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Full Length Research Paper

Credit constraints and adoption of modern cassava production technologies in rural farming communities of Anambra State, Nigeria

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This study was motivated because of low adoption of cassava production technologies in rural areas of Nigeria. The supply of cassava product, which is major staple food in Nigeria has not match up with the demand especially now the government is trying to increase her non-oil export through cassava export. It expected that increase in adoption of modern production technologies will scale-up cassava production and reduce poverty and increase food safety net in Nigeria. The study was carried out with random selected rural farmers. Data were collected and analyzed with combination of descriptive and univariate probit regression model. The major findings are that though credit is important in adoption of modern cassava technologies, credit from informal institutions appears to be the major influencing factor in adoption of modern cassava production technologies. Education and availability of modern input in the rural areas are also important variables that affect adoption. In view of this, increasing financial base of informal institutions and vigorous rural education campaign and increasing availability of the technologies through rural community based organizations are among the recommendations made.

Key words: Cassava, adoption, technologies, credit, poverty, Nigeria.

INTRODUCTION

Cassava (*manihot esculenta*) is a staple food of average household (especially for rural poor household) in Nigeria. Cassava or its derivatives form part of daily food for both poor and non-poor households. Therefore, cassava is an important factor in food security, poverty alleviation and reducing unemployment among others. Cassava can grow in poor marginal soil where most crops cannot grow (Ali, 2005). Cassava matures in 12 to 18 months after planting. Cassava can be processed into variety of products such as garri, fufu, tapioca, cassava chips and flour among others.

In recognition of the benefit of cassava, the present President of Federal Republic of Nigeria – Chief Olusegu Obasanjo has taken steps to ensure that cassava export forms one the major non-oil export (Asadu, 2004). Recently, cassava has occupied a prominent place in national non-oil export commodity especially exports in sub-Saharan Africa that international demand is far above the supply (Frecso, 1993; Nweke et al, 2002). This increase in cassava export has also negatively affected local supply. It is also important to note that cassava production is mostly done by rural smallholder farmers using low-level production techniques (Omonona, 2009; Oyegbami et al., 2010; Nweke et al., 2002). Though government at various levels has been trying in various ways to encourage rural farmers to adopt the modern cassava production technologies in order to increase the rural farmer's productivity (Fresco, 1993; Otoo, 1994; Ali, 2005), there are constraints to adoption in rural farming communities (Nweke et al., 2002; Teklewold et al., 2006). In some instances, farmers reject some of modern technology due to their cultural background and inhibitions due to perhaps illiteracy and religious beliefs. Nevertheless, credit constraint has been singled out as a

major factor militating against adoption of modern cassava production techniques (Nweke et al., 2002).

The technologies are herbicides application, use of hybrid cassava stake, use of insecticides, use of herbicides, use of inorganic fertilizer, use of tractor, appropriate spacing, planting date and tillage practices. The adoption of modern cassava production technologies is an important route out of poverty for many in the developing world including Nigeria because of the major role cassava play in food security. Many studies have noted poor technology adoption in cassava production (Barham and Boucher, 1994; Ogboso, 2005).

Yet the influence of credit in adoption of modern agricultural innovations in cassava production, remain poorly understood in cassava production (Omonona, 2009; Adesina and Forson, 1995; Ersado et al., 2004). Access to credit affects household welfare outcomes through at least two channels. First, it alleviates the capital constraints on agricultural households. Access to credit also reduces the opportunity costs of capital-intensive assets relative to family labor, thus encouraging labor-saving technologies and raising labor productivity, a crucial factor for agricultural development, especially in many African countries (Delgado 1995; Zeller et al., 1997). The second channel through which access to credit affects household welfare is by increasing its risk-bearing ability and altering its risk-coping strategy. The household may therefore be willing to adopt new, more risky technologies (Baidu - Forson, 1999; Aliou et al., 2000; Polson and Spencer, 1990).

This paper presents evidence on the complementarities between the adoption decisions of farmers concerning modern cassava production technologies and credit constraints in cassava production in rural farming communities of Anambra State. This will help in formulating a well targeted policy in cassava production in Nigeria. Though this work is on credit and adoption of modern cassava technologies, effort was made to x-ray other factors that affect the adoption of modern technologies in cassava production.

METHODOLOGY

This study was conducted in rural farming communities of Anambra State in 2005. A random sampling technique was used to select two rural local government areas in Anambra State. These local government areas are Aguata and Orumba South Local Government Areas. Cassava farmers in each of the selected local government areas were identified with the help of Extension Agents. List of these cassava farmers were compiled. From the list, a random sampling technique was also used to select a sample of 180 farmers.

Primary and secondary data were used. However, primary data was the main source of data used for this analysis. Primary data was collected with questionnaire. The questionnaire collected information on socioeconomic characteristics of the farmers, credit obtained, awareness of modern cassava technologies available to farmers, used and extent of use of such technologies as well as cost of using such technologies. Secondary data was sourced from published and unpublished materials.

Data collected were analyzed with descriptive statistics and univatiate probit regression model. It should also be noted that when a farmer adopts five out of eight modern cassava production technologies, the farmer is regarded as an adopter; otherwise the farmer is regarded as non-adopter. Specifically, two univariate probit regressions were run. The first was for general determinants of adoption. The second is specific on examining the effect of credit on adoption.

Econometric methodology

The basic theory underlying this study is household utility model. A complete model of household choice decisions posit that the household choose whether to adopt modern cassava technologies or not to adopt because of utility derived from it. The probability that household "h" chooses to adopt is equals to the probability that the utility derived from adopting modern technologies in cassava production is greater than not adopting. In this case, I have assumed that adopting and not adopting are independent. This therefore necessitates the use of univariate probit regression.

However, in the bivariate probit, let the latent variable y_1^* represent the underlying continuous index affecting the decision of adopting cassava technologies and y_2^* represent the decision of household not to adopt the technologies. Therefore the general specification for a two-equation model would be

$y_1^* = \beta_1 + \varepsilon_1$, $y_1 = 1$ if $y_1^*>0$, 0 otherwise ---------- (1)

$y_1^* = \beta_2 + \varepsilon_2$, $y_2 = 1$ if $y_2^*>0$, 0 otherwise ---------- (2)

$E[\varepsilon_1] = E[\varepsilon_2] = 0$
$Var[\varepsilon_1] = var[\varepsilon_2] = 1$,
$Cov[\varepsilon_1, \varepsilon_2] = \rho$.

and the likelihood function to maximize is

$$L = \prod \int_{-\infty}^{\beta_1 X_1} \int_{-\infty}^{\beta_2 X_2} \phi_2(z_1, z_2; \rho) dz_2 dz_1$$

where $\Phi_2(z_1,z_2; \rho) = [2\pi(1- \rho^2)^{1/2}]^{-1} \exp[-1/2(1- \rho^2)^{-1}(z_1^2 + z_2^2 - 2\rho z_1 z_2)]$ and ρ = Coefficient of correlation between the two equations. X_1 and X_2 = row vectors of exogenous variables which determine respectively, adopting and not adopting propensities. β_1 and β_2 = associated parameter column vectors.

To evaluate the magnitude of the effect of a change in the regressors on the outcome variables, the coefficients need to be adjusted to be marginal effects, unlike standard linear regression models. In this probit model $E[y] = \Phi(\beta' x)$, then the marginal effects are

$$\partial \frac{\partial \Phi(\beta' x)}{\partial x_i} = \Phi(\beta' x)\beta$$

These marginal effects would obviously vary with the values of x because of the nonlinearity of the model. It worth noting that all the coefficients β would have the same scale factor $\Phi(\beta' x)$ applied.

Except for dichotomous variables, these marginal effects would be valid for small changes in explanatory variables. In case of dichotomous variables, it is better to calculate the difference in

Table 1. Distribution of respondents according to awareness of modern cassava production technologies.

Technologies	Frequency	Percentage
Hybrid cassava stakes	150	83%
Appropriate planting date	70	39
Tillage practices	89	49
Use of herbicides	60	33
Use of insecticides	55	31
Use of inorganic fertilizer	180	100
Use of tractor	100	55
Appropriate spacing	58	32

Note multiple responses were recorded. Source: Field survey, 2005.

probabilities when the variable is 1 and when it is zero. Hence the marginal effect for the dummy variable I,(δ_i), would be defined as

$$\delta = \Phi(\beta_{-i}\bar{x}_{-i} + \beta_i) - \Phi(\beta_{-i}\bar{x}_{-i})$$

where the –i subscript represent all the variables but the it^{h,} and $\bar{x}_{-i}$ are their sample means.

However, because am only interested in whether farmer adopt or not. I therefore use univariate probit model. The reduced form of the econometric model is explained below.

The decision of farmer to adopt is described by the following latent variable model.

$$= \beta + \varepsilon \quad (1)$$

$W_i^* \quad X_{1i} \quad _1 \quad _{1i}$ ----------

Where W_i^* is the net benefit attained by the farmer by adopting modern cassava technologies, X_{1i} are the vector that expected to influence the farmer's decision to adopt or not to adopt modern cassava technologies, W_i^*, and ε_{1i} is the random error, with zero mean and unit variance. However, W_i^* is not observed. What is observed is the following binary variable:

{1, if the farmer adopts modern cassava production technologies

0, otherwise (2)

We can put these two equations (Equations 1 and 2) into observable form (Y_i), which is written as thus:

$Y_i = W^*_I > 0$, otherwise, 0 (if a farmer adopt modern cassava technologies.

The general univariate probit regression model is implicitly stated as:

$Yi = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}) + U$ --------(1)

Where Yi is dichotomous choice model, which is "1" if farmer adopted at least 5 of modern cassava production technologies, 0 otherwise

X_1 = age of the farmer (years),
X_2 = age of the farmer squared (years)
X_3 = level of education of farmer (years),
X_4 = gender of the farmer (dummy 1 if male, 0 otherwise)
X_5 = type of institution where credit is sourced (dummy 1 if informal, 0 otherwise)
X_6 = number of extension contacts (continuous variable)
X_7 = family size (continuous variable),
X_8 = distance to informal financial institution (km),
X_9 = distance to formal financial institution (km),
X_{10} = total income apart from credit available to the farmer
X_{11} = amount of credit obtained from formal financial institutions
X_{12} = amount of credit obtained from informal financial institutions,
X_{13} = farming experience (years)
X_{14} = farm size (hectares)
X_{15}= Accessibility (dummy 1 if 5 out of the eight technologies are available, 0 otherwise)
U = error term

For the effect of credit on adoption of modern cassava production technologies, the model is implicitly specified as follows

$Yi = f(X_1, X_2, X_3, X_4, X_5) + U$ ---------- (2)

Where Yi is dichotomous choice model, which is "1" if farmer adopted modern cassava production technologies, 0 otherwise
X_1 = type of institution where credit is sourced (dummy 1 if informal, 0 otherwise),
X_2 = distance to informal financial institution (km),
X_3 = distance to formal financial institution (km)
X_4 = amount of credit obtained from formal financial institutions
X_5 = amount of credit obtained from informal financial institutions
U = error term

RESULTS

First, the level of knowledge of modern cassava production technologies is analyzed. This is presented in Table 1. The result shows that all the respondents are aware of fertilizer as one of cassava production technologies. This is closely followed by those that are aware that modern cassava cultivars is one of cassava production technologies. However, the knowledge of tractor and appropriate tillage practices as cassava production technologies were fairly known by respondents. The use of insecticides and herbicides are the least known cassava production technologies. These results show that more sophisticated production technologies are less known to farmers. This has implication in the terms of usage of modern cassava production technologies.

Apart from the knowledge, the data was also analyzed

Table 2. Distribution of respondents according to use of modern cassava production technologies.

Technologies	Frequency	Percentage
Hybrid cassava stakes	80	44
Appropriate planting date	60	33
Tillage practices	63	35
Use of herbicides	3	2
Use of insecticides	3	2
Use of inorganic fertilizer	120	67
Use of tractor	1	0
Appropriate spacing	43	24

Note multiple responses were recorded. Source: Field survey, 2005.

Table 3. Distribution of respondents according to reasons for difficulty in adoption of modern cassava production technologies.

Reasons	Frequency	Percentage
Not available	90	50
High cost	150	83
Farm size	87	48
Harmful	30	17
Lack of knowledge	67	37

Note multiple responses were recorded. Source: Field survey, 2005.

based on the level of usage of these production technologies. This result is presented in Table 2.

Table 2 shows generally, that 55% of respondents use modern cassava production technologies. Specifically, most of the respondents use fertilizer and modern cassava cultivars. However, almost no respondent use tractor and insecticides in cassava production probably because of land tenure arrangement inherent in study area where a farmer owns small and scattered pieces of land usually less than 0.5 ha. In addition, about 2% of the respondents use herbicides in their cassava production because of the tenure and cost of input, which is usually high per unit output. The overall analysis of this table shows that farmers use less sophisticated and cheap cassava production technologies because of land tenure system in the area, which do not usually encourage mechanization.

The reasons for difficulty in adoption of cassava production technologies were also analyzed. The result is presented in Table 3. The table shows that 83% of the respondent attributed their low adoption to high cost of technologies. This is closely followed by those that attributed the low usage of technologies to non-availability of the technologies. The level of use of these two factors shows that production credit and accessibility are important factors in adopting particular technologies. However, fairly less than 50% (48%) of respondent attributed their low adoption to farm size.

Table 4 shows the relationship between credit and adoption of modern cassava production technologies in descriptive terms. The table shows that there is a positive relationship between credit obtained and adoption of cassava production technologies. For instance, rural farmers who are able to secure more than N50000 credit were able to adopt 74% of modern cassava production technologies. In addition, farmers who secure less than N10000 credit from financial institutions are able to adopt 15% of the recommended technologies.

Table 5 presents the univariate probit regression estimates of probability of farmer adopting modern cassava production technologies or not. The dependent and independent variables are already defined in methodology. The general result shows that a number of variables determine adoption of modern cassava production technologies in the study area. These variables vary in magnitude as revealed by marginal effect results. Generally, the model is significant as explained by Chi-square and loglikelihood ratio. The result shows that age, education, access to informal credit institution, extension contact, amount of credit from informal credit institutions and access to technology were positively associated with adoption in cassava production. The marginal effect shows a fairly strong effect of this variable on adoption of modern cassava production technologies.

Table 4. Distribution of technology adopted and credit obtained.

Credit obtained	Frequency	Percentage
<10000	14	15%
10001 – 20000	26	27
20001 – 30000	38	40
30001 – 40000	55	58
40001 – 50000	58	62
>50000	70	74

Note multiple responses were recorded. Source: Field Survey, 2005.

Table 5. Parameter estimation of univariate probit regression for the determinants of adoption of modern cassava production technologies.

Variables	Coefficient	t-cal	Marginal effects
X_1 *	.318	19.38	.098
X_2 *	-0.201	-16.38	.041
X_3 *	0.010	3.99	0.071
X_4	-0.067	-1.03	.008
X_5 *	0.169	4.92	.183
X_6 *	0.104	2.00	.036
X_7	0.096	1.82	.005
X_8	0.016	1.62	.008
X_9	0.072	1.72	.029
X_{10} .	0.308	6.57	.113
X_{11}	0.053	1.80	.010
X_{12} .	0.154	10.24	.261
X_{13}	0.051	1.54	.005
X_{14}	0.024	1.09	0.014
X_{15} .	0.189	5.10	0.093
Chi-square*	245.08		
Log-likelihood ratio	1721.35		
Pseduo R^2	0.06		

Values asterisk are significant at 5% probability level. Computed from Field survey, 2005.

The econometric model used to specifically analyze the effect of credit variables on adoption of modern cassava production technologies shows that type of institution dictates the probability of adopting cassava production technologies or not (Table 6).

The result shows that there is a more likelihood of adopting modern cassava production technologies when a farmer obtain loan from the informal financial institutions than formal institution. Further analysis of the result shows that access to informal financial institution is negatively related to adoption of cassava modern production technologies. It should also be noted that credit from informal financial institutions has strong effect on probability of adopting modern cassava technologies or not. The result of marginal effect analysis of this variable shows that a one naira increase in the amount of credit from the informal financial institutions increases the probability of adopting modern cassava technologies by 38%.

DISCUSSION

The discussion of the result is presented in this section. Fairly less than 50% (48%) of respondent attributed their low adoption to farm size. This is not surprise because in most rural communities, fragmented land tenure system is practiced. This system does not encourage mechanization or use of most modern cassava production technologies because of higher production cost per unit

Table 6. Parameter estimation of univariate probit regression for relationship between credit and adoption of modern cassava production technologies.

Variables	Coefficient	t-cal	Marginal effects
X_1 *	.041	14.75	.296
X_2 *	-.058	-3.41	.093
X_3	-.020	-0.44	.024
X_4	0.213	1.78	.073
X_5 *	0.134	29.76	.381
Chi-square*	376.23		
Loglikelihood ratio	1938.99		
Pseduo R^2	0.15		

Values asterisk are significant at 5% probability level. Computed from Field Survey, 2005.

output. This also shows that rural farmers are always willing to adopt technologies when they are sure that benefit outweighs the cost, which is a rational behaviour in economic sense. The result also shows that in addition, farmers who secure less than N10000 credit from financial institutions are able to adopt 15% of the recommended technologies. This is not surprising because rural farmers are not able to adopt most modern production technologies because they are relatively poor. Therefore, for them to adopt most technologies they must require external funding, which could come in form of subsidy and credit. This finding is supported by various researchers on credit and adoption technologies (Barham and Boucher, 1994; Feder et al., 1990; Meloria, 2003).

The econometric result shows that some variables have significant impact with varied strength on the technology adoption. Specifically, the marginal effect shows that a unit increase in age will result 10% increase in adoption. The negative age square coefficient for farmer suggests, however, that the inflow into non-adoption becomes weaker in the younger farmers. The result also suggests that educated farmers are more likely to adopt technologies than illiterate farmers. However, the marginal effect is not very strong (7%). This result shows that education is an important variable in adoption. Similar results have been found elsewhere (Adesina and Forson, 1995; Ersado et al., 2004). The result also shows that male farmers are more likely to adopt cassava production technologies than female farmers. This result is not surprise because studies have shown that male have more asset than female in rural areas, which has shown to have strong correlation with adoption of technologies (Okpukpara, 2006). The type of institution patronized also dictates the adoption of modern cassava production technologies. The result shows that farmers that obtain their credit from informal financial institution are more likely to adopt modern cassava production technologies than those that got theirs from formal financial institution. This is surprising because most studies have attributed adoption to educated farmers who always patronize formal financial institutions. However, it could mean that informal financial institutions are more accessible in rural areas, which make them more responsive to farmer's demand for credit. Nevertheless, the effect of this variable on adoption is strong (18%), as explained by marginal effect analysis. The number of extension contact is also significant in dictating adoption of cassava production technologies. The result also shows that farmers are more likely to adopt a technology if the number of extension contacts is increased. Income of the farmer also is an important variable in explaining adoption in cassava production. The effect is positive and strong. The result is not surprising because as the farmer's income increases, there is more opportunity for the farmer to afford the cost of modern production technologies. Similar result has been found elsewhere (Zeller et al., 1997).

The result also shows that amount of credit obtained from informal financial institution are more likely to increase adopt modern cassava production technologies. This is not surprising because most studies have noted the importance of informal credit institutions in rural communities in developing countries (Okpukpara, 2005). In view of popularity of this type of institutions, which give farmers more access to their credit than other form of financial institutions, most farmers obtain credit from these institutions though at a very high rate of interest. In addition, credits that are mostly given by these institutions are small; yet, farmers prefer it. The effect of this variable on adoption is strong (26%). Accessibility in terms of availability also increases the adoption of cassava production technologies. This not surprising because it is possible that farmers will have the money to buy modern cassava input but when it is not available in the area, farmers will be handicapped in procuring the input. The marginal effect of this variable posit that if farmers modern cassava production input is available to

farmer, the adoption of technologies is likely to be (9%). The overall analysis of this econometric result shows, farmer's age, education, gender, type of institution, number of extension contacts, income of the farmer, amount of credit from informal financial institutions and accessibility are important variables that should be considered in promoting adoption of cassava production technologies in rural areas. However, emphasis should be on age of the farmer, type of institution patronized, income apart from credit, amount of credit from informal financial institutions and accessibility of the modern input. As these variable shows relatively large effect on adoption of modern cassava production technologies.

The econometric result that dealt specifically on influence of credit variables on adoption shows that the number of variables were significant. The result shows that there is a more likelihood of adopting modern cassava production technologies when a farmer obtain loan from the informal financial institutions than formal institution. This indicates that informal financial institutions are the most accessible institution for financing rural farming.

Further analysis of the result shows that access to informal financial institution is negatively related to adoption of cassava modern production technologies. This further strengthened the importance of informal financial institution in financing adoption of technologies in rural areas. It should also be noted that credit from informal financial institutions has strong effect on probability of adopting modern cassava technologies or not. The result of marginal effect analysis of this variable shows that a one naira increase in the amount of credit from the informal financial institutions increases the probability of adopting modern cassava technologies by 38%. This is not surprise because farmers access to production inputs like improved varieties of cassava cultivars, herbicides and farming tools and implements depends on their access to credit. A number of countries in the region practice some sort of rural credit scheme to assist smallholder farmers improve their agriculture. In most cases the banks handling the credit fund are found in the city and larger towns, away from the farming community. Accessing such credit for agricultural purposes has proved difficult for small-holder farmers. Worse still, formal banking institutions also demand collateral as a prerequisite of giving loan to rural farmers. This collateral is often in form of land, house or title to some immovable assets.

Smallholder farms in many countries in the region often cannot afford any of the above requirements. The situation is often more difficult when it comes to the women, who in most countries, have no rights to ownership of expensive property including housing and land. Therefore, these farmers seek credit from other financial institution that recognizes and able to give them credit considering their own peculiar circumstances. That is the reason for the high patronage of informal financial institutions. Therefore, failure to access soft loan and credit for agricultural activities and inputs has a severe bearing on technologies adoption.

Conclusion

It has been established that credit along with other socio-economic variables are important in adoption of technologies. Therefore, a number of recommendations are made based on the findings. These recommendations are:

1. Since education is important in adoption of modern cassava technologies, effort should be made by governmental and non-governmental agencies as well as other stakeholders in rural farming to organize and operationalize adult literacy campaign. This is necessary because most farmers in rural areas are illiterate which makes it difficult for them to adopt cassava production technologies. It also important to workout a suitable schedule for the adult education programme for the rural farmers, which will ensure non-interference with their normal farming activities timetable.
2. It is also important to address the problem of lack of extension agent in the rural areas. Government should provide additional incentives for extension agents that agree to work with rural farmers. This will increase their activities in the rural areas. This also implies, for an effective information communication, the relationship between farmers and extension agents must be improved.
3. Income of the farmer is also important variable. It will be the best technologies adoption strategies to give farmers more non-farm income opportunities to increase their level of technologies adoption. In addition, government should subsidize the prices of major cassava modern technologies input as strategy of increasing their value of income.
4. Credit appears to have strong effect on probability of adopting modern cassava technologies especially credit from informal financial institutions. Therefore, government should strengthen the financial base of informal institutions by providing credit subsidies to them. This effort is aimed at encouraging them to continue to offer credit delivery to rural farmers. In addition, formal institutions should not only be encouraged to give credit to farmers but also "force" them to give soft loan to farmers. Effort should also be made by stakeholders in rural credit schemes to increase the establishment of informal institutions in the rural areas because it appears to be the major access to farm credit. In addition, the developments of rural financial institutions, such as the development of rural banking, are appropriate to encourage not only access to credit at reasonable terms

but also savings, which will enhance access to credit by rural farmers.

5. The issue of access to modern cassava technologies in terms of availability should also be tackled by the way of providing these inputs where it can be purchased. This can be done through providing these inputs in informal institutions such as cooperative societies, women and men organizations, age grades and others informal organizations in rural areas that are involved in not only extending credit but also other groups that are well known and has strong influence in rural communities.

6. Government should encourage communities to liberalize ownership of land for those that are willing to farm. This will discourage traditional land tenure arrangement, which usually does not allow mechanization.

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