

## Adoption of Improved Cassava Varieties in Ghana

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**Abstract:** The study explores the adoption of improved cassava varieties among smallholder farmers in Ghana. The improved cassava varieties introduced to farmers in the study area (Sekyere South district, Ghana) are *Bankye hema* and *Bankye afisiafi*. The effects of the determinants of the extent of adoption are analysed with the Tobit Model. The empirical results indicate that age and education of the farmer, household size, membership of farmer-based organization, access to credit tend to have positive influence on the extent of adoption of improved cassava varieties by farmers. The age of the farmer and location-level specific effects tend to be negatively related to the extent of adoption of the improved cassava varieties. It is recommended that policy-makers create an enabling environment for farmers to join farmer-based organizations. Farmers must be provided frequent education and training on technology adoption.

**Key words:** Ghana, improved cassava variety, technology adoption, Tobit, policy makers, farmers

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### INTRODUCTION

Cassava is one of the dominant staple food crops in many developing countries, especially in the humid and sub-humid tropics of Africa. About >500 million people in the tropics particularly Africa depend on cassava (RTIP, 2004). The potential for improving the living standards of rural farmers in West Africa through cassava production has been documented (Omonona *et al.*, 2006; Kormawa *et al.*, 2001; Dankyi and Adjekum, 2007). In Ghana, cassava is one of the major food crops cultivated in most rural communities (Moses, 2008). It contributes about 22% of the agricultural Gross Domestic Product (GDP) and employs a large number of the rural population. It is estimated that the production of cassava in Ghana is >12 million metric ton annum<sup>-1</sup> (SRID, 2009). In terms of quantity produced, cassava is the most important root crop in Ghana followed by yam and cocoyam (SRID, 2009). The national output of cassava in Ghana increased from 7.15 million ton in 1997-10.6 million ton in 2008, representing an increase of 48.3% (WAAPP, 2009). The area cultivated under cassava increased by 45.8% from 592,000 ha in 1997 to 840,000 ha in 2008. Due to the ability of cassava to withstand drought and thrive well on poor soils, it is considered as one of the strategic famine reserve crops in areas where rainfall is unreliable (Hendershot, 2004). This gives it an advantage over yam and other root and tuber crops in Africa. The yield per unit area of cassava has remained almost the same over the years in Ghana. In order to reverse the low

productivity of cassava in Ghana, root and tuber improvement strategies have been implemented in Ghana since 2006. The Sekyere South district in the Ashanti region of Ghana is one of the beneficiaries of the programme for improving the productivity of roots and tubers. Under such a programme, improved cassava varieties with early harvest ability (6 months maturity after planting), good plant type (tall and non-branching or less-branching), good stake quality (germination and storage duration), good root shape with white flesh, tolerant to major pests and diseases have been introduced to rural farmers in the district.

Yield per unit of cassava in the Sekyere South district was 12.1 ton ha<sup>-1</sup> in 1997 and 12.8 ton ha<sup>-1</sup> in 2008. With an average yield potential of 12.00 ton ha<sup>-1</sup> about 81,240 ton of cassava was produced from the 6,770 ha of land in the district in 2009 (SRID, 2009). Farmers normally obtain 12 ton ha<sup>-1</sup> from cassava production but the improved cassava varieties have an average yield potential of 30 ton ha<sup>-1</sup> (SRID, 2009). In spite of the superior characteristics and qualities of the improved cassava varieties, Agricultural Extension Agents (AEAs) and other stakeholders claim that farmer awareness of the improved varieties has not been translated into adoption as adoption rates have been very slow. If the improved cassava varieties had been planted by farmers about 3,508,260 ton of cassava would have been obtained from the 6,770 ha of land. Dankyi and Adjekum (2007) for instance, point out that the adoption rate and adoption intensity of the improved cassava varieties in the

Southern part of Ghana as at 2007 were 9 and 37%, respectively. Among the many factors that contribute to increased agricultural productivity, improved technology is the most important but its adoption has been a major challenge in Africa (Adesina and Baidu-Forson, 1995). The extent of adoption is one of the questions that must be addressed in the adoption process of any technology. The main objective of this study is to investigate the factors which influence the probability and extent of adoption of the improved cassava varieties by farmers in the Sekyere South district in the Ashanti region of Ghana. Understanding the effects of the factors which influence farmers' preferences for the improved cassava varieties would serve as an input to the design of effective strategies for the diffusion of high yielding cassava. The theme of the present study is therefore relevant.

## MATERIALS AND METHODS

### Literature review on adoption of cassava varieties in Ghana:

A lot of attention has been given to the development and adoption of new cassava varieties in Ghana due to the importance of cassava in contributing to food security in Ghana. For almost 35 years (1928-1962), cassava research has been carried out in Ghana by relevant institutions including Kwame Nkrumah University of Science and Technology (KNUST), University of Cape Coast, Council of Scientific and Industrial Research (CSIR), Crop Research Institute (CRI) and the Savanna Agricultural Research Institute (SARI). The Ministry of Food and Agriculture (MoFA) has also played a critical role in the adoption of new cassava varieties by farmers in Ghana. Systematic breeding and selection started in 1930 when there was an outbreak of Cassava Mosaic Virus Disease (CMVD). In 1935, four outstanding varieties namely; Queen, gari, williams and ankrah were released. These were high yielding (7-10 ton ha<sup>-1</sup>) of good taste, highly resistant to CMVD and were grown widely throughout the country. In 1965, four varieties K357, K162, K680 and K491 were released to farmers. The best K680, yielded around 19 ton ha<sup>-1</sup> had moderate resistance to CMVD with good palatability and cooking quality (Korang-Amoakoh *et al.*, 1987).

Another four new cassava varieties were released in 1993 by the National Research Institutions and the universities (CRI, 1994). These include afisiafi, gblemo and abasafitaa; all released by CSIR-CRI and Tekbankye which was released by KNUST. These are early maturity and high-yielding cassava varieties with maturity period of 12 months and with a yield of about 35 ton ha<sup>-1</sup>. The varieties are also tolerant to the cassava mosaic virus and have moderate resistance to the cassava mealybug pests. Notably, the new cassava varieties out-yield local

varieties on farmers' fields by 40% without fertilizer. The varieties are superior to local varieties in terms of yield, earliness and pest and disease tolerance and they are as good as the local varieties in terms of various post-harvest attributes and for intercropping. In 2005, the research efforts by the CSIR-CRI and CSIR-SARI and the universities led to the release of eleven new cassava varieties. These were essam bankye, bankye hema, dokuduade, agbelifia all released by CSIR-CRI. The others were fillindiakong, eskamaye, nyerikobyia released by CSIR-SARI, capevars bankye and bankye botan released by the University of Cape Coast. The KNUST also released Nkabom and IFAD Banakye in 2005. The average yield of these improved cassava varieties is about 48 ton ha<sup>-1</sup>. All the varieties were highly tolerant to cassava mosaic virus disease and cassava bacteria blight. Some of them also had limited tolerance to brown leaf spot, root rot and anthracnose. Recently, specifically in 2010, four new varieties were released by CSIR-CRI to boost cassava production in Ghana. These are among, bankye bron, sika bankye and otuhia, all with an average yield of 35 ton ha<sup>-1</sup>.

Although, these new varieties confer very good attributes and resistance to African cassava mosaic virus disease, literature on the levels of adoption and diffusion in Ghana have been scanty. This present study attempts to contribute to the existing literature by focusing on the extent of adoption of *Bankye hema* and *Bankye afisiafi* in Ghana. The extent of adoption is examined as the area cultivated under the improved cassava varieties.

### Conceptual framework and empirical specification:

The extent of adoption of the improved cassava varieties among the farmers is explored with a Tobit Model:

$$J_{ik}^* = \begin{cases} Z\alpha' + \varepsilon_{ik} & \text{if } J_{ik}^* > 0; \varepsilon_{ik} : N(0, 1), k = 1, 2 \\ 0 & \text{if } J_{ik}^* \leq 0 \end{cases} \quad (1)$$

Where:

- $J_{ik}$  = A censored dependent variable indicating the extent of adoption of cassava variety  $k$  by the farmer  $i$
- $k$  = The area cultivated under each of the two of the improved cassava variety
- $\alpha'$  = Vector of parameters to be estimated, vector
- $Z$  = Comprises the personal, household and farm-specific characteristics of the farmer, specifically, farmer's age, education, gender, household size, membership of a farmer organization, credit access family labor and location of farmer
- $\varepsilon_1$  = A standard normally distributed error term capturing unobserved effects

The Tobit Model examines not only the probability of adoption but also the extent of adoption of the improved cassava technologies. The extent of adoption of improved cassava variety is measured as the areas cultivated (hectares) under *Bankye hema* and *Bankye afisiafi*. The relevant explanatory variables are the following: Age denotes the age of the farmer (years). Male denoting gender is equal to 1 if the farmer is male and 0 otherwise. Educn denotes the number of years of farmer's formal education. Credit is equal to 1 if the farmer accessed credit for farming in 2010 and 0 otherwise FBO = 1 if the farmer is a member of a farmer-based organization and 0 otherwise. Hhsize denotes the farmer's household size. Famlab indicates 1 if the farmer used family labor on the farm and 0 otherwise and:

$$\sum_{i=1}^{n-1} (\text{LSDUM})_{ij}^{n-1}$$

indicates location-specific dummies where the number of dummies,  $n = 4$ . Age of the farmer is expected to be negatively related to the extent of adoption. The risk aversion of farmers increases as they advance in age. So, the likelihood of rejecting new technologies by older farmers tends to increase. This assertion that relatively younger farm household heads have higher probability to increase area under improved agricultural technology is supported by Hoang. Male-headed households are often more likely to get information about new technologies and take risky businesses than female-headed households (Asfaw and Admassie, 2004). The male variable is expected to have positive effect on the extent of adoption of the improved cassava varieties. Tenge *et al.* (2004) have argued that female-headed households in sub-Saharan Africa tend to be reluctant in adopting new technologies because of their limited access to information, land and other resources. The household size of farmers is hypothesized to increase the probability and extent of adoption of improved technological package since large household sizes tend to provide available labor input on the farm (Ekong, 2003).

Education is expected to increase the extent of adoption of improved agricultural technology. Education is relevant to farm production in a rapidly changing technological or economic environment (Munshi, 2004). Increasing literacy and numeracy may help farmers to acquire and understand information and to calculate appropriately input quantities in a modernizing or rapidly changing environment. Education directly enhances farm productivity by improving the quality of labour and the propensity to adopt agricultural innovations successfully (Feder *et al.*, 2003; Knight *et al.*, 2003). Improved attitudes, beliefs and habits may lead to greater willingness to accept risk, adopt innovations, save for

investment and generally to embrace productive practices. Schooling is not only useful after new technologies have been adopted but it may also help to determine whether a farmer decides to be an early adopter of innovations and the extent to which the new innovation will be used (Renko *et al.*, 2002). Exposure to formal education will increase a farmer's ability to obtain, process and use information relevant to the adoption of technology.

The variable representing farmer-based organization is expected to be positively related to area cultivated under the improved cassava variety. Farmers who join in community-based organizations and participate actively in the activities of FBO's are likely to have access to information on improved technologies. The homogeneity within groups with the same beliefs and social norms encourages trust and sharing of information on adoption of new technologies (Yli-Renko *et al.*, 2002). Farmer's access to credit is hypothesized to have a positive relationship with the extent of adoption of improved cassava variety. Farmers with liquidity constraints and limited access to credit for farming may not be able to raise sufficient funds to invest in new agricultural technology (Langyintuo and Mekuria, 2008).

**Sources of data:** The study's target population comprises all cassava farmers in the Sekyere South district of the Ashanti region of Ghana. The district was purposely selected amongst the 26 districts in the Ashanti region because of the ongoing Root and Tuber Improvement and Marketing Programme (RTIMP) introduced in the area in 2006 by the Government of Ghana (GoG) and the International Fund for Agricultural Development (IFAD).

The study was carried out in 2010 after 4 years of the implementation of the RTIMP in the district. The project is expected to end in 2012. For agricultural purposes, the district is divided into 13 operational areas namely, Agona East, Agona West, Jamasi, Dawu, Boanim, Wiamease, Bepoase, Bipoa, Afamanaso, Domeabra, Tano-Odumase, Kona and Asamang. Five of these operational areas were randomly selected. Based on the population of farmers in the 5 selected areas, 81 farmers were randomly selected from Tano Odumase, 93 from Kona, 75 from Agona East, 35 from Agona West and 66 from Jamasi making a total sample of 350 cassava farmers for the study. Random sampling technique was employed due to its simplicity and its appropriateness by way of allowing each cassava farmer in the district an equal chance of being selected for the study. Structured questionnaires were used for the primary data collected for the study. The questionnaires captured information on the personal and household characteristics of the cassava farmers such as age, educational level, membership of farmer-based organization, credit access, household size and family labor of the farmers in the area. Age and education of the

**Table 1: Descriptive statistics of variables used in the regression models**

Variables	Variable definition	<i>Bankye hemma</i>			<i>Bankye afisiafi</i>		
		Adopters		Mean dif.	Adopters		Mean dif.
		(N = 38)	Non-adopters (N = 312)		(N = 18)	Non-adopters (N = 332)	
Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Age	Age of the farmer (years)	37.05 (6.60)	53.44 (8.73)	-16.39***	40.33 (5.680)	52.27 (9.75)	-11.94***
Male	1 if farmer is a male, 0 otherwise	0.66 (0.48)	0.32 (0.47)	0.34***	0.72 (0.460)	0.34 (0.34)	0.38***
Eductn	No. of years of schooling	9.79 (2.28)	5.94 (3.42)	3.85***	10.72 (1.990)	6.12 (3.43)	4.60***
Credit	1 if farmer access credit in 2010, 0 otherwise	0.89 (0.31)	0.30 (0.46)	0.59***	0.83 (0.380)	0.34 (0.48)	0.49***
FBO	1 if farmer is a member of Farmer-Based Organization, 0 otherwise	0.53 (0.51)	0.04 (0.19)	0.49***	0.78 (0.430)	0.05 (0.22)	0.73***
Hhsize	Household size	11.53 (2.65)	7.88 (2.72)	3.65***	14.06 (4.150)	7.96 (2.51)	6.10***
Famlab	1 if farmer employs family labor on the farm, 0 otherwise	0.82 (0.39)	0.90 (0.30)	-0.08	0.78 (0.430)	0.90 (0.30)	-0.12
Jamasi	1 if farmer is located at Jamasi, 0 otherwise	0.24 (0.43)	0.18 (0.39)	0.06	0.11 (0.320)	0.19 (0.40)	-0.08
Kona	1 if farmer is located at Kona, 0 otherwise	0.26 (0.45)	0.27 (0.44)	-0.01	0.28 (0.460)	0.27 (0.44)	0.01
Agona	1 if farmer is located at Agona, 0 otherwise	0.18 (0.39)	0.33 (0.47)	-0.15**	0.06 (0.240)	0.33 (0.47)	-0.27**
Tano	1 if farmer is located at Tano Odumase, 0 otherwise	0.32 (0.47)	0.22 (0.42)	0.10	0.56 (0.510)	0.21 (0.41)	0.35**

\*\*\*, \*\*Denotes significant at 10, 5 and 1% level, respectively. Figures in parentheses are standard deviations. Field survey (2010)

farmer are shown in Table 1. The farm characteristics, specifically, areas cultivated under *Bankye afisiafi* and *Bankye hema* (ha) and labor source are shown in Table 1. The dependent variable in each Tobit specification explains the extent of adoption of the improved cassava variety among the sampled farmers. Notably, researchers represent the extent of adoption of the improved cassava varieties by the area under the improved cassava variety.

**RESULTS AND DISCUSSION**

Majority of the adopters (25%) of the improved cassava varieties are from Tano Odumase. This is probably due to the predominant gari processing activities in the community. The farmers tend to produce cassava to feed the cassava processing factory located in the community. Notably, about 19% of the farmers have adopted the *Bankye hema*. Farmers mentioned higher yield and suitability for consumption and gari processing as reasons for the adoption of this improved cassava variety. About 5% have adopted the *Bankye afisiafi*. The results further reveal a high proportion of non-adoption of the improved cassava varieties among the sampled cassava farmers. Most of the farmers (53%) mentioned the non-availability of planting materials from the Ministry of Food and Agriculture (MoFA) as the main reason for the non-adoption of the improved cassava varieties in the sampled area. Also, about 26.2% of the farmers attributed the non-adoption of the improved cassava varieties to the high moisture content and 13.1% indicated high starchy content of the improved cassava varieties. Interestingly, 5.23% hinted that lack of information on the improved varieties also hinders adoption. The sources of the planting materials are the District Office of the Ministry of Food and Agriculture (82.02%) and own-purchase from the Mampong Research Center (5.66%) in the Ashanti

**Table 2: Tobit estimates on the extent of adoption of improved cassava varieties**

Variables	<i>Bankye hemma</i> coefficient	<i>Bankye afisiafi</i> coefficient
Age	-0.1674 (-3.33)***	-0.0368 (-0.42)
Male	1.0562 (167)*	0.5869 (0.41)
Eductn	0.0342 (0.22)	0.5173 (1.95)**
Credit	3.2157 (2.70)***	-0.2460 (-0.12)
FBO	1.7336 (1.93)**	4.1824 (2.29)**
HHsize	0.0809 (0.63)	0.4741 (2.17)**
Famlab	0.0626 (0.06)	-0.8354 (-0.49)
Jamasi	-0.5637 (-0.54)	-4.2130 (-1.77)*
Kona	-0.8233 (-0.90)	-3.2192 (-1.95)**
Agona	-1.1312 (-1.10)	-2.6156 (-1.39)
Constant	0.1275 (0.05)	-12.9333 (-2.06)**
Observations	350	350
Pseudo-R <sup>2</sup>	0.3240	0.3559
Log-likelihood	-115.6111	-73.5574

\*, \*\*, \*\*\*Denotes significant at 10, 5 and 1% level, respectively. Figures in parentheses are t-values. Field Survey (2010)

region of Ghana. The descriptive statistics of the variables employed in the regression models and their differences in means are shown in Table 1. There are significant differences between the adopters and non-adopters of both *Bankye hema* and *Bankye afisiafi* regarding their age, gender, education, access to credit, membership of farmer-based organization and household size. The Tobit estimates on the extent of adoption of the improved cassava varieties are shown in Table 2. Generally, the Tobit estimates indicate that the relevant factors which influence the extent of adoption of improved cassava varieties are the age and education of the farmer, household size, membership of farmer-based organization, access to credit and village-level specific effects. In addition, having more males in the farm household tend to increase the area cultivated under the improved cassava variety.

The negative coefficient for the age variable suggests that the area cultivated *Bankye hema* increases as the age of the farmer decreases, a result which suggests that younger farmers tend to adopt the *Bankye hema*. The coefficient of the variable representing male is significant

at the 10% level and has a positive influence on the area cultivated under *Bankye hema*. The coefficient of male in the specification of *Bankye afisiafi* on the other hand is positive, albeit statistically insignificant even at the 10% level. These empirical results suggest that male farmers tend to adopt and increase area under improved cassava varieties than female farmers. The education variable has significant positive significant effect on the area cultivated under *Bankye afisiafi*. The coefficient for *Bankye hema* rather exhibits the hypothesized sign but statistically insignificant. These suggest that the area cultivated under the improved cassava varieties increases as the number of years of schooling of the farmer increases. Education improves the managerial skills and human capital of farmers. It enlightens and imparts the necessary knowledge on new technological packages and provides the skills and understanding on how to use the new technology efficiently. Again, a person's exposure to education tends to increase his ability to obtain process and utilize information relevant to technology. The empirical result concurs with Kudi *et al.* (2011). Access to information on new technologies is crucial for awareness creation and changing of attitudes towards technology adoption (Caviglia and Kahn, 2001). Access to credit by farmers has a positive and significant impact on the area cultivated under *Bankye hema*. The coefficient of *Bankye afisiafi* also shows the expected positive sign. This indicates that when rural farmers have adequate cash to purchase inputs such as improved cassava planting materials, agrochemicals and labor, adoption of improved technology is enhanced and area cultivated also increases. These empirical finding is consistent with Lawal *et al.* (2004) and Kudi *et al.* (2011). Omonona *et al.* (2006), however found negative relationship between the probability of adoption of improved cassava varieties and access to credit.

The coefficients of membership of farmer-based organization are statistically significant at 5% levels in both Tobit Models specified for the areas cultivated under the improved cassava varieties. The results thus indicate that membership of farmer-based organization significantly increases the likelihood of farmers to adopt and increase the area under cultivation of the improved cassava varieties.

The household size variable is significant at the 5% level and positively related to the area cultivated under the improved cassava varieties. This suggests that larger household size tend to increase the area cultivated under improved cassava varieties. Large rural households tend to have available family labor for farmwork which

enhances adoption and increases area under cultivation of improved agricultural technologies. Omonona *et al.* (2006), however did not find household size as a significant factor in adoption of improved agricultural technology.

Also, Amao and Awoyemi (2008) found a negative effect for the household size variable. Also interesting to note are the significant negative coefficients of the location-specific variables examined in the regression models. Specifically, the location dummies for Jamasi and Kona exhibit significant negative relationships with the area cultivated under *Bankye afisiafi*.

The default location dummy is Tano-Odumase which in this case has positive effect. Location of a farmer may influence how readily he could access information on improved agricultural technology. Acquisition of variable inputs and micro-credit to enhance expansion of area under cultivation may also be influenced by the location-specific effects.

## CONCLUSION

The study has examined the adoption of the improved cassava varieties with a cross-sectional data collected in 2010 among 350 cassava farmers in the Sekyere South district of the Ashanti region of Ghana.

The most adopted improved cassava varieties introduced into the district by the Root and Tubers Improvement Marketing Programme (RTIMP) are the *Bankye hema* and *Bankye afisiafi*. Adoption rates of the improved cassava varieties were found to be low as only 15% of the sampled farmers have adopted the improved cassava varieties mostly due to unavailability and inadequate planting materials and high moisture content of some of the improved cassava varieties. The empirical investigation revealed that factors such as age and education of the farmer, household size, membership of farmer-based organization, access to credit and village-level specific effect tend to influence the extent of adoption of the improved cassava varieties by the farmers.

## RECOMMENDATIONS

To enhance the adoption of improved cassava varieties in Ghana, it is recommended that policy-makers should create the enabling environment for farmers to form or join farmer-based organizations. Farmers should be encouraged to register with the local credit-unions

and community-based credit organizations that offer interest-free and accessible micro-credits with flexible repayment plans. Frequent training and education should be provided to farmers on by and crop breeders and other stakeholders on technology development and transfer. In particular, farmers should be involved in the evaluation of challenges associated with newly introduced agricultural technologies.

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