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ANALYSIS OF ADOPTION OF IMPROVED CASSAVA (*MANIHOT ESCULENTA*) VARIETIES IN GHANA: IMPLICATIONS FOR AGRICULTURAL TECHNOLOGY DISSEMINATIONS

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Abstract

The importance of cassava in the food system of Ghanaians cannot be underestimated. Research and development systems have released 25 new cassava varieties. The adoptions of these varieties have been low. The study explores factors that induce farmers to use improved cassava varieties in Ghana. The study used data from 450 cassava farmers and employed multinomial logistic model. The results revealed that apart from the farm and farmer characteristics such as farm size, distance, age and gender, perception of cassava characteristics had strong influence on the use of improved cassava varieties. Perception of disease resistance, perception of longevity in-soil and high yielding had effect on adoption of improved cassava varieties. Institutional factors including awareness, field demonstrations and extension visit significantly affected adoption. The importance of strengthening and resourcing research institutions and extension services to promote and create awareness about the existing improved cassava varieties is vital.

Key words: L*ongevity, multinomial logistic model, perceptions, technology transfer, varietal development*
Jel Codes: *Q16, Q18*

1. Introduction

Cassava is recognized as a commodity that could stimulate economic growth, fight poverty and improve food security in Ghana (Nweke, 2004; Angelucci, 2013). Owing to the potential of cassava to provide multiple opportunities for poverty reduction and nourishment for the poor people in Ghana, lots of research efforts have gone into the development and dissemination of it. There have been official releases of 25 new cassava varieties (Table 1) which mature early and yield high and also tolerant to biotic and abiotic stresses.

However, cassava production in Ghana is still reliant on landraces developed by generations of farmers using traditional breeding techniques (Manu-Aduening et al. 2005; Manu-Aduening et al. 2006). This has resulted in unimpressively low yields of about 19t/ha far below achievable yields of 45t/ha (Ministry of Food and Agriculture, 2016). In an attempt to salvage the situation many studies have been conducted that have led to the identification of several factors that constrain cassava's adoption in Ghana (Dankyi & Agyekum 2007;

Owusu &Donkor 2012; Acheampong et al. 2018). Factors normally enumerated to influence adoption are farmers' characteristics (e.g., gender of head of household, age, education, household size) and institutional factors such as extension access, credit and infrastructure. The role of cassava variety trait perception has received little attention in cassava adoption studies in Ghana. However, trait perception has been recognized to encourage the use of new varieties (Adesina & Baidu- forson 1995; Udoh & Kormawa 2009; Tumuhimbise et al. 2012).

Table 1. Improved Cassava Varieties Released in Ghana and Their Characteristics

Variety	Year Released	Maturity Period (Months)	Mean Root Yield (T/ha)	Total Dry Matter (%)	Uses	CMV Resistance
Afisiafi	1993	12-15	28-35	32	Starch, flour, gari	Tolerant
Abasafitaa	1993	12-15	29-35	35	Starch, flour, gari	Tolerant
Tekbankye	1997	12-15	30-40	30	fufu, ampesi, gari	Susceptible
Dokuduade	2005	12	35-40	30	Starch, gari	Resistant
Agbelifia	2005	12	40-45	33	Starch, gari	Resistant
Essam bankye	2005	12	40-50	35	Flour, gari	Resistant
Bankyehemaa	2005	9-12	40-50	32	Flour, gari, fufu	Resistant
Capevars bankye	2005	9-12	30-35	30	Flour, gari, fufu, starch	Resistant
Bankyebotan	2005	12-15	25-30	28	Flour, gari, starch	Tolerant
Eskamaye	2005	15-18	16-23	25	Tuo, konkonte	Tolerant
Filindiakong	2005	15-18	16-20	28	Tuo, konkonte	Tolerant
Nyerikobga	2005	15-18	17-29	30	Tuo, konkonte	Tolerant
Nkabom	2005	12-15	28-32	32	Starch, fufu	Tolerant
IFAD	2005	12-15	30-35	30	Starch, fufu	Tolerant
Ampong	2010	12	40-50	36	Flour, Starch, fufu	Resistant
Broni Bankye	2010	12	40-45	33	Flour, bakery products	Resistant
Sika bankye	2010	12	40-45	36	Flour, Starch	Tolerant
Otuhia	2010	12	35-40	39	Flour, Starch	Resistant
CRI-Duade Kpakpa	2015	12-15	60	37	Poundable, Flour, starch	Resistant
CRI-Amansan bankye	2015	12	57	38	Flour and bakery products	Resistant
CRI-AGRA bankye	2015	12	63	32	Starch, flour	Resistant
CRI-Dudzi	2015	12	49	38	Starch, Flour	Resistant
CRI-Abrabopa	2015	12-15	46	40	Hi-starch	Resistant
CRI-Lamesese	2015	12	50	39	Poundable, Beta-Carotene, Flour	Tolerant

Note: CMV is cassava mosaic virus

Studying newly introduced crop characteristics, farmers' perceptions and adoption decisions in Sierra Leone using a Tobit model, Adesina and Zinnah (1993) found that perceptions of the specific attributes of the new varieties are the major factors responsible for adoption and use intensities. The perceptions of the suitability or unsuitability of the attributes of the newly developed variety largely determine the adoption of the technology. Applying similar method to improved sorghum and rice varieties in Burkina Faso and Guinea, Adesina and Baidu- forson (1995) established that farmers' perception of improved variety attributes considerably affects their decision to use them. In modelling effects of farmer characteristics, institutional and technology specific factors on the choice of semi-arid farmers to integrate cassava into their farming systems in of West Africa (Ghana, Chad, Nigeria, Burkina Faso, Niger) by using Probit and Logit models, Udoh and Kormawa (2009**)** found farmers perceptions of improved cassava varieties characteristics such as pest and disease resistance to be significant and positive in decision to adopt cassava varieties. Using structured interviews and applying descriptive analysis Tumuhimbise et al. (2012) examined farmers' perceptions on early maturity of cassava in East and Central Uganda. Results showed that farmers' perceptions of cassava varietal characteristics such as high yielding, pests and diseases resistance, and palatability were important in growing new cassava varieties. In analysing adoption processes of new cooking banana hybrids in Uganda and applying a Zero Inflated Poisson (ZIP) regression model to assess the effect of farmers' perceptions on hybrid banana traits, Kenneth et al. (2012) found perceptions of varietal traits, disease and pests, yield and agronomic traits, as linked to the cultivation of most of the hybrid bananas.

This study assessed the influence of farmers' perceptions, along with the standard farm and farmer-specific variables on likelihood of adoption of new cassava varieties. The study contributes to literature on adoption of developed cassava varieties. This is essential to guide the distribution of the newly developed cassava varieties by National Agricultural Research Institutions and Extension systems to ensure a reasonable adoption.

2. Methodology

2.1 Conceptual Framework and Empirical Model

Adoption is basically the use of a technology and it is part of a decision making process. Adoption of a technology is the decision to apply the technology and continue to use it. The process involves a chain of actions and choices over time and through that a person assesses a new knowledge and chooses to integrate the knowledge into an ongoing practice (Rogers, 1995). Feder *et al.* (1985), define individual adoption as '' degree of use of a new technology in the long-run equilibrium when the farmer has full information about the new technology and its potential''. As noted by Rogers (1995), four factors influence adoption of a new technology and these include ''1) the technology itself, 2) the communication channels used to spread information about the technology, 3) time, and 4) the nature of the society to whom it is introduced''. Based on the theory of perceived attributes persons might use a new technology if they perceived that the technology has some relative advantage over an existing technology. That the technology is compatible with existing values and practices. The technology must be easy to use. This means the technology can be tested for a limited time without adoption. Many concepts have been developed for the adoption of a new technology. The economic constraint concept purports that inputs such as capitals, land and labour are fixed and that they essentially reduce undertakings in production and determine technology adoption decisions (Smale et al., 1994; Shampine, 1998). The innovation diffusion concept assumes that innovations are well developed but the individual's inability to adopt is due to improper communication (Feder & Slade, 1984; Shampine, 1998; Smale *et al.*, 1994). This study combines both concepts to analyse the adoption decisions of cassava farmers.

Considering that there are more than one cassava varieties introduced to farmers at a period and farmers can decide to use only local varieties or one or more improved cassava varieties on one or more plots, a multinomial logistic model (MNL) is appropriate for identifying the factors influencing farmers decisions to adopt these crops. The MNL is grounded on the random utility model. The utility U to an adopter from selecting an alternative is stated as a linear function of the farm and farmer characteristics (β) and the attributes of that alternative (X) and a stochastic error component (e):

$$\mu_{i1}(\times) = \beta_1 \times_i + e_{i1} \qquad Adoption \tag{1}$$

$$\mu_{i2}(\times) = \beta_2 \times_i + e_{i2} \qquad Non-Adoption \tag{2}$$

As utility is random, the i^{th} farmer will choose the new cassava variety if and only if $\mu_{i1} > \mu_{i2}$. Thus, for farmer i, the possibility of adoption is given by:

$$P(1) = P(\mu_{i1} > \mu_{i2}) \tag{3}$$

Let the possibility that the i^{th} farmer selects the j^{th} variety be P_{ij} and denote the choice of the i^{th} farmer by Y where $Y'i = (Y_{i2}, Y_{i1} \ldots Y_{ij})$ $Y_i^* = Y_{i1}, Y_{i2}, \ldots Y_{ij}$ where $Y_{ij} = 1$ if the j^{th} variety is selected and all other elements of Y_i^* is zero. If each farmer is observed only once, the likelihood function of the sample of values $Y_{i1} \ldots Y_{ij}$ is:

$$L = \prod_{i=1}^{T} P_{i1}^{Y_{i1}} P_{i2}^{Y_{i2}} \ldots P_{ij}^{Y_{ij}} \tag{4}$$

Assuming that the errors across the variety (e_{ij}) are independent and identically distributed leads to the following MNL.

$$P_i = \frac{exp(\beta X_{it})}{1+exp(\beta_2 X_{i2})+\cdots exp(\beta_j X_{ij})} = \frac{exp\{\beta X_{ij}\}}{1+\sum_{j=2}^{j} exp\{\beta_j X_j\}} \tag{5}$$

The MNL is used to predict the likelihood that a farmer demands a certain variety and how that demand is dependent on farm and farmer characteristics and attributes of the variety valued by the farmers. By differentiating equation (4) with respect to the covariates the marginal effects of the individual characteristics on the probabilities are determined as:

$$\frac{\partial P_j}{\partial X_j} = P_j \left[\beta_j - \sum_{k=0}^{i} P_k \beta_k \right] = P[\beta_j - \beta] \tag{6}$$

The marginal rate of substitution (MRS) between two varieties is presented to be a weighted sum of the marginal contribution of each variety to the total amount of each attributes demanded. Farmers might concurrently plant multiple varieties if certain attributes are unique to a particular variety. Table 2 presents the definition of variables used in the model. These variables were chosen based on literature review on adoption studies.

Table 2. Variables definitions

Variables	Definition	Expected sign
Farm and farmer characteristics		
Age	Age in years of a farmer	+-
Gender	Male =1; Female =0	+-
Number	Years of schooling	+
Experience	Years in farming	+-
Farm size	Total farm size in hectares	+
Land owner	Owned land=1; 0 otherwise	+
Hiring of labour	Hired labour=1; 0 otherwise	-
Institutional and access related variables		
Extension access	Extension access=1; 0 otherwise	+
Extension visits	Number of times extension visited	+
Participation in field day/demonstration	Participation in cassava demonstration=1; 0 otherwise	+
Awareness	Knowledge of improved cassava variety=1; 0 otherwise	+
Credit access	Access to credit=1; 0 otherwise	+
Distance	Distance to output and input market in kilometers	+
Technology characteristics		
Improved cassava can be infected by to diseases and pest than local	If farmer perceived that improved cassava can be infected by diseases and pest than local=1; 0 otherwise	+
More drudgery in Improved cassava cultivation than local	If farmer perceived more drudgery in improved cassava cultivation than local=1; 0 otherwise	+
Improved cassava yields more than local	If farmer perceived that improved cassava yields higher than local(1=yes)	+

Many studies (Faturoti et al., 2006; Dontsop et al., 2013; Ghimire et al., 2015) have found these selected variables to influence adoption of crop varieties either positively or negatively. The gender of a farmer was measured as dummy variable that had 1 as the value if the farmer was a male, and 0 if female. Being a male or a female may influence the decision to adopt improved cassava varieties. Age may negatively or positively influence adoption decisions. It was measured in years. The likely sign of the coefficient on age could be indeterminate. Younger people may be risk-averse and less likely to adopt. On the other hand older people may have more experience and resources that may engender adoption. Household size was measured as a continuous variable. Larger family size may encourage participation in off-farm activities or increase family labour. Therefore household size can have positive or negative effect. Education was measured in years. It is established to enhance the ability of farmers to perceive, to interpret correctly and to undertake actions that will appropriately reallocate their resources (Feder et al., 1985). Education is likely to influence the decision to adopt improved cassava varieties. Awareness or Knowledge could influence adoption positively. Knowledge of the various improved cassava varieties was hypothesized to positively influence their adoption.

Farm size would influence farmers' adoption of improved varieties positively as farmers with large landholdings are able to try new technologies on portions of their land. Landownership is security and may influence adoption positively Extension access was measured as a binary variable: 1 if farmers contacted extension agents, 0 otherwise. Extension contact is hypothesized to impact positively on adoption. Frequent visits of extension agents may influence the farmers' decision to adoption. It was measured as a continuous variable. Frequency of visits is hypothesized to affect the probability of adoption. The accessibility of credit should have a positive influence on the decision to adopt. Credit access was measured as binary variable with 1 equal's access and 0 otherwise. Distance to input and output market is an essential factor expected to encourage adoption. It was measured in kilometres.

Perception on improved cassava characteristics will influence adoption. (Adesina &, Baidu-Forson,1995). Farmers make comparisons of the attributes of new and local varieties and they adopt modern varieties when they are perceived as having better characteristics than the locals.

2.2 The Study Area

This investigation was carried out in three regions namely Ashanti, Brong Ahafo and the Eastern regions of Ghana. Figure 1 presents the regional map[1] of Ghana showing the study area. The study area was selected due to high production of cassava, their proximity to National Crops Research Institute and familiarity with the most of the improved varieties. The three regions are situated within the semi-deciduous rainforest and the forest savannah transition agro ecological zones. The semi-deciduous forest has bimodal distribution of rainfall, and the mean annual rainfall is1500mm.

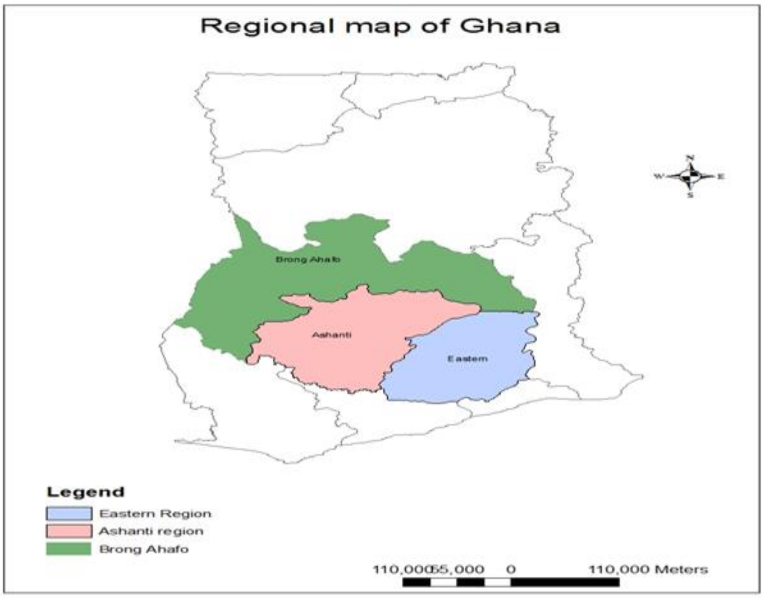

Figure 1. Map of Ghana Showing the Study Area

The growing periods are 150-160 days for the major season and 90 days for the minor season. The topography is gently rolling. The Forest savannah transition also has a bimodal rainfall, and the mean annual rainfall is 1300mm. The length of the growing periods is 100 – 120 days for the major season and 60 days for the minor season. Both ecological zones are ideal for cassava production. Production of food crops such as maize, roots and tuber crops, vegetables and tree crops such as cocoa and oil palm are the main agricultural activities of the smallholder farmers from the three regions. Farmers generally practice mixed cropping in the area as most farmers planted more than two crops on a piece of land.

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2.3 Data Collection and Sampling

The data presented is based on a cross-sectional farm household level survey conducted in three cassava producing districts in Ghana. The data was collected by means of structured questionnaires in the form of in-person survey technique. A multi-stage sampling technique was used for the study. Three Regions in which the study was conducted were purposively selected to reflect cassava production and distribution patterns in the country and agro-ecological zones. From the regions one district each was again purposively selected based on cassava production levels and familiarity with some of the improved cassava varieties. A list of all locations in each of the selected district was obtained from respective district and municipal offices of the Ministry of Food and Agriculture. Using random numbers from statistical table 10 villages were randomly selected from each district. The list of farmers in each of the selected villages had to be drawn up with assistance of the District Agricultural Extension officers and local people. From the lists of farmers 15 farmers were again randomly selected from each of the selected communities. On the whole a total of 450 farmers were selected for the survey. The information gathered included farmer demographics, farm size, cassava production, perception on improved cassava traits, crop income etc.

3. Results and Discussions

3.1Descriptive Statistics of respondents

Table 3 shows demographics and production statistics of farmers. Male farmers dominated female farmers across the districts. Mean age of farmers across the districts was 46 years. Respondents had spent on average 8 years in formal education. An average family size of a farmer consisted of 6 members with corresponding mean economically active individuals (above 18 years) of 2 persons.

Table 3. Descriptive Statistics of Sampled Farmers by District

Variable	Atwima district (N=150)		Techiman municipal (N=150)		Fanteakwa district (N=150)		All(pooled) (N=450)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Farmer characteristics								
Gender (1=male)	0.52	0.50	0.54	0.50	0.76	0.42	0.60	0.49
Age of a farmer (years)	46.51	11.58	48.51	12.48	43.39	12.60	46.28	12.39
Education (years)	7.78	4.52	6.36	5.49	8.00	4.38	7.38	4.69
Household size (count)	6.64	3.11	6.8	2.9	5.90	2.6	6.4	2.9
Economically active members	3.27	2.40	4 .00	2.50	3.08	2.44	3.45	2.50
Experience (years)	18.45	11.9	22.6	14.03	18.78	11.06	19.94	12.52
Farm characteristics								
Farm size(ha)	3.21	2.03	4.44	4.97	3.86	3.37	3.82	3.69
Land tenure(1=own)	0.66	0.47	0.70	0.45	0.98	0.14	0.59	0.49
Land under cassava(ha)	1.12	0.89	1.24	0.96	1.16	0.44	0.92	0.91
Institutional and access related factors								
Distance to market (Km)	4.43	2.22	8.31	8.52	8.60	4.6	7.11	6.17
Extension contact(1=yes)	0.64	0.48	0.54	0.49	0.55	0.49	0.25	0.43
Number of extension contact (count)	2.4	5.67	2.16	4.32	2.26	4.35	2.27	4.81
Field day participation (1=yes)	0.08	0.28	0.14	0.34	0.10	0.30	0.11	0.31

On the Average a farmer had had 20 years of experience in farming. Across the study area a farmer had a farm size of about 4 hectares. Mean cassava farm size was about 1 hectare. Distance from farm to market was 7km. Generally more (58%) farmers had contacts with extension agents but only few had participated in cassava field days and demonstration.

3.2 Adoption of improved cassava varieties

Table 4 presents the adoption rates of developed cassava varieties in the study area.

Table 4. Adoption Rates of Improved Varieties

Cassava varieties	Frequency	Percentage
Traditional varieties	335	74.4
Improved varieties		
Afisiafi	55	12.2
Bankyehema	35	7.8
‘Abasafitaa	25	5.6
Total	450	100.0

Of the total sample (450) interviewed, 335 farmers representing 74.4% of the total sample cultivated traditional cassava varieties. Only 25.6% of the total sample cultivated improved cassava varieties. Improved cassava varieties grown were *Afisiafi*, *Bankyehema and Abasafitaa. Afisiafi,* was cultivated by 12.2% of the population, *Bankyehema* was cultivated by 7.8% and *Abasafitaa* was grown by only 5.6% of the farmers. *Abasafitaa* and *Afisiafi* were released in 1993 and *Bankyehemaa* was released in 2005 but they seemed to be popular among cassava farmers. These varieties are mostly used in the preparation of local meals such as ''fufu[2]'' and ''gari[3]''. The low adoption rates of new cassava varieties are also found in various cassava adoption studies in Ghana (Manu-Aduening et al. 2005; Dankyi and Agyekum 2007; Owusu and Donkor 2012) which corroborates with the results of this study.

3.3 Empirical Results and Discussion

Table 5 presents results of the marginal effects from the MNL of the effects of socioeconomic and institutional characteristics and technology characteristics on the decision to adopt a given improved cassava variety.

Table 5. Estimates from Multinomial Logit Regression on the Selection of Improved Cassava Varieties

Variable	*Bankyehma*		*Abasafita*		*Afisiafi*	
	δy/δχ	Std	δy/δχ	Std	δy/δχ	Std
Age	-0.004***	0.001	-	0.002	-0.005	0.002
Gender	0.072**	0.034	0.027	0.022	-0.008	0.034
Household size	0.002	0.004	-0.01***	0.004	0.007	0.005
Experience	-0.003	0.001	-0.001	0.001	0.001	0.002
Education	0.002	0.003	0.002	0.002	0.002	0.003
Hired labour	0.011	0.035	0.009	0.031	0.115**	0.056
Farm size	0.002	0.004	0.006	0.001	0.003***	0.001
Access to credit	0.045	0.035	0.008	0.028	-0.081	0.056
Extension contact	-0.019	0.028	0.003	0.023	-0.015	0.034
Extension visit	0.005***	0.001	0.001	0.001	0.001	0.003
Field day/demonstration	0.035	0.036	0.051**	0.027	-0.049	0.056
Land owner	-0.037	0.025	0.020	0.021	-0.015	0.031
Awareness	0.079	0.072	0.035	0.049	0.195**	0.106
Distance	-0.027*	0.004	-0.008	0.001	-0.002	0.003
Perception that improved cassava is more resistant to diseases and pest than local(1=yes)	0.100**	0.054	0.006**	0.002	0.112	0.080
Perception that improved cassava stays longer in the soil than local	0.015	0.052	0.134***	0.031	0.170***	0.061
Perception that improved cassava yields more than local	0.174***	0.069	-0.028	0.040	-0.109	0.085
Number of observations Pseudo R-squared Log likelihood	450 0.216 -					
Log likelihood	-					

Note: *** 1% significant level; ** 5% significant level; * 10% significant level

As indicated earlier, the parameter estimates of the MNL model provide only the direction of the effect of the independent variables on the dependent variable. Estimates do not represent actual magnitude of change or probabilities. Thus, the marginal effects from the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, are reported and discussed. The base was adoption of traditional cassava varieties. The improved varieties were *Abasafitaa, Bankyehema and Abasafitaa.* The results revealed that farmers were both homogeneous and heterogeneous in making decisions to use different new cassava varieties.

There was homogenous effect of gender on adoption decisions regarding the three improved cassava varieties. The gender variable was only positive and significant at 1% with the adoption of *Bankyehema.* Specifically, the results revealed that it was more probable for males than females to adopt Bankyehema. Some empirical studies (Nwakor et al., 2011; Tarawali et al., 2012) on improved cassava varieties in Nigeria have found that males adopt improved cassava varieties more than females, similar to findings in this study. Males may have the resources such as land and funds to be able try new varieties.

There was a negative effect of age on the probability of use of *Abasafita*. This could suggest that younger farmers were more likely to try new cassava varieties. Younger farmers are more curious and educated and are able to take risk. Owusu and Donkor (2012) found similar results in their study of improved cassava varieties adoption in Ghana. Nonetheless, studies in Tanzania (Kavia et al., 2007) and Nigeria (Mohammend-Lawal et al., 2012) found positive effect of age on adoption of improved cassava varieties.

The impact of hired labour on probability of adoption of *Afisiafi* was significant at 1%. The suggestion is that the likelihood of adoption of *Afisiafi* will increase with the use of hired labour. This highlights the importance of labour availability to improved cassava adoption, consistent with findings by Anyaegbunam et al. (2012) that improved cassava adoption increased with labour accessibility in their study of cassava productivity among smallholder farmers in Nigeria. Again the probability of adoption of *Afisiafi* increased with farm size. The coefficient of farm size was significant at 1% indicating its influence on adoption of *Afisiafi*. The positive influence of farm size on adoption of improved cassava varieties is established in many studies in Nigeria (Imoh and Essien, 2006; Udensi et al. 2011; Mohammend-Lawal et al. 2012; Madu et al. 2008) and in Tanzania by Kavia et al. (2007) which corroborates with the findings in this study.

Access to information on new technologies is important to creating awareness and forming attitudes towards the adoption of the new technology. In this study, though access to extension indicated by contact with an extension agent, had no impact on the choice of any of the improved varieties, the number of times of extension visit impacted positively on the probability of choice of *Bankyehemaa* .This underscores the importance of regular visits of extension agents, consistent with findings by Dankyi and Agyekum (2007) and Onyemauwa (2012). Regular visits of extension agents give farmers access to enough information on innovations, their use and management. In this study number of times of extension visits impacted positively on the adoption of *Bankyehemaa.* Generally, extension officers establish demonstration plots where farmers get practical training and can try-out new farm knowledge. Regarding the three varieties in this study, it was found that participation in field demonstrations impacted positively on the adoption of Abasafita. Farmers that participate in extension programmes are more likely to adopt improved technologies. In Nigeria, Orebiyi et al. (2005) and Onyemauwa (2012) found similar results in their studies of determinants of farmers' participation in improved cassava varieties.

Knowledge or awareness of the improved varieties was significant at 1% on the likelihood of use of *Afisiafi*. The positive effect of awareness variable corroborates with results from studies on maize varieties in Tanzania (Shiferaw et al.2008), cowpea varieties in Nigeria (Kristjanson et al. 2005) and maize seeds in Tanzania (Kaliba et al. 2000).

Distance to output and input market was negative and significant at 5% with the adoption of *Bankyehemaa.* The implication is that the shorter the distance to a market the more likely that a farmer would grow *Bankyehemaa*. Farmers farther away from an input and output market may be disadvantaged due to lack of market information and so may incline more to subsistence production. Consequently, farmers may not be interested in participation in new varieties so long as the local varieties provide subsistence level of production for the family (Langyintuo & Mekuria, 2008).

There was a heterogeneous effect of the perception of disease resistance regarding *Bankyehemaa* and *Abasafitaa*. The disease resistance variable was positive and significant at 5% with both varieties. Disease resistance assures farmers of stable yields and gives farmers the opportunity of realizing their dual objectives of consumption and sale. This finding supports a study conducted in West Africa (Korwawa et. al., 2001) where perception that improved cassava varieties were high yielding affected adoption.

The results also showed heterogeneous effect of in-soil storage (longevity of roots after maturity) regarding *Abasafitaa* and *Afisiafi* varieties. The coefficient was significant at 1%. The probability of adoption of *Abasafita*a and *Afisiafi* will increase with assurance of matured root remaining longer in the soil without rotting. The option to adopt Bankyehemaa and *Afisiafi* is jointly affected by the perception of poundability/malleability (ability to be used for *fufu* meal). Cassava is grown mostly by smallholder farmers whose aim is firstly consumption and then sale. Malleability attribute is very much considered by these farmers as that is the attribute that allows for the preparation of *fufu* meal. Most improved cassava varieties are rejected by farmers due to their inability to be used in the preparation of *fufu*. Acheampong et al. (2018) in their study of farmers' preferences for cassava varieties traits in Ghana found out that farmers consider root longevity in-soil trait of cassava.

4. Conclusion and Implication

This study has empirically assessed cassava farmers' adoption of improved cassava varieties using MNL model. We discovered that only 25.5% of the total sample had adopted three improved cassava varieties. Interestingly factors influencing adoption decisions of farmers regarding different improved varieties were varied. Whereas gender, number of times of extension visit, distance to market and perception of higher yield impacted on the probability of use of developed cassava variety *Bankyehemaa,* age, field demonstrations and perception of disease resistance affected the probability of adoption of newly developed cassava variety *Abasafitaa*. Age, hired labour, farm size, awareness, perception of disease resistance and perception of longer root storability in the soil after maturity affected the likelihood of acceptance of cassava variety *Afisiafi.*

The results revealed the youth were likely to accept developed cassava varieties. This suggests the need for age targeting during dissemination of new cassava varieties. The government could incentivize the youth by providing them with affordable credit facility and arrangements that will make land accessible and available.

Institutional factors such as awareness, extension visits, field demonstrations, farm size, and hired labour had effect on adoption probability of developed cassava varieties. These results make a convincing case for increased awareness education of the improved cassava varieties and organization of more farmer field schools and on-farm trails to display the yield advantage of improved varieties over indigenous ones. These activities need resources such as funds and other logistics e.g. motor bikes and 4x4 vehicles due to poor road networks. Government and private sector could increase support to Research and Extension to enable regular visits and on-farm demonstrations of improved cassava technologies. Farmers are able to avoid information asymmetry and obtain first-hand information concerning improved crop varieties.

Perceptions on cassava variety attribute such as longevity in-soil, malleability and disease resistant influenced adoption probability. The need for policy to support and resource Research Institutions and extension services to create awareness about the existing improved cassava varieties is imperative.

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[1] Note that the study was conducted when Ghana had ten regions

[2] 'Fufu' is local meal prepared with cassava

[3] 'Gari' is granulated cassava