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How Does Farmers' Characteristics Affect Their Willingness to Adopt Agricultural Innovation? The Case of Biofortified Cassava in Oyo State, Nigeria

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Abstract

Adoption of new technology, especially as it relates to agricultural production has been considered to play an important role in improving food security in developing countries which Nigeria is one. Crop farmers, especially those that cultivate cassava often record high productivity but with increase in deficiencies of essential nutrients such as zinc, vitamin A, Iron among others, causing malnutrition and consequently, poor health of individuals. This study examined perception and determinants of rural farmers' willingness to adopt biofortified 'yellow' cassava in Oyo State, Nigeria. Primary data employed in the study were obtained from 120 respondents which were selected using a multi-stage random sampling technique. Analysis of the socio-economic characteristics showed that the mean age of household heads in the area was 46.06±15.58 years while almost all the farmers had up to 17years of farming experience and above. With respect to the level awareness of biofortified cassava, almost all the respondents were aware of the biofortified cassava. Logit Regression Model result revealed that farmers' willingness to adopt biofortified cassava in the study area was influenced mainly by gender, source of inputs, marital status, access to extension officer and membership of farmer organization. However, the constraints faced by the respondents reported were: the risks in adoption, access to credit and access to market while the least severe constraints were size of farm, access to information, tradition and extension officer. The study recommends that existing programmes that disburse agricultural input should be increased in the rural areas since the study found source of input to affect the adoption of biofortified cassava. This could be done by including the biofortified cassava stem in the inputs disbursed through the e-wallet agricultural policy.

Key Words: Biofortified cassava; perception; willingness to adopt and logit model

Introduction

Cassava (*Manihot esculenta*) has been considered the most important food crop in sub-Saharan Africa (Akoroda and Teri, 2004). This is due to the fact that households take meals made from cassava daily throughout the year. During the rainy season this percentage goes up to 96% of the households. In the same vein, cassava has become a staple food for most Nigerians (not only among rural people but also among the urban dwellers) possibly because of the ease with which its major food product (Garri) can be prepared and used as a source of food (IITA, 2004).

Cassava has some inherent characteristics which make it attractive, especially to the small holder farmers in Nigeria. First, it is rich in carbohydrate especially starch and consequently has a multiplicity of end users (IITA, 2006). Secondly, it is available all the year round, making it preferable to other more seasonal crops such as grains, peas and beans and other crops of food security (Akoroda & Teri, 2004). As a cash comparison with other staples (FAO, 2005). Also, an estimated 70 million people obtain more than 500 calories per day from cassava. With its productivity on marginal soils; ability to withstand disease, drought, and pests; and flexible harvest dates. This is a remarkably adaptable and hearty crop, consumed in areas where drought, poverty, and malnutrition are prevalent (Oparinde *et al.*, 2012). However, frequent consumption of cassava by consumers pose greater risk in terms of malnutrition, especially deficiencies in vitamin A, iron, and zinc compared with consumers of other diets, particularly those that are cereal-based (Gegios *et al*., 2010).

Malnutrition is a devastating problem in Nigeria, not only to its people, but also to its security and economy. Although the numbers have decreased in recent years, 41 percent of children under the age of five are still stunted, 23 percent are still underweight, and 14 percent are still wasted (NPC, 2008), while 12 percent of mothers are clinically undernourished (Nweke *et al.*, 2004). In addition to a lack of basic protein and energy, the immediate causes of malnutrition are a lack of micronutrients such as vitamin A, iodine, and iron. Almost 63 percent of women are anemic and 31 percent are iodine deficient, while close to 30 percent of under-fives is vitamin A deficient (Rubino *et al.,* 2012). In addition, malnutrition is concentrated in the rural areas of Nigeria and primarily affects poor women and children. Improving the nutrition of these rural people, especially women and children, is therefore necessary because better-nourished citizens are more effective participants in the labor force (Kumar and Quisumbing, 2010). In other words, Nigerians must expand their fortification programs as well as focus on the roles of women in the nutritional outcomes of their children (Rubino *et al.,* 2012). This could be through biofortification of staple crops that these household consume.

Agricultural innovation that involves breeding staple foods that are dense in minerals and vitamins provides a low-cost, sustainable strategy for reducing levels of micronutrient malnutrition. Bio-fortification complements existing strategies and has its own unique "niche," as conditioned by its comparative advantages, most importantly the level of the "dose" that bio-fortification can be expected to deliver. Thus, permanent solution to micronutrient malnutrition in developing countries may be a substantial improvement in dietary quality-higher consumption of pulses, fruits, vegetables, fish, and animal products, which the poor already desire but cannot presently afford. However, although biofortified staple foods cannot deliver as high a level of minerals and vitamins as supplements or industrially fortified foods, they can help to bring millions over the threshold from malnourishment to micronutrient sufficiency. More so, the new yellow cassava varieties have high yields and are resistant to many pests and diseases. Like ordinary cassava, they do not need nutrient rich soils or extensive land preparation and does not suffer during drought (Consortium, 2012).

According to Rubino *et al.* (2012), bio-fortification is the use of traditional crop breeding practices or modern biotechnology to produce micronutrient dense staple crops to reduce micronutrient deficiencies. International research effort on bio-fortification has focused on three micronutrients in particular: iron, zinc and vitamin A with new and promising public health intervention for addressing vitamin A deficiency (Oparinde *et al*, 2012). Much attention is on regular daily intake of consistent and large amount of food staples consumed by all family members and, since staple foods are predominant in the diets of the poor, this strategy implicitly targets low-income households (Nestel *et al*., 2006). In view of this, plant breeders have been working to develop biofortified cassava which has been a major staple food in Nigeria in the past decade. In 2011, the national committee on naming, registration and release of crop varieties of Nigeria released officially three improved pro-vitamin A cassava varieties (Oparinde *et al.*, 2012). These varieties were bred using conventional breeding methods to contain higher concentrations of beta-carotene (pro-vitamin A), which account for the yellow colour of the varieties while white or cream cassava varieties contain either no carotenoids or levels of carotenoids that are too low to significantly contribute to human health (Oparinde *et al*, 2012).

Studies have shown that the new yellow cassava (bio-fortified cassava) can provide up to 25% of daily recommended vitamin A intake for consumers (Rubino *et al.*, 2012). Since cassava is a major part of many people's diets, introducing cassava biofortified with vitamin A is an excellent innovation to improve health on a large scale and also reaching the millennium development goal (4) to reduce the under-five (5) child mortality ratio by two-thirds and the maternal ratio by three-quarter between 1990 and 2015.

Against this background, this study seeks to assess the perception of farmers to bio-fortified cassava, examine the constraints to adoption and estimate the factors influencing the willingness to adopt this new technology in the study area. While different studies have been carried out on mineral nutrition of cassava, microbiological studies on cassava fermentation as well as bio-fortification of cassava, there exist gaps in knowledge about farmers' willingness to adopt biofortified cassava.

Methodology

Description of the Study Area

This study was conducted in Oyo State, Nigeria. The area is situated in the South western zone of the country and is characterized by tropical climate with two major seasons; dry and rainy seasons. Farming is the dominant occupation in the area and prominent crops grown include; cassava, cocoa, maize, yam, melon, mangos, cashew, palm-kernel etc. which are available in large quantities for local consumption and also for export.

Type and Source of Data

Data for the study was obtained from primary source using well-structured questionnaire. Data were collected on households' socio-economic characteristics, such as sex, age, marital status and other factors that can influence willingness to adopt.

Sampling Procedure

A multistage sampling technique was employed in selecting respondents for this study. The first stage was the selection of one Local Government Area (LGA) in Oyo State, because of high concentration of cassava farmers in this local government. The second stage involved the random selection of 5 wards out of a total of 10 wards in the local government area. In the third stage, 120 cassava farmers were selected based on probability proportionate to size of the wards in the local government area.

Analytical Techniques

The descriptive tools used include tables, the construction of simple frequency distribution and measures of central tendency, particularly, mean, percentage and frequencies to identify the socioeconomic characteristics of the farmers and to examine farmers' perception and attitude towards biofortified cassava.

Likert scale was used to examine the level of awareness of biofortified cassava among respondents and to examine farmers' perception and attitude towards biofortified cassava. This was used by asking some basic questions in which the answers were given in a likert scale form. For instance, awareness question which stated "are you aware of the biofortified yellow cassava"? The answer would be chosen from a range of responses such as aware; willing to adopt; not aware and not willing to adopt.

Logit Model

Using the logit model, the factors influencing farm households' decisions to adopt biofortified cassava were estimated.

The logistic function is given as;

$P(X) = e(\infty+\beta X)1+e(\infty+\beta X)$ .... (1)

$Q(X) = 1 - P(X) = 11+e(\infty+\beta X)$ .... (2)

Where P= probability (Y=1)

Q= Probability (Y=0)

P= P(X)

P= P(X, Q

Where P(X) is a probability that *Yi* = 1

Y is the dependent variable: Farmers' willingness to adopt biofortified cassava

X is a set of explanatory variables, □ and □ are absolute coefficient estimates from the logistic regression. The explanatory variables specified as determinants of adoption are defined as follows:

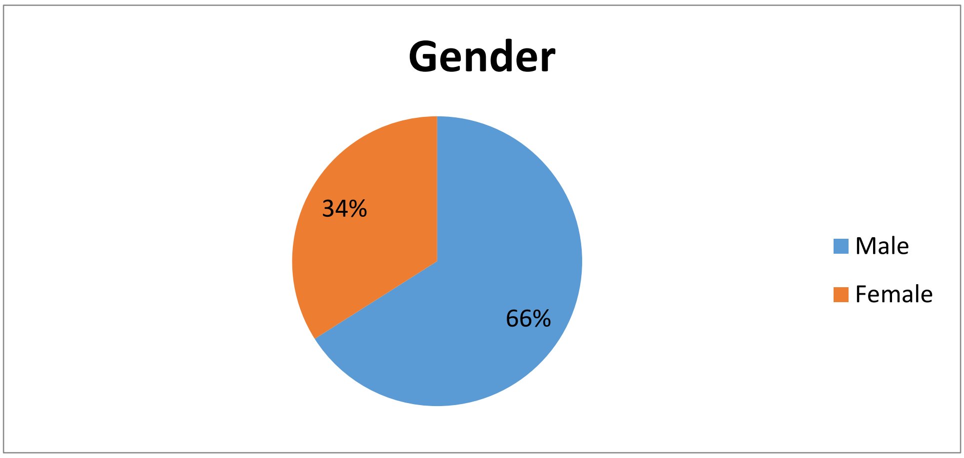
X_1 = Age (years); X_2 = Credit Access (Yes=1; 0, if Otherwise); X_3 = Access to Extension Agent (Yes=1; 0, if Otherwise); X_4 = Family Type (Monogamous= 1; 0, if Otherwise); X_5 = Membership of Organization (Yes=1; 0, if Otherwise); X_6 = Farm Size (Hectare); X_7 = Landownership (Yes=1; 0, if Otherwise); X_8= Divorced (Yes=1; 0, if Otherwise); X_9= Single (Yes=1; 0, if Otherwise); X_{10}= Widowed (Yes=1; 0, if Otherwise); X_{11}= Separated (Yes=1; 0, if Otherwise); X_{12}= Artisan (Yes=1; 0, if Otherwise); X_{13}= Civil Servant (Yes=1; 0, if Otherwise); X_{14}= Farming (Yes=1; 0, if Otherwise); X_{15} = Trading (Yes=1; 0, if Otherwise); X_{16} = Sex of Household head (Male = 1; O, if Otherwise); X_{17} = Source of Input (Yes=1; 0, if Otherwise)

X_{18} = Household Size (Number); and U= Error term

Results and Discussion

Socio-economic Characteristics of the Respondents

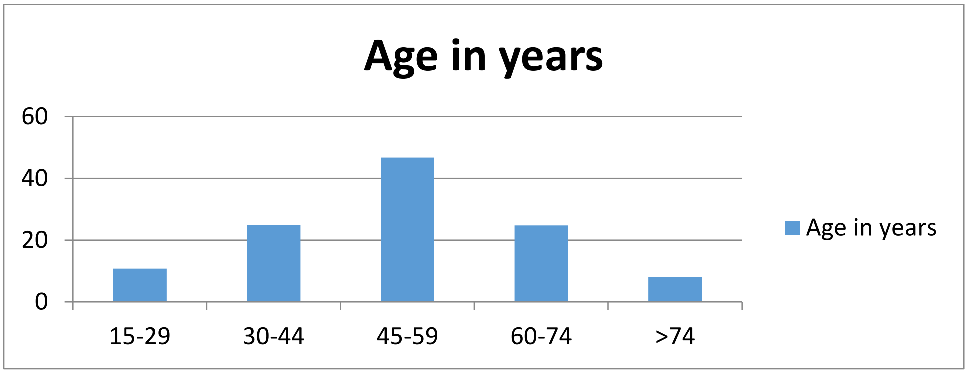
Figure 1. Gender of the household head



Source: Field survey, 2013

The result in Figure1 shows that majority of the household heads were males accounting for 66% while the remaining 34% were females. This is in line with the pattern of households in southwest, Nigeria where most households are headed by the male gender.

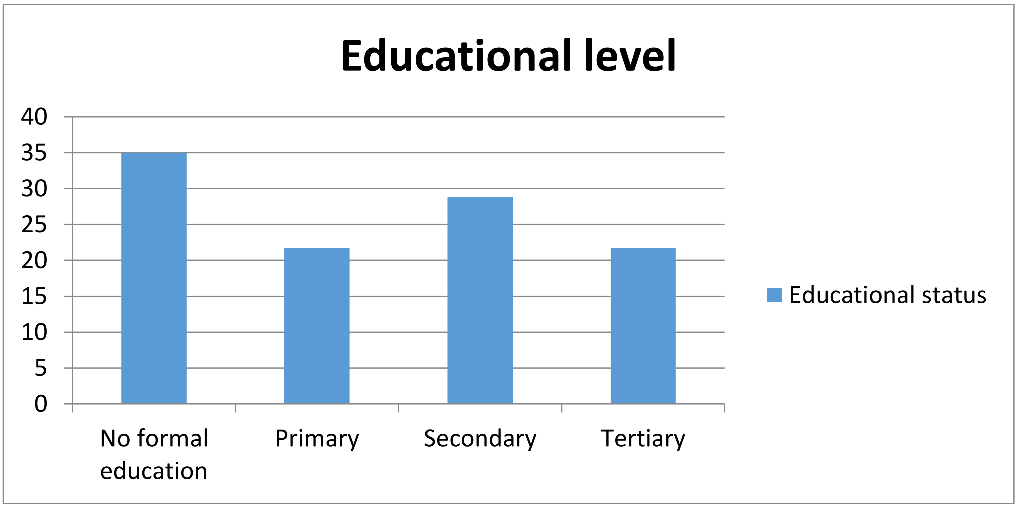
Figure 2: Age of the household head



Source: Field survey, 2013

Figure 2 shows that about 83% of the respondents were below 60 years of age with the mean age of all the interviewed farmers being 46years. This means that an average household head is within their economically active age.

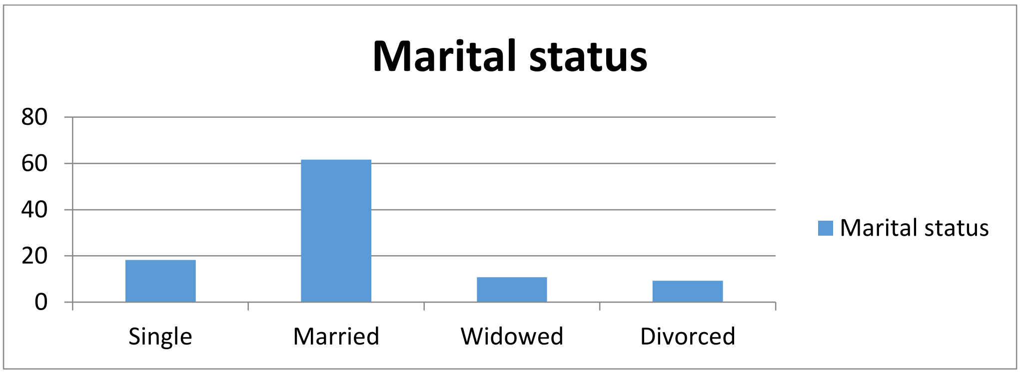
Figure 3. Educational level of the household head



Source: Field survey, 2013

The results from figure 3 show that less than half of the respondents representing 29% have no formal education, this is closely followed by primary level of education and tertiary level of education having 22%, and 21% respectively. This implies that the respondents have an appreciable level of education which is expected to influence their level of adoption of biofortified cassava.

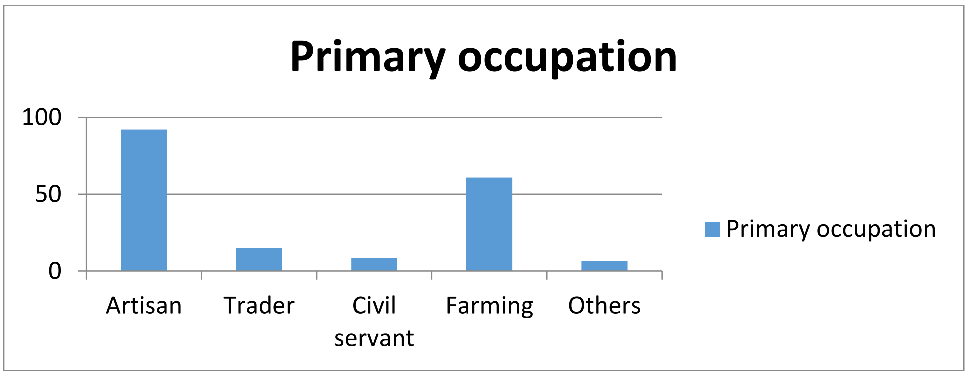
Figure 4: Marital status of the household head



Source: Field survey, 2013

The analysis from figure 4 shows that about 62% of the respondents were married. This could have implications on the household size and hence quantity of food and income of farmers. Further results, however, showed that only 18% of the respondents were single while others were divorced, widowed or separated.

Figure 5: Primary occupation of the household head



Source: Field survey, 2013

Table 5 revealed that the commonest types of occupation of the respondents were artisan, trader, civil servants, farming and other which could include working as employee in the private sector. This result reveals that majority of respondents are farmers and primarily depend on farming to earn a living. A high and expected 61% are engaged farming activities which further confirms that households in this study area are dependent on farming.

Table 1 showed that 60% of the respondents have more than 5 household members while households with less than 5 household members account for the remaining 40%. The average household size is 5 persons. Also the results from table 1 shows that about 61% of the respondents have farm size less than 5 hectares. However, the average farm size is 1.74 hectare and which implies that majority of the farmers fall within this range of farm size.

Farmers' Perception and Attitude towards Biofortified Cassava

Farmers' perception and attitude towards biofortified cassava presented in Table 2 which shows a high degree of variation. This has the potential to affect the eventual adoption of biofortified cassava. Also, adoption of biofortified cassava may not be in the current interest and needs of the farmers and could be responsible for their perception as at the time of this study. The farmers' perception and attitude towards biofortified cassava could therefore be an emphasis on the need for a supply-driven biofortified cassava rather than the biofortified cassava.

The Market Price of Yellow Cassava is Higher than White Cassava

Results from table 1 showed that about 90% of the respondents agree to the fact that market price of yellow cassava is higher than white cassava while only 10% of the household heads did not agree to the fact that the market price of yellow cassava is higher than white cassava.

The small size of my Farm will be a Constraint to the Adoption of Yellow Cassava

Table 1 further showed that about 91.7% agree to the fact that the small size of their farms will be a constraint to the adoption of yellow cassava while 8.3% of the household heads did not agree to the fact that the small size of my farm will be a constraint to the adoption of yellow cassava. Similarly, according to the result in table 1 about 86.7% of the respondents agreed to the fact that the source of yellow cassava is not genuine and 12.5% of the household heads did not agree that the source of yellow cassava is not genuine.

Results in table 1 also revealed that about 85.8% of the farmers agreed to the fact that the taste of yellow cassava is better than white cassava and 13.3% of the farmers did not agree to the taste of yellow cassava is better than white cassava. The table also showed that about 80% agreed to the fact that yellow cassava has a higher yield compared with white cassava and 20% of the farmers did not agree to the fact that yellow cassava has a higher yield compared with white cassava. 93.3% agreed to the fact that cassava has nutritional benefits compared with white cassava and 6.7% of the farmers did not agree to fact that cassava has nutritional benefits compared with white cassava.

Factors Influencing Farmers' Willingness to Adopt Biofortified Cassava

The results of the Logit regression model used to analyse the determinants of farmers' willingness to adopt biofortified cassava is presented in table 3. The pseudo R_2 indicates the variation in WTA explained by the independent variables. The overall model was significant at 1%. Z-test was used to test the null hypothesis that the association coefficients are zero. The result indicates that only five variables were significant in determining the willingness to adopt biofortified cassava by farmers in the study area. These variables include: Divorced, Sex, Access to extension agent, source of input and Membership of farmers' organization.

The coefficient of "Divorced" was negative and significant at 5% which indicates that household heads that are divorced were less likely to be willing to adopt biofortified cassava. This finding agrees with that of Asiabaka *et al.,* (1999) who found out that marital status of respondents has an influence on willingness to adopt biofortified cassava. Similarly, the coefficient of farmers' membership of association implies that farmers who were members of association were more likely willing to adopt biofortified cassava. Also, the coefficient of access to extension agents was statistically significant at 5% and had a positive sign which indicates that farmers with access to extension agents were more likely to be willing to adopt biofortified cassava. This does not agree with the findings of Mazvimavi and Twomlov, (2009) who found contact with extension agent to increase the adoption of biofortified cassava. This may be due to the fact that majority of the respondents perceived that small size and scale is not a major constraint and therefore, do not see the need for an extension agent.

On the other hand, the positive and significant coefficient of sex is an indication that male headed households were more willing to adopt biofortified cassava than their female counterparts. The coefficient of source of input was also statistically significant and has a positive sign. This implies that increase in source of input will increase the willingness to adopt biofortified cassava. There are other factors though not significant but with positive relationships in the table 3. They include landowner, family type, household size, marital separated, primary occupation and primary occupation trader. Though not statistically significant, the coefficient of these variables have positive sign implying that increase in any of these variables will increase the willingness to adopt biofortified cassava.

Constraints to Adoption of Biofortified Cassava

According to the results in table 4, the most severe constraint (1st based on ranking) faced by the respondents in the study Area is the risk and unforeseen circumstances involved in planting the biofortified cassava as the respondents are not certain about the risk involved in adopting the variety. As a result of the perishable nature of cassava which is due to its high moisture content with inadequate storage facilities, risk is likely to hinder them from investing their resources in the production.

The second most severe constraint is the fact that they have limited access or no access to credit. This is due to the high collateral demanded by micro finance banks and also cooperatives.

Certain market for their produce was also reported as a major constraint (third, based on rank of severity) by all the cassava farmers in the study area. Having cassava to be a perishable good, the market for such commodity is needed**.** Furthermore, it was noted that the respondents reported on high cost of adoption as a major constraint. This was the fourth constraint based on the severity. The cost of adopting biofortified cassava was seen to be expensive as the distance to the source of input supply is far and thus expensive. This could be owing to the fact that more than half of the respondents (65 percent) do not have contacts with a village extension officer to inform them of the source of input. Similarly, farmers reported long distance to market as one of the severe constraints they faced. This constraint was the fifth based on severity. The reason for this can be attributed to the fact that distance from the farm and farmers' home was long kilometres away from the Local market where 54.2 percent of the respondents sold their cassava produce. The size of farm and the level of production were also reported by the respondents taking the sixth rank based on severity. This may be due to the fact that most of the farmers do not have access to credit. Consequently, this affected their investment and ability to expand their production thus a small farm size.

Little or no access to labour supply was the seventh constraint based on severity, which means it was not a major constraint faced by the cassava farmers in the study area. This point to the fact that the farmers make use of their households mainly as labour, since about 60percent of respondents have at least five individuals in their households. The least severe constraint (12th) faced by the cassava farmers in as shown in the table was having the variety to be against their tradition. This could be as a result of the fact that majority of the farmers are in one way or the other educated as the level of non-educated farmers accounts for 29percent of the respondent.

Conclusion and Recommendations

Farmers' willingness to adopt biofortified cassava is very important as it contributes to achieving some of the Millennium Development Goals (MDGs) particularly, MDG one; to eradicating extreme poverty and hunger and MDG four;

reducing child mortality rates. It also contributes to nation building as it is in line with solving problems of malnutrition mostly amongst the poor; this is in line with the aim of biofortified cassava which helps to bring about nutritional balance in the foods consumed which would result in reduction in death rate, increase in productivity and living standards.

Biofortified cassava is a staple crop that has potentials for foreign exchange earnings and would be widely consumed by individuals due to its benefits. It can help eradicate the issue of malnutrition, in which in the study area specifically, most of the farmers are willing to adopt the biofortified cassava despite the risk and unforeseen circumstances, unguaranteed market for produce which could be as a result of its high nature of perishability. Also, most of the respondents had lands that they cultivated, but had problem of labour supply since they were mostly making use of hired labour with most of these youths now migrating to the urban areas for white collar jobs. Sizeable proportions of respondents had no access to extension services and are not members of any farmers' membership organization. Thus, farmers' willingness to adopt biofortified cassava could allow grass root involvement of youths and extension agents and in turn bring about relatively cheap labour for efficient production.

Therefore, farmers' willingness to adopt biofortified cassava may be promising if policies adopted in the study area ensure that bottlenecks such as unguaranteed market for produce, access to credit and cost of adoption are given critical attention.

Based on findings of this study, the study recommends that;

- Adoption of biofortified cassava has been perceived to involve much risk as the farmers are not aware of the circumstance that awaits them when such is adopted. Therefore, there is need for increased awareness or publicity on the benefits of biofortified cassava so as to change farmers' perception.
- Existing programmes that disburse agricultural input should be increased in the rural areas since the study found source of input to affect the adoption of biofortified cassava. This could be done by including the biofortified cassava stem in the inputs disbursed through the e-wallet agricultural policy.
- Farmers should be encouraged to form groups or organization that encourages social interaction which will propel dissemination of information about the benefits of biofortified cassava. The study revealed that those who were members of informal organizations, are likely to adopt biofortified cassava as compared to their counter-parts who do not belong to any organization.

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Table 1: Distribution of Respondents by Household Size and farm size

Household Size	**Frequency**	**Percentage**
0-5	65	54.2
6-10	49	40.8
≥10	6	5
Farm Size	**Frequency**	**Percentage**
0-4.5	80	66.6
5-9.5	31	25.8
10-14.5	6	5.0
≥15	3	2.5
Total	120	100.00

Source: Field Survey, 2013

Table 2 Farmers' Perception towards Biofortified Cassava

Variables	Strongly Disagree (%)	Agree (%)	Undecided (%)	Strongly Agree (%)	Disagree (%)
The market price of yellow cassava is higher than white cassava	12(10.0)	0(0)	0(0)	108(90)	0(0)
The small size of my farm will be a constraint to the adoption of yellow cassava	10(8.3)	0(0)	0(0)	110(91.7)	0(0)
The small size of my farm will be a constraint to the adoption of yellow cassava	15(12.5)	0(0)	1(0.8)	104(0)	0(0)
The source of yellow cassava is not genuine	15(12.5)	0(0)	1(0.8)	104(86.7)	0(0)
The taste of yellow cassava is better than white cassava	16(13.3)	0(0)	1(0.8)	103(85.8)	0(0)
Yellow cassava has a higher yield compared with white cassava	24(20)	0(0)	0(0)	96(80.0)	0(0)
Cassava has nutritional benefits compared with white cassava	8(6.7)	0(0)	0(0)	112(93.3)	0(0)
Frequency of contacting extension officer influence willingness to adopt biofortified cassava	8(6.7)	0(0)	0(0)	112(93.3)	0(0)
Yellow cassava performs well under different environmental conditions than white cassava	26(21.7)	0(0)	0(0)	94(78.3)	0(0)
Yellow cassava is resistant to disease and insects than white cassava thereby reducing risk and damage	30(25.0)	0(0)	0(0)	90(75.0)	0(0)
Yellow cassava matures earlier than white cassava	34(28.3)	0(0)	86(71.7)	0(0)	0(0)

Source: Field Survey, 2013

Table 3. Results of Logit Regression Analysis of Consumers' WTA Biofortified Cassava

Variables	Coefficient	Z	P>|z|
Credit	-0.5235	-0.84	0.399
Source of input	0.4138**	2.17	0.030
Age	-0.3981	-1.06	0.290
Extension officer	0.7931**	1.90	0.058
Farmer organization	1.1778*	1.84	0.066
Farm size	-0.2106	-0.93	0.352
Landowner	0.0714	0.12	0.908
Divorced	-3.5451**	-2.41	0.016
Widowed	-0.9617	-0.28	0.780
Single	0.2440	-1.16	0.246
Separated	0.3289	0.31	0.755
Artisan	-0.4926	-0.37	0.708
Civil servant	2.3520	1.48	0.138
Farming	1.6686	1.35	0.176
Trader	0.4377	0.37	0.709
Gender	0.6726***	2.60	0.009
Household size	0.1997	1.59	0.111
Constant	1.8458	0.81	0.421

Source: Field Survey, 2013

Number of Observations = 120

LR chi2(17) = 47.20

Prob > chi^2 = 0.0001

Log likelihood = -52.782053

Pseudo R^2 = 0.3090

Table 4: Constraints Faced by the Respondents Based on Severity

Constraints	**Weighted Score**	**%**	**Rank**
It is costly to adopt	66	9.8	4th
My farm is small, I produce on a small scale	59	8.7	6th
The distance to the market is far	65	9.6	5th
I have little or no access to information on the new variety	52	7.7	9th
I have little or no access to labour supply	53	7.8	7th
I belong to an organization that makes decisions for me	31	4.6	11th
It is difficult to adopt	52	7.7	8th
There are risk and unforeseen circumstances involved in planting this variety	88	13.0	1st
I don't have a certain market for my produce	71	10.5	3rd
I have limited access or no access to credit	80	11.8	2nd
It is against our tradition here	16	2.4	12th
I don't have contact with extension agaencies	44	6.5	10th
Total	677	100	

Author's Compilation, 2013