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The Marked Attributes of the Adopters and Non-Adopters of Biofortified Cassava Farmers in South West Nigeria

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Abstract:

Objective*: The understanding of underlying characteristics of smallholder farmers can guide in the allocation of resources for technological development. This study objective was to examine the marked attributes of the adopters and non-adopters of biofortified cassava farmers In South West Nigeria.*

Method*: Data were gathered through structured interviews conducted with 396 respondents who were chosen using a multistage sampling technique.*

Results*: This study results show that, when compared with adopters, non-adopters were older, had smaller farm size, lesser formal education, cosmopolitan and income from agricultural sources, and engaged more family labour. Future technological interventions should therefore focus on these special attributes in order to enhance adoption and sustainability.*

Keywords*: Attributes; Adopters; Non-adopters; Biofortified cassava; and Technology.*

JEL Classification*: D1; D83; D91; E03, J11; 013; A13; A14; D30; D91*

Introduction

The understanding and evaluation of adoption of new technologies require critical analysis of technical, political and socio-economic conditions to discover determinants of when and whether farmers' adoption takes place (Milkias and Abdulahi, 2018). Understanding the

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specific and unique characteristics and attributes of farmers serves to provide information that could assist in demographic interventions. According to Okwuonu et al. (2021), the pervasiveness of micronutrient deficiencies all through Nigeria can be linked with families' socio-economic status which is determined by factors such as income, educational levels and sanitary practices. It is believed that adoption and utilization of new technologies increase production and productivity, hence the attention from stakeholders in developmental interventions and policy makers on factors that influence adoption. Adequate knowledge of the target group's attributes can provide information for producer groups, research bodies and policy makers on how the technology will be received and help to take informed decisions on allocation of the scarce resources for technology development. Arising from the foregoing, this research was embarked upon to investigate some social, cultural and economic attributes of individuals who have taken up (the adopters) and those who have not taken up (the non-adopters) biofortified cassava in the South West region of Nigeria to provide new evidence as it affects adoption of technologies. A null hypothesis was tested in the study. Ho1: There is no marked difference in the selected socio-economic attributes of adopters and non-adopters

The structure of the study is outlined into sections as follows: The first section provides the introduction, the second section delves into the literature review, the third section describes the methodology, while the fourth section presents the research results and discussions. The last section concluded and provided recommendations arising from the study.

Review of Literature

The COVID-19 pandemic has its effects lingering all over the globe thereby making it difficult to breakthrough in economic recovery thus, creating setbacks in efforts to combat hunger, food insecurity and ending all forms of malnutrition (FAO, 2022). There are also cases of extreme climatic conditions coupled with conflicts and war trends that have intensified challenges in food security and nutrition. Micronutrient deficiency which is a fall out of hidden hunger affects about two billion people all over the world (IFPRI, 2016). The significantly high malnutrition prevalence poses developmental challenges, risk of death, poor cognitive development and low productivity in adults and many other challenges. Recent statistics show that the world is moving backwards in its efforts to end hunger and malnutrition in all its facets (FAO, 2022). This may continue until the agrifood systems are transformed and are able to proactively devise means of delivering nutritious foods to all especially the rural populace who form the bulk of the food producers in the Nigerian economy. Cassava is a food security tuber crop capable of supplying the needed calories for over 500 million people in developing countries (FAO, 2013) and specifically for over 180 million Nigerians. Cassava (Manihot esculenta Crantz) is a tropical and subtropical woody shrub that bears an edible root and is cultivated in regions across the world with such climates. Cassava plays a significant role in the agriculture of developing nations, especially within sub-Saharan Africa.

This is attributed to its adaptability to poor soils and low rainfall conditions, making it a resilient perennial crop that can be harvested as needed. Cultivating cassava is relatively less burdensome because it exhibits tolerance to both biotic and edaphic challenges that often impede the growth of other crops (IITA, 2013). It is capable of combating some of the problems challenging human health. In Nigeria and Benin, cassava holds the utmost significance as a staple food, whereas in Sierra Leone, it follows rice as the second most important staple crop (FAO, 2013), making her the highest cassava producer in the world. Cassava holds a similar importance to African peasant farmers as rice does to Asian farmers or as wheat and potatoes do to European farmers (El-Sharkawy, 2003).

However, with the great potentials of this important crop, the mineral content of its convectional breeds is deficient at nutritionally significant levels due to limited genetic diversity within the available germplasm thereby, exposing the teeming consumers of cassava to hidden hunger. Supplementation, food diversification and fortification are examples of some of the interventions put in place to improve the nutritional contents of staple food consumed but a large percentage of the populace still suffers from micronutrient deficiencies. It is in a bid to overcome this persistent improper nutrition that the idea of biofortification is also being conceptualized and explored.

Biofortification is a process of loading nutrients into common agricultural crops achieved through traditional breeding methods, genetic modifications or farming techniques. It potentiates cost reduction in the long run and is able to offer continued good effects to both rural and urban populations. Overarchingly, It offers a genuinely viable method of reaching undernourished communities residing in remote rural regions, delivering naturally-enriched food to population segments with restricted availability to commercially-promoted fortified food, which is more easily accessible in urban areas (Okwuonu et al., 2021; Bouis, 2003).

Adetomiwa and Adeyera (2021) affirmed that there was an increase in farm yield, farmers' income and welfare status when farmers adopted biofortified cassava. Specifically the study showed a 39.1% rise in per-capita total outlay and a 29.7% increase in per-capita food outlay. Subsequently, the number of individuals living in poverty decreased by 21.3% which confirms a reduction in the level of poverty. Furthermore, the adoption of biofortified cassava exhibited varied distributional effects with reference to size of the farm and sex of the farmers.

Above one million farming households were already growing the biofortified cassava otherwise known as the vitamin-A cassava just about five years after it was introduced, thus offering employment opportunities for Nigerians (Harvest Plus, 2016). Bamire et al. (2018) examined the profitability of investments in biofortification in Nigeria using the case of value chain in biofortified cassava. With a sample size of 130 businesses, there was a high level of integration of 53% of biofortified cassava out of all the entire traded cassava. The study further affirmed that investment in biofortified cassava business is very profitable with profit ranging from 79% for micro investors to 190% for medium scale investors, confirming that

the larger the scale of investment into biofortified cassava, the more the profit that can be derived. An analysis conducted using cross-sectional data from a survey of farmers in China aimed to investigate the effect of adopting biofortification on return on investment (ROI). The study found that the adoption of biofortification has a positive and statistically significant impact on ROI. Furthermore, a heterogeneity analysis revealed that high-income adopters derived greater benefits compared to middle and low-income adopters (Zeng et al., 2022).

The majority of staple foods available in Nigeria cannot adequately address malnutrition arising from deficiency of essential micronutrients in the diet. Also, dependence on meat and products from it as a replacement for micronutrient source is unreliable, due to insufficient production to meet the increasing population growth in Nigeria. Despite the conspicuous advantage of the biofortified cassava being capable of positively influencing the health of consumers in Nigeria and other countries by increasing the mineral content, the cassava breed has some limitations that have reduced the rate of its adoption. Some of the disadvantages of biofortified cassava include; the high moisture content, low starch quantity and its yellow colouration. Olatade et al. (2016) identified the most severe constraints limiting biofortified cassava adoption to be inadequate storage facilities due to the high moisture content and perishability, limited access or no access to credit and guaranteed market for the products.

The biofortified cassava was first disseminated to farmers in 2011 by IITA for adoption and utilization. Whether this technology will be adopted and sustainable in practice depends on farmers' attributes, attitudes and the specific management practices that accompanies it. However, due to variations in natural resources, culture, political systems, traditions, beliefs, and socio-economic factors, the factors influencing technology adoption vary across different locations. Adoption is defined as the final decision of an individual to become a regular user of an innovation. It is influenced by personal, socio-cultural, economic and communication factors (Rogers, 2003). A study carried out on the effects of socio-economic characteristics on farmers' perception and cassava production revealed that some socio-economic features of farmers such as; household size, marital status and age influenced cassava production in Ondo state, the study area (Ayodele et al., 2016). Empirical evidence revealed that physical capital endowment such as farm size, livestock and farm implements or equipment owned affect adoption of technology (Putler and Zilberman, 1988). Kaguongo et al. (2012) revealed the importance of formal education on adoption as it has a positive association with adoption. The number of years of formal education was significantly higher for adopters than that of non-adopters. In a study on estimates of adoption rates and determinants of adoption of highland maize varieties, farm size, farmers' income extension and credit access and participation in training have been found to positively influence adoption (Milkias and Abdulahi, 2018).

Research Methodology

This study was conducted in South West, Nigeria. It lies between latitude 40 and 90N and longitude 300 and 70E with about 191,843 square km (Oni and Odekunle, 2016). To select the respondents, a multi-stage sampling procedure was used. Ogun, Oyo and Lagos were the three states purposively selected in South West for the research because they produce large quantities of cassava. The study's sampling frame used was based on the agricultural activities arrangements of the Agricultural Development Project (ADP). ADP is a government organization co-founded by the World Bank. Proportional sampling was used at the second stage to select half of the zones in each state. Those selected locations were the places where biofortified cassava were first introduced in those states. From Oyo State, Oyo and Ibadan/Ibarapa zones were selected; from Ogun State, Ijebu-Ode and Abeokuta zones; and from Lagos State, Far Eastern (Epe) and Eastern (Imota) zones were selected. This selection was followed by selection of half of the blocks in each zone randomly. The breakdown is as follows: 4 ½ blocks from Ibadan/Ibarapa zone, 3 blocks from Oyo zone, 3 blocks from Abeokuta zone, 3 blocks from Ijebu-ode zone, 2 blocks from Imota zone and 3 blocks from Epe zone, resulting in 18 and a half blocks. The next stage was an independent simple random selection of 25 percent of all cells in each block, resulting in 33 cells in all. At the last stage, 12 cassava farmers were selected from each cell. The total number of respondents use for the research at the end of the selection was 396 respondents. Relevant data were gathered on socioeconomic features of the respondents and the gathered data were analyzed with inferential and descriptive statistics.

Results and Discussions

Respondents' Age

As presented in Table 1, most respondents (39.4% adopters and 35.6% non-adopters) were between 41 – 50 years. The mean age of 46.9 and standard deviation of ±10.5 years shows a spread across 56 to 36 years for the farmers' age. The age spread corresponds to an active age group which can still productively contribute to agriculture. However, the study showed about 5 years variations in the average ages of the non-adopters (50.1) years and the adopters (45.3) years. This implies that non-adopters were slightly older than the adopters. This also indicates that more of the older farmers were in non-adopters' category. More of those who were younger adopted biofortified cassava than those who were older. In agreement with Nmadu et al. (2015), younger farmers are more disposed to adoption of innovations. Young people are more innovative and take more risks than older ones.

Sex of Respondents

As shown in Table 1, the respondents were mainly males (68.9%), while 31.1% were females. Though both males and females were involved in cassava cultivation, there was a male dominance in its cultivation in the study areas. Osikabor et al. (2011) confirmed male

dominance in cassava production with 82% male involvement in cassava cultivation in Oyo State Nigeria. Ayanwuyi et al. (2013) asserted more male involvement than female in agricultural production in Southwestern Nigeria. The results showed that there were more females in the non-adopter group (38.6%) than in the adopters group (27.3%). This shows men were more receptive to the technology than women.

Years of Experience of Respondents

Table 1 shows the adopters (46.1%) and non-adopters (37.1%) had above 20 years of cassava farming experience. Average number of years of experience in cassava farming for both respondents was 20 years. The implication of this is that these farmers were well grounded in cassava production. This is expected because most children follow their parents to farm from childhood in Nigeria as confirmed from the FGD carried out in the study. According to Ikwuakam (2013), about 84.9% of cassava farmers in south eastern Nigeria had about 25-50 years farming experience. During the FGD conducted at Egbeda LGA in Ibadan/Ibarapa ADP zone, one of the discussants stated this:

Most of us started our livelihood activities with farming since we followed our parents to farms when we were young. Some of us even had small plots to ourselves on our parents' farms and since then we have been practicing farming in one form or the other. (FGD at Egbeda LGA in Ibadan/Ibarapa ADP Zone, Oyo State).

Farm Size of Respondents

According to Table 1, the mean farm size for adopters was 1.9±1.7 hectares and non-adopters 1.4±1.1 hectares while both respondents had a mean of 1.8±1.6 hectares. The spread in the standard deviation value shows that there were farmers with small farm size as low as 0.2 hectares which implies a small scale farm holding. For both adopters and non-adopters 73.0% among the respondents owned a cassava farm size between 0 – 2 hectares, which also implies small scale cassava farming. Osikabor et al. (2011), Ayanwuyi et al. (2013), and Ayodele and Akindele (2017) had confirmed that the majority of crop farmers in Nigeria hold less than five hectares of farm. The results however confirmed that non-adopters had smaller farm sizes than the adopters.

Religion of Respondents

Table 1 shows that 54.3% were Christians, 43.9% were Muslims and 1.8% were traditional worshippers. This implies that religion was no barrier to cassava production as the three major religions practiced in Nigeria were represented among the respondents. They were all represented both in the adopters and non-adopters categories.

Marital Status of Respondents

Findings from the study as revealed in Table 1 show most respondents (87.1%) were married while 6.6% were single, 0.8% were separated, 2.0% were divorced and 3.5% were

widowed. This implies that a good number of the respondents were married. This is expected in the agricultural profession as it is labour intensive. It is believed that marriage facilitates access to unpaid labour. Osikabor et al., (2011) confirmed that majority 94.7% and also Ikwuakam (2013) affirmed that 97.7% of cassava farmers were married. There were more singles in the adopters' category (9.1%) than the on-adopters (1.5%). That could be because they don't have to consult any partner before making an adventurous decision.

Respondents' Main Source of Labour

Table 1 further shows that the hired labour (55.8%) was the most used source of labour for cassava farming. This was followed by family labour (20.7%), mechanised farming (19.7%), and communal labour (3.8%). This finding is in contrast to the results of Nwafor et al., (2016) where family labour (53.3%) was the most used source of labour in cassava farming in Abia State, Nigeria. The percentage of the farmers that made use of mechanized farming (19.7%) is noteworthy. Some farmers in the study area organized themselves into cooperatives and other forms of groups which enabled them to get involved in farm mechanisation. Given this assertion, it is logical to have some farmers cultivating larger areas of cassava as opposed to smallholder farming in cassava production. In comparison, the adopters used more of hired labour (56.4%) and mechanized farming (4.2%) than the non-adopters whereas, the non-adopters used more of family labour (30.0%) than the adopters (15.9%) for their cassava production. This is expected as the adopters have larger farm size as seen earlier in the study.

Household Size of Respondents

Table 1 shows the mean household size for adopters to be six persons and non-adopters seven persons while both respondents had a mean of 7 persons. The adopters, non-adopters and all respondents had 65.9% of the respondents in the 5-8 household size category. This implies that most households had between 5-8 members. It is worthy of note that household size has not translated into labour use as most of the respondents used hired labour for farming activities as shown earlier in the study. According to Ajibefun et al. (2000), the rise in the number of individuals within a household now represents a higher dependency ratio (liability) rather than an increase in human capital (asset).

Types of Respondents' Membership of Organisation

From Table 1, it is shown that 86.1% of the respondents belong to organisations ranging from commodity, cultural, religious and political. This is in tandem with Akinnagbe and Ajayi (2010) that confirmed that 80% of farmers belong to different social organisations and that farmers' organisations play a vital role in agricultural development in developing countries. There was no marked difference in the composition of group membership for adopters (86.0%) and non-adopters (86.4%). The type of membership organisation is presented in

Figure 1 in descending order. Though it was a multiple response variable, 73% belong to religious groups, 65.4% to cooperative societies, 50.5% to occupation/commodity groups, 40.4% to cultural/social associations and 24.7% to political groups. This indicates that most of the respondents belong to religious groups. This result corroborates Ademola (2016), which affirmed rural residents are more inclined to be affiliated with religious organizations rather than economic groups such as cooperative societies and commodities groups. The implication of this is that religious organisations thrived more among farmers. When introducing technologies, the planners and other key players can get across to the target beneficiaries through religious organisations it could be affirmed that membership organisation plays a vital role in agricultural production.

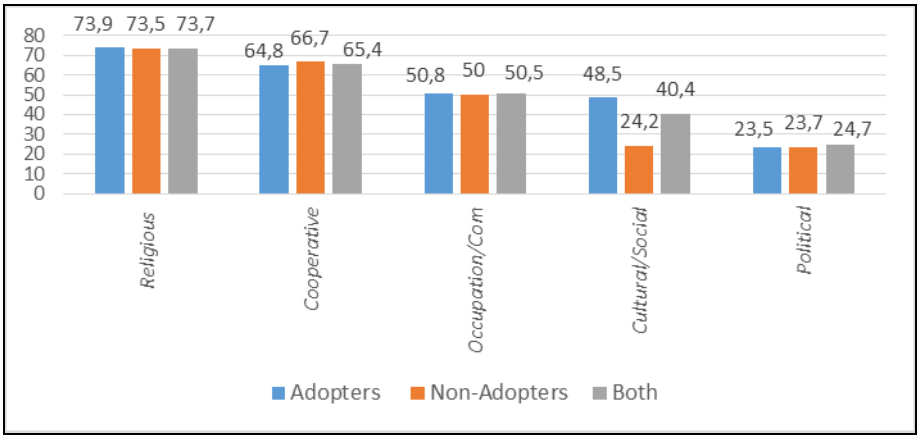
Table 1: Respondents' distribution according to socio-economic characteristics

Marked Attributes	Adopters n = 264		Mean	Non Adopters n = 132		Mean	All Respondents n = 396		Mean
	F	%	±SD	F	%	±SD	f	%	±SD
Age (years)									
30 & below	20	7.6	45.3	2	1.5	50.1	22	5.6	46.9
31 – 40	72	27.3	±10.4	27	20.5	±10.1	99	25.9	±10.5
41 – 50	104	39.4		47	35.6		151	38.1	
51 – 60	50	18.9		35	26.5		85	21.5	
Above 60	18	6.8		21	15.9		39	9.8	
Sex									
Male	192	72.7		81	61.4		273	68.9	
Female	72	27.3		51	38.6		123	31.1	
Years of Experience									
≤ 10	61	23.1	20.4	28	21.2	19.2	89	22.5	20.0
11 – 20	81	30.7	±10.5	55	41.7	±9.5	136	34.3	±10.2
> 20	122	46.2		49	37.1		171	432	
Farm Size (hectares)									
< 2	181	68.5	1.9	112	84.8	1.4	289	73.0	1.8
2 – 5	67	25.4	±1.7	15	11.4	±1.4	85	21.5	±1.6
> 5	16	6.1		5	3.8		22	5.5	
Religion									
Christianity	142	53.8		73	55.3		215	54.3	
Islam	117	44.3		57	43.2		174	43.9	
Traditional	5	1.9		2	1.5		7	1.8	
Marital Status									
Single	24	9.1		2	1.5		26	6.6	
Married	223	84.5		118	89.5		345	87.1	
Separated	3	1.1		2	1.5		3	0.8	
Divorced	6	2.3		4	3.0		8	2.0	
Widowed	8	3.0		6	4.5		14	3.5	

Marked Attributes	Adopters n = 264		Mean	Non Adopters n = 132		Mean	All Respondents n = 396		Mean
	F	%	±SD	F	%	±SD	f	%	±SD
Major Source of Labour									
Family	42	15.9		40	30.0		82	20.7	
Hired	149	56.4		72	54.5		221	55.8	
Communal	11	4.2		4	3.0		15	3.8	
Mechanised	62	23.5		16	12.1		78	19.7	
Household size									
1-4	48	18.2	6	12	9.1	7	60	15.2	7
5-8	174	65.9	±2.36	87	65.9	±2.41	261	65.9	±2.39
> 9	42	15.9		33	25.0		75	18.9	
Membership of Organisation									
Yes	227	86.0		114	86.4		341	86.1	
No	37	14.0		18	13.6		56	13.9	

Source: Field survey, 2018

Figure 1: Distribution of Respondents according to Type of Membership Organisation (Multiple response)



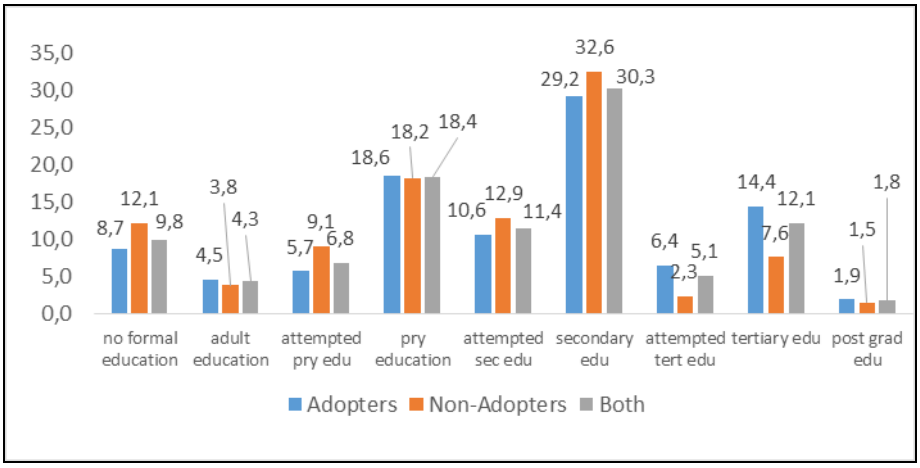
Source: Field Survey, 2018

Educational Status of Respondents

The study shows that most of the respondents had secondary education 29.2%, 32.6% and 30.3 % for adopters, non-adopters and both respondents respectively (Figure 2). However, 12.1% of the non-adopters, 8.7% of adopters and 9.8% of both categories lacked formal education. This suggests more of the non-adopters had no educational background. Furthermore, 12.1% had tertiary education and 1.8% respondents had postgraduate

education. This shows literacy level was high in the study area and implying education could impact adoption. Ikwuakam (2013) and Ayodele et al. (2016) conducted studies on socio-economic characteristics of cassava farmers which confirmed that most cassava farmers had formal education. This is anticipated to have a positive influence on adoption of the innovation. According to Nmadu et al. (2015), level of education affected adoption decisions of farmers.

Figure 2: Distribution of Respondents according to Educational Status

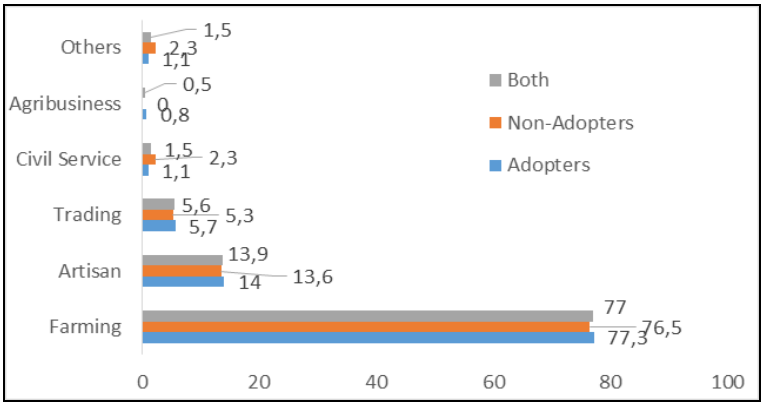


Source: Field Survey, 2018.

Primary Occupation of Respondents

Findings from the study as presented in Figure 3 show that 77% of all the respondents had farming as their primary occupation. Some other primary occupations present included civil service (13.9%) and trading (5.6%). This implies that farming is a major occupation in the study area. The study equally showed that the adopters were more into farming than the non-adopters, while the non-adopters were more of artisans and also got engaged in other occupations other than farming. This could have an effect on adoption as those whose main occupation was farming would want to try any agricultural technology that would advance their production. Moreover, agricultural intervention is time bound, since they are always on ground to monitor the situation of things with the adoption of a new technology. Olatade et al. (2016) confirmed that farming, artisan, and trading were the most common occupations among farming communities.

Figure 3. Distribution of Respondents according to Primary Occupation



Source: Field Survey, 2018

Respondents' Annual Income Generated from Cassava

The percentage distribution of respondents' income is presented in Table 2. It shows that the mean annual income generated from cassava production was N252, 452.02 in 2017 and N238693.18 in 2018. However, a reduction in income generated from cassava was noticed in year 2018. This indicates that income generated from cassava dwindled in the study area. Also, a wide margin was noticed in the average annual cassava income for the adopters (N279742.42) and non-adopters (N197871.21) in 2017; adopters (N265256.44) and (N185166.67) in 2018. This was expected and logical since the mean farm size of the adopters exceeded the size of the non-adopters. The average annual income from cassava according to Nwafor et al. (2016) and Ikwuakam (2013) was N234,580.67 and N275,771.70 respectively. The decrease in the income generated from cassava was a great disincentive to cassava cultivation.

Table 2: Distribution of Respondents according to Annual Income Generated from Cassava

Income (N)	Non-Adopters n = 132		Adopters n = 264		All Respondents n = 396	
	2017 (%)	2018 (%)	2017 (%)	2018 (%)	2017 (%)	2018 (%)
≤ 100,000	28.0	32.6	21.2	22.0	23.5	25.5
100,001 – 200,000	46.2	42.6	30.3	31.8	35.6	35.4
200,001 – 300,000	11.4	12.9	24.2	22.0	19.9	18.9
300,001 – 400,000	5.3	5.3	8.0	8.7	7.1	7.6
> 400,000	9.1	6.8	16.3	15.5	13.9	12.6
Mean (N)	197871.21	185166.67	279742.42	265256.44	252452.02	238693.18

Source: Field Survey, 2018.

Cosmopoliteness of Respondents

Cosmopoliteness of respondents as presented on Table 3, shows that adopters had mean above the mean score of 1.5 for all the visits except for visit to agricultural institute/ universities ($\bar{x}$ = 1.30) and visit outside the country ($\bar{x}$ = 0.14). Visits to other town within the LGA was the highest for both adopters ($\bar{x}$ =2.35) and non-adopters ($\bar{x}$ = 2.30). On the other hand, only visits to other towns/communities, LGAs and States had mean above 1.5 for non-adopters. This result implies a variation in cosmopoliteness of the two categories. It equally exhibits that the adopters have more cosmopoliteness than non-adopters. This corroborates the findings of Milkias and Abdulahi (2018) that a difference existed in the cosmopoliteness of adopters (55.7%) and non-adopters (2.17%). Cosmopoliteness, which involves showing a breath of knowledge having traveled widely, could afford farmers interaction with other farmers thereby exposing them to first hand innovations. High cosmopoliteness can influence farmers' knowledge and increase chances of adoption of innovation owing to exposure to first-hand information and information exchange.

Table 3: Respondents' Distribution according to Cosmopoliteness

Exposure/ Travel	Frequency	Adopters n = 264		Mean	Non Adopters n = 132		Mean	All Respondents n = 396		Mean
		F	%	±SD	F	%	±SD	F	%	±SD
Others towns in the LGA	Never	0	0		0	0		0	0	
	Rarely	39	14.8	2.35*	17	12.9	2.30*	54	13.6	2.34*
	Often	94	35.6	±0.72	58	43.9	±0.69	152	38.4	0.71
	Very often	131	49.6		57	43.2		190	48.0	
Other LGAs	Never	6	2.3	1.92*	5	3.8	1.93*	11	2.8	1.92*
	Rarely	81	30.7	±0.81	35	26.5	±0.83	116	29.3	±0.82
	Often	105	39.8		56	42.4		161	40.7	
	Very often	72	27.3		36	27.3		108	27.3	
Other States	Never	21	8.0	1.56*	4	3.0	1.67*	25	6.3	1.60*
	Rarely	114	43.2	±0.84	62	47.0	±0.83	176	44.4	±0.84
	Often	90	34.1		39	29.5		129	32.6	
	Very often	39	14.8		27	20.5		66	16.7	
Other Countries	Never	234	88.6	0.14	125	94.7	0.06	376	94.9	0.05
	Rarely	24	9.1	±0.40	6	4.5	±0.27	19	4.8	±0.24
	Often	6	2.3		1	0.8		1	0.3	
	Very often	0	0		0	0		0	0	
Ministry of Agric	Never	34	12.9	1.65*	47	35.6	1.15	81	20.5	1.48
	Rarely	45	17.0	±0.95	32	24.2	±1.02	77	19.4	±1.00
	Often	71	26.9		39	29.5		101	25.5	
	Very often	114	43.2		14	10.6		137	34.6	
Research Institutes / Universities	Never	34	12.9	1.30	76	57.6	0.72	149	37.6	1.11
	Rarely	78	29.5	±1.03	29	22.0	±0.99	106	26.8	±1.05
	Often	97	36.7		15	11.4		91	23.0	
	Very often	55	20.8		12	9.1		50	12.6	
Agric Shows/ Field days	Never	50	18.9	1.51*	49	37.1	0.96	99	25.0	1.32
	Rarely	97	36.7	±1.07	56	42.4	±0.98	108	27.3	±1.07
	Often	50	18.9		10	7.6		59	14.9	
	Very often	67	25.4		17	12.9		130	32.8	

Source: Field Survey, 2018. Note: Mean score = 1.5, *High

Level of Respondents' Cosmopoliteness

Table 4 shows the findings on the level of respondents' cosmopoliteness using grand mean for classification into high and low. Respondents with mean lower or equal to the grand mean were classified into low while farmers with higher mean score above the grand mean score were classified into high. About half (51.0%) had low cosmopoliteness while almost half (49.0%) equally had high cosmopoliteness, though the non-adopters had more respondents in the high category. This implies the respondents' level of exposure as a result of wide travel or visit to exhibitions and other places to acquire knowledge was low. This has the implication of low technology adoption on farmers. Bandiera and Rasul (2006) opined that the probability of technology adoption is higher among farmers with high social networks especially discussing agriculture with others.

Table 4: Respondents' Distribution according to Level of Cosmopoliteness

Cosmopoliteness Level	Adopters n = 264			Non Adopters n = 132			All Respondents n = 396		
	F	%		F	%		F	%	
Low	139	52.7		61	46.2		202	51.0	
High	125	47.3		71	53.8		194	49.0	
Minimum	1			1			1		
Maximum	19			18			18		
Mean ±SD	10.42 ± 3.57			8.8± 3.10			9.84 ± 3.44		

Source: Field Survey, 2018

Frequency of Extension Access by the Respondents

The frequency of extension access by the farmers is shown on Table 5. Results show only 10.6% of the respondents did not have extension visits at all, while 89.4% had extension access at one time or the other. The result also reveals that adopters had higher score ($\bar{x}$ = 4.24) than the non-adopters ($\bar{x}$ = 3.68). This implies the adopter had more extension access than non-adopters. This has implications on adoption. Ayinde et al. (2017) confirms that adopters of the same technology had higher extension access.

Table 5: Distribution of Respondents based on Frequency of Extension Visit

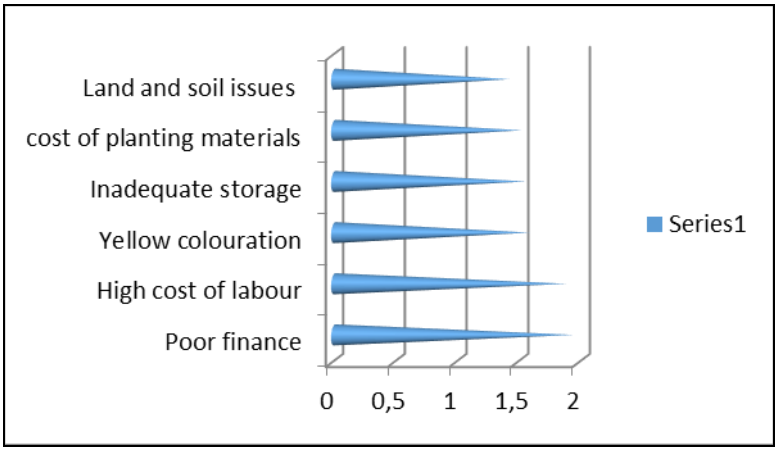
Frequency of visit	Adopters n = 264		Mean	Non Adopters n = 132		Mean	All Respondents n = 396		Mean
	F	%	±SD	F	%	±SD	f	%	±SD
None	16	6.1	4.24	26	19.7	3.68	42	10.6	4.06
Not specific	12	4.5	±1.48	3	2.3	±2.0	15	3.8	±1.69
Yearly	1	0.4		1	0.8		2	0.5	
Biannually	4	1.5		1	0.8		5	1.3	
Quarterly	86	32.6		33	25.0		119	30.1	
Monthly	121	45.8		61	46.2		182	46.0	
Fortnightly	24	9.1		7	5.3		31	7.8	
Total	264	100.0		132	100.0		396	100.0	

Source: Field Survey, 2018

Constraints Limiting the Adoption of Biofortified Cassava

Constraints limiting biofortified cassava adoption are presented in Figure 4. The major constraints were poor access to finance ($\bar{x}$ = 1.94), high cost of recruiting labourers ($\bar{x}$ = 1.88), yellow colouration and low starch content of biofortified cassava ($\bar{x}$ = 1.58), inadequate storage facilities leading to high perishability ($\bar{x}$ = 1.55), access to planting materials ($\bar{x}$ = 1.52) and land and soil related issues ($\bar{x}$ = 1.42). This indicates that farmers were faced with the challenge of not having enough finance for the production of biofortified cassava. The study, in tandem with that of Olaosebikan et al. (2019), recognized low access to loan, poor soil fertility, high weeding cost of cassava farm and high cost of paying for labourers as the major constraints affecting the adoption of biofortified cassava.

Figure 4: Constraints limiting adoption of biofortified cassava.



Source: Field Survey, 2018

Hypothesis Testing

H_{o1}: The hypothesis tested for a significant difference in the selected socio-economic characteristics of adopters and non-adopters of biofortified cassava. This was analysed using t-test. The results show that there existed a significant difference in some socio-economic features of the two categories as presented in Table 6. There was a significant difference in household size (t = -4.18, p= 0.00); farm size (t = 3.95, p = 0.00); age (t = -4.44, p = 0.00); cosmopoliteness (t = 4.32, p = 0.00) and income (t = 3.30, p= 0.00) of the two groups. On the other hand, there was no significant difference in the education status (t = 1.06, p = 0.29) and farming experience (t = 1.87, p = 0.06). The above values indicate that there was statistical evidence of differences in age, income, farm size, household size and cosmopoliteness of the respondents. There was a mean difference of 4.87 years in the ages

of adopters and non-adopters the average age for the adopters was 45.27 whereas that of non-adopters was 50.14 years, which indicates the non-adopters were older. This implies, farmers who are younger farmers are likely to adopt more than older farmers. The farmers who are younger are adventurous and so they are likely to try new technologies. The study also reveals a mean difference of 0.73 hectares in farm size with the adopters having a higher farm size (2.29 hectares), which indicates farmers with larger farm holdings allocated more land to the cultivation of biofortified cassava and equally took the risk of allocating more part of their farm to trying innovations. There was equally a statistical difference of N162160.99 in the mean income with adopters having a higher income of N545198.86 which implies that the higher the income of a farmer, the more the chances that he can afford to try out innovations because he or she may likely be able to afford the cost of the technology. A mean difference of 1.55 was equally revealed in the cosmopoliteness of respondents with adopters having a higher cosmopoliteness mean of 10.35. Higher cosmopoliteness which involves showing a breath of knowledge having traveled widely could afford farmers interacting with other farmers thereby exposing them to first hand innovations. However, there was no significant difference in the education and years of farming experience of adopters and non-adopters. This indicates that the fact that a person had higher educational status and more years of experience does not mean the person was an adopter. The variation in the average of education status for the adopters and non-adopters was not statistically significant to influence adoption. The apriori expectation was that those who adopt should be more educated than those who did not adopt, meaning, education should influence adoption. It is expected that education should give farmers capacity to comprehend and react to new information at a faster pace than their counterparts without education. But the result implies that education did not influence adoption. Similar empirical research studies on adoption of agricultural technologies by Milkias and Abdulahi (2018), reveals that farmers with larger farm and household size, higher cosmopoliteness, higher participation in field days and trainings, higher credit and extension, and lower age are more adopters of agricultural technologies.

Table 6: Socio-Economic Characteristics Difference of the Adopters and Non-Adopters

Variable	Adoption Status	N	Mean Values	Mean difference	t-value	Df	Sig
Age	Adopter	264	45.27	-4.87	-4.44	394	0.00*
	Non-adopter	132	50.14				
Years of experience	Adopter	264	20.38	1.15	1.06	394	0.29
	Non-adopter	132	19.23				
Farm size	Adopter	264	2.29	0.73	3.95	394	0.00*
	Non-adopter	132	1.57				
Income	Adopter	264	545198.86	162160.99	3.30	394	0.00*
	Non-adopter	132	383037.88				

Variable	Adoption Status	N	Mean Values	Mean difference	t-value	Df	Sig
Cosmopoliteness	Adopter	264	10.35	1.55	4.32	394	0.00*
	Non-adopter	132	8.80				
Education status	Adopter	264	9.67	1.02	1.87	394	0.06*
	Non-adopter	132	8.65				
Household size	Adopter	264	6.09	-1.04	-4.18	394	0.00*
	Non-adopter	132	7.14				

Source: Field Survey, 2018. Decision * Significant

Conclusions and Policy Implications

The study extensively analyzed the marked attributes of the adopters and non-adopters of biofortified cassava and made comparative analysis of the two groups. It was revealed in the study that farmers with larger farm and household size, higher cosmopoliteness, higher access to extension services, higher access to credit, higher education status, greater participation in field days and trainings and lesser age adopted the technology more than their counterparts. The study revealed a difference of 162160.99 Nigerian Naira in the income of the two categories and a higher farm size for adopters with a difference of 0.5ha. The findings proved that adoption of biofortified cassava allowed the farmers to enhance their income and production. This provides justification for farmers to the biofortified cassava technology. This study concluded that farmers' socio-cultural and economic characteristics affect the adoption of technologies. The significant differences that existed in the knowledge level, cosmopolitan, educational status, income and other attributes of the farmers, that is between adopters and non-adopters call for special attention when considering best approaches to be used for policy designs. Those attributes that favoured adoption should be explored.

Policy Recommendations

The policy implications of these findings are; younger farmers should be given favorable conditions to embrace the technology through access to extension services and capital; and given more secured land for cultivation in order to increase farm size.

There should be an increase in the creation of awareness by private and governmental organizations to sensitize the populace about nutritional contents and benefits derived from consuming biofortified cassava and its profitability. This will increase production of biofortified cassava and subsequent increase in the income of farmers and improve the health of the consumers. Furthermore, the government should encourage and engage farmers who have higher income, those who have larger farm size and greater cosmopolitan to grow more biofortified cassava so as to lead by example.

Policy makers and other stakeholders seeking technology adoption should create a forum for farmers where information can be posted and shared in order to enhance the flow of information flow and keep them abreast with global information so that farmers with low cosmopolitan who are not able to go outside of their communities with not be completely kept out of innovations and latest information.

The study therefore recommends a proper understanding and adequate knowledge of characteristics and attributes of farmers and possibly put measures in place to improve deficiencies before introducing new technologies to farmers so as to enhance meaning and impactful intervention. Also, younger farmers should be made the target when introducing innovations as they are seen to be more receptive to innovations.

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