous measure of adoption is more appropriate. Many other studies used measures of the proportion of land allocated to improved varieties as the measure of adoption. According to An (2013), adoption of

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a technology could be slow in the beginning of the process, and some farmers never adopt even after the technology matures. Also, limited use of some improved cassava varieties previously developed by research institutions in Nigeria has been noted (Nweke, Dunstan, Spencer, and. Lynam 2002)

Several factors could drive the adoption process and the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies and socioeconomic characteristics of farmers (Afolami, Obayelu and Vaughan, 2017). Low or non-adoption of agricultural technologies could be conditioned by institutional and structural factors, such as social networks and the market structure of seed systems some personal and socio-economic factors (Akinola, Alene, Adeyemo, Sanogo, Olanrewaju, Nwoke, Nziguheba, and Diels (2010); Ojeleye,(2018) and identification of these factors is imperative for improvement in the adoption process. It is in line with this, that this paper is designed to ascertain the factors influencing the adoption of this variety.

Objectives of the study include to:

1. describe the socio- economic characteristics of Cassava farmers in the study area.
2. determine the influence of socio- economic characteristics of farmers on the adoption of bio-fortified cassava

THEORETICAL FRAMEWORK

The theoretical backings of this study are the Rogers's theory of diffusion of innovation and theory of perceived attribute. Diffusion is defined as the communication process by which a new idea or new product is accepted. Theory of innovation-decision process and the theory of perceived attributes explain why and how innovations are adopted. The innovation-decision process theory is based on time and five distinct stages. The first stage is knowledge. Potential adopters must first learn about the innovation. Second, they must be persuaded as to the merits of the innovation. Third, they must decide to adopt the innovation. Fourth, once they adopt the innovation, they must implement it. Fifth, they must confirm that their decision to adopt was the appropriate decision. Once these stages are achieved, then diffusion results (Rogers and Shoemaker, 1995)

The theory of perceived attributes is based on the notion that individuals will adopt an innovation if they perceive that the innovation has the following attributes. First, the innovation must have some relative advantage over an existing innovation or the status quo. Second, it is important the innovation be compatible with existing values and practices. Third, the innovation cannot be too complex. Fourth, the innovation must have trialability. This means the innovation can be tested for a limited time without adoption. Fifth, the innovation must offer observable results (Rogers and Shoemaker, 1995). Drawing from Roger's theory of diffusion, it is agreed that the adoption of bio-fortified cassava is influenced by the farmers' perception of the usefulness of the innovation, such that those who perceive it as being highly useful would adopt it fully while those who view it as less useful would either not adopt it or partially adopt it.

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METHODOLOGY

Anambra State is made up of twenty –one (21) Local Government Areas and Four (4) Agricultural Zones (AZs) namely Awka, Onitsha, Aguata and Anambra zones. **T**he study was carried out in Anambra Agricultural zone. Multistage, purposive, and random sampling techniques were used to select the respondents for the study. The first stage was the purposive selection of Anambra Agricultural zone because cassava production is prevalent in the zone. (ADP bulletin, 2018). In stage two, four (4) Local Government Areas (Ayamelum, Anambra West, Anambra East and Oyi) were purposively selected from the zone. ln stage III, a random selection of three Communities across the four LGAs was made to arrive at twelve (12) Communities. The final stage was random sampling of ten (10) cassava farmers from each of the 12 Communities giving a sample size of 120 respondents.

Agricultural Zone	Local Government Area	Communities	Respondents
Anambra Zone	Ayamelum	Ifete Ogwari	10
		Igbakwu	10
		Omor	10
	Anambra East	Aguleri	10
		Umueri	10
		Igbariam	10
	Anambra West	Umueze Anam	10
		Miata	10
		Umuewelu	10
	Oyi	Awkuzu	10
		Ogbunuke	10
		Nteje	10
Total			**120**

Primary data used for the study was collected using well-structured questionnaire which was administered to sampled cassava farmers in the study area. 120 copies of questionnaire were administered to the farmers with the help of trained enumerators while 105 copies of the returned questionnaire were found useful and thereafter utilized to collate data for analyses.

The Socio-economic variables for the study were measured as follows;

i. **Gender:** This is measured as dummy variables, 1 for male and 0 for female.
ii. **Age:** The actual ages of the farmers in years.
iii. **Educational attainment**: Number of years of formal education of the farmers.
iv. **Farming experience:** This is measured by the number of years of experience in cassava production.
v. **Membership of farmers' co-operative group**: This is measured in number.
vi. **Marital status:** This is measured as dummy (if married = 1, otherwise =0)

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vii. **Extension contact/visit:** Access to information on improved cassava varieties through extension agents. 1 if there is access , otherwise 0
viii. **Farming status:** Measured as dummy variables will be used in this regard as, 1 if the farmer is a full time farmer and 0, if otherwise.
ix. **Household size:** Number of members of the household living and feeding together.
x. **Farm size:** Actual farm size
xi. **Farm income:** Actual Amount
xii. **Cost of planting material:** Amount spent on procurement of bio-fortified cassava stems
xiii. **Access to planting material** (access 1, no access 0)

In analyzing the data, descriptive statistical tools such as means, frequency counts, and percentages was used to achieve **objective one;** socio- economic characteristics of the respondents**. Objective two;** the influence of farmers' socio-economic characteristics on the adoption of yellow cassava varieties was realized using Probit model. The classification was done to identify farmers that had planted at least one variety bio fortified cassava as adopters (1) and those that had not planted any variety at all as non-adopters (0).

Model Specification
The Probit model
The Probit model is appropriate when the dependent variable takes one of only two possible values. The classification for the two possible values was done to identify farmers that had planted at least a bio-fortified cassava variety as adopters (1) and those that had not planted the varieties as non- adopters (0) and the probability that a farmer would adopt was postulated as interplay of some socio-economic factors. This is expressed as in Gujarati (2009) and adopted by Osondu, Anyiro, Ijioma and Obike (2013 and Chiekezie, Nwankwo and Offia (2020).

The general form of the univariate dichotomous choice model can be expressed as in equation 1
$P_{i=}\ P(Y=1) = f(z_i)\ _i = \ldots..n$ ---------- (1)
Where:
$Z_i = \beta_0 + \beta_1 X_1$
$Y_i = \beta_1 + \beta_2 X_{2i} + \ldots\ldots\ldots + \beta_k X_{ki} + \mu$ ---------- (2)
Y_i^* is unobserved but $Y_i = 0$ if $y_i^* < 0$, $Y_i = 1$ if $y_i^* \geq 0$
$P\ (y_i = 1) = P\ (y_i^* > 0)$
$P\ (\mu_1 \geq -\beta_1 + \beta_2 X_{2i} \ldots\ldots + \beta_k X_{ki}$----------(3)

Where:
Y_i= is the dependent variable and a dummy variable where an adopter of any bio-fortified variety is scored 1 and Non adopters are scored 0. Adoption in this study is defined with a dichotomous variable (adopted –where a farmer has used at least one bio-fortified cassava and not adopted where a farmer has never used any bio-fortified cassava) .

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$\mathbf{X_i}$ = the independent variables and the vector of characteristics of ith individual which are defined as follows; $\mathbf{X_1}$ = Gender (1 = male; 0 = female), $\mathbf{X_2}$ = Age (years), $\mathbf{X_3}$ =Marital Status(Married 1, otherwise 0), $\mathbf{X_4}$ = Educational level (years in school), $\mathbf{X_5}$ = Farming Experience (years), $\mathbf{X_6}$ = Farm size (hectares), $\mathbf{X_7}$= Extension contact (number of visits), $\mathbf{X_8}$ = Farm income (Naira), $\mathbf{X_9}$ = Membership of farmers association (1 = member; 0 = otherwise), $\mathbf{X_{10}}$= Household size (number), $\mathbf{X_{11}}$=Farming status (Full-time = 1, Part-time = 0); $\mathbf{X_{12}}$= Access to planting material(access1, other 0) $\mathbf{X_{13}}$=Cost of planting material

$\boldsymbol{\beta}$ = Unknown coefficients,
$\boldsymbol{\mu}$ = Error term;
i = 1, 2 .....105;

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents.

Table 1: Distribution of Cassava Farmers according to their socio-economic characteristics.

S/N	VARIABLES	Frequency	Percentage
1	**Gender**		
	Male	57	54.29
	Female	48	45.71
	TOTAL	**105**	**100.00**
2	**Age (years)**		
	21 - 30	7	6.70
	31 - 40	37	35.23
	41 - 50	34	32.37
	51 - 60	16	15.23
	60 and above	11	10.47
	TOTAL	**105**	**100.00**
3	**Marital Status**		
	Single	5	4.76
	Married	74	70.48
	Widow	20	19.04
	Divorced/Separated	6	5.72
	TOTAL	**105**	**100.00**
4	**Household Size**		
	1 – 3	41	39.05
	4 – 6	40	38.09
	7-10	16	15.24
	11 and above	8	7.62
	TOTAL	**105**	**100.00**
5	**Farming Experience**		
	1 – 10	7	6.67
	11 – 20	66	62.86
	21 and above	32	30.47
	TOTAL	**105**	**100.00**
6.	**Educational Level**		

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	No formal education	19	18.1
	Primary education (6years)	40	38.1
	Secondary education(12years)	38	36.7
	Tertiary education (16years)	8	7.1
	TOTAL	**105**	**100.00**
7.	**Extension Visit (No. of visits)**		
	No visit	39	37.0
	1	60	60.0
	2	3	3.0
	3 and above	-	-
	TOTAL	**105**	**100.00**
8	**Farm Size (No of hectares)**		
	>1 hectare	33	31.4
	2-3hectares	62	59.1
	< 4 hectares	10	9.5
	TOTAL	**105**	**100.00**
9	**Membership of farmers association**		
	Yes	75	71.43
	No	30	28.57
	TOTAL	**105**	**100.00**
10	**Farming Status**		
	Full time	68	64.76
	Part-time	37	35.24
	TOTAL	**105**	**100.00**
11	**Farm Income**		
	<20,000	7	6.67
	20,000-50,000	66	62.86
	>50,000	32	30.47
	TOTAL	**105**	**100.00**
12	**Access to Planting Material**		
	Accessed easily	33	31.4
	Not Accessed easily	72	68.6
	TOTAL	**105**	**100.00**
13	**Cost of planting material (**per medium sized bundle**)**		
	<N1500		
	N1500-N2000	41	39.05
	<N2000	48	45.71
	TOTAL	16	15.24
		105	**100.00**

Source: Field Survey, 2021

Socio-economic characteristics of the Respondents.

The result in table 1 indicates that the mean age of the farmers is 42.5years. This implies that farmers in the area are dominated by an age range considered to be economically active and highly productive

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(Ugwumba and Chiekezie, 2014). Analysis of gender shows that there were more males (54.29 %%) than females (45.71%) who engaged in vitamin A Cassava production in the study area. Result on the marital status shows that greater proportions (70.48%) of the respondents were married while (4.76%) were single. However, 19.04% are widowed and 5.72% are divorced/separated. Analysis of household size shows a mean size of 4-6 persons and this is reasonably high since members of the farmers' household contribute immensely to family labour supply and this confirms the assertion that rural households in Nigeria are characterized by moderate to large households (Ndem and Osondu, 2018). Result of educational attainment shows that most of the farmers attained primary and secondary school. Education is an important element in adoption of innovation. The highest range of years of farming experience is between 11-20years and this implies that they should be capable of deciding whether to adopt or not. Majority (64.76%) of the respondents are full time farmers. Analysis shows that most farmers have between 2-3 hectares for farm size. This is in line with the result of Ugwumba and Chiekezie, (2014) who asserted that the low level of farm size indicates the subsistence nature of the rural farmers. Result of the analysis of membership to other society indicates that 71.43% of farmers belong to a cooperative society. Analysis of contact with the extension agents shows that (60%) farmers have had at least one contact. Finally, the result indicates that 68.6% of the farmers do not access the planting material easily.

Table 2: Socio-economic factors that influence the adoption of bio-fortified cassava in the study area

Variable	Estimated Coefficient	t- values	Marginal effects
Constant	**-0.5921**	-3.5161	-0.032
Gender	0.0047	0.0623	0.007
Age	0.2261	0.0330	0.041
Education	0.0033	3.1160***	0.005
Marital status	0.0773	2.0164	0.031
Household size	-0.0071	-0.3271	0.002
Farm Experience	0.3028	0.2224	0.033
Farm size	0.0991	1.1114*	0.001
Extension contact	0.0361	3.1340**	0.004
Farm income	0.4356	1.1071	0.011
Societies membership	0.0187	1.3424**	-0.031
Farming status	0.0561	-0.2019	0.002
Cost of planting material	0.0072	2.3401	-0.071
Access to planting material	0.3213	5.0162***	-0.031
Number of observation	105		
R^2	0.60		
Log-likelihood Function	-223.04		
Restricted log-likelihood	-141.15		
Chi-Squared	34.2		

Source: Computed from survey data, 2021
* ,**, *** are significant at 10%, 5% and 1% respectively

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The result of probit regression analysis of factors that influence the planting of bio-fortified cassava among farmers shown on table 2 reveals education, extension contact, farm size, access to planting material and membership of cooperative societies are significantly positive. The estimated coefficient of education (3.1160) and access to planting material (5.0162) were positive and statistically significant at 1%. This implies that the higher the level of education of farmers, the more they will seek and adopt tested and proven innovations over the years. This is true because educated farmers are intelligent and calculative in utilization of available resources and are able to adopt innovations (Igboji, Anozie, and Nneji (2015). In a study by Nwakalor, Ifenkwe and Asumugha (2011), education was found to be an important determinant of adoption of innovation. In the same vein, availability of planting materials makes the usage of the materials easy and hence facilitates adoption. The estimated coefficient of farm size (1.1114) is positive and statistically significant at 10% implying that increases in farm size will lead to more use of the planting material and then increase in output. This agrees with the study of Ekpunobi, Nwigwe and Nkamigbo that farm size increase has direct increase with output. The coefficient of membership of co-operatives (1.3424) and extension contact (3.134) were positive and statistically significant at 5%. This implies that co-operators and more contact with extension agents have high probability of accessing innovations. It is likely that cooperative societies in the area are very efficient and have made the desired impact in the life of the farmers and that a unit increase in access to extension services increases the probability of adoption by about 3.13. Abdoulaye, Bamine, Adewale and Akinola (2015) assert that the validity of extension activities is a key factor in promoting the adoption of innovations. In addition, the Model result reveals that factors affecting the adoption of bio-fortified cassava varieties in the study area showed log-likelihood function of -223.04 and the Chi^2 of 34.2 were all significant ($p < 0.001$) suggesting that the model has a strong explanatory power. The pseudo coefficient of multiple determination (R^2) of 0.60 shows that 60% of the variation in farmers' decision to adopt vitamin A, bio-fortified cassava varieties in the study area was collectively explained by the independent variables. This implies that the overall model had a good fit and the explanatory variables used in the model were collectively able to explain the farmers' decisions regarding the adoption of vitamin A bio-fortified cassava varieties in the study area.

CONCLUSION AND RECOMMENDATIONS

This study looked at the determinants of the adoption of bio-fortified Vitamin A Cassava in Anambra Agricultural Zone of Anambra State. The result of the study found out that the adoption of bio-fortified Vitamin A Cassava
was determined by education , access to planting material ,membership of cooperative society extension contact. This implies that increases in these factors will lead to more adoption of bio-fortified cassava among the farmers in the study area. Based on the findings, the researchers recommend among others that

1. Government should endeavour to increase the multiplication of the planting material, in order to make it available to farmers for production and create a sustainable market out let if optimum production is desired.
2. Government policy interventions should improve the working condition of ADP extension staff and equip the body with necessary equipment in order to boost and strengthened the extension efforts in the area

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