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Articles

An Empirical Analysis of the Determinants of Adoption of Improved Cassava Varieties in Mampong Municipality, Ghana

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Abstract

The main idea behind this study was to ascertain the extent and factors that influence the adoption of improved cassava varieties in Mampong Municipality, Ashanti Region of Ghana. This is because, many years after implementing the Root and Tuber Improvement and Marketing Programme (RTIMP) in Ghana, little evidence exist regarding the extent of adoption and the factors that influence the adoption of improved cassava varieties in Ghana. The study was carried out in the Mampong Municipality in the Ashanti Region of Ghana. The study employed a multi-stage sampling technique to select 250 cassava farmers. The Tobit and Multinomial Logistic Regression Models were used to analyse the dataset. Results show that the returns on the local varieties were higher than that of the improved cassava varieties. This might have accounted for the low adoption of the improved cassava varieties. The significant factors influencing the adoption of improved cassava varieties include access to extension services, access to credit, member of farmer associations and educational level. It is recommended that access to extension services should be enhanced, and credit opportunities should be made affordable to farmers. These are likely to increase the extent of adoption of the improved cassava varieties to enhance food security.

Keywords: adoption, Ashanti region, factors, Ghana, improved cassava varieties.

1. Introduction

Food and nutrition security is a global concern. Over the years, the number of people living in hunger has kept increasing in most developing countries (Cooke et al., 2016). Although technological advances in agriculture have been carried out over the years and have contributed massively to the level of production of crops, the demand for food has continually outpaced supply, leading to substantial food deficits (Aidoo, 2009). This discouraging trend, especially for cassava, has mainly been attributed to the low proportion of adoption of improved technologies (Umunakwe et al., 2015). The potential for agriculture is greatest for root and tuber crops like cassava and yam because they are drought-tolerant, have low soil fertility, grow in a variety of climates, are flexible in mixed cropping systems and contribute a lot to household food security. With its increased usage in developing countries, it is likely to significantly affect the global food

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systems, policies and investments (Aidoo, 2009). Also, the absolute utilisation of roots and tubers in developing nations is estimated to increase by 58 %. A lot of the expansion will be 44 % for cassava, potato's 29 % and sweet potato and yam's offer will be 27 %.

Historically, policymakers and researchers have given almost no consideration to root crops, as most of their endeavours have focused on cash crops. Root crops were considered food for poor people and assumed an exceptionally minor function in worldwide trade. This misguided judgment has lingered for such a long time because of the absence of appreciation for the number of individuals who rely upon these root crops and the number of lives spared during starvation or calamities by root crops. The inclination to regard roots and tubers as undifferentiated commodities have clouded their varying uses and performance. It has likewise thwarted examining their roles in the global food framework, blurred comprehension of their future possibilities, and disabled formulation of appropriate policies and approaches to exploit their undiscovered opportunities. In this way, it is imperative to isolate the different roots and tubers as individual food crops for basic examination (Ahmed, 2015).

Adopting improved innovations could increase adopters' incomes (Adofu et al., 2013). Nonetheless, the Ministry of Food and Agriculture (MoFA, 2004) points out that improved cassava varieties introduced to farmers did not directly translate into increased incomes. Though the output gap might have been achieved, it might have led to a price effect; thus, a reduction in producer price. As private investors, cassava farmers would want to maximise their profit and go for varieties that have a ready market. Literature indicates that most cassava farmers are smallholder resource-poor farmers who sell their produce to traditional open markets mainly for processing into food products (Deepa et al., 2015; Food and Agriculture..., 2005). Due to this, the farmers are bound to use local varieties that are low yielding because they are familiar with them and also, there are assured markets.

Research indicates that farmers are often reluctant to adopt the improved cassava varieties if they envisage there will be no ready market for their produce. In Ghana, the level of adoption of improved cassava varieties is low regardless of the effort by the government through RTIMP (Donkor et al., 2014). The issue now is that since most cassava farmers depend on the incomes from sales of their produce for their livelihood, this worrying trend of low productivity despite the several existing improved cassava varieties is worth investigating. Thus, there is the need to quantify the extent of adoption of individual improved cassava varieties and determine the factors associated with the observed levels of adoption and disentangle their individual effects.

Furthermore, existing studies on adopting improved cassava varieties concentrated on the aggregation of the improved varieties as against the local varieties (Ahmed, 2015; Awotide et al., 2014). That is, there is a dearth of literature on the reasons accounting for the adoption of different improved cassava varieties, and the present study investigates differential proportions of adoption of the improved varieties in the Mampong Municipality where the Root and Tuber Improvement and Marketing Programme (RTIMP) has a multiplication and distribution site for providing improved cassava planting materials to producers (MoFA, 2013). Given the importance of cassava to Ghana and to the rest of the world, adopting improved cassava varieties aimed at increasing food production for maximum food security cannot be ignored. Hence identifying the proportion of adoption and factors that influence adoption is vital, and this study seeks to fulfil this task. Therefore, the study's purpose was to ascertain the extent of adoption and the factors influencing the adoption of improved cassava varieties in Ghana.

2. Materials and methods

The study was carried out in the Mampong Municipality in the Ashanti Region of Ghana. The Mampong Municipality is one of the six municipalities in the Ashanti Region, with Mampong as its administrative capital. It is also one of the thirty administrative districts in the Ashanti Region, Ghana. The Municipality has an area of 23.9 square kilometres (km^2), and the total population is estimated to be 88,501 (42,653 males and 45,398 females). The major towns in the Municipality include Mampong Krobo, Dadease, Asaam, Kofiase, Adidwan and Apaah (Ghana Statistical Service, 2010). The study focused on cassava producers in the Mampong Municipality in the Ashanti Region. The population of cassava producers in the study area is unknown, but according to (Ghana Statistical Service, 2010), about 11,698 people in the study area engage in crop farming, including cassava.

The study employed a multi-stage sampling technique to get the sample size. This technique involves different sampling methods. Here, the respondents were chosen through a process of defined stages. The Mampong Municipality was purposively selected for the study because of its prominence in the production of cassava not only in the Ashanti Region but also in the entire country. The area has also received a lot of interventions in terms of research through the Root and Tuber Improvement and Marketing Programme (RTIMP). The study population was all cassava farmers in the Mampong Municipality. With the aid of Agricultural Extension Agents (AEAs), a list of major producing communities was prepared, after which a simple random sampling technique was used to select eleven (11) communities from the Municipality to provide a fair representation of the views of the diverse nature of respondents through the balloting approach. Communities selected for the study were *Krobo, Kyerimfaso, Mprim, Atonsuagya, Bunuso, Bosomekyekye, Abuomtem, Konkomba Village, Adidwan, Dome and Woraso*.

The farmers were selected through the simple random sampling approach using a list the Agric Extension Agents provided to reduce selection biases significantly. Thus, the simple random technique ensured that all cassava producers in the areas had an equal chance of being selected. In all, a total of Two Hundred and Fifty (250) cassava farmers were selected, comprising a minimum of eleven (11) and a maximum of forty-six (46) depending on the size of the selected communities. Past studies used this sampling approach (*Ayoade, 2013;* Ojo, Ogunyemi, 2014). The data for the study was collected from cassava producers in Mampong Municipality using questionnaires and face-to-face interviews by the researcher. Statistical Package for Social Sciences (SPSS v.20), Microsoft Excel and Stata (V. 12) were used to process, document and analyse the data collected. The Tobit Model and return on investment methods were used to estimate the extent of adoption of improved cassava varieties and returns on cassava varieties. *Additionally,* we used the Multinomial Logistic Regression Model to examine the factors and extent of adopting improved cassava varieties.

Analytical Framework

This study employed the Multinomial Logit and Tobit Models to examine the factors influencing the adoption of improved cassava variety and the extent of adoption, respectively.

2.1. Tobit Model

Given

$$\ln L = \ln\left(\prod_{y_i>0} f(y_i)\prod_{y=0} F(0) = \sum_{y_i>0}\ln f(y_i) + \sum_{y=0}\ln F(0)\right) \quad \text{..... (1)}$$

as the likelihood function, since y_i is normally distributed, the log-likelihood function can be expressed in terms of the cumulative distribution and density function as follows:

$$\ln L = \beta\left[\sum_{y_i>0}\ln\left(\frac{1}{\sigma}\phi\left(\frac{y_i - x_i'\beta}{\sigma}\right)\right) + \sum_{y_i=0}\left(1-\Phi\left(x_i'\beta\right)\right)\right] \quad \text{..... (2)}$$

Where $\Phi(.)$ is the cumulative distribution function of a standard normal distribution and $\phi(.)$ is the corresponding density function.

Equation (3.2) can therefore be rewritten as follows:

$$LA_i = \gamma_0 + \sum_{i=1}^{5}\gamma_i\, INST_i + \sum_{i=6}^{10}\gamma_i\, SOCIO_i + \mu_i \quad \text{..... (3)}$$

where LA_i, the dependent variable represents the land area adopted by the ith cassava producer and measures the extent of adoption. Past studies have measured the extent of adoption using the total land area for improved cassava cultivation (Owusu and Donkor, 2012; Awotide et al., 2014). Again, $INST_i$ and $SOCIO_i$ represent institutional and socio-economic factors as explained earlier in equation (1). γ_0, γ_i and μ_i are the constant term, coefficient of the institutional and socio-economic factors to be estimated and the disturbance term, respectively.

2.2. Multinomial Logit Model

In specifying the multinomial model for this study, the researcher followed (Wooldridge, 2002). Given equation (4) and equation (5) as the probabilities of adopting an improved cassava variety and probability of not adopting an improved cassava variety, respectively.

$$P_{ij} = e^{\sum_{j=1}^{k} \alpha + \beta_{kj} X_{kji}} \quad \text{..... (4)}$$

$$P_{ij} = \sum_{1}^{J} e^{\sum_{j=1}^{K} \alpha + \beta_{kj} X_{kji}} \quad \text{..... (5)}$$

i and *j* represent cases and categories accordingly, k denotes the independent variables and P_{ij} represents the probabilities.

Equations (4) and (5) are then rewritten as:

$$ADOPT_i = \beta_0 + \sum_{i=1}^{5} \beta_i INST_i + \sum_{i=6}^{10} \beta_i SOCIO_i + \varepsilon_i \quad \text{..... (6)}$$

where $ADOPT_i$ which is the dependent variable denotes varieties of improved cassava, $INST_i$ is the institutional factors comprising access to extension service (EXT), access to credit (CR), membership of farmer association (FA), market access (MA) and land tenure (LT). $SOCIO_i$ captures socio-economic factors and include age (AGE), education (EDUC), marital status (MS), household size (HS) and labour (LAB). Again, β_0,β_i(i=1,2,3,...10) and ε_i are the intercept, parameters to be estimated and the error term of the model, respectively.

3. Results and discussion

Extent of adoption of improved cassava varieties

1. Identification of the various improved cassava varieties and proportion of adoption

Despite the introduction of the improved cassava varieties in the area, the study revealed that not all of them had been adopted. Some of the farmers had also not adopted any of the improved cassava varieties. The study showed that the improved cassava varieties that had been adopted in the area were *Bankyehemaa, Essambankye, Nkabom, Abasafitaa* and *Afisiafi*. The result shows that out of the 250 farmers interviewed, only 99 (39.6 %) indicated that they had adopted the improved cassava varieties, and 151 (60.4 %) farmers asserted that they had not adopted the improved cassava varieties but still cultivate the local variety. However, this gives an overall adoption proportion of 39.6 %, which is relatively higher than the 9 % reported by (Owusu, Donkor, 2012).

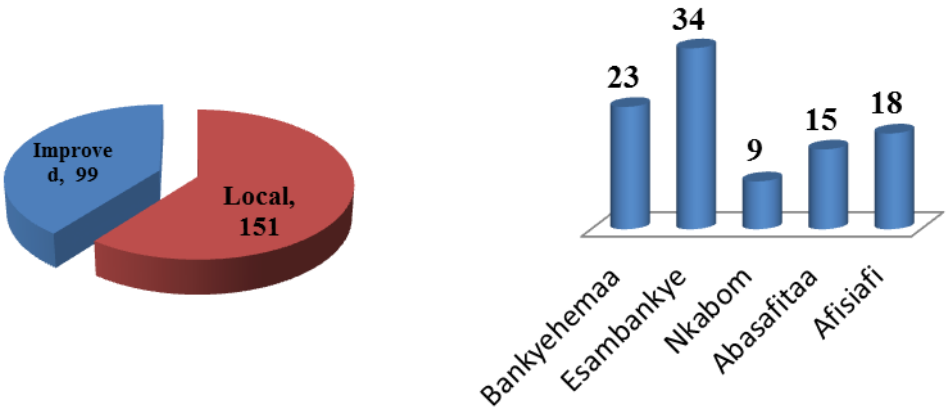

Fig. 1. Proportion of adoption of improved cassava varieties by farmers

From Figure 1, out of the 99 farmers who had adopted these improved cassava varieties, 23 and 34 had adopted Bankyehemaa and Essambankye, representing 9.2 % and 13.6 %, respectively. It was also revealed that 9 farmers representing 3.6 % had adopted *Nkabom*. It can also be inferred that of the improved cassava varieties introduced in the study area, the most adopted variety is the *Essambankye* (13.6 %) and this is followed by *Bankyehemaa* (9.2 %). The least adopted variety is the *Nkabom* which has an adoption proportion of 3.6 %.

2. Extent of adoption of improved cassava varieties

Extent adoption is defined as the total land area used to cultivate improved cassava varieties adopted by farmers. Figure 2 shows the average acres of land used to cultivate improved cassava varieties.

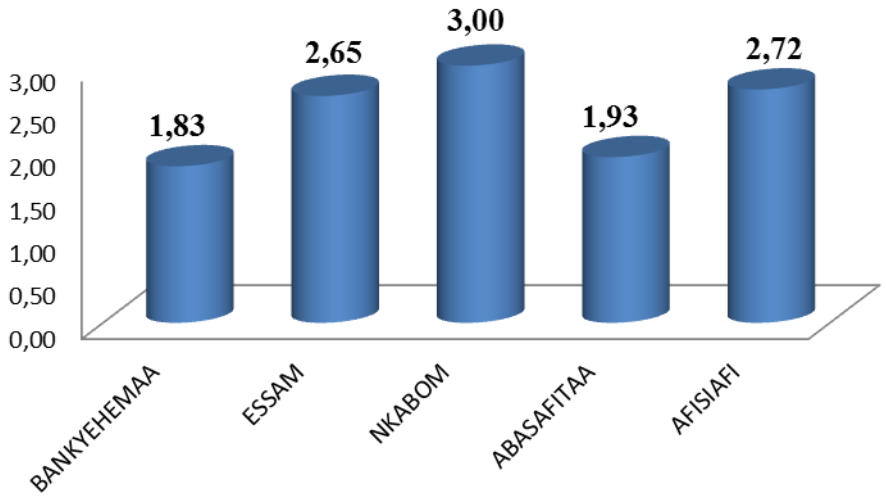

Fig. 2. Average acres of land used in the cultivation of improved cassava varieties

Figure 2 showed that *Nkabom* had the highest average land (3.0 acres) for cultivation in the study area, followed by Afisiafi, with an average farm size of 2.72 acres. *Bankyehemaa* had the least acre of land with a value of 1.83 acres. *Nkabom* having the highest average acre of land for cultivation compared with *Essambankye* which had the highest proportion of adoption, could be attributed to the fact that though the proportion of adoption was low for *Nkabom,* the farmers had large farm sizes compared with farmers who adopted *Essambankye*.

3. Returns on adopting improved cassava varieties

Regarding the returns on the improved cassava varieties cultivated in the study area, the researcher computed the total cost of cultivating the improved cassava varieties in the previous season and the returns obtained from selling the output. The average returns (net income) for each variety, return on investment (ROI) which measures the gain or loss on investment in cassava production given the total amount invested in cultivation and profit margin (PM), which measures how much out of every Cedi of sales a farmer actually keeps in earnings were computed. The results are presented in Table 1. Among the five improved cassava varieties adopted in the study area; *Bankyehemaa, Essambankye, Nkabom, Abasafitaa* and *Afisiafi,* the average net income ranges from USD 3349.50 to USD 9955.00 as the minimum and maximum values respectively. The variety that has the highest net income is *Essambankye,* with an average net income of USD 9955.00, followed by *Afisiafi,* with an average net income of USD 8822.00. The variety with the least net income is *Nkabom,* with an average net income of USD 3349.50. Therefore, it is unsurprising that Essambankye had the highest adoption rate (13.6 %) while Nkabom had the least (3.6 %).

Table 1. Returns from Improved Cassava Varieties (ICV) and local varieties

Variety	ATC (USD)	ATR (USD)	NI (ATR - ATC) (USD)	ROI (%) (NI/TC x 100%)	PM (%) (NI/TR x 100%)
Improved Varieties					
Bankyehemaa	6985	14135	7150	102	51
Essambankye	6985	16940	9955	143	59
Nkabom	6985	10334.5	3349.5	48	32
Abasafitaa	6985	15323	8338	119	54
Afisiafi	6985	15807	8822	126	56
Local Varieties					
Garibankye	6572.5	11011	4438.5	68	40
Debobankye	6572.5	20009	13436.5	204	67
Kuffourbankye	6572.5	16885	10312.5	157	61

Notes: ATC – Average Total Cost; ATR – Average Total Revenue; NI – Net Income
ROI – Return on Investment; PM – Profit Margin.
Source: Field Data

Regarding the return on investment and profit margin figures, the result further revealed that *Essambankye* has the highest return on investment, about 143%, concerning the amount invested in the cultivation processes. This means that a farmer will get more than double the amount invested in *Essambankye* cultivation. The variety with the second highest ROI is *Afisiafi,* with a return on investment value of 126 %, also indicating that a farmer who invests in Afisiafi will get double the amount invested. Again, *Nkabom* has the least ROI, with a value of 48 %, indicating the profit a farmer will get from *Nkabom* will not be up to half of the amount invested. The same can be said about the profit margin figures. *Essambankye* had the highest profit margin (59 %), followed by *Afisiafi* (56 %), and the least was *Nkabom* (32 %). This means that for every Cedi a farmer invests in *Essambankye, Afisiafi* and *Nkabom*, a profit margin of USD 3.25, USD 3.25 and USD 1.76 will be generated, respectively. Regarding the local varieties (*Garibankye, Debobankye,* and *Kuffourbankye), Debobankye* has the highest net income (USD 13436.50), followed by *Kuffourbankye* (USD10312.50), and the least being *Garibankye* (USD 4438.50). The ROI and PM values also show that *Debobankye* has the highest returns, followed by *Kuffourbankye,* and the least was *Garibankye*.

Table 2. Estimated results for the Tobit Regression Model

Variable	Coefficient	Rob. Std. Err.	Marginal Effect	Prob. Value
EXT	3.2395	1.0770	3.2395***	0.0029
CR	1.2022	0.8478	1.2022	0.1575
FA	3.6246	1.0387	3.6246***	0.0006
MA	-1.1042	0.8418	-1.1042	0.1909
LT	0.0288	0.7920	0.0288	0.9710
AGE	-0.0677	0.1749	-0.0677	0.6992
AGE squared	0.0014	0.0017	0.0014	0.4062
EDUC	0.2085	0.0978	0.2085**	0.0341
MS	0.6674	1.1649	0.6674	0.5673
HS	-0.4504	0.2944	-0.4504	0.1274

HS squared	0.0145	0.0093	0.0145	0.1217
LAB	0.1774	1.6687	0.1774	0.9154
Constant	-4.4581	5.0926	-	0.3822
Number of observation = 250			Prob > F= 0.0000	
F (12, 238) = 3.92			Pseudo R squared = 0.0820	

Notes: Dependent variable is Total Land Area (LA) cultivated for Improved Cassava Variety. Reference categories of the dummy independent variables: EXT (No access to extension contact); CR (No access to credit); FA (Not belonging to Farmer association); MA (No market accessibility); LT (Land not owned); MS (Not married; single, divorced, separated, widowed); LAB (Hired labour). Other independent variables: Age and Age squared (In years); EDUC (In years); HS and HS squared (Number in a household).

Regarding the extent of adoption of the improved cassava variety, the estimated Tobit results are presented in Table 2. Except for access to extension service, farmer association and education, the rest of the independent variables were not statistically significant from the results. It was found that having access to extension contact increases the total land area used for cultivating the improved cassava varieties, which was significant at a 1 % significance level. Specifically, having access to extension contact increases the extent of adoption by 3.24 %. By implication having access to extension, contact brings improvement in production in the sense that the farmers will be educated on best farming practices and also be informed on the importance of the improved cassava varieties over the local varieties. Farmers understanding these issues then see the need to increase the land area for the improved cassava varieties cultivation compared with the land area cultivated by farmers who do not have access to extension contact. This outcome is consistent with the finding by *(*Awotide et al., 2014), who reported that having access to extension services increases the adoption of improved cassava varieties.

As expected, the results showed a positive relationship between the extent of adoption and farmer association. That is, a farmer belonging to an association increases the extent of adoption by 3.62 % and is statistically significant at a 1 % significance level. By implication, farmers who belong to associations are more likely to get enough information regarding the improved cassava varieties, and this is also likely to influence the extent of adoption compared with counterparts who do not belong to any association, all other things being equal. Again, information related to the improved cassava varieties and best farming practices is more likely to be shared during association meetings. Hence, improving farmers' production capacities and increasing the land area used to cultivate the improved cassava varieties. This result agrees with the study in Ghana by Owusu and Donkor (2012), who reported similar findings.

The result further revealed a positive correlation between the extent of adoption and education, as expected. That is, increasing the number of years a farmer spent in school increases the extent of adoption of improved cassava varieties. Specifically, a unit increase in the number of years a farmer spends in school increases the extent of adoption by 0.21 % and is statistically significant at 5 % significance level. The positive correlation could be attributed to the fact that increasing school years enhances farmers' knowledge and facilitates the acquisition and adoption of new technologies and farming practices. On the other hand, farmers with few years in school may find it difficult embracing new technologies as well as its adoption and this is likely to influence the adoption. Again, farmers who spend more years in school are more likely to use new and improved farming methods, which is likely to influence the total size of land (acres) to be used for the production of improved cassava varieties compared with counterparts who spend little years in school. Again, this result is consistent with past studies *(*Adofu et al., 2013; Owusu, Donkor, 2012).

However, the insignificant relationship between the extent of adoption and the other variables: access to credit, market accessibility, land tenure arrangement, age, marital status, household size, and source of labour does not mean the relationship does not exist; instead, it is absent in the current study. It also means that considering the study area, these variables do not influence the extent of adoption of improved cassava varieties but might influence it in other localities and settings.

4. Analysis of factors and extent of adoption of Improved Cassava Varieties

As expected, the results revealed a positive relationship between access to extension services and adoption of an improved cassava variety. Access to extension contact exhibited a positive and significant relationship in all the five improved cassava varieties. That is, farmers who have access to extension services relative to those not having access are more likely to adopt the improved cassava variety relative to the local variety. Specifically, farmers who have access to extension services relative to those who do not have access are 6.8 times, 3.0 times, 3.4 times, 11.7 times and 6.0 times more likely to adopt *Nkabom, Essambankye, Bankyehemaa, Afisiafi and Abasafitaa* accordingly relative to local varieties and these are statistically significant at 1 % and 5 % significance level, respectively for *Nkabom* and *Essambankye* and 10 % significance level for *Bankyehemaa, Afisiafi* and *Abasafitaa*. By implication, having access to extension contact means that farmers will have enough information regarding the improved cassava variety, such as the advantages of the improved variety over the local variety, and this enhances their adoption, all things being equal. On the other hand, farmers who do not have access to extension contact may lack such information, which hinders the adoption of the improved varieties. This result is consistent with past studies (Ojo, Ogunyemi, 2014).

Table 3. Estimated results for the Multinomial Logistic Regression

Variable	Coefficient	Rob. Std. Err	Relative Risk Ratio	Prob. Value
Bankyehemaa				
EXT	1.2341	0.7486	3.4352*	0.0992
CR	1.0282	0.5377	2.7961*	0.0558
FA	1.1183	0.5855	3.0597*	0.0561
EDUC	0.1863	0.0527	1.2048***	0.0004
MS	-1.7042	0.7946	0.1819**	0.0320
HS squared	0.0079	0.0046	1.0079*	0.0904
Constant	-6.9273	3.4396	0.0010	0.0440
Essambankye				
EXT	1.1016	0.4922	3.0089**	0.0252
FA	1.9384	0.5255	6.9476***	0.0002
MA	-1.0649	0.4729	0.3448**	0.0243
Constant	-0.5790	2.5487	0.5605	0.8203
Nkabom				
EXT	15.7327	0.4746	6.80e+06***	0.0000
EDUC	0.1273	0.0547	1.1358**	0.0200
MS	14.5420	0.6056	2.07e+06***	0.0000
LAB	-14.3705	0.7376	0.0000***	0.0000
Constant	-36.4181	5.8499	0.0000	0.0000
Abasafitaa				
EXT	1.7913	0.9997	5.9971*	0.0732
FA	1.2322	0.6277	3.4288**	0.0496
Constant	-8.0855	3.5271	0.0003	0.0219
Afisiafi				
EXT	2.4582	1.3517	11.6840*	0.0690

CR	1.2509	0.6500	3.4934*	0.0543
MS	-2.4262	0.6730	0.0884***	0.0003
Constant	-6.6720	3.2034	0.0013	0.0373
Number of observation = 250			Prob > chi squared = 0.0000	
Wald chi squared (60)= 1985.06			Pseudo R squared = 0.2138	

The results further revealed a positive correlation between access to credit and adoption of improved cassava variety as expected and significant in the cases of *Bankyehemaa* and *Afisiafi*. That is, farmers who have access to credit relative to those who do not have access are more likely to adopt improved cassava variety related to the local variety. Specifically, farmers with access to credits are 2.8 times and 3.5 times more likely to adopt *Bankyehemaa* and *Afisiafi,* respectively, relative to local varieties and are significant at 10 % significance level. The positive correlation could be attributed to the fact that farmers who have access to credit are more likely to purchase more farm inputs and planting materials related to the improved cassava variety for their production compared with counterparts who do not have access to credit which hinders their purchasing abilities. Therefore, having access to credit in a way enhances the adoption of improved cassava variety by the farmers, all other things being equal. This finding is consistent with the result by Owusu and Donkor (2012) in Ghana but contradicts that of (Afolami et al., 2015) in Nigeria, who reported a negative relationship between the adoption of improved cassava variety and access to credit though it was insignificant.

Regarding the relationship between farmer association and adoption of improved cassava variety, it was found that farmers who belong to associations relative to those who do not belong to associations are more likely to adopt improved cassava variety relative to the local variety. Precisely, farmers who belong to farmer associations are 6.9 times, 3.4 times and 3.1 times more likely to adopt *Essambankye, Abasafitaa and Bankyehemaa,* respectively, which are statistically significant at 1 %, 5 %, and 10 % significance level accordingly. The relationship could be ascribed to the fact that farmers who belong to associations are more likely to get information regarding the improved cassava variety, and for that matter, the probability of adopting it will be higher compared with farmers who do not belong to any association. Again, it could also be assumed that the advantages of improved cassava variety over the local variety would be discussed and shared during association meetings, enhancing adoption. Studies by Ojo and Ogunyemi (2014) and Johnson and Silveira (2014) reported the same finding in Nigeria and Southern Sierra Leone, respectively. Awotide et al. (2014) also examined factors influencing the adoption of improved rice varieties (IRV) in rural Nigeria using the Tobit Regression Model, where the dependent variable (intensity of adoption) was defined as the proportion of farmland allocated to improved rice variety. Their empirical results identified factors such as membership in a Farmer-Based Organization (FBO), the level of training and distance to the seed input shop that positively and significantly affects IVR's intensity.

The results of market accessibility and adoption revealed a negative relationship that contradicts the a priori expectation and is significant only in the case of *Essambankye*. That is, farmers who have access to market for their products relative to farmers who do not have access are less likely to adopt *Essambankye* relative to the local variety. Farmers who have market access are 0.3 times less likely to adopt *Essambankye* compared with counterparts who do not have access and is statistically significant at 5 % significance level. The result is surprising because having access to the market for produce should positively influence the adoption of improved variety, all other things being equal. This notwithstanding, it could be because farmers in the study area do not put much emphasis on market accessibility before adopting *Essambankye*. It could also be attributed to the preference for *Essambankye*. If there is market accessibility and the preference for it is absent, the probability of adopting it will be lower as a result has shown.

Table 3 shows a positive relationship between education and adoption of improved cassava varieties as expected. That is, spending more years in school increases the probability of adopting improved cassava variety. Specifically, farmers who spend more years in school compared to those who spend little years in school are 1.2 times and 1.1 times more likely to adopt Bankyehemaa and Nkabom, respectively. Accordingly, these are statistically significant at 1 % and 5 % significance levels. By implication, spending more years in school improves the skills of farmers, enhancing

their knowledge and understanding more than uneducated farmers or spending fewer years in school. Formal education enlightens the farmers' view on adopting improved cassava varieties; for that matter, it enhances the adoption of improved cassava varieties. Again, spending more years in school facilitates using new technologies and farming practices, increasing the likelihood of adopting the improved variety given its advantages over the local variety. Previous studies by Ehinmowo and Fatuase (2016) reported a positive relationship between education and the adoption of improved cassava variety. Gebresilassie and Bekele (2015) found that farmers with higher years of formal education have a higher probability of allocating a significant proportion of their farmlands to an improved variety of wheat seeds. This is because educated households are better skilled and can quickly synthesise production technologies and market information.

The results revealed a mixed relationship between marital status and adoption of improved cassava varieties. The relationships between adoption of *Bankyehemaa* and *Afisiafi* and marital status are negative and are statistically significant at 5% and 1% significance levels, respectively, while that of adoption and *Nkabom* is positive and significant at a 1% significance level. This implies that farmers who are married relative to those who are not married (single, separated/divorced, widowed) are 2.1 times more likely to adopt *Nkabom* relative to the local variety. Again, farmers who are married are 0.2 times and 0.1 times less likely to adopt *Bankyehemaa* and *Afisiafi,* respectively relative to the local variety. By implication, farmers who are married are more concerned about food security and family welfare. For this reason, they are more likely to adopt *Nkabom* to have enough food to feed the family and ensure food security. Again, married farmers will want to increase returns to be able to cater for the family in terms of finances and are more likely to adopt Nkabom, an improved variety with higher yield relative to the local variety. In other studies, Afolami et al. (2015) and Johnson and Silveira (2014) reported a positive relationship between the adoption of improved cassava varieties and marital status in Nigeria and Southern Sierra Leone, respectively.

On the other hand, the negative relationship between marital status and adoption of *Bankyehemaa* and *Afisiafi* could explain that married farmers might have noticed or experienced something (bad taste, chemicals) about the improved varieties, reducing their likelihood of adopting it relative to the local variety. This could be true as many people have raised concerns about the negative implication on health regarding the introduction of new and improved varieties of crops and other plants in the country. Again, it could also be attributed to the fact that married farmers who are much concerned about the family health might consider the negative effect of such improved variety and, for that matter, less likely to adopt it. Previous studies have reported a negative relationship between marital status and adoption of improved cassava variety *(*Ojo, Ogunyemi, 2014).

The results in Table 3 further showed a positive relationship between the adoption of improved varieties and the size of household size. That is, an increase in household size (to a certain threshold) increases the likelihood of adopting *Bankyehemaa*. Farmers with greater household size are 1 point more likely to adopt Bankyehemaa relative to local variety, which is significant at 10 %. Farmers with greater household sizes will have more labour to cultivate *Bankyehemaa* should it be adopted. Therefore, farmers with larger household size are more likely to adopt it as more labour (especially within the active labour group) are generally needed for farming activities. A larger household size could also help cultivate a larger land area to feed the family and ensure food adequacy since members are likely to assist in farming activities. This finding is consistent with that of previous studies by Owusu and Donkor (2012) but contradicts the result by *Amao and Awoyemi, 2008*.

Regarding the source of labour and adoption of improved cassava varieties, the study revealed a negative relationship which contradicts the apriori expectation. Farmers who use owned labour or their labour for their cultivation relative to those who hire labour are 0.0001 times less likely to adopt Nkabom relative to local variety and is significant at a 1% significance level. This implicitly means that farmers who hire labour for cultivation are more likely to adopt improved cassava varieties. The negative relationship could mean that farmers' own labour might not be enough for farming activities compared with farmers who hire labour and, for that matter, might have enough labourers for farming activities. This, therefore, reduces the likelihood of adopting *Nkabom* as revealed by the result. This result agrees with the findings by Awotide et al. (2014), who

reported that farmers who hire labour for farming activities are more likely to adopt improved cassava variety than farmers who use their labour for cultivation.

4. Conclusion

Given the results obtained and the discussions, the study has the following conclusions:

First, the proportion of adoption of improved cassava varieties was generally low. Essambankye was the most adopted variety in the study area among the improved cassava varieties. The returns on the local varieties were higher than that of the improved cassava varieties. This might have accounted for the low level of adoption of the improved cassava varieties. Thus, the studies found that returns influenced adoption. The significant factors that increased the adoption of improved cassava varieties are access to extension services, access to credit, membership in farmer associations, educational level, marital status, and household size. Access to extension services, membership in farmer associations and educational level increase the adoption of improved cassava varieties. We recommend that due to the advantages of the improved cassava varieties, such as higher output over the local varieties, awareness and education on improved cassava varieties should be intensified so that the farmers will adopt them.

Secondly, we recommend that the government, through MoFA, improve access to extension services and make credit affordable to farmers in the study as the study has revealed that farmers who have access to these are more likely to adopt the improved cassava varieties. This will likely motivate farmers to cultivate on larger land areas to ensure food security and get higher returns, all other things being equal. Enhancing access to extension services is also likely to increase the extent of adoption, as revealed by the study. Again, the study has revealed that about 196 (78.4%) farmers do not have access to credit, so if this is addressed, the proportion of adoption of improved cassava varieties will be improved considering the 39.6% adoption rate revealed by the study. The study has shown that farmers who belong to farmer associations were more likely to adopt improved cassava varieties. It is recommended that farmers in Mampong Municipality should be sensitised on the importance of belonging to the farmer association and encouraged to join.

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6. Declaration of Competing Interest

The manuscript's authors declare that there is no interest in conflict, and all reference materials were dully acknowledged.

7. Funding

None.

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