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Adoption of selected improved cassava varieties among smallholder farmers in South-Eastern Nigeria

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Abstract

Cassava is a dominant component in crop mixtures in South-Eastern Nigeria. It is a preferred food security crop among smallholder farmers, because it can tolerate drought, low soil fertility and its production requires minimum external inputs. Various constraints have been shown to affect the widespread adoption of improved cassava varieties. This study examines various factors influencing the adoption of selected improved cassava varieties by smallholder farmers in Abia State, Nigeria, using the probit model. A multi-stage random sampling procedure was used to select 510 cassava farmers from 17 Local Government Areas of Abia State in 2007. Results of the study showed that 56.5% of the respondents were females. The majority (90.2%) consisted of those who were in their productive years. Most (78.8%) of the respondents were married, 83% attended formal schools; while75% had a household size of more than 5 persons. All the respondents were basically small-holder farmers; with 47% full time, 50% of the respondents had secured tenurial arrangements; 93% had more than 6 years of farming experience and 82.2% of them had adopted improved cassava varieties. Results indicated that 74% of 510 farmers who responded adopted improved cassava varieties, either solely or in combination with local varieties. The most popular varieties were NR-8082 (38.6% of total adopters), TME-419 (36.7%) and TMS-980505(12.9%). Marital status, household size, farm size, cassava maturity period and tenurial status were negatively and significantly related to adoption. Cassava yield and average income had a positive relationship with the adoption of the improved varieties. Implicit in these results is that policies should be aimed at introduction and prompt release of high yielding and early maturing cassava varieties, and converting tenurial arrangements of land to more secure forms.

Key words: Adoption, improved cassava varieties, probit model.

Introduction

Cassava is a staple food for over 200 million people in sub-Saharan Africa. It is the most important source of carbohydrates for human consumption in the tropics after rice and maize. It is an important food and cash crop in several tropical African countries, especially, Nigeria, where it plays a principal role in the food economy [1]. In most African countries, cassava is becoming an important cash crop that has high potential for use as an industrial raw material to manufacture starch, flour, etc. [2]. The use of cassava flour in confectionery industries recently in Nigeria is new and fast gaining ground. Cassava is an important food crop in south-eastern Nigeria where it contributes to about 15% of the daily dietary energy intake of most Nigerians and supplies about 70% of the total calorie intake of about 60 million people in Nigeria [3]. Nigeria is the largest producer of cassava in the world; with a production record of about 34 million tons per annum which represents 37% and 19% of African production and total global production, respectively [4]. Most families in Nigeria, especially in the South-East, consume the storage roots in various forms, such as gari, fufu, starch, fresh and dry flakes (abacha*)* and tapioca. Also, cassava often serves as the main crop or the dominant component in crop mixtures in South-Eastern Nigeria [5]. As a cash crop, about 45% of it is sold for various household income needs [6]. Data from the Collaborative Study of Cassava in Africa (COSCA) showed that 80% of Nigerians in the rural areas eat a cassava meal at least once a week [7,8].

The main socio-economic factors affecting production relate to inadequate resource allocation, infrastructure, and extension services [9]. Multiplication, distribution, and adoption of improved varieties have increased significantly over the years, thus putting Nigeria in the current position of the largest producer of cassava in the world [10].

A considerable amount of research had been done to generate new technologies and practices that would increase the output of cassava at the farm level [11]. However, to assess the usefulness of these technologies to cassava farmers, there is need to determine the farmers' attributes responsible for their choice of cultivars as well as the major constraints militating against the effective use of these cultivars. Earlier studies show that farmers' decisions to use particular crop cultivars had many influences, some of which are market-driven or socio-culturally based [12-15]. Several of these factors had also been listed to include farm size, risk exposure and capacity to bear risk, human capital, labor availability, credit

constraints, land tenure and access to market [16]. However, another study noted that direct short-term benefits to farmers usually serve as important incentive in fostering adoption of resource-conserving technologies [17]. The Integrated Cassava Project of International Institute of Tropical Agriculture (IITA) in collaboration with Agricultural Development Programme (ADP) of Abia State, National Root Crop Research Institute (NRCRI), farmers' cooperatives and organized farmers' groups promoted cassava resistant to Cassava Mosaic Disease (CMD) and other improved varieties. This was one component of the set of technologies introduced to farmers to encourage sustainable production and commercialization of cassava in Nigeria. In view of the popularity of improved cassava varieties among farmers in Nigeria which has contributed immensely in boosting national output, it becomes pertinent to examine factors associated with adoption of the improved varieties. This study, therefore, seeks to examine the various factors influencing the adoption of selected improved cassava varieties among small-holder farmers in South-Eastern Nigeria.

Methodology

Study sites: The study area is Abia State, in southeast Nigeria and on longitude 7°00' E and 8°00' E and latitudes 4°45'' N and 6°17' N. The climate is tropical and humid all the year round. The rainy season is from March to October and the dry season from November to February. The state has an annual rainfall between 2000 and 2500 mm and a temperature between 22 and 31°C [19]. The vegetation generally can be classified as tropical rainforest, however, some areas (Abia North and Central) are characterized as derived savanna, and Abia South is in the heavy rainforest vegetation [18]. The soils fall within the broad group of ferrallitic soils of the coastal plain sand and escarpment. The State is divided into 17 administrative units called Local Government Areas (LGAs). These units were further grouped into three agricultural zones: Abia North, Abia Central and Abia South. Abia North and Abia Central consist of five LGAs each; Abia South consists of seven LGAs. These zones favor production of root and tuber crops. These crops are grown on smallholder plots, usually in mixtures of at least two simultaneous crops [19, 20] .

Survey methodology: This study utilized primary data. A structured questionnaire containing both closed and open-ended questions was designed to elicit relevant information. The sampling frame, from where the sample was drawn, was obtained from the community list of farmers across the zones in the state. Multistage, simple random sampling procedure was employed in selecting the sample from where the data was collected. This method ensures a high degree of representation by providing the elements with equal chances of being selected as part of the sample [21]. Thirty farmers were selected from each of the 17 LGAs to give a total sample size of 510 respondents who were sampled for a detailed study.

The theoretical model: To adopt or not to adopt technology is a discrete choice. Discrete choice econometric models have been widely used in estimating discrete adoption decision variables [22]. Also, the use of qualitative response models such as the Tobit and Probit models has been recommended in similar studies [16]. The Probit model [23, 24], which tests factors affecting the incidence and intensity of adoption was used, and can be specified as follows implicitly:

$$Y_t = X_t\beta + U_t \quad \text{if } X_t\beta + U_t > 0$$
$$= 0 \quad \text{if } X_t\beta + U_t \leq 0$$
$$_t = 1,2,\ldots,N$$

where Y_t = dummy variable for adoption of improved cassava technology (1 = adopted, 0 = otherwise); N = number of observations; X_t = vector of independent variables; β = vector of unknown coefficients; and U_t = independently distributed error term assumed to be normal with zero mean and constant variance σ^2.

$U_t = 1$ if $Y_t > 0$ (household (t) planted improved cassava variety)
if $Y_t = 0$ (household did not plant improved cassava).

The empirical model: The general form of the adoption model can be specified explicitly:

$$Y = \beta_0 + \beta_1 X_1 + \ldots\ldots \beta_{12} X_{12} + \varepsilon_1$$

where Y = household adoption of improved cassava technology (dummy variable, 1 = adopted, 0 = otherwise); X_1 = gender (dummy variable, 1 = male, 0 = female); X_2 = age of farmer in years; X_3 = marital status; X_4 = educational status (years in school); X_5 = household size (number of persons); X_6 = occupational status (dummy variable, 1 = full-time farmer, 0 = part-time farmer); X_7 = use of fertilizer (dummy variable, 1 = use, 0 = non-use); X_8 = yield of cassava in tons; X_9 = farm size in ha; X_{10} = maturity time for cassava in months; X_{11} = average income in Naira; X_{12} = tenurial system (dummy variable, 1 = non-squatters, 0 = squatters); ε_1 = error term.

Results and Discussion

Socio-economic characteristics of the respondents: Table 1 shows that 56.5% of the farmers were females while 43.5% were males. So women constitute a greater percentage of those who are engaged in cassava production in the State. Gender issues in agricultural production and technology adoption have been investigated for a long time. Most show mixed evidence regarding the different roles men and women play in technology adoption. Studies on improved maize technology and coffee production in Ghana and Papua New Guinea showed insignificant effects of gender on adoption [25-26].

The results indicate that 35.7% of the farmers in the state were within the range of 21 to 40 years of age, 54.3% were between 41 and 60 years old while only 9.8% were aged above 60. Age is said to be a primary latent characteristic in adoption decisions. However, there is contention on the direction of the effect of age on adoption [27]. The ability of a farmer to bear risk and be innovative has been reported to decrease with age [28].

Majority of the male farmers (78.8%) were married, 6.1% single and 3.3% divorced; 66.7% of the female farmers were married; 16.7% were single, 14.1% were widowed and 1.0% divorced. Married people dominate in agricultural activities in Abia State.

While 87.2% had formal education, about 12.7% of the farmers had no formal education as shown in Table 1. Educated farmers are expected to be more receptive to improved farming techniques,

Table 1. Distribution of cassava farmers according to socio-economic characteristics in Abia State.

Variable	Frequency	Percentage
Gender		
Male	222	43.5
Female	288	56.5
Age		
< 21	2	0.4
21-40	181	35.5
41-60	277	54.3
≥ 60	50	9.8
Marital Status		
Single	31	6.1
Married	402	78.8
Widowed	72	14.1
Divorced	5	1.0
Educational Status		
No Schooling	65	12.7
Primary	180	35.3
Secondary	196	38.4
Tertiary	69	13.5
Household Size		
1-5	130	25.5
6-10	352	69.0
11-15	28	5.5
>15	0	0.0
Occupational Status		
Full time farming	239	46.9
Part-time farming	271	53.1
Farm Size (Ha)		
<0.1	27	5.3
0.1-0.25	124	24.3
0.26-0.41	55	10.8
≥ 0.42	304	59.6
Tenurial System		
Non market based	255	50.0
Market Based	255	50.0
Farming Experience(years)		
0-2	5	1.0
3-4	12	2.4
5-6	19	3.7
>6	474	92.9
Level of adoption		
Non-adopters	91	17.8
Adopters	419	82.2
Sample Size (N)	510	

Source: Field Survey, 2007.

but farmers with a low level of education or without any education would be less receptive [29, 30]. This emphasizes the likelihood that novel cassava interventions would be adopted by the targeted farmers since most of them are educated.

The average household size of the respondents was 8 persons. However, a large proportion (69.0%) of the respondents had a household size of 6-10 persons while 25.1% had household size of 1- 5 persons. Since large households are more likely to provide more labor required for farm operations, such as weed control, and fertilizer application, a large household size has the likelihood of enhancing adoption of improved production and processing technologies. A relatively large household size has been shown to enhance the availability of labor [31, 32].

Table 1 also showed that 53.1% of the respondents were part-time farmers while 46.9% were full-time farmers. Full-time farmers were expected to have a higher adoption rate of improved varieties.

The majority of the male respondents had (59.6%) cassava holdings of more than 0.41 ha, which are relatively small. Cassava production in the study area is dominated by smallholder farmers.

Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and many more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption, especially if the technology is costly [33].

Table 1 also revealed that 50% of the respondents had market-based (leased, mortgaged and purchased) tenure arrangements; the other half had not-market-based (inheritance and gift) ones. African customary land tenurial systems are often characterized by the inalienability of land. Fields are to a varying degree controlled by the extended family and influenced by community-level decisions. In many parts of West Africa, individuals have private user rights on the product from cultivation but do not have private ownership of land in terms of their ability to sell land [34].

Adoption of improved vs. local cassava varieties by farmers: Across the agricultural zones and the communities in Abia State, farmers were either planting local, improved cassava varieties, or both. In Abia North zone, out of the 150 farmers surveyed, 53% (80 farmers) were planting local varieties while 47% of the farmers (70 farmers) were using improved cassava varieties (Fig. 1). Abia Central zone has the highest level of adoption of improved cassava varieties following the initial exposure to these new varieties. Out of the 150 farmers surveyed 4.7% (7 farmers) were planting local varieties, 16% (24 farmers) improved varieties only, and 79.3% (119 farmers) local and improved varieties combined. A total of about 95.3% (143 farmers) were using improved varieties of cassava. Similarly, in Abia South zone, survey results show that out of 210 farmers who responded, 42.9% (90 farmers) were using local varieties only while 57.1% (120 farmers) used improved cassava varieties (Fig. 1). As in Abia Central, 4.8% of the farmers in Abia South zone used only improved varieties and 52.3% (110 farmers) used both improved and local varieties in their farms. A total of about 57.1% (120 farmers), were using improved varieties of cassava in the southern zone of the State.

Aggregating over the state, survey results show that out of the 510 farmers interviewed, 135 (26.4%) planted a local varieties only, 63 (12.4%) planted improved varieties solely while 312 (61.2%) planted improved varieties as well as local varieties in their farms (Fig. 1).

The general trend here was that most of the farmers in the state were still growing same local varieties. However, significant progress had been made in replacing these local varieties with improved varieties, especially in Abia Central. More efforts are needed in distributing the improved varieties, particularly to Abia South where traditional varieties still seem to be dominating as a

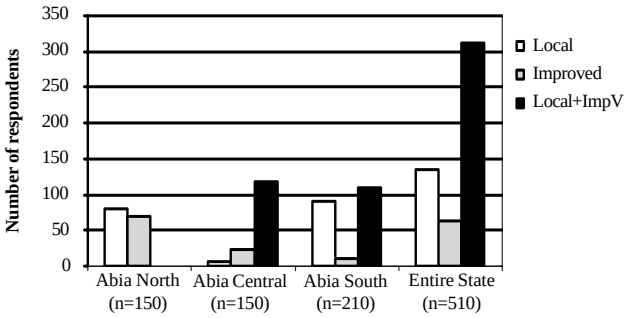

Figure 1. Frequency of cassava types (local and improved) planted by farmers in the study area.

result of late introduction of the new varieties to this zone.

Types of improved cassava varieties adopted by farmers: Various types of improved cassava varieties were introduced to farmers through the Integrated Cassava Project in the study area. Six major types were identified, TME 419, TMS 98/0581, TMS 98/0510, TMS 98/0505, TMS 97/2205 and NR8082. The first five are varieties resistant to Cassava Mosaic Disease (CMD). The predominant variety among farmers in the state is NR8082, accounting for about 38.6% of the total number of adopters (Fig. 2). This is followed by TME 419 (36.7%) and TMS 98/0505 with about 12.9% of adopters. The adoption status for the other varieties was less than 10%: TMS 98/0581 (6.7%), TMS 98/510 (5.1%), and TMS 97/2205(4.9%) (Fig. 2). The predominance of NR8082 and TME 419 was due to active promotion of NR8082 varieties by NRCRI Umudike who developed the variety as well as the outstanding yield potentials of the TME 419 varieties developed by IITA Ibadan (Table 2).

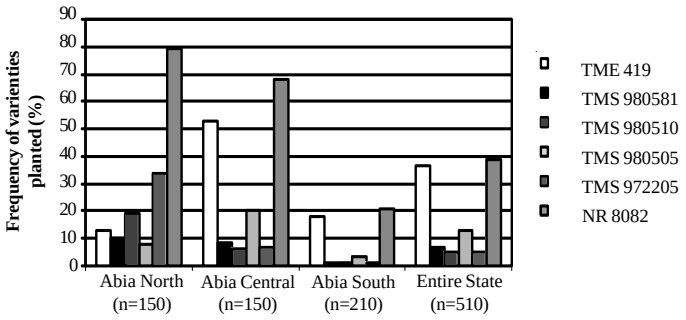

Figure 2. Frequency of identified improved cassava varieties adopted by farmers.

Table 2. Fresh root yield (t/ha) of released CMD varieties.

	Fresh root yield (t/ha)		
Clone	Min	Max	Mean
97/2205	10.00	49.00	23.67
98/0505	17.63	58.00	30.72
98/0510	9.83	55.33	28.81
98/0581	14.00	62.50	29.85
TME419	14.29	45.00	28.90
NR8082	10.00	32.00	21.00

Source: IITA-CEDP and NRCRI Annual Reports: November 2005.

Averaged over variety and adoption rate, Abia North (27.25%) and Abia Central (27.01%) zones have a higher number of farmers using or adopting improved cassava varieties than Abia South zone (7.64%). Possible explanation for this could be the proximity of these two zones to NRCRI and IITA-ICP offices in Umuahia, Abia Central zone. Secondly, logistic difficulties with respect to transportation hindered distribution of the improved varieties in Southern Abia, as well as other factor not explained. These results confirm the findings of related studies that the probability of adopting production technologies is lower for farmers in villages far away from urban centers and higher for farmers in contact with or close to research development and extension agencies [35]. However, wide disparities exist among the LGAs within and across the zones (Fig. 3).

The variety NR8082 stood out also as the most popular variety followed closely by TME 419, and TMS98-0505, TMS98-0581, TMS98-0510 and TMS97-2205 in that order across the 17 LGAs. Two LGAs, Aba North and Osisioma recorded the lowest level of

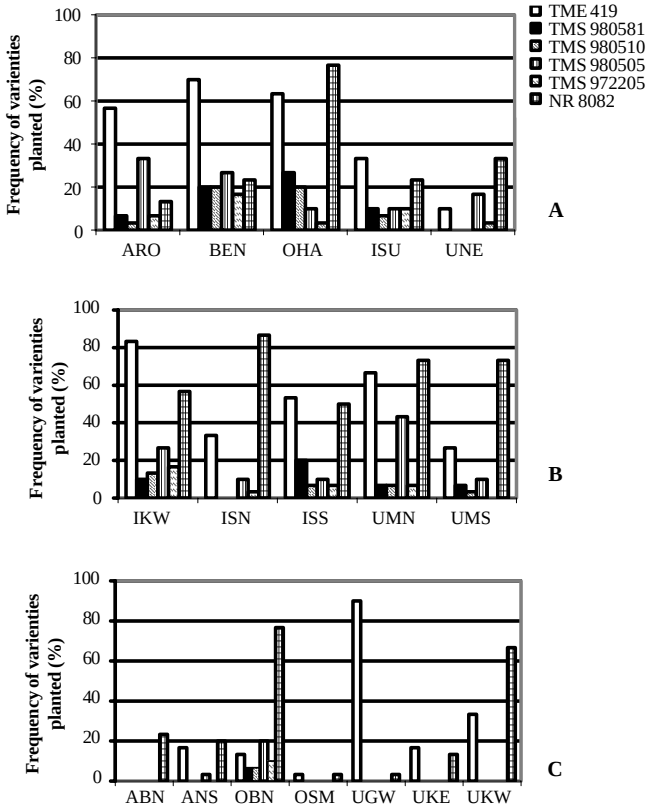

Figure 3. Frequency of identified cassava varieties adopted by farmers per zone and LGA (17 LGAs): (A) represents Abia North zone and Local Government Areas (LGAs) (ARO = Arochukwu, BEN = Bende, OHA = Ohafia, ISU = Isukwuato, UNE = Umunneochi); (B) Abia Central Zone and the LGAs (IKW = Ikwuano, ISN = Isiala Ngwa North, ISS = Isiala Ngwa South, UMN = Umuahia North, UMS = Umuahia South); (C) Abia South zone and LGAs (ABN = Aba North, ABS = Aba South, OBN = Obingwa, OSM = Osisioma, UGW = Ugwunagbo, UKE = Ukwa East, UKW = Ukwa West).

adoption of all the improved varieties. This could probably be attributed to the urban nature of these two LGAs which are the center of commerce in Abia State and residents belong to the commercial and not the farming sector.

Determinants of adoption of improved varieties of cassava: The Probit estimates of adoption of improved cassava varieties in Abia State are presented in Table 3. The Chi square tests of 3553.985 show that the model is significant in explaining the adoption of improved cassava varieties ($P< 0.05$). The coefficients for marital status, household size, farm size, cassava maturity period and tenurial status were negative and highly significant at 1% level. This implies that any increase in any of these variables would lead to a decrease in the level of adoption of improved varieties. A large household which is largely synonymous with those who are married may have a lot of family needs which causes a decrease in adoption of innovations. Though, large family size may seem to have the advantage of labor availability [31, 32]. However, this may depend on the type or complexity of the innovation, family farm size, and the cost associated with the technology or innovation. With small farms, it has been argued that large fixed costs become a constraint to technology adoption especially if the technology is costly [33].

It has also been demonstrated that a small land area may provide

Table 3. Probit analysis of influence of selected variables on farmers adoption of improved cassava varieties in Abia State.

Variables	Parameter	Coefficient	Standard Error	t-value
Constant term	β_o	-1.5906	0.1037	–15.3342***
Gender	β_1	-0.0244	0.0188	–1.2985
Age in years	β_2	0.0040	0.0132	0.3039
Marital status	β_3	-0.1314	0.0219	–6.0129***
Educational status	β_4	0.0103	0.0123	0.8390
House hold size	β_5	-0.0082	0.0029	–2.8690***
Occupational status	β_6	0.0170	0.0217	0.7820
Fertilizer use	β_7	0.0182	0.1703	1.0686
Yield (t)	β_8	0.0227	0.0018	12.4888***
Farm size in (ha)	β_9	-0.0361	0.0090	–4.0277***
Maturity period	β_{10}	-0.0420	0.0165	–2.5520***
Average income	β_{11}	0.0000	0.0000	3.9528***
Tenurial system	β_{12}	-0.1362	0. 0202	–6.7383***
Chi Square	3553.985			
P	0.0000***			

Source: SPSS, Survey data, 2007 ** and *** = Significant at 5% and 1%, respectively.

an incentive to adopt a technology, especially if the innovation is labor-intensive or land-saving [36, 37]. In that study, the availability of land for agricultural production was low, consequently most farms were small. Hence, adoption of land-saving technologies seemed to be the only method to increase agricultural production. Many authors conclude that the inverse relationship is a result of differential factor use intensity [38-42]. They concluded that small farms have a greater average and marginal productivity of land.

It is expected that the longer maturity period, typical for local varieties, would lead to decreased adoption. With the increase in population pressure, food security of households is likely to be a major concern. Hence, technologies that produce an earlier maturing crop may be a good choice and the probability of adoption is likely to be higher than for one with a longer maturity period. This implies that farmers are likely to abandon their local cassava varieties for improved cassava varieties. This is happening now in Abia State. Farmers' perception of early maturity was an important variety attribute that motivated the adoption of improved varieties [43].

Farmers who are squatters (on leased or rented land) may avoid adopting technologies that are expensive and of long-term nature. Those who own land (purchased, inherited, or were given) may have the motivation to adopt new technologies even when they are expensive [44]. The results showed that increasing farmers' tenurial rights over land would increase the possibilities of adoption; this is consistent with results from similar studies [35, 45].

The coefficients for cassava yield and income were positive and highly significant at 1% level. This implies that any increase in the variables would lead to increased adoption of improved varieties. Household income as a significant factor in the adoption of improved cassava varieties implies the existence of a capital barrier that needs to be lifted before adoption can take place. Hence, the higher the household average income, the more resources are available to finance both household consumption and farm production, including investments to enhance farm productivity. In this case, farmers with higher income are more likely to have the necessary funds to finance the initial cost of adopting improved varieties, for example, sourcing planting materials, such as stem cuttings, and the labor requirement for planting and subsequent farm operations. The result is similar to that found among dairy cattle farmers in Kenya, and adopters of dual-purpose forage in the Philippines [46, 47]. Similarly, high yields have been reported as a motivational factor for improved varieties adoption [43].

The coefficients for age, education, occupational status and fertilizer use were positive but not statistically significant. The coefficient for gender was negative but not statistically different from zero. However, the negative sign associated with the gender factor suggests that women farmers have a higher adoption probability and intensity of use of improved varieties than male farmers. This likely differential adoption based on gender can be explained by the fact that women are more involved in cassava cultivation than men. This category of farmers should therefore be empowered in promoting the cassava industry in Abia State and Nigeria in general.

Conclusions

Adoption of improved cassava varieties is dependent on social, economic and other factors. The study indicates that cassava farmers in Abia State are predominantly women who are part-time farmers, married, literate with large households and who can be described as experienced. Important factors positively related to the adoption of improved cassava varieties were yield and income. On the other hand, factors negatively related to adoption include marital status, household size, farm size, maturity period and tenurial status.

The level of cassava production and the tendency to use improved planting material in the study area is encouraging; one can conclude from the findings of this study that majority of the farmers are aware of the benefits of improved cassava varieties. The extent of adoption may be depending on the individual farmer's characteristics as identified in this study. Therefore, effort should be geared towards the intensification of breeding programs on high yielding and early maturing varieties of cassava. This will enable farmers to have a wide range of varieties to replace local varieties which are not resistant to Cassava Mosaic Diseases with improved varieties that are high yielding and are resistant. This will boost the level of production of the farmers and subsequently enhance income generation and poverty reduction. Also, measures should be taken to convert tenurial arrangements to more secure forms of tenure. This can be done through communal land development programmes supported by government or private sector initiatives, to enable farmers have a more secured form of land ownership. Giving land to smaller farms will increase overall production, as well as improving the welfare of the small and landless peasantry, since the bulk of agricultural food is produced by the smallholder farmers in Abia State, Nigeria. To facilitate and sustain adoption improved varieties, farmers need to have some minimum level of income base. Farmers who do not have the capital base to adopt improved varieties or technologies may likely drop someway along the line. Such farmers should be linked to micro-credit schemes, so as to sustain productivity and adoption.

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