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Understanding Farm Level Agricultural Innovations Adoption: Lessons Learned From Adoption of Biofortified Cassava in South West Nigeria

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Abstract
Awareness forms the basis for which information on innovations can be linked to the target beneficiaries. This study was carried out to assess the awareness and knowledge levels of farmers on biofortified cassava technology. Sources of information; extension services available on the technology and influencing factors for adopters were also duly examined. A multi-stage sampling procedure was used to select 396 respondents for the study. The study reveals respondents' low awareness of the benefits and knowledge of the technology. It further shows that special projects such as CAVA were feasible in information dissemination and the provision of planting materials. Adopters of the technology had more extension access and this reinforces the importance of extension activities in the adoption process. Awareness (relative advantage), cultivation on a small scale (divisibility), ease of cultivation (non-complexity) and ability to shade off weeds (adaptivity) ranked very high among the influencing factors of the technology and thus are to be given high priority in designing similar technologies in the nearest future.

Keywords: Awareness, knowledge, adoption, information, extension service and biofortified cassava

Introduction

The bites of the war in Ukraine, the scourge of the COVID-19 pandemic and other global challenges have heightened the fragilities in the food systems of many countries of the world thereby increasing the number of people who are not able to afford a healthy diet from 112 million to 3.1 billion (FAO, IFAD, WFP and WHO (2022). Hunger remains an everyday challenge for almost all countries of the world. In Nigeria, about 2 million children are suffering from severe acute malnutrition and seven per cent of women of childbearing age suffer the same, thus making malnutrition a direct or underlying cause of forty-five per cent of all deaths of children who are under the age of five (UNICEF, 2023). These high rates of malnutrition pose a great threat to healthy living and development challenges for the country. Looking forward to addressing world hunger, each country could leverage the production of crops especially staples where it has a comparative advantage. One such crop in Nigeria is cassava. Nigeria is the largest producer of cassava globally with about 58 million tons of production annually (Adetarami *et al*., 2022). Cassava (Manihot spp) is a dicotyledonous plant that belongs to the family Euphobiaceae with its origin traced to Central America. It was introduced to West Africa in the 16th and 17th centuries by Portuguese explorers and also in Nigeria at about the same time (WAAPP-Nigeria, 2013). Cassava is particularly important among the staple foods in Nigeria because of its adaptability to diverse agro-ecological environments, it is drought resistant and its production requires less labour per unit of output than other major staple crops. It can practically survive in relatively poor soil and low rainfall areas and still give reasonable yields. These attributes have attracted scientists to further improve and strengthen its capability as a food security crop.

The sustained interest in cassava research birthed cassava biofortification with an emphasis on addressing malnutrition. Biofortification is a technology that provides a feasible means of reaching malnourished people, especially in agrarian areas, through the delivery of naturally-fortified foods to people with limited access to commercially-marketed fortified foods that are more readily available in urban areas (Bouis, 2003).

Vitamin A cassava varieties have been well cultivated with the growing trend in its adoption in Nigeria since its introduction in 2011 following the pattern through which it was introduced in the country. Ten Local Government Areas were selected as the entry points within four pilot States (Oyo, Imo, Akwa Ibom and

Benue) for its dissemination to farmers using extension services and other forms of crop promotion. Adoption studies show that the crop is more adopted in the southern states reflecting the density of its consumption which also translates to the pattern of the crop's cultivation due to the types of soil in Nigeria. There is also evidence that Oyo State had the highest rate of adoption of the crop in Nigeria (Ayinde *et al*., 2017). Innovation and technology according to Rogers (2003), and Van den Ben and Hawkins (1999) are taken to be the same. Ekong (2010), defines adoption as a decision to continue the full use of innovation while the adoption process is a decision-making process. The Food and Agricultural Organization (2013), observed that in many developing countries, wide adoption of research results by farmers is quite limited. This is partly because, many of the farmers in developing countries live in rural areas where they have inadequate sources of information (Okwuonu *et al*., 2021). To enhance the uptake and adoption of technologies, the availability of relevant information is very key. Information on innovations can be linked to farmers or the target beneficiaries through awareness. Awareness can facilitate; communication, problem identification and problem-solving and also enhance personal interactions within a formal or informal setting. According to Bonabana-Wabbi (2002), the first step towards determining the impact of a given technology on a group of farmers is to obtain some knowledge about the rate of diffusion or adoption of the technology and the factors that influence that. Also, farmers' lack of awareness was identified as a major reason for not adopting farm-level technology in East Africa (Doss, 2003).

The role of extension service is also crucial in the adoption of agricultural innovation. According to Van Den Ban and Hawkins (1999), the goal of the extension is to ensure that increased agricultural productivity is achieved by stimulating farmers to use modern and scientific production technologies developed through research. Ukaejiofo and Gao (2013), in a study to ascertain the effect of extension training on the adoption of improved farm practices by farmers in Adana, Southern Turkey confirms that the adoption of improved technologies is influenced by the activities of extension programmes. The study was thus carried out to provide information on the level of awareness of farmers on the benefits, knowledge level on the technology, sources of information available to farmers about the technology, the extension activities provided and the factors affecting the adoption of the technology. The findings from this research are to contribute to the design and implementation of informed clientele knowledge in uptake and upscale technologies such as food biofortification in Nigeria.

Methodology

The study was carried out in South West, Nigeria which consists of Ekiti, Lagos, Ogun, Ondo and Oyo. The area lies between longitude $2^{0}31^{1}$ and $6^{0}00^{1}$ and latitude $6^{0}21^{1}$ and $8^{0}37^{1}$N and has a land area of about 77,818km^{2}. A multi-stage sampling procedure was used for the respondents' selection. Ogun, Oyo and Lagos were the three states purposively selected in South West for the study because of the volume of cassava produced in the states. The sampling frame used in the study was based on the agrarian zoning system of the Agricultural Development Project (ADP) which applies to all the states in the country. Proportional sampling was used in the second stage to select half of the zones in each state. The selected halves were the ADP zones where the technology was first disseminated in each state. Namely, they are; the Ibadan/Ibarapa and Oyo zones in Oyo State, Abeokuta and Ijebu-Ode zones in Ogun States; and Eastern (Imota) and Far Eastern (Epe) zones in Lagos State: At the next stage, there was a random selection of half of the blocks in each zone. The breakdown of blocks selected is as follows: 4 ½ blocks from the Ibadan/Ibarapa zone, 3 blocks from the Oyo zone, 3 blocks from the Abeokuta zone, 3 blocks from the Ijebu-ode zone, 2 blocks from the Imota zone and 3 blocks from the Epe zone to make the total of 18 ½ blocks. This was followed by an independent simple random selection of 25% of the cells in each block to make a total of 33 cells. In the final stage, 12 cassava farmers were selected from each cell. This resulted in a total number of 396 respondents being selected for the study.

Measurement of Variables

Awareness level of benefits of biofortified cassava

Respondents' were asked awareness questions on the benefits of the technology such: as the presence of vitamin A for improved eyesight and reduction in weight. A three-point Likert-type scale was used and labelled as Much Aware- 2, Just Aware – 1 and Never Aware- 0.

Farmers' Knowledge Level of Special Characteristics of Biofortified Cassava

The knowledge level of farmers on special characteristics of biofortified cassava was examined using questions such as Fermentation reduces the Vitamin A content, Vitamin content of cassava can be lost through exposure to light. Has knowledge was labelled as Yes and scored as 1, while No knowledge was labelled as No and scored as 0.

The first source of biofortified cassava planting material for the adopters

Respondents who were adopters were asked about their first source of biofortified cassava planting material

Sources of Information Available to Farmers on Biofortified Cassava: Identified sources and the frequency at which respondents received information were measured on a four-point Likert type scale of Always -3, Sometimes – 2, Rarely – 1 and Never = 0 and presented using the mean score.

Extension Activities on Biofortified Cassava

Extension activities available and accessible to the farmers were equally determined using a four-point Likert-type scale of Always -3, Sometimes – 2, Rarely – 1 and Never = 0. This was later categorized into low and

high levels using the pooled mean.

Frequency of extension access by the respondents: was determined as follows: None; Not specific; Yearly; Biannual; Quarterly; Monthly; Fortnightly

Extension activities available and accessible to the farmers

his was determined using a Four-point Likert type scale of Always -3, Sometimes – 2, Rarely – 1 and Never = 0. This was later categorized into low and high levels using the pooled mean

Level of Adoption of Biofortified Cassava Cultural Practices

This examined the adoption of various cultural practices associated with the cultivation of biofortified cassava. For instance, the planting distance, method of stem cutting and, the planting period. It was assessed on a four-point Likert-type scale of Always -3, Sometimes – 2, Rarely – 1 and Never = 0. This was categorized into low and high levels using the pooled mean.

Influencing Factors for Adopters

Identified factors known to affect adoption such as ease of cultivation and access to planting materials were linked with the adoption of biofortified cassava and were administered only to the adopters. The level of influence on adoption was determined on a four-point Likert type scale of High – 3, Moderate – 2, Low – 1 and Never – 0. This was later analysed using factor analysis, a procedure to sort deserving variables to be included in further statistical tests (Adekoya, 2014)

Results and Discussion

Awareness of the Benefits of Biofortified Cassava

Table 1, shows the result of the awareness level of the benefits of biofortified cassava. All the adopters had high knowledge of the benefits of the technology, while only the awareness that biofortified cassava contains vitamin A was high for non-adopters. From the result, 31.1% of the non-adopters could not even link the benefit of the high content of vitamin A to improved eyesight. Only awareness of the content of Vitamin A and improved eyesight on the benefits of the technology had a mean above one for adopters and non-adopters. This result indicates low awareness of the benefits of the technology. Ayodele, Fasina and Osundahunsi (2020), revealed in a study on determinants of adoption of cassava using a binary logistic regression model that awareness of benefits was among the strong determinants of the technology.

Awareness Level of the Benefits of Biofortified Cassava

The result of the level of awareness using the grand mean for classification into high and low is shown in Table 2. Respondents with a mean lower than the grand mean were classified as low while those that fell into the grand mean and above were classified as high awareness. The adopters had grand $\overline{x}$ = 8.79 while the non-adopters had grand ($\overline{x}$ =2.14). This indicates a wide difference. Also, the result showed that 50.8% of all respondents had low awareness of the benefits of the technology. The low level of awareness is likely to hinder the adoption of the technology. Etuk and Umoh (2014), opined that awareness was found to influence the adoption of technology in a study carried out on the adoption pattern of pro-vitamin A technology among farmers in Akwa Ibom State, Nigeria. During the FGD conducted in Isanya-Ogbo of Ijebu-Ode Zone of Ogun State, a discussant stated that: "*I am not even aware that there is a cassava variety called vitamin A cassava not to talk of the benefits. I am just hearing about biofortified cassava from your mouth".*

Farmers' Knowledge about Special Characteristics of Biofortified Cassava

The knowledge of farmers about some special characteristics of biofortified cassava is shown in Table 3. More than 90% of the adopters knew all the selected special characteristics. It could be because of their experience with the cultivation and utilisation of biofortified cassava. On the other hand, there was none of the special characteristics where up to half (50%) of the non-adopters had the knowledge. This indicates knowledge about special characteristics of biofortified cassava was higher with adopters of the technology. However, the knowledge that the crop lignifies (becomes woody and relatively rigid) had the highest ($\overline{x}$ =0.81), while the knowledge that exposure to the sun reduces Vitamin A content had the least ($\overline{x}$ = 0.75). It is, therefore logical to say that knowledge of the characteristics of biofortified cassava influenced its adoption. This corroborates the findings of Kolapo and Kolapo, (2021) and Kaup (2008), which stated that knowledge about a particular innovation is fundamental to the decision-making process and its ultimate adoption. Also, Ayinde *et al*, 2017and Foster and Rosenzweig (1995) found that farmers may not initially adopt new technology because of imperfect knowledge about the technology; however, adoption eventually occurs due to their own experience and neighbours' experience. The in-depth Interview conducted during the farmers' field day at the ADP Zonal office in the Ibadan/Ibarapa Zone of Oyo State testified to this:

"*One of the major problems with this vitamin A cassava is that it turns to wood quickly in the soil once it reaches maturity. Even if you're not ready for harvest, you must harvest it immediately otherwise, what you will get when you process it will be very small".*

Source of Improved Vitamin A Cassava Stem Cutting

The first source of biofortified cassava stem cutting for the adopters is shown in Figure 1. The values show that all the identified sources were relevant in making the stem available to the farmers. However, 26.1% got from fellow farmers, 25.0% from Projects such as HarvestPlus, West African Agricultural Productivity Program (WAAP) and Cassava Adding Value for Africa (CAVA). The results show that fellow farmers are very important in technology diffusion. Also, The Cassava Adding Value for Africa (CAVA) Project has been

reported to play a major role in the improvement of livelihoods and incomes of smallholders in some African countries such as Nigeria, Ghana and Uganda (Westby *et al.,* 2011). In addition, 24.2% got from ADP which showed that ADP was very effective in the dissemination of the biofortified technology. The membership organisations equally played an appreciable role with 14.0% of the respondents having accessed the stem through them. Agro-dealers/sales agents were not left behind with 8.7% of the respondents having accessed the stem through them for the first time. This equally indicates that some farmers paid for cassava cuttings. Also, 1.9% of the respondents got theirs from research institutes. These set of people are probably the innovators who run after technology, and that explains the small proportion. But, remarkably, that some people were able to get the stem cuttings directly from research institutes. That indicates that people are aware of and do visit research institutes.

Sources and Frequency of Information Available to Farmers on Biofortified Cassava

The sources and frequency of information of the respondents are presented in Figure 2 using the mean scores. For both adopters and non-adopters, Four (4) out of the ten (10) sources of information identified had a mean above the mean score of 1.5 and these are: fellow farmers/friends ($\bar{x}$ =2.30), MANR/ADP ($\bar{x}$ =1.95), membership organisation ($\bar{x}$ =1.62) and radio ($\bar{x}$ =1.50). The study further shows that information on biofortified cassava did not spread much through mass media which can be used to reach a larger population, instead, the technology used more individual contacts such as ADP extension agents, projects such as HarvestPlus, WAAP and CAVA and membership organisations. This could explain why the diffusion of the technology was slow. This corroborates the findings of Umunakwe *et al.* (2015) that farmers mostly obtain information from farmers' groups, friends/relatives and radio. Internet ($\bar{x}$ =0.16) was the least mean score for both categories. However, some respondents accessed information on biofortified cassava through television. This should be encouraged as it is an audio-visual means of communication. Various stakeholders such as Nollywood actors and actresses can equally be incorporated. A respondent in Ikorodu zone has this to say during an in-depth interview:

"*I first heard and watch a film about Vitamin A through the television as a movie acted by Nigerian Nollywood. This aroused my interest and the following day I went to the ADP extension office in my zone to ask how I could get the stem and thereafter got other relevant information on it'.*

Frequency of Extension Access by the Respondents

The frequency of extension access by the respondents is shown in Table 4. The results show that 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 a higher mean score (4.24) than non-adopters (3.68). This implies the adopter had more access to extension agents than the non-adopters. This has implications on adoption. Ayinde *et al.* (2017) confirm that adopters of the same technology had higher extension access. The success of the adoption process depends very much on the activities of extension agents.

Extension Activities accessed by the Adopters on Biofortified Cassava

Results in Table 5 show the extension activities accessed by the adopters in descending order. Good extension service is essential for any technology to be adopted. The result shows that all the extension activities were highly accessed by the adopters with facilitating access to planting materials ranking first having a mean of 2.49. Training on cultivation practices and providing necessary information on biofortified cassava rank second and third with mean scores of 2.43 and 2.34 respectively. This result implies that adopters had high access to extension activities on biofortified cassava and that extension agents were very effective in the study area concerning the technology. Dissemination of information related to technology is important for its adoption. In general, farmers have conservative attitudes and more time and information are needed to be persuaded to adopt new technology. Etuk and Umoh (2014) affirmed that training on the cultivation and processing of biofortified cassava was not a constraint to its adoption in Abia State, Nigeria. The leader of the farmers in Isanya-Ogbo in Ijebu Ode during an FGD in the area stated that:

"*Oga Agric. (The Extension officer in charge of the area) brought the cassava sticks to us for the first time in a pack. He called it a starter pack. He taught us how to plant and nurture the plant. He organised training on how to process it some months after. He told us we must not expose the harvested tuber to too much sun after harvesting as it can lose some of the vitamins.*

Level of Extension Activities accessed by the Adopters on Biofortified Cassava

The extension activities accessed by the adopters were grouped into high and low using the pooled mean. Those that were between the minimum (0) and the mean (22.68) were categorized as low while those above the mean were categorized as high. Table 6 confirms high extension activities accessed by the respondents with 58.3% in the high category. This indicates that extension services were available for the adopters of the technology.

Adoption of Biofortified Cassava Cultural Practices

Table 7 shows the results of the adoption of cultural practices in the cultivation of Vitamin A cassava in the study area in ascending order. With a mean score of 1.5, all the identified cultural practices associated with biofortified cassava had high adoption. Cultivation of different varieties ranked first with a mean of 2.25 ±0.39 showing a spread of 1.86 – 3.64. This indicates that none of the adopter respondents was below the mean which shows a good compliance with that practice. Fertilizer application with a mean value of 1.93 ± 1.22 ranked the

least cultural practice adopted. The spread of 0.71 – 3.15 shows some respondents were below the mean. This indicates that some respondents were not well disposed to the use of fertilizer in the study area.

Level of Adoption of Biofortified Cassava Cultural Practices

Table 8 shows the level of adoption of biofortified cultural practices by the adopters. Using the pooled mean to categorize into high and low categories, 64.4% of the adopter respondents had high adoption. This reveals high compliance with cultural practices associated with the technology. A discussant at the FGD conducted at Odeda, Abeokuta zone in Ogun State said this: "*Since it is a new technology our ADP officer introduced to us, it is whatever, he asks us to do that we did. He even told us that if we want to get good yield we must plant it differently from the old cassava cultivars. For instance, he told us we must make good heaps and plant horizontally instead of vertical planting that we were used to".*

Factors Influencing Adoption by the Respondents of Biofortified Cassava

Factors that are known to always influence the adoption of technology were identified, analysed and presented using the mean score in Table 9. The factors that influenced the respondents' adoption of biofortified cassava using the mean score were presented in descending order. The first five were awareness of the health/nutritional benefits ($\bar{x}$ = 2.36), the crop can be planted on a small scale ($\bar{x}$ = 2.28), persuasion from extension agents ($\bar{x}$ = 2.27), ability to shade off weeds ($\bar{x}$ = 2.24) and ease of cultivation ($\bar{x}$ = 2.20). This implies that awareness (relative advantage), cultivation on a small scale (divisibility), ease of cultivation (non-complexity) and ability to shade off weeds (adaptivity) are very important factors to be considered in the adoption of the technology and similar technologies. The activities of the extension agents which were linked with creating awareness went a long way in making the respondents adopt the technology. The last set of factors which were also below the mean of 1.5 was pest/disease resistance ($\bar{x}$ = 1.45), ease of processing ($\bar{x}$ = 1.47), cultural compatibility ($\bar{x}$ = 1.45), government support/policy ($\bar{x}$ = 1.45), ease of processing ($\bar{x}$= 1.47), cultural compatibility ($\bar{x}$ = 1.45), government support/policy ($\bar{x}$ = 1.41), the plant can do well on unfertile soil ($\bar{x}$ = 1.24), access to credit facilities ($\bar{x}$ = 0.94) and no alternative crop in the community ($\bar{x}$ = 0.75). The stakeholders can work on the factors with low mean values to increase the adoption of the technology or step up on dissemination of information on the benefits of the technology as shown in the study. Hammering on these factors can sustain adoption and get others to adopt. Increasing awareness and much effort by extension agents can shore up adoption. The findings from this research are in line with Adekoya and Tologbonse (2008) that identified characteristics of innovation that affect its adoption as relative advantage, compatibility, divisibility, observability, and complexity.

Conclusion

The study shows generally low awareness of the biofortified cassava technology among the respondents and confirms a wide margin in the awareness and knowledge levels of the technology by the adopters and non-adopters. Moreover, special knowledge about innovation which is fundamental to the decision-making process and the ultimate adoption is low in the study area. Special projects such as Harvest Plus, CAVA and WAAP play a crucial role in the improvement of the livelihoods of smallholder farmers as they were active in making the planting materials available to the farmers. Though very few, some farmers visited research institutes for planting materials and information on the technology, which shows that farmers were gaining consciousness of the importance of research organisations. Information on biofortified cassava did not spread much through mass media which can be used to reach a larger population, instead, the technology used more individual contacts and that explained the low spread of the technology. Though the adopters had more access to extension agents than the non-adopters, all the extension activities were highly accessed by the adopters with facilitating access to planting materials ranking first and all the cultural practices associated with the technology had high compliance. The major influencing factors for the adopters were: awareness of benefits (relative advantage), availability of planting materials, cultivation on a small scale (divisibility), ease of cultivation (non-complexity) and ability to shade off weeds (adaptivity). Findings from the study, therefore, call for the attention of the planners of technological intervention and policymakers on the provision of extension services and the creation of adequate awareness and enlightenment on knowledge on special characteristics of technology while duly paying attention to attributes of technology such as availability; relative advantage; divisibility, adaptability and non-complexity in future technology designs.

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Table 1: Respondents' Distribution according to Awareness of the Benefits of Biofortified Cassava

Benefits	Level of Awareness	Adopters			Non-Adopters			All Respondents		
		n = 264		Mean	n = 132		Mean	n = 396		Mean
		F	%	±SD	F	%	±SD	F	%	±SD
It contains Vitamin A	Much aware	206	78.0	1.78*	9	6.8	1.02*	215	54.3	1.52*
	Just aware	58	22.0	±0.42	116	87.9	±0.35	174	43.9	±0.53
	Never aware	0	0.0		7	5.3		7	1.8	
Improves good eyesight	Much aware	188	71.2	1.71*	25	18.9	0.88	213	53.8	1.43*
	Just aware	75	28.4	±0.46	66	50.0	±0.70	141	35.6	±0.68
	Never aware	1	0.4		41	31.1		42	10.6	
Reduces constipation	Much aware	128	48.5	1.33*	0	0.0	0.08	128	32.3	0.91
	Just aware	95	36.0	±0.73	10	7.6	±0.27	105	26.5	±0.85
	Never aware	41	15.5		122	92.4		163	41.2	
Strong immune system	Much aware	140	53.1	1.41*	1	0.8	0.05	141	35.6	0.96
	Just aware	92	34.8	±0.70	5	3.8	±0.26	97	24.5	±0.87
	Never aware	32	12.1		126	95.4		158	39.9	
Prevention of diarrhoea	Much aware	142	53.8	1.31*	1	0.8	0.05	143	36.1	0.89
	Just aware	62	23.5	±0.82	5	3.8	±0.26	67	16.9	±0.91
	Never aware	60	22.7		126	95.4		186	47.0	
Lightweight in the body	Much aware	130	49.2	1.26*	1	0.8	0.06	131	33.1	0.86
	Just aware	72	27.3	±0.81	6	4.5	±0.27	78	19.7	±0.89
	Never aware	62	23.5		125	94.7		187	47.2	

Source: Field survey, 2019. Mean value = 1. * represents high awareness

Table 2: Distribution of Respondents based on Level of Awareness of the Benefits

Awareness Level	Adopters n = 264		Non-Adopters n = 132		All Respondents n = 396	
	F	%	f	%	F	%
Low	120	45.5	93	70.5	201	50.8
High	144	54.5	39	29.5	195	49.2
Minimum	2		0			
Maximum	12		11			
Pooled Mean ±SD	8.79 ± 3.20		2.14 ± 1.24		6.58 ± 4.15	

Source: Field Survey, 2019

Table 3: Distribution of Respondents according to Knowledge Level about Special Characteristics of Biofortified Cassava

Knowledge	Yes/No	Adopters n = 264		Mean ±SD	Non-Adopters n = 132		Mean ±SD	All Respondents n = 396		Mean ±SD
		F	%		F	%		F	%	
Fermentation reduces the Vitamin A content	Yes	255	3.4	0.97	61	46.2	0.46	316	79.8	0.80
	No	9	96.9	±0.18	71	53.8	±0.50	80	20.2	±0.40
Vitamin A content can be washed away in the water	Yes	254	96.2	0.96	56	42.4	0.42	310	78.3	0.78
	No	10	3.8	±0.19	76	57.4	±0.49	86	21.7	±0.41
The crop lignifies itself	Yes	263	99.6	0.99	57	43.2	0.43	320	80.8	0.81
	No	1	0.4	±0.06	75	56.8	±0.49	76	19.2	±0.40
The plant can shade off weeds	Yes	262	99.2	0.99	54	40.9	0.41	316	79.8	0.80
	No	2	0.8	±0.09	78	59.1	±0.49	80	20.2	±0.40
Exposure to the sun reduces Vitamin A content	Yes	247	93.6	0.94	51	38.6	0.37	298	75.3	0.75
	No	17	6.4	±0.25	81	61.4	±0.49	98	24.7	±0.43
It is sweet, so it attracts pests	Yes	261	98.9	0.98	53	40.2	0.40	314	79.3	0.79
	No	3	1.1	±0.11	79	59.8	±0.49	82	20.7	±0.41
Plant stem within one week of harvest for germination	Yes	257	97.3	0.97	53	40.2	0.42	310	78.3	0.78
	No	7	2.7	±0.16	79	59.8	±0.49	86	21.7	±0.41

Source: Field survey, 2019

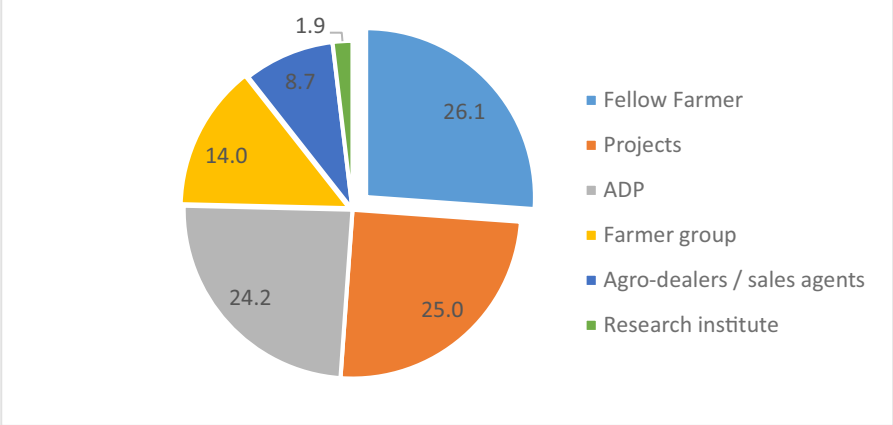

Figure 1: Respondents' Distribution based on Source of Vitamin A Cassava Planting Stem Source: Field Survey, 2019

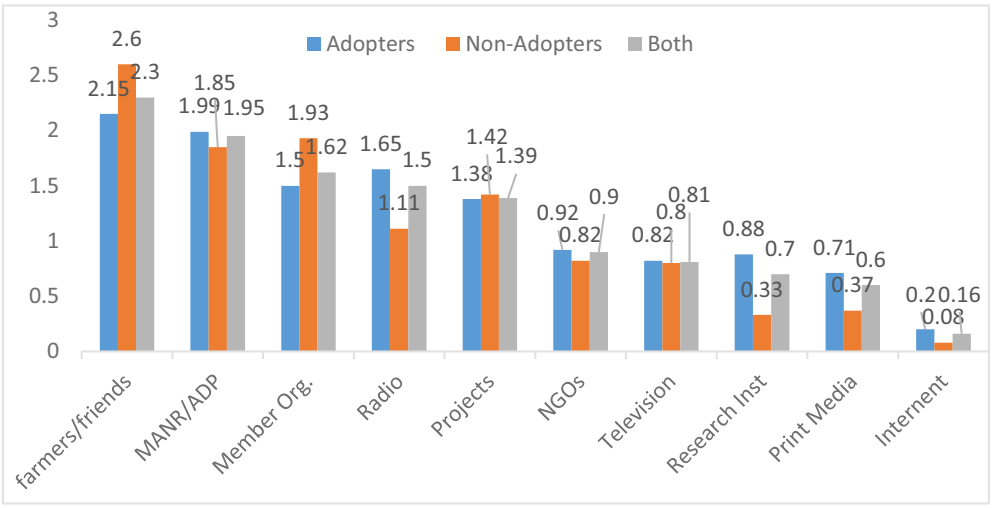

Figure 2: Distribution of Respondents According to Sources of Information about Biofortified Cassava. (Multiple responses). ***Mean score 1.5. Source: Field survey, 2019***

Table 4: Distribution of Respondents based on Frequency of Extension Access

Socio-economic characteristics	Adopters n = 264		Mean ±SD	Non-Adopters n = 132		Mean ±SD	All Respondents n = 396		Mean ±SD
	F	%		F	%		F	%	
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, 2019

Table 5: Distribution of Respondents based on Extension Activities Accessed by the Adopters of Biofortified Cassava

Activities Accessed	Never		Rarely		Sometimes		Always		Mean	SD±
	F	%	F	%	F	%	F	%		
Facilitating access to planting materials	19	7.2	8	3.0	62	23.5	175	66.3	2.49*	0.86
Training on improved cultivation practices	18	6.8	27	10.2	42	15.9	177	67.0	2.43*	0.93
Facilitating access to necessary information	24	9.1	35	13.3	53	20.1	152	57.6	2.34*	1.58
Sensitizing on nutritional benefits	21	8.0	19	7.2	84	31.8	140	53.0	2.30*	0.91
Facilitating access to inputs	29	11.0	19	7.2	66	25.0	150	56.8	2.28*	1.00
Training on value addition	22	8.3	32	12.1	61	23.1	149	56.4	2.28*	0.97
Training on better storage techniques	20	7.6	36	13.6	65	24.6	143	54.2	2.25*	0.96
Training on better processing techniques	22	8.3	35	13.3	67	25.4	140	53.0	2.23*	0.97
Facilitating access to marketing opportunities	28	10.6	21	8.0	99	37.5	116	43.9	2.16*	0.95
Facilitating access to credits	51	19.3	28	10.6	86	32.6	99	37.5	1.88*	1.12

Source: Field Survey, 2019. Mean score = 1.5, *Highly Accessed

Table 6: Distribution of Respondents based on the Level of Extension Activities

Level of Extension Activities	Adopters			
	Score range	F	%	Pooled Mean ±SD
Low	0 – 23	110	41.7	22.68 ± 8.01
High	24 – 40	154	58.3	
Total		264	100	
Minimum	0			
Maximum	40			

Source: Field survey, 2019

Table 7: Distribution of Respondents based on the Adoption of Cultural Practices associated with Biofortified Cassava Cultivation

	Never		Rarely		Sometimes		Always		Mean	SD±
Cultural practices	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**		
Cultivation of different varieties of Vit.A cassava	1	0.4	0	0.0	38	14.4	255	85.2	2.85*	0.39
Spacing	2	0.8	8	3.0	74	28.0	180	68.2	2.64*	0.58
Weed control	1	0.4	20	7.6	58	22.0	185	70.1	2.62*	0.64
Row/ planting technique	1	0.4	34	12.9	85	32.2	144	54.5	2.41*	0.72
Pest control	4	1.5	32	12.1	53	20.1	175	66.3	2.51*	0.77
Disease control	4	1.5	33	12.5	53	20.1	174	65.9	2.50*	0.77
Land preparation techniques	14	5.3	30	11.4	58	22.0	162	61.4	2.39*	0.88
Fertilizer application	54	20.5	44	16.7	32	12.1	134	50.8	1.93*	1.22

Source: Field survey, 2019. Mean = 1.5, *Highly Adopted

Table 8: Distribution of Respondents based on the Level of Adoption of Cultural Practices associated with Biofortified Cassava Cultivation.

Level of Adoption		**Adopters**		
	Score range	**F**	**%**	**Pooled Mean ±SD**
Low	4 – 20	94	35.6	19.83 ± 4.40
High	21 – 24	170	64.4	
Total		264	100	
Minimum	4			
Maximum	24			

Source: Field survey, 2019

Table 9: **Factors Associated with Biofortified Cassava that Influenced its Adoption**

	Level of Influence									
	None		**Low**		**Moderate**		**High**			**SD**
Factors	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**Mean**	**±**
Awareness of benefits	0	0	34	12.9	100	37.9	130	49.2	2.36	0.70
Can be planted on a small scale	0	0	30	11.4	131	49.6	103	39.0	2.28	0.65
Persuasion of Extension Agents	7	2.7	24	9.1	124	47.0	109	41.3	2.27	0.73
Ability to shade off weeds	11	4.2	28	10.6	112	42.4	113	42.8	2.24	0.80
Ease of cultivation	0	0	22	8.3	166	62.9	76	28.8	2.20	0.58
Curiosity / Quest for innovations	0	0	82	31.1	81	30.7	101	38.3	2.07	0.83
Value addition to crop	0	0	45	17.0	164	62.1	55	20.8	2.04	0.62
Availability of the crop variety all-round the year	0	0	36	13.6	183	69.3	45	17.0	2.03	0.56
Early maturity than LV	9	3.4	27	10.2	193	73.1	35	13.3	1.96	0.61
High quality products	11	4.2	88	33.3	81	30.7	84	31.8	1.91	0.90
Higher yields than conventional cassava	0	0	104	39.4	98	37.1	62	23.5	1.84	0.78
Ease of access to planting material	0	0	37	14.0	154	58.3	73	27.7	1.83	0.70
Premium price/ higher income	17	6.4	87	33.0	88	33.3	72	27.3	1.81	0.91
Project/Sponsors support	10	3.8	35	13.3	124	47	95	36.0	1.77	0.71
Dignity associated with crop	8	3.0	107	40.5	98	37.1	51	19.3	1.73	0.80
Encouragement from my group/association	26	9.8	96	36.4	67	25.4	75	28.4	1.72	0.98
Higher satisfaction over other varieties planted	20	7.6	105	39.8	86	32.6	53	20.1	1.65	0.88
Acceptance of the crop in the community/high demand	0	0	152	57.6	67	25.4	45	17.0	1.60	0.76
Ease of storage	0	0.0	150	56.8	93	35.2	21	8.0	1.51	0.64
Peer pressure (Co-farmers and friends	19	7.2	145	54.9	46	17.4	54	20.5	1.51	0.90
Pests/disease resistance	13	4.9	140	53.0	83	31.4	28	10.6	1.48	0.75
Ease of processing	0	0	141	53.4	122	46.2	1	0.4	1.47	0.51
Cultural compatibility	0	0	144	54.5	120	45.5	0	0	1.45	0.50
Government support	0	0	189	71.6	42	15.9	33	12.5	1.41	0.70
Can do well on infertile soil	39	14.8	149	56.4	49	18.6	27	10.2	1.24	0.83
Access to credit facilities	94	35.6	111	42.0	39	14.8	20	7.6	0.94	0.90
No alternative	107	40.5	119	45.1	36	13.6	2	0.8	0.75	0.71

Source: Field survey, 2019