Proceedings of the 13th ISTRC Symposium, 2007
pp. 641 - 647

Determinants of the adoption of improved cassava varieties in Southern Ghana - logistic regression analysis

Dankyi A.A.[1] and Adjekum A.A.[2]
[1]Crops Research Institute, P. O. Box 3785, Kumasi, Ghana.
[2]RTIP, Ministry of Food and Agriculture, P. O. Box 7728, Kumasi, Ghana

Abstract. A benchmark adoption survey under the Root and Tuber Improvement Project of Ghana was conducted in 2001 to provide baseline indicators of adoption and impact for cassava. The sample size of the survey was 150 farmers selected at random from 18 agricultural districts under 5 of the regions of southern Ghana. The adoption rate for improved cassava varieties was 9%. The adoption intensity which is the area under improved cassava cultivation was 37% in the 2001 crop season. The mean size of fields planted to improved cassava by farmers was 3.6 hectares compared with 0.8 hectares by farmers planting local varieties. This means that farmers who plant improved cassava varieties may appear few but cultivate larger field sizes than their counterparts who plant local varieties. For farmers who never used improved cassava varieties, their reasons were related to availability of improved cassava planting material. Most of them did not know about the improved varieties or could not get them to plant. In a logistic regression analysis to determine the factors affecting the adoption of the improved varieties, land tenure, total field size farmed in 2001 and decisions with extension staff on cassava with farmers had positive and significant effect on the adoption of improved cassava varieties. Years of self-decision on farming and whether farmers had ever bought cassava cuttings were however, negatively related and significant. This suggests that farmers who have recently been in cassava cultivation are more likely to adopt improved cassava varieties than their counterparts with longer experience. Gender and planting arrangement did not have a significant effect although they were positively related.

Introduction

Cassava is an important food security crop in Ghana. Yields from farmers fields are generally low, about 12 tons/ha compared with the achievable yield of 28 tons/ha. The Root and Tuber Improvement Project (RTIP) was set up to help increase production in farmers' fields by developing and extending improved technologies of root and tuber crops to Ghanaian farmers. Cassava was one of the target crops. In the course of developing and transferring technologies it was necessary to assess the adoption rates of the improved technologies and the factors influencing adoption. The results could serve as a feedback information to research, extension, policy makers and other stakeholders. The results could also be used as a measure of progress and the discovery of challenges for future research and extension in Ghana.

The purpose of this paper was to examine the adoption rate for improved cassava varieties and the key factors affecting adoption in Southern Ghana.

The Analytical Model. The use of discrete choice models such as LOGIT, PROBIT and TOBIT in explaining adoption are well documented (Shiverly, 1997; Tennassie and Sanders, 1996; Adesina and Badu-Forson

1995). These studies have variously used farmer and farmer characteristics and or farmer perceptions to explain the adoption process.

Understanding adoption behaviour goes beyond looking at single relations to multivariate relationships. Multiple regression may be used to analyse such relationships but the dependent variable must be continuous. Since many adoption studies deal with adoption as a "yes" or "no" dependent variable, LOGIT, PROBIT and TOBIT analyses are the appropriate tool.

Both LOGIT and PROBIT techniques use a series of characteristics of the farmer or the farm to predict the probability of adoption. LOGIT and PROBIT analyses give similar results. The difference is that while LOGIT assumes that the dependent variable follows a logistic distribution, PROBIT assumes a cumulative normal distribution.

The estimated probability of adoption in the LOGIT model is given by:

$$F(b'X) = 1/\ 1+e^{-b'x}$$

This is the cumulative probability distribution. The expression b'X is defined as:

$$b'X = b_o + b_1 X_1 + b_2X_2 + ... + b_kX_k$$

Where:

b_o = constant

b_1, b_2,....b_k = other estimated coefficient.

X_1, X_2,....X_k = values of independent variables.

With this expression, the probability of adoption of a new technology can be estimated.

In this study, the logistic regression model is used to determine the factors affecting the adoption of improved cassava varieties. The logistic regression gives the same results as LOGIT. The logistic regression can be rewritten in terms of the "odds" of an event occurring. The odds of an event occurring are the ratio of the probability that it will occur to the probability that it will not. When the logistic model is written in terms of the log of the "odds", it is called a LOGIT. The Logistic regression estimates directly the probability of an event occurring and is suited to models where the dependent variable is dichotomous.

The sample. Given the resources available and the fact that cassava is grown in all the southern regions of Ghana, a decision was taken to randomly select five out of the seven southern regions in Ghana. The regions chosen at random were the Ashanti, Brong Ahafo, Greater Accra, Volta and the Eastern Regions. The number of districts chosen per region was based on the number of districts in the region, the population (using the 1984 Population Census of Ghana) and the ecological zones. Based on these criteria, 5 districts in the Brong Ahafo, 4 in the Ashanti, 3 in the Eastern, 2 in the Volta and 4 in the Greater Accra Regions were selected among all the districts cultivating cassava in the region. A total of 18 districts were covered. The actual selection of the districts was made random but proportional to the area under cassava cultivation using the 1999 Production data from the Ministry of Food and Agriculture (MOFA). Thus a district with a bigger area under cassava cultivation had a higher chance of being picked. From these districts, 2 villages were further sampled randomly. Since it was not possible to obtain a list of all farmers cultivating cassava because almost all farmers planted cassava, houses in the villages were chosen at random and if a farmer fell into the sample, he or she was interviewed. In each village 5 houses were selected and a farmer interviewed in each of the houses. Thus, 5 farmers were chosen from each of the villages. Thirty villages were covered and the total sample size was 150. The districts sampled and their ecological zones are shown in Table 1.

In addition to frequencies, the logistic regression model was employed to determine the factors affecting the adoption of improved varieties.

Table 1: Sampled districts, Ghana.

Region	District	Ecological zone
Ashanti	Sekyere East	Forest
	Ejisu-Juaben	Forest
	Amansie East	Forest
	Ashanti-Akim North	Forest
Brong Ahafo	Wenchi	Transition
	Tano	Forest
	Nkoranza	Transition
	Techiman	Transition
	Sunyani	Forest
Greater Accra	Ga	Coastal savannah
	Dangbe East	Coastal savannah
	Tema	Coastal savannah
	Dangbe West	Coastal savannah
Volta Region	Akatsi	Coastal savannah
	South Tongu	Coastal savannah
Eastern Region	New Juaben	Forest
	East Akim	Forest
	Fanteakwa	Forest

Results

Sample characteristics. The characteristics of the sample are summarized in Table 2. Male farmers formed about two-thirds of the sample and female farmers were one-third. Most of the farmers were natives of the towns and villages. Thirty two percent of the sample had no formal education. About half (49%) of the farmers had between 6 and 10 years of formal education. Age group between 20 years and over 60 years were involved in the cultivation of cassava. The age group of 30-39 years and 40-49 years formed over half of the farmers planting cassava.

Some descriptive statistics of the sample indicated that farmers began taking their own decisions between 1 and 60 years ago. The mean number of years of self-decision on farmers' cassava farm was 17.9 years suggesting that they have had a long experience in the cultivation of cassava. The size of main cassava field was between 0.04ha – 4ha and a mean of 0.8 ha.

A descriptive statistic of all land farmed to all crops in 2001 showed that the mean size of 1.32ha was farmed. Cassava occupied 61% of the total area cropped to all crops by farmers in 2001. Most farmers (95%) cultivated cassava in a single field at a time and the rest had two or more fields.

Land ownership. An important ingredient to decision-making is land ownership. For cassava production, 70% of the farmers owned the land they cultivated, 14% rented, 13% sharecropped and 3% practiced communal or other land arrangements. These mean that majority of the farmers had rights to the land and got the benefits accruing from cassava farming.

Cropping systems. The majority of the farmers (83%) intercropped cassava with other crops and only 17% monocropped. Therefore, intercropping was the dominant practice. Farmers who intercropped and sharecropped planted significantly larger area of mean of 0.16ha compared with those monocropping and sharecropping of 0.04ha.

Adoption rate. Adoption rate may be defined as the proportion of the population practicing the new technology that, in this case, is the use of improved varieties. The intensity of adoption, however, is the percentage of the area where the technology is used (Adesina and Zinnah, 1993). Both definitions are important in the analysis of adoption of improved technologies. The improved cassava varieties extended to farmers were Afisiafi, Tek bankye, Gblemo duade and Abasafitaa. The adoption rate for all the improved cassava varieties in 2001 (Table 3) was 9%. However, in terms of the area under cultivation referred to as the adoption intensity, the value for the improved varieties was 37%. This means that although few farmers adopted the improved cassava varieties, they planted larger area. Indeed, the mean size of farmers who planted improved cassava varieties was 3.6ha compared with 0.8ha of those planting local cassava.

Extension activities. Sixty-two percent of the farmers obtained their improved cassava varieties from extension, 23% from research and 15% from other farmers. It is also interesting to note that farmers who planted improved cassava had significantly more discussions with extension agents than their counterparts who planted local varieties. The number of times farmers had discussions on cassava production techniques with extension agents between 1999 and 2001 was 8 compared with 2 for farmers planting local cassava.

Table 2: Characteristics of the sample.

Characteristic	Percent of farmers
Gender:	
Male	63
Female	37
Residence status	
Native	80
Settler	20
Formal education	
0 years	32
1-5 years	7
6-10 years	49
Over 10 years	12
Age (years)	
20-29	15
30-39	28
40-49	26
50-59	14
60 and above	17

Logistic model. The empirical Logistic Model was developed using farm and farmer specific characteristics. Since the variables are dichotomous, 1 is used if a farmer is likely to use improved cassava and 0, otherwise. The dependent variable is the adoption of improved cassava varieties (MCUSER). The other variables in the model are described in Table 4. The model takes the form

$$MCUSER = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8) + e$$

As shown in Table 5, land tenure, total area under all crops in 2001, and extension had positive coefficients and significant relationships. The significant relationship between land tenure and varietal adoption implies that owners are more likely to adopt improved varieties than tenants. This observation is consistent with the conclusions of Flinn *et al.* (1980). Similarly, the larger the total land cultivated to all crops by the farmer, and the more discussions on

Table 3: Adoption rates for improved cassava varieties, 2001.

Technology	Adoption rate (%)
Improved variety	
Afisiafi	3
Abasafitaa	1
Gblemo duade	5
Total (All improved)	9
Local	81

Table 4: Definition of the variables in the Logistic Regression equation

Dependent variable	
MCUSER	Improved cassava. 1 if improved cassava is adopted, and 0 otherwise.
Independent variables	
X	Land Tenure. 1 if land is owned and 0 if other land arrangements.
X	Total area under all crops in 2001. Measured as a continuous variable
X	Planting arrangement. 1 if cassava is planted in rows, 0 if planted at random.
X	Number of years farmer has taken his or her own decisions on his or her farm. It is measured as a continuous variable.
X	Size of largest cassava field. Continuous variable
X	Gender. 1 if female, 0 if male.
X	Ever bought cassava cuttings for planting. It is a binary variable: yes = 1 and no = 0
X	Number of extension discussions on cassava production. Continuous variable.
E	Error term

Source: Compiled by the authors.

Table 5: Indicator Variables for factors affecting adoption of improved cassava, Southern Ghana.

Variable	Coefficients	Standard Error	Wald	Degrees of freedom	Significance of level	R (Partial correlation)
X	2.3052	1.1954	3.7187	1	0.0538	0.1396
X	0.5609	0.1838	9.3160	1	0.0023	0.2882
X	0.6009	0.9189	0.4276	1	0.5132	0.0000
X	-0.0699	0.0353	3.9201	1	0.0477	-0.1477
X	0.4207	0.2353	3.1967	1	0.0738	0.1166
X	0.6314	0.9274	0.4636	1	0.4959	0.0000
X	-2.3177	1.0891	4.5285	1	0.0333	-0.1694
X	0.2155	0.0665	10.5155	1	0.0012	0.3110
Constant	15.3374	1.5709	11.5438	1	0.0007	

-2 Log Likelihood 53.937
Goodness of Fit 91.991
Cox & Snell – R^2 0.206
Nagelkerke - R^2 0.459
Percent of cases predicted correctly 91.89%.

improved cassava production with extension, the chances that farmers adopted improved cassava varieties. This is also consistent with other studies such as Padma and Flinn (1985). The number of years that the farmer has been taking his or her own decisions on his or her cassava farming activities and whether farmers had ever bought cassava cuttings to plant were however, negatively related. This seems to suggest that farmers whose decision making was recent adopted improved cassava varieties than their counterparts with longer experience. Gender and planting arrangement did not show any significant effect although were positively related. Thus both female and male farmers may adopt the improved cassava

Table 6: Correlation matrix for variables in the Logistic Regression equation.

	Constant	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Constant	1.000								
X	-0.781	1.000							
X	-0.385	0.238	1.000						
X	-0.405	0.071	0.032	1.000					
X	0.119	-0.197	-0.570	-0.081	1.000				
X	0.052	-0.033	-0.563	-0.151	0.147	1.000			
X	-0.509	0.095	0.273	0.485	-0.161	-0.049	1.000		
X	0.140	-0.152	-0.499	-0.007	0.465	0.087	-0.105	1.000	
X	-0.179	0.167	0.453	-0.106	-0.474	-0.371	0.012	-0.510	1.000

varieties. Thus, the technology, improved cassava varieties seem not gender-biased. Planting arrangement had little effect. Thus whether farmers planted in rows or at random did not matter much when it comes to the use of improved cassava varieties.

The correlation matrix of the variables in the Logistic Regression used is presented in Table 6 and shows how the variables are correlated. The values of the correlation coefficients are generally low indicating that there are little relationships among the variables. This further suggests that the model is devoid of any serious multicollinearity problem and the variable selected for the analysis is appropriate.

Conclusion

Factors affecting the adoption of improved cassava varieties in Southern Ghana were examined through Logistic Regression model. The study reveals that adoption of cassava varieties is influenced positively by land tenure, size of land cultivated to all crops and number of discussions with extension officers on cassava production. However, adoption is negatively influenced by the length of farmer's decision-making on his or her own cassava farm and the fact that farmers buy cuttings for planting. These factors are important indicators to be considered in the transfer of cassava varieties to farmers in Southern Ghana.

The study also reveals that it is important to examine adoption not only in terms of number of farmers, but also in its intensity with regards to the percentage area under improved cassava cultivation.

References

Adesina, A. A. and Badu-Forson, J. 1995. "Farmers' Perception and Adoption of New Agricultural:Evidence from Analysis in Burkina Faso and Guinea, West Africa." Agricultural Economics 13: pp. 1-9.

Adesina Akinwumi A. and Moses M. Zinnah. 1993. "Technology Characteristics, Farmers' Perceptions and Adoption Decisions: A Tobit Model Application in Sierra Leone." Agricultural Economics 9(4): 297-331.

Flinn,J.C., B.B. Karki, T. Rawal, P. Masicat, and K. Kalijaran. 1980. "Rice Production in the Tarai of Kosi Zone, Nepal." IRRI Research Paper Series No. 54, IIRI: Philippines.

Ministry of Food and Agriculture. 2002. Statistics Research and Information Directorate. Annual Sample Survey of Agriculture of Ghana, Accra, Ghana.

Nichola Tennassie and John H. Sanders. 1996. "A Probit Analysis of the Determinants of Adoption when Inputs are Rationed: The Gezira Experience with Hybrid Sorghum." Science, Technology and Development.Vol,14.no.3, pp.107-119.

Padma B. Shakya and J.C. Flinn. 1985. " Adoption of Modern Varieties and Fertilizer use on Rice in the Eastern Tarai of Nepal." J. of Agricultural Economics. Vl.36. No. 3: pp. 409-419.

Shively Gerald E. 1997. "Consumption Risk, Farm Characteristics and Soil Conservation Adoption among Low-income Farmers in the Philipines." Agricultural Economics. 17: pp.165-177.