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Factors Informing the Smallholder Farmers' Decision to Adopt and Use Improved Cassava Varieties in the South-east Area of Nigeria

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Abstract

The factors influencing farmers' adoption and use intensity decisions on improved cassava varieties were investigated. Data collected from 510 cassava farmers randomly selected among the users (62.9%) and non-users (37.1%) from Abia State, south-east, Nigeria were used for the study. Descriptive and inferential statistics and tobit regression technique, with its associated elasticity decomposition framework were used in data analysis. Results revealed that plot size ($p<0.01$), farmer's age ($p<0.01$), education status ($p<0.01$), and awareness through workshop and trainings ($p<0.05$) had significant positive influences on adoption and use while awareness through friends ($p<0.01$) and radio/television ($p<0.01$) had negative influences. Results were consistent for all three variants of the regression output considered. Elasticity results showed that the marginal effects of changes in all variables increased the elasticity of the probability of use more than they increased the probability of adoption for all households. The implication is that constant training and retraining of farmers on best farming and management practices would foster adoption and use of improved varieties to impact on the farmers' wellbeing. Interactions among farmers during meetings, co-operatives, and other non-formal forums should be encouraged, but appropriately monitored, to ensure that only right messages were circulated to avoid distortion and negative outcomes.

Keywords: adoption decisions, *Manihot esculenta*, improved varieties, rural farmers, tobit, use intensity

1. Introduction

Cassava (*Manihot esculenta* Crantz) is an important food and cash crop that contributes immensely to the growth and development of most rural economies of Africa. Its huge potential includes use as industrial raw material to manufacture starch, flour, glucose syrup and ethanol (Nweke *et al*., 2002). It contributes about 15% of the daily dietary energy intake and supplies about 70% of the total calorie intake of about 60 million Nigerians (Ezulike *et al*., 2006). Nigeria is adjudged the world's largest producer of cassava with a production record of about 34 million tons per annum, representing 37% and 19% of the total African and global production (FAO, 2000). Cassava often serves as the main crop or the dominant component in crop mixtures in south-east Nigeria (Ikeorgu and Mbah, 2007). Also, cassava products are important staples for the rural and urban households in southern Nigeria (FAO and IFAD, 2005). As a cash crop, about 45% of cassava is sold for various household income needs (Nweke *et al*., 1996). Report from Collaborative Study of Cassava in Africa (COSCA) revealed that about 80% of Nigerians in the rural areas eat a cassava meal at least once a week (Carter and Jones, 1989; Nweke *et al*., 2002). The main socio-economic factors affecting production relate to inadequate resource allocation, infrastructure, and access to technology and extension services (IITA, 1990).

Over the years, a considerable amount of research has led to generation of new technologies and practices to increase cassava output at the farm level (Udensi *et al*., 2011). Multiplication, distribution, and adoption of improved varieties might have significantly contributed to Nigeria's current position as the world's largest producer. Nevertheless, to assess the usefulness of these technologies to cassava farmers, there is need to determine the attributes of farmers determining their choices of the available technologies. Earlier studies show that farmers' decisions to use a particular crop variety have many influences, some of which are market-driven or socio-culturally based (Nwawuisi *et al*., 2007; Kimenju *et al*., 2005; Springer *et al*., 2002; Dorp and Rulkens, 1993). Also, farm size, risk exposure and risk-bearing capacity, human capital, labor availability, credit constraints, land tenure and access to market have been identified among the influential factors (Feder *et al*., 1985). Elsewhere, it was noted that direct short-term benefits to farmers usually serve as important incentive in fostering adoption of resource-conserving technologies (Harrington, 1994).

The International Institute of Tropical Agriculture (IITA) had from 2001-2009 implemented the Integrated Cassava Project (ICP), a hybrid of two independent but complementary projects – the pre-emptive management of the Cassava Mosaic Disease (CMD) project in Nigeria and the Cassava Enterprises Development Project (CEDP). The CMD component of ICP was funded by the United States Agency for International Development (USAID), Federal Government of Nigeria (FGN), Niger Delta Development Commission (NDDC), and the participating state governments. It was aimed at forestalling the spread of the virulent form (Ugandan strain) of the cassava mosaic disease through the development and deployment of improved, high-yielding and disease-resistant cassava varieties. It was expected to increase cassava productivity and precipitate into surpluses. The CEDP component, co-funded by the USAID and Shell Petroleum Development Corporation (SPDC), was initiated to mop up the surpluses from the CMD-Project through the use of appropriate processing technologies and development of the cassava enterprise sector. The trust in the sister projects led by IITA was to contribute to development in the Nigerian agricultural sector by facilitating the development of a viable cassava value chain.

The ICP was implemented in collaboration with the Agricultural Development Programme (ADP) of various States and the National Roots Crop Research Institute (NRCRI), Umudike, Nigeria while the farmers' cooperatives and organized groups promoted the use of the improved cassava varieties resistant to CMD and other pests. Improved cuttings were a component of the set of technologies introduced to encourage sustainable production and commercialization of cassava in project zones. The use of improved varieties among Nigerian farmers has been of immense contribution to the increasing national output. While the influences of socio-economic and other factors on farmers' decisions to adopt or not to adopt new innovations have been widely reported in literature (example Baffoe-Asare *et al*., 2013; Idris *et al*., 2012; Ojiako *et al*., 2007; Arega *et al*., 2000; Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993; Feder *et al*., 1985), not much is known of factors that explain the adoption and use intensity of improved cassava varieties. This study seeks to examine the factors that have influences on the adoption and use intensity of improved cassava varieties introduced to the smallholder farmers in south-east Nigeria. The hypotheses the study explores are that influence on adoption and use intensity is positive for plot size, education status, household size, number of adult women and children, and different sources of awareness and negative for age and gender of the farmer.

2. Review of literature on adoption decisions of farmers

The development and dissemination of improved agricultural technologies in sub-Saharan Africa and elsewhere resulted from the need to improve the well-being of the rural poor farmers to enhance national income (Phiri *et al*., 2004). Farmers' adoption and use of these technologies would not only provide justification for the research efforts thereto, but were also imperative to the realization of the purpose of their introduction. The adoption of an innovation was described as the decision to apply the innovation and to continue to use it (Oladele, 2005). Often, it was explained in terms of incidence or pattern of adoption and intensity of use (Langyintuo and Mekuri, 2005). For the crop-improvement innovation, the incidence would provide an answer to whether or not a farmer had used the technology while the intensity would explain the degree of use (Langyintuo and Mekuri, 2005). Generally, adoption studies were considered important because they help to quantify the number of users of an innovation over time, thereby assist in assessing the extension requirements, provide information for policy reform, and provide a basis for measuring the impacts (Langyintuo and Mekuri, 2005).

Evidences from adoption literature established three main paradigms for adoption analysis: the innovation-diffusion, economic-constraint or farm structure, and the adopter-perception paradigms (Adesina and Zinnah, 1993; Langyintuo and Mekuri, 2005). The innovation-diffusion paradigm followed Rogers' earliest work on diffusion and contended that access to information was a critical factor in the adoption and diffusion of technologies. Consequently, the approach reduced the problem of adoption to that of communicating information on a particular technology to the probable users and placed emphasis on extension as a means of increasing the adoption of new technologies (Langyintuo and Mekuri, 2005). On its part, the economic constraints paradigm argued that economic constraints were the major determinants of adoption. The proponents affirmed the superiority of the economic constraint over the innovation-diffusion models, although their conclusions had also been challenged (Langyintuo and Mekuri, 2005). The adopter-perception paradigm focuses on perceived attributes of an innovation and highlights that, in the case of improved crop variety, the user's perception of technological attributes like taste, ease of cooking, yield, storability, resistance to diseases and paste, size, colour, among others, are the major determinant of their adoption decisions. As Langyintuo and Mekuri (2005) succinctly argued, adoption studies should pay special attention to farmers' perceptions of technology characteristics by using either dummy variables or farmers' rating scores of inter-varietal comparisons of characteristics.

Even though each of the aforementioned paradigms was considered individually important, most recent adoption studies have attempted to incorporate the three into a single adoption model (Adesina and Zinnah, 1993). And relating to the choice of analytical model, efforts at determining factors influencing adoption decisions in sub-Saharan Africa had one time or the other made use of such formulations as the ordinary least square and step-wise regression analysis (as in Chikwendu *et al*., 1995; Osuntogun *et al*., 1986; Robinson *et al*., 2002), discriminant analysis (Arene, 1994; Chinaka *et al*., 1995; Sharma and Pradhed, 1996), probit analysis (Falusi, 1974; Akinola, 1987), logistic analysis (Adesina and Baidu-Forson, 1995; Green and Ng'ong'ola, 1993; Nzomoi *et al*., 2007), and tobit analysis (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Arega *et al*., 2000; Fernandez-Cornejo *et al*., 2001; Nkonya *et al*., 1997; Kotu *et al*., 2000; Wubeneh and Sanders, 2006; Langyintuo and Mekuria, 2005; Langyintuo and Mungoma, 2008).

The specific variables whose influences on adoption decisions have been variously discussed could be strategically grouped under the (a) farmer characteristics, including farmer's age, gender, marital status, years of experience as a farmer or sole decision-maker in own farm, level of education, household size, farm and non-farm income; (b) institutional factors and farm characteristics, including farm size, membership of association, leadership position in community, access to credit, exposure to information, access to input and output markets; and (c) broad technological attributes, including farmer's perception of the improved variety in respect of yield, taste, resistance to diseases and pests, maturity period, ease of management, and colour and size of seed The following are some specific findings on the influence of the aforementioned variables on adoption.

In a joint study of adoption of improved maize seed and fertilizer conducted in northern Tanzania using a bootstrapped simultaneous tobit model, Nkonya *et al*. (1997) found that farm size and level of educational attainment of farmers had positive and significant effects on their adoption behaviours. Comparable findings followed from the study of farmer's decisions on tractor hiring services scheme in Nigeria using probit model (Akinola, 1987) and in the investigation on the determinants of adoption and utilization of improved maize in central highlands of Ethiopia using tobit analysis (Arega et al., 2000). The influence of landholding or farm size was equally recognized (Abdul *et al*., 1993; Polson and Spencer, 1991). On the other hand, Bezuayehu *et al*. (2002) argued that education improves human capital, farm management capacity, and ability to understand and adopt new agricultural technologies and has positive and significant influence on adoption decisions.

Apart from their finding on the influences of farm size and levels of education, Arega *et al*. (2000) also documented that household labour and farm income significantly influenced adoption and use intensity of improved maize. The positive and significant effect of household size was corroborated by Manyong and Houndekon (1997) while the negative influence was supported by Owu (1995) in a separate study. Similarly, Arene (1994) investigating the adoption potentials of small-holder farmers and prediction of extension cost in Nigeria using the discriminant model identified the significant influence of family size on adoption decisions. Other socio-economic variables found to have positively influenced adoption at different times are farming experience, gender, number of dependants and marital status (Rao and Rao, 1996; Adesina and Zinnah, 1993; Sanginga *et al*., 1999]. The sign of age has been found to be indeterminate (Adesina and Baidu-Forson, 1995; Bamire *et al*., 2002). On the one hand, it was argued that the younger farmers might have greater tendency to adopt new innovations because they are relatively more knowledgeable, more open to risk-taking, and have longer planning horizon (Adesina and Zinnah, 1993). On the other hand, older farmers might show more likelihood to adopt for three main reasons: first, they might have over the years acquired much personal capital they would be willing to invest in a new innovation; second, as village elders they might have better access to privileged information through extension services or development projects' staff working in their community, and/or three, they might have acquired better skills in accessing the prospects of new crop variety in relation to a local one that they already knew and used.

Most recently influences of household wealth and neighbourhood effects have been reported. Langyintuo and Mungoma (2008) investigated the effect of household wealth on the adoption of improved high yielding maize (IHYM) varieties in Zambia and found that factors influencing the adoption and use intensity of IHYM varieties differ between the wealth categories. They recommended wealth group-specific interventions to increase the adoption and use intensity of such varieties and their subsequent impacts on food security and general livelihoods of the households. Langyintuo and Mekuria (2008) used a spatial Tobit model to assess the influence of neighbourhood effects on adoption of improved agricultural technologies in Mozambique and emphasized the need to test and correct for spatial heterogeneity in technology adoption modeling to improve the efficiency of the estimated results. According to them, ignoring the spatial heterogeneity can result in biased or inefficient regression estimates, which would lead to misleading conclusions. Voh (1982) highlighted the influence of socio-economic variables on adoption decisions of households while Rao and Rao (1996) elsewhere found that training received, cropping intensity, aspiration, economic motivation, innovativeness, information source and its utilization, agent credibility have influence on adoption behaviours of households.

In a study of fertilizer adoption pattern among farmers in the ecological zones of south-western Nigeria, Bamire *et al*. (2002) found a negative and significant relationship between extension visits and fertilizer adoption, which disagreed with the conclusion from another study on adoption of improved maize and fertilizer (Nkonya *et al*., 1997) that revealed a positive relationship between the variables. Further, Akinola (1987) acknowledged an association between access to credit and membership of cooperatives and meetings, which corroborates Arega *et al*. (2000) who equally identified that extension services and timely availability of improved seeds significantly influenced adoption and use intensity of improved maize. They found further that off-farm income and age of household head were insignificant in explaining adoption and use intensity behaviours. An attempt made by Oladele (2005) to investigate the factors that explained farmers' discontinued use of improved technologies incidentally found that farmers' propensity to discontinued adoption of improved varieties of cowpea was significantly influenced by extensions visit.

3. Research and Methods

3.1 Study area

This study was conducted in Abia State, south-east Nigeria. Abia State lies between latitudes $4^o 45'$ to $6^o 17'$ N and longitude $7^o 00'$ to $8^o 00'$ E. The climate is tropical and humid all the year round. The rainy season runs from March – October and the dry season from November – February. The State has an annual rainfall range of 2000 – 2500 mm and a temperature range of 22 – 31^o C (FOS 1999). Generally, the vegetation of the State can be classified as tropical rainforest, although, some areas (like Abia North and Central) are characterized as derived savanna and Abia South is in the heavy rainforest vegetation (Ohaeri and Eluwa, 2007). The soils fall within the broad group of ferrallitic soils of the coastal plain sand and escarpment. The State is divided into three agricultural zones: Aba (Zone 1), Ohafia (Zone 2), and Umuahia (Zone 3). Politically, these agricultural blocks are also known as the senatorial zones: Abia North and Abia Central, each of which consists of five Local Government Areas (LGAs) and Abia South with seven LGAs. In all, the State is split into17 administrative units, called or LGAs. The area is very conducive for agriculture and favors mainly the growing of root and tuber crops. These crops are grown on smallholder plots, usually in mixtures of at least two simultaneous crops (FOS, 1999; World Bank, 2000).

3.2 Sampling procedure

This study used primary data collected from farmers selected from the seventeen LGAs of Abia State, Nigeria. Abia was purposively selected because it was the only state from the south-east (SE) geo-political zone of Nigeria originally included in the project designed for implementation in the Niger Delta area. It was a pilot state in the SE where the improved cassava varieties from IITA were initially introduced. A structured questionnaire was designed to elicit relevant information from respondents. A multistage random sampling procedure was employed in selecting respondents for the investigation. By providing all farmers with equal chances of being selected into the sample, this method ensured a high degree of representation (Babbie, 1994). In the first stage, a ward was randomly selected from each LGA. In the second stage, a village (community) was randomly selected from each selected ward. In each village, the household-listing of cassava farmers was conducted using trained enumerators from the Abia State ADP. In the third stage, thirty households were randomly selected from the generated list of households in each village. In each household, questionnaire was administered on the household head or his or her representative. Thus, a total of 30 household heads were selected and used for the study from each of the 17 LGAs. In all, 510 respondents were used for the study.

3.3 Methods of data analysis

3.3.1 Conceptual model

To determine and quantify the relationship between the adoption index of the improved cassava varieties and the included explanatory variables, the tobit regression analysis was applied. The tobit analysis is a hybrid of the probit and multiple regressions analysis. The method, which goes after Tobin (1958), who first proposed it, was initially presented by Rosett and Nelson (1975), discussed in Maddala (1983), and has been variously applied to adoption studies (Ojiako, 2011; Ojiako *et al*., 2007; Fernandez-Cornejo *et al*., 2001; Arega *et al*., 2000; Nkonya *et al*., 1997; Adesina and Zinnah, 1993; Akinola and Young, 1985). The two-limit tobit is appropriate when the observed dependent variable lies between 0 and 1. The model can be expressed as:

$$y^* = \beta' X_i + e_i \qquad (1)$$

where

y^* = a latent variable that is unobserved for values less than 0 and greater than 1;

x_i = an *n x k* matrix of the explanatory variables that includes factors affecting adoption and intensity of use of improved cassava varieties among farmers;

β = a *k x 1* vector of unknown parameters *i*

e_i = an independent normally distributed error term with zero mean and constant variance (σ^2), that is, ei ~ N (0, σ^2I), and *i = 1, 2… n*, where n is number of observations

The functional form of the Tobit model (Ramasamy *et al*., 1998; Adesina and Zinnah, 1993) can be specified as follows:

$$y_i = X_i \beta, \quad if \;\; y = X_i \beta + \tau_i > T \qquad (2)$$

$$y_i = 0, \qquad if \;\; y^* = X_i' \beta + \tau_i \le T \qquad (3)$$

where y_i is the probability of adoption and intensity of use of the improved cassava varieties, y^* is a non-observable latent variable, T is a non-observed threshold value which can either be a constant or a variable (Wu, 1992), X_i is an nxk matrix of the explanatory variables, which in this study consists of farmers' socio-economic characteristics, and a set of other variables depicting the sources of farmers' awareness of the improved cassava varieties, β_i is a kx1 vector of parameters to be estimated, and τ_I is an independent normally distributed error term with zero mean and constant variance, N(0, σ^2I). The conceptual model of equations (2) and (3) is both a simultaneous and stochastic decision model (Adesina and Zinnah, 1993). If y^*>T, the observed qualitative variable that indexes adoption (y_i) becomes a continuous function of the independent variables. But if y^*≤T, the observed qualitative variable (yi) will take zero value. In the first case adoption is observed while in the second adoption is not observed. Equations (2) and (3) also represent a censored distribution of the data. The tobit model can be used to estimate the expected value of Yi as a function of a set of the explanatory variables (X_i) weighted by the probability that Yi > 0 (Oladele, 2005).

The disturbance term of the tobit model is a function of the independent variables, hence attempting to estimate the functional form using the ordinary least squares (OLS) method would produce biased and inconsistent estimates (Wu, 1992). If the unobserved y_i^* is assumed to be normally distributed, the estimation of the Tobit model could be performed using the Maximum Likelihood Estimation (MLE) method. The likelihood function is expressed as:

$$L = \prod_{y^* > T} (1 - G_i) \prod_{y^* \le T} \frac{1}{2\pi\sigma^2} e\left[-\frac{1}{2\sigma^2} (y_i - \beta X_i)^2 \right] \qquad (4)$$

where, G_i is the distribution function of τ_i. The resultant coefficients of the likelihood function are consistent, asymptotically efficient, unbiased and normally distributed.

3.3.2 Tobit decomposition framework

The total effect of the explanatory variables of the Tobit model can be decomposed using the Tobit decomposition framework suggested by McDonald and Moffit (1980) and applied elsewhere (Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993). Two effects of a given change in a variable can be distinguished: effect on probability of adoption of improved cassava varieties, and effect on probability of intensity of adoption of the varieties.

Consider a dependent variable, y_i: suppose $E(y_i)$ is the expected value of the dependent variable across all observations and $E(y_i^*)$ is the expected value for farmers who have made the adoption decision. Further, if $\Phi(Z)$ is the probability that the farming household will fall below the threshold or the probability of non-adoption, where Φ is a cumulative normal distribution function and $Z = X_i\beta/\sigma$, it is possible to state the relationship between the variables as:

$$E(y_i) = \Phi(Z).E(y_i^*) \tag{5}$$

Differentiating equation (5) with respect to every $x_i \in X$, we obtained

$$\frac{\delta E(y_i)}{\delta X_i} = \Phi(Z)\left\langle \frac{\delta E(y_i^*)}{\delta X_i} \right\rangle + E(y_i^*)\left\langle \frac{\delta\Phi(Z)}{\delta X_i} \right\rangle \tag{6}$$

By multiplying through by $X_i / E(y_i)$, we can convert the relation in equation (6) into elasticity forms as follows:

$$\frac{\delta E(y_i)}{\delta X_i}\cdot\frac{X_i}{E(y_i)} = \Phi(Z)\left\langle \frac{\delta E(y_i^*)}{\delta X_i} \right\rangle\cdot\frac{X_i}{E(y_i)} + E(y_i^*)\left\langle \frac{\delta\Phi(Z)}{\delta X_i} \right\rangle\cdot\frac{X_i}{E(y_i)} \tag{7}$$

Substituting $\Phi(Z)\cdot E(y_i^*)$ for $E(y_i)$ in the right hand side of equation (7) will give:

$$\frac{\delta E(y_i)}{\delta X_i}\cdot\frac{X_i}{E(y_i)} = \Phi(Z)\left\langle \frac{\delta E(y_i^*)}{\delta X_i} \right\rangle\frac{X_i}{\Phi(Z)E(y_i^*)} + E(y_i^*)\left\langle \frac{\delta\Phi(Z)}{\delta X_i} \right\rangle\frac{X_i}{\Phi(Z)E(y_i^*)} \tag{8}$$

Further simplification will reduce equation (8) to:

$$\frac{\delta E(y_i)}{\delta X_i}\cdot\frac{X_i}{E(y_i)} = \left\langle \frac{\delta E(y_i^*)}{\delta X_i} \right\rangle\cdot\frac{X_i}{E(y_i^*)} + \left\langle \frac{\delta\Phi(Z)}{\delta X_i} \right\rangle\cdot\frac{X_i}{\Phi(Z)} \tag{9}$$

Equation (9) suggests that the total elasticity of a change in any of the included explanatory variable could be decomposed into two different effects: the first that reflects a change in the elasticity of the probability of being an adopter of the improved cassava varieties, and the second that reflects a change in the elasticity of the expected level of use intensity of the improved varieties for farmers who had already adopted them.

3.3.3 Empirical tobit model

The empirical tobit model for this study is specified implicitly as:

$$ICAD_i = ICAD_i(PLS_i, GEN_i, AGE_i, EDS_i, HHS_i, NOW_i, NOC_i, ARF_i, ANP_i, ARD_i, AWS_i, \xi_i) \tag{10}$$

where, with respect to individual farmer *i*, $ICAD_i$ is a variable measuring the improved cassava varieties adoption status; PLS_i is the plot size; GEN_i is gender of the farmer; AGE_i is the age of the farmer; EDS_i is farmer's education status; HHS_i is the household size; NOW_i is the number of adult women resident in the household; NOC_i is the number of children, ARF_i, is initial awareness through friends and other farmers; ANP_i is initial awareness through newspapers, magazines and other print sources; ARD_i is initial awareness through radio and television; and AWS_i is initial awareness through workshops and trainings programmes. The measurements and a priori expectation assumptions relating to the explanatory variables are presented follow in the subsequent paragraphs.

$ICAD_i$, the dependent variable is a measure of adoption of the improved cassava varieties status. It was calculated as the ratio of the number of improved cassava varieties cultivated by the household to the total number of all introduced varieties. Dummies (1=if planted by farmers; and 0=if otherwise) were assigned to each of the five identified cassava varieties. Sums of scores were obtained for each respondent and the result was divided by the maximum attainable score to arrive at a ratio. This ratio entered the model as a dependent variable. The definition, measurement, and expected signs of the explanatory variables considered for inclusion in the empirical model are presented in Table 1.

Table 1. Description and measurement of variables

Variable	Description	Measurement
$ICAD_i$	Improved cassava (technology) adoption, is the adoption index and dependent variable. It rrepresents the proportion of all improved cassava varieties being grown by the farmer.	Ratio of plots devoted to improved cassava varieties. Assumes values between zero and one ($0 \leq ICAD_i \leq 1$)
PLS_i	Plot size devoted to growing of the improved cassava varieties by the farmer.	Hectares
GEN_i	Gender of the farmer.	1=female; 0=male
AGE_i	Age of the farmer.	Years
EDS_i	Educational status or highest level of educational attainment of the farmer	0=None; 1=Primary; 2=Secondary; 3=Tertiary
HHS_i	Household size, number of persons living together in the household, cooking and eating together from the same pot	Number
NOW_i	Number of adult women resident in household	Number
NOC_i	Number of children resident in household	Number
AFR_i	Awareness of the improved cassava varieties through friends, neighbours and other farmers	Dummy (1=Yes; 0=No)
ANP_i	Awareness of the improved cassava varieties through newspapers and other print news mediums	Dummy (1=Yes; 0=No)
ARD_i	Awareness of the improved cassava varieties through radio	Dummy (1=Yes; 0=No)
AWS_i	Awareness of the technology through workshops and trainings	Dummy (1=Yes; 0=No)

Source: Compiled using Farm-level Field Survey Data

PLS_i is the plot size, defined as the area of farm fields/plots the farmer devoted to improved cassava production during the period of study, measured in hectares. It might be possible that a part of or all the plots were devoted to improved cassava varieties. However, Kotu *et al*. (2000) succinctly argued that the farm area cultivated by a farmer was an indicator of wealth and could serve as a proxy for social status and influence within the community. Consequently, a positive sign is expected for PLS_i.

GEN_i is the gender of the farmer. It is measured as a dummy variable (1=female; 0=male). Although used to capture sex, the variable is also often used to capture the social role of the individual farmer (Baffoe-Asare *et al*., 2013). In tropical Africa, including Nigeria, social roles have significant impact on resource endowment and distribution within the family particularly in the rural farming communities (Buffoe-Asare *et al*., 2013). Although women, especially widows, play significant role in agriculture (Langyintuo and Mekuria, 2005), male farmers by virtue of the inheritance system happen to be relatively more resource endowed against the resource constrained women, be it in consideration of land or other assets. Also, women are generally marginalised in terms of access to information, external inputs as well as income in most agrarian societies of Africa (Buffoe-Asare *et al*., 2013; Matata *et al*., 2010; Dey, 1981). For example, Langyintuo and Mekuria (2005) argued that in southern Africa as in most parts of the developing world, most extension workers are usually biased towards men in their extension activities. In general, effect of gender on adoption could be negative or positive depending on the nature or the characteristics of the technology being assessed (Ntege-Nanyeenya *et al*., 1997). In this study, a negative relationship was hypothesized for gender.

AGE_i of the farmer, measured as 1 to 4 for different age categories (Table 1), is among the commonly used explanatory variables in adoption studies. Its effect on adoption has been considered indeterminate (Buffoe-Asare *et al*., 2013; Ojiako, 2011; Ojiako *et al*., 2007; Adesina and Baidu-Forson, 1995; Bamire *et al*., 2002) or somewhat controversial in explaining technology adoption in literature (Langyintuo and Mekuria, 2005). They argued that, on the one hand, the older persons are sometimes viewed to be less amenable to change and as such will be reluctant to change their old ways of doing things while on the other hand, older people may have higher accumulated capital, more contacts with extension, making them more prepared to adopt a technology than the younger ones. In the first instance, age will have a negative effect on adoption while in the second the effect will be negative. In this investigation we hypothesized that age of farmers and adoption are inversely related.

EDS_i is the education status of the farmer. Educated farmers are usually assumed to possess better capacity to search for, process, and interpret information about appropriate technologies capable of assuaging the constraints associated with their production activities. Put differently, education provides farmers with the ability to perceive, interpret, and respond to new information much faster than their counterparts without education (Langyintuo and Mekuria, 2005). Therefore, education is expected to be positively related to adoption behaviour of farmers and it is so hypothesized in this study.

HHS_i is the household size. It is the number of persons who dwell in the same household and share food from the same cooking pot. In this study, the household was considered following Cogill (2003) as either single persons, who had made provision to live with no assistance, or multi-persons, who are related or unrelated, or a combination of both. In adoption studies, household size is considered an important socioeconomic variable used to measure labour availability or endowment in traditional agricultural production (Baffoe-Asare, 2013). Labour accounts for about 60% of the total cassava production cost. Consequently, farm households with large membership are expected to be in a better position to supply the needed labour and as such more ready to adopt improved cassava technology package (Nkamleu, 2007). It was hypothesized that HHS_i would have a positive sign.

NOW_i is the number of adult women while NOC_i is the number of children resident in the household as defined. The role of women and children in African agriculture cannot be undervalued. Women (in most cases housewives) and children complement the activities of men farmers and in cases where men become unavoidably away, the women take over the management of the farms (Ojiako, 2011). Both NOW_i and NOC_i are related to household size and it is expected that each would increase the number of workforce available for farm work. Consequently, we hypothesized that each was positively related to household's adoption decisions.

Each of the variables that we used to capture sources of awareness of the improved varieties: AFR_i (awareness through friends, neighbours and other farmers), ANP_i (awareness through newspapers), ARD_i (awareness of the technology through radio), and AWS_i (awareness of through workshops and trainings) was expected to be directly related to adoption decisions. This is because each of the variables has the tendency to increase the farmer's knowledge of the technology (improved varieties) introduced at various times in the area.

The choice of the aforementioned explanatory variables was based on theory, evidence from past adoption studies, and hypothesized relationships with the dependent variable. Analysis of the bivariate correlation matrix (Manyong *et al*., 1996) was used to screen the explanatory variables pair wise to retain only the important variables. Variables were considered relevant if they were making significant contribution in the model. Udoh (2000) had also argued that reduction in number of interactions could help to ease computation, reduce the risk of multicollinearity while ensuring that only variables that were economically meaningful and theoretically plausible were retained for analysis. An iterative maximum likelihood algorithm provided by the standard Limdep software was used to obtain parameter estimates of the empirical tobit model that were asymptotically efficient. Preference of the maximum likelihood estimates followed previous adoption studies (Adesina and Baidu-Forson, 1995; Adesina and Zinnah, 1993).

In this study, we had estimated three variants of the empirical model. First, the dependent variable ($ICAD_i$) was regressed on the farmers' socio-economic variables, like age, gender, plot size, level of education, and household size. Second, the same dependent variable was regressed on the set of variables that depicted the sources of farmers' knowledge and awareness of the improved cassava varieties, including awareness through relations and other farmers, awareness through radio and television, and awareness through newspapers, and awareness through trainings and workshops. Lastly, the dependent variable was regressed on all the explanatory variables pooled together.

4. Results and Discussion

4.1 Descriptive statistics and association variables

The descriptive statistics of the included variables are presented in Table 2.

Table 2. Descriptive statistics of variables

Variable	Definition and measurement	Exp. Sign	All Farmers Share (%)	All Farmers Mean (Std. Dev.)	Users+ Share (%)	Users+ Mean (SD)	Non-users++ Share (%)	Non-users++ Mean (Std. Dev.)	Mean diff. (t-value)
Dependent									
ADP_i	An adoption index. Proportion of total cassava farm area farmer had devoted to improved cassava varieties.	NA		0.1748 (0.198)		0.279 (0.181)		0.000 (0.000)	0.279*** (27.56)
Explanatory									
PLS_i	Plot size	+		1.298 (0.398)		1.352 (0.374)		1.208 (0.423)	0.144*** (3.86)
GEN_i	Gender of the farmer.	-		0.567 (0.496)		0.550 (0.499)		0.600 (0.491)	0.058 (1.282)
	0=Male		56.67%		54.52%		60.32%		
	1=Female		43.33%		49.87%		39.68%		
AGE_i	Age of the household head	+/-		2.735 (0.632)		2.779 (0.645)		2.661 (0.602)	0.117ns (2.03)
	1=20 years & below		0.39%						
	2= 21 – 30 years		54.31%						
	3= 31 – 40 years		34.49%						
	4= 41 years & above		9.81%						
EDU_i	Education status:	+		1.64 (1.09)		1.42 (0.86)		1.87 (1.25)	0.417*** (5.307)
	0=No education		12.75%		9.03%		19.05%		
	1=Primary education,		35.29%		31.46%		41.80%		
	2=Secondary education		38.43%		41.75%		32.80%		
	3=Tertiary education		13.53%		17.76%		6.35%		
HHS_i	Household size	+/-		6.894 (2.946)		6.888 (2.641)		6.905 (3.409)	0.017 (0.063)
NOW_i	Number of adult women.	+		1.78 (0.83)		1.58 (0.80)		1.99 (0.81)	0.043 (0.951)
NOC_i	Number of children	-		4.93 (2.67)		4.962 (2.41)		4.878 (3.06)	0.084 (0.345)
AFR_i	Awareness through friends and other farmers	+				0.595 (0.49)		0.799 (0.40)	0.204*** (5.086)
	0=No		32.94%		40.50%		20.11%		
	1=Yes		67.06%		59.50%		79.89%		
ANP_i	Awareness through newspapers and other printed materials	+			(0.21)	0.05	(0.21)	0.05	0.000 (0.046)
	0=No		95.29%		95.33%		95.24%		
	1=Yes		4.71%		4.67%		4.76%		
ARD_i	Awareness through radio/television	+				0.06 (0.23)		0.11 (0.32)	0.055** (2.094)
	0=No		92.35%		54.39%		88.89%		
	1=Yes		7.65%		5.61%		11.11%		
$AWSi$	Awareness through workshops, trainings, etc.	+				0.20 (0.40)		0.17 (0.38)	-0.025 (0.687)
	0=No		80.98%		90.06%		82.54%		
	1=Yes		19.02%		19.94%		17.46%		
TOTAL			n=510 (100%)			n=321 (62.9%)		n=189 (37.1%)	NA

Note: + Farmers planting at least one improved variety used; ++Farmers planting no improved variety used. ***=significant at 1%; **=significant at 5%; *=significant at 10%; ns=not significant; NA=Not applicable; values in parentheses are standard deviations. Source: Computed using Farm-level Field Survey Data

The average size of plot was computed to be 1.3 ha. The average size of plots for users was 1.02 ha while the average for non-users was 1.47 ha, leaving a mean difference of 0.45 ha that was statistically significant ($p<0.01$). The plot sizes ranged from 0.4 ha to 1.6 ha implying that respondents were smallholders who farmed cassava mainly for sustenance and food security. The age distribution of respondents is presented in Figure 1. It showed that majority of the respondents (277 of the 511 persons or 54.31%) fell within the 31-40 years age bracket. This is against the 181 respondents (34.49%) who aged 31-40 years, 50 respondents (9.80%) who aged 41 years and above, and 2 persons (<1%) that aged 20 years and below.

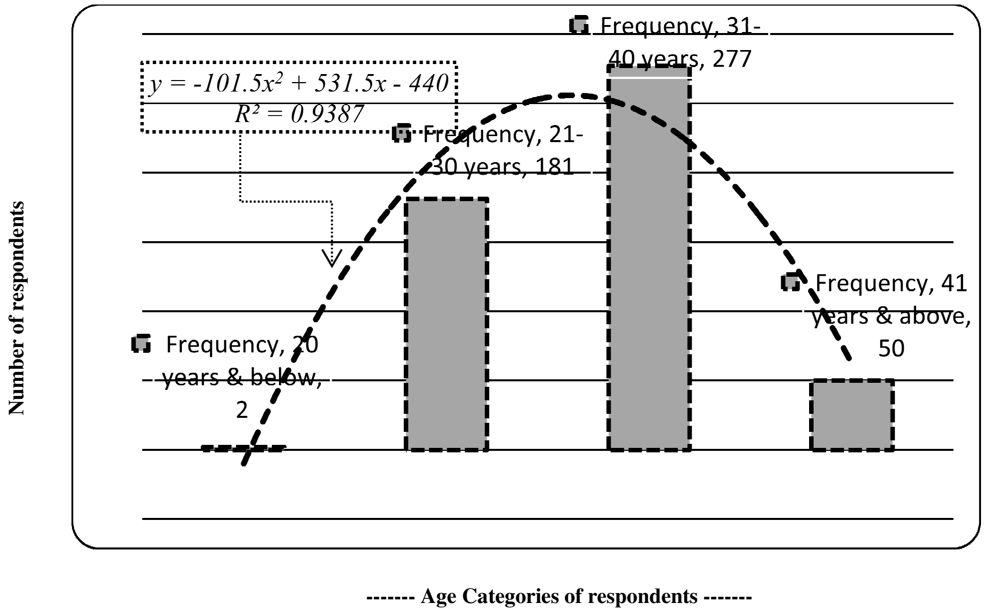

Figure 1: Age distribution of respondents
Source: Computed using Farm-level Field Survey Data

The calculated average age of all respondents was 2.74 years, which expectedly fell into the 31-40 years age range. Similarly, the averages were calculated as 2.68 for users and 2.66 for non-users of improved cassava varieties, which also fell into the 31-40 years age bracket. It follows from the finding that majority of the respondents (users and non-users alike) belongs to the active working population. However, the calculated difference in the age categories of users and non-users was not statistically significant (Table 1). Gender of respondents revealed that 56.67% was male while 43.33% was female. Among the users, female farmers constituted 49.87% of respondents while among the non-users they constituted 39.68%. Thus, there were more male than female farmers, which to a large extent was a true reflection of situation in the study area where men owned most of the farms due to their relative advantage in land access.

The classification of the respondents by education status confirmed that 38.43% (majority) had secondary education. This was in comparison with 35.29% with primary education, 13.53% with tertiary education and 12.75% without any formal education. Among the users, as much as 41.75% had secondary education as against 32.80% within the same category among the non-users. Also, 17.76% of the users had tertiary education compared to only 6.35% of the non-users. The percentage of non-users without education exceeded the percentage of users that belong to the same category. In general, there were more educated farmers among the users than the non-users of improved cassava. The differences in levels of educational attainment of users and non-users of the varieties was statistically significant ($p<0.01$). The average household size for all respondents was 7 persons. It is approximately the same for both users and non-users of the improved varieties. There was no significant difference in the household sizes. Similarly, the average values were 5 and 2 persons respectively for numbers of children and adult women resident in the household. Like the household size there were no significant differences in the two variables.

Relating to the sources of awareness, 67.06% of respondents, 59.50% of users and 79.89% of non-users, affirmed awareness through friends and other farmers, demonstrating the strength of person-to-person interaction in the dissemination of information relating to improved technology. This effect of interpersonal interaction on promoting the adoption of improved soybean varieties was also reported elsewhere (Ojiako *et al*., 2007). Interactions among farmers result from group meetings, cooperative movements, social activities, et cetera. The Table shows further that access to other sources of awareness, like newspapers and other printed materials, radio and television, and workshops and trainings was each confirmed by less than 20% of respondents (including users and non-users).

The correlation matrix of the explanatory variables is presented in Table 3. Most variable pairs have low correlation coefficients (r<0.4) justifying their retention and inclusion in the empirical regression (Udoh, 2000). However, few other pairs, like HHS_i and NOC_i (r=0.95), HHS_i and NOW_i (r=0.54), NOC_i and NOW_i (r=0.41), and ANP_i and ARP_i (r=0.46) were high and significant, leading to their non use jointly.

Table 3. Correlation matrix of the explanatory variables

Variable	PLS_i	GEN_i	AGE_i	EDS_i	HHS_i	$NOWi$	NOC_i	AFR_i	ANP_i	ARD_i	AWS_i
PLS_i	1.000	-0.109**	0.142***	0.102**	0.161***	0.109**	0.155***	-0.044	0.075*	0.099**	0.050
		(0.014)	(0.001)	(0.021)	(0.000)	(0.014)	(0.000)	(0.321)	(0.090)	(0.025)	(0.256)
GEN_i		–	-0.039	-0.223***	-0.022	-0.041	-0.016	0.013	-0.068	-0.062	-0.082*
			(0.382)	(0.000)	(0.624)	(0.357)	(0.7120	(0.773)	(0.127)	(0.164)	(0.065)
AGE_i		–	–	-0.109**	0.276***	0.149***	0.291***	-0.069	-0.112**	-0.055	0.037
				(0.014)	(0.000)	(0.001)	(0.000)	0.119	(0.011)	(0.218)	(0.404)
EDS_i		–	–	–	-0.085*	0.016	-0.123***	-0.191***	0.025	0.029	0.062
					(0.055)	(0.712)	(0.005)	(0.000)	(0.579)	(0.5170	(0.165)
HHS_i		–	–	–	–	0.535***	0.951***	0.009	-0.027	-0.060	-0.064
						(0.000)	(0.000)	(0.843)	(0.549)	(0.177)	(0.149)
NOW_i		–	–	–	–	–	0.412***	-0.073	0.023	-0.024	0.030
							(0.000)	(0.100)	(0.603)	(0.587)	(0.5020
NOC_i		–	–	–	–	–	–	0.005	-0.033	-0.059	-0.076
								(0.903)	(0.464)	(0.183)	(0.088)
AFR_i		–	–	–	–	–	–	–	0.077*	-0.049	-0.128***
									(0.083)	(0.2650	(0.004)
ANP_i		–	–	–	–	–	–	–	–	0.459***	0.293***
										(0.000)	(0.000)
ARD_i		–	–	–	–	–	–	–	–	–	0.255***
											(0.000)
AWS_i											1.000

Note: ***=significant at 1%; **=significant at 5%; *=significant at 10%; PLS_i=plot size; GEN_i=gender of the respondent; AGE_i=age of respondent; EDS_i=education status of respondent; HHS_i=household size; NOW_i=number of adult women; NOC_i=number of children; AFR_i=awareness through friends, neighbors and other farmers; ANP_i=awareness through newspapers; ARD_i=awareness through radio and television; AWS_i=awareness through workshops and trainings; values in parentheses are probability values.

Source: Computed using Farm-level Field Survey Data

4.2 Determinants of adoption and use intensity of improved cassava varieties

The output of regression for determinants of adoption and use intensity of improved cassava varieties is presented in Table 4 for the socio-economic and demographic characteristics, variables that measure awareness, and combination of both.

Table 4. Factors influencing farmers' adoption and use intensity of improved cassava varieties in Abia State

Variables	Code	Socio-economic variables			Awareness variables			All variables		
		Coefficient	Std. error	z-value	Coefficient	Std. error	z-value	Coefficient	Std. error	z-value
Constant		-0.2406***	0.0916	-2.628	0.1805***	0.0229	7.862	-0.1219ns	0.0921	-1.323
Plot size	PLS_i	0.0359***	0.0135	2.671	-	-	-	0.0372***	0.0131	2.838
Gender	GEN_i	-0.0287ns	0.0263	-1.092	-	-	-	-0.0339ns	0.0255	-1.329
Age of farmer	AGE_i	0.0577***	0.0213	2.717	-	-	-	0.0434**	0.0206	2.107
Education status	EDU_i	0.0829***	0.0153	5.421	-	-	-	0.0725***	0.0150	4.822
Household size	HHS_i	-0.2002ns	0.0046	-0.431	-	-	-	-0.0016ns	0.0045	-0.351
Aware thro' others	AFR_i	-	-	-	-0.1163***	0.0259	-4.479	-0.0889***	0.0252	-3.521
Aware thro' radio	ARD_i	-	-	-	-0.1481***	0.05106	-2.900	-0.1667***	0.0497	-3.356
Aware thro' workshop	AWS_i	-	-	-	0.0364***	0.0129	2.801	0.0316**	0.0125	2.520
Sigma		0.2712***	0.0116	23.375	0.2734***	0.0117	23.339	0.2608***	0.0111	23.455
Log Likelihood		-185.84			-191.49			-168.952		
OLS R^2		0.0861			0.0760			0.1445		
Conditional Mean		0.1667			0.1683			0.1632		
Scale factor		0.6465			0.6469			0.6528		
Sample size (n)		510			510			510		

Note: ***=significant at 1%; **=significant at 5%; *=significant at 10%; workshop includes trainings.
Source: Computed using Farm-level Field Survey Data

The first variant of the empirical model that used only the socio-economic and demographic variables found that three of the variables (60%) – plot size (PLS_i), age (AGE_i) and the education status (EDU_i) – were significant at p<0.01 level. The plot size had a positive sign, meaning that the larger the plot size the higher the adoption index, which conforms to the a priori expectation. Similar anticipated positive signs were also found for respondent's age and educational status. The second variant that used only the measures of awareness found that all three included variables: awareness through other farmers and friends (AFR_i), awareness through radio/television (ARD_i), and awareness through trainings and workshops (AWS_i) were significant at p<0.01. Although AWS_i produced the desired positive sign, AFR_i and ARD_i had negative signs. The third variant that used all explanatory variables found that six of the eight variables significantly explained adoption and intensity of use. The variables PLS_i and EDU_i were significant at p<0.01 with positive signs while AGE_i and AWS_i were also both significant at p<0.05 with expected positive signs. Similarly, AFR_i and ARD_i were significant at p<0.01 but, with negative signs.

4.3 Elasticity of adoption and use intensity

The coefficients of elasticity for the three variants reveal that apart from AGE_i and EDU_i, the total elasticity for all other variables are less than unity (Table 5).

Table 5. Responsiveness of improved cassava adoption to changes in variables

Variable	Socio-economic & demographic variables			Sources of awareness			All variables		
	Elasticity of probability	Elasticity of use Intensity	Total elasticity	Elasticity of probability	Elasticity of use Intensity	Total elasticity	Elasticity of probability	Elasticity of use Intensity	Total elasticity
PLS	0.267	0.269	0.537***	--	--	--	0.276	0.284	0.560***
GEN	0.093	0.098	0.191	--	--	--	0.110	0.118	0.228
AGE	0.903	0.947	1.851***	--	--	--	0.679	0.728	1.407**
EDU	0.724	0.760	1.484***	--	--	--	0.633	0.678	1.311***
HHS	0.079	0.083	0.162	--	--	--	0.062	0.066	0.128
AFR	--	--	--	0.446	0.472	0.918***	0.341	0.372	0.712***
ARD	--	--	--	0.065	0.067	0.132***	0.073	0.078	0.151***
AWS	--	--	--	0.040	0.079	0.119***	0.034	0.071	0.105**

Note: ***=significant at 1%; **=significant at 5%; *=significant at 10%

Source: Computed using Farm-level Field Survey Data.

4.4 Implication of findings

The study reveals that the respondents' improved cassava varieties' adoption decision is positively related to changes in plot size, age of the farmer, education status, and awareness through trainings/workshops but, negatively related to gender, household size, and awareness through electronic media, like radio and television and other farmers. The finding on plot size suggests that farmers that devoted large plots are more likely to adopt than those who devoted less size of plots. Two major reasons could account for the positive relationship: farmers having large plot sizes are considered relatively wealthier with higher capacity to adopt, and as Baffoe-Asare et al. (2013) succinctly observed, large farm size would result to easy realization of the benefits of cassava production due to economy of scale. Expectedly, availability of large farms would make it less risky for the farmer to devote part of the farm for demonstration of the new technology. The influence of wealth and socio-economic status of rural farmers on their capacity to adopt improved crop varieties was also recognized in the case of soybean in Kaduna and Kano States, Nigeria (Ojiako, 2011). However, it was argued elsewhere that small farmers had greater tendency to adopt improved technologies at a faster rate if substantial additional gains were expected (Idrisa et al., 2012; Shiyani et al., 2002).

The relationships of farmers' adoption behaviours with age, education, and awareness through training implies that the older, more educated and trained farmers were more likely to adopt than the younger, less educated and untrained farmers. Among other things, this highlights the importance of education and training in promoting adoption of improved innovations. The influences of education and training in promoting adoption of improved innovations were also reported elsewhere (Baffoe-Asare *et al*., 2013; Bezuayehu *et al*., 2002). Also, Baffoe-Asare *et al*. (2013) corroborated the finding on age while Rao and Rao (1996) supported that on information source. The other sets of significant variables, including awareness through friends and other farmers and awareness through electronic media, like radio and television have unexpected negative signs, reflecting their inverse influences on adoption and use intensity of the improved cassava varieties. Interestingly, the two are measures of awareness, which may be a reflection of negative feedbacks arising from poor interpretation of messages from those sources.

Economic conclusions can be drawn from the findings through interpretation of the elasticity coefficients, which reflect degrees of responsiveness of the adoption index to a unit change in a particular variable necessitating it while holding other variables constant. When the socio-economic variables were used alone for the regression, the result showed that a 10% increase in the farmer's age resulted to 9.0% increase in elasticity of probability of adoption and 9.5% increase in the elasticity of use intensity of the improved cassava varieties. This reflected 18.5% increase in the total elasticity. For level of education, a 10% increase in ratio of farmers that received higher levels of educations resulted to a 7.2% increase in the probability of adoption and 7.6% increase in the probability of use intensity of improved cassava variety thereby giving a total of 14.8% increase in total elasticity. Similar findings resulted when all variables were included together in the regression model – 14.1%

total increase in total elasticity for age of the farmer and 13.1% increase in total elasticity for level of education. Another significant socio-economic variable was plot size. It also returned a positive sign, but had total elasticity coefficient of 0.54 when socio-economic characteristics were independently regressed and 0.56 when regressed alongside all others. The results implies that a 10% increase in plot size will result to 5.4% or 5.6% increase in the adoption of improved cassava varieties, other factors remaining unchanged, which is an inelastic case.

All three variables that measured awareness were significant but inelastic. A 10% positive change (increase) in the proportion of farmers that received information on the improved varieties though friends and other farmers led to 4.5% decrease in elasticity of probability of adoption and 4.7% decrease in the elasticity of use intensity for farmers who had adopted. This resulted to a 9.2% decrease in total elasticity when only the awareness variables entered the model alone. When all variables were used together, it was found that similar 10% positive change led to 3.4% decrease in elasticity of adoption and 3.7% decrease in elasticity of use intensity, giving a total of 7.1% decrease. Also, a 10% increase in the proportion of farmers that received the message on improved varieties through radio and television resulted to a reduction in elasticity of probability of adoption and elasticity of use intensity to the tune of 0.7% and 0.8% respectively when all variables were used in the regression model. The only awareness variable that produced the anticipated positive sign was workshop and trainings. When regressed independently, result showed that a 10% increase in the proportion of farmers who attended and received the message about improved cassava varieties at workshop and trainings resulted to 0.4% increase in elasticity of probability of adoption and 0.8% increase in the elasticity of use intensity for farmers that had already adopted, giving a total elasticity of 1.2%. When all variables were used together, similar 10% increase resulted to 0.3% and 0.7% increase in elasticity of probability of adoption and elasticity of use intensity respectively for farmers who had already adopted the varieties. The total increase in elasticity was therefore 1.0%, which was inelastic. In general, the decomposed elasticity values reveal that a one percentage change in the explanatory variables result to lower change in the elasticity of adoption probability than in the elasticity of use intensity of the improved cassava varieties.

5. Conclusion

The findings from this study have revealed that plot size, farmer's age, level of education, and awareness through workshop and trainings had significant and positive influences on adoption and use intensity. An increase in each of these would result to an increase the farmers' probability of adoption and use intensity of the technology. Conversely, awareness through friends and other farmers and through radio and television had significant and negative influences, which could result from the fact that messages from these sources could be distorted or misinterpreted thereby preventing them from producing the desirable impact. Policies and programmes that consider these adoption characteristics of farmers will be desirable in the quest to promoting the adoption of crop-improvement technology, like cassava varieties. For instance, ease of farmers' access to land through appropriate legislation can assist to increase plot sizes while access to higher education can be encouraged by providing the enabling environment and minimal basic amenities needed in the schools. Age had positive relationship with adoption meaning that the older farmers had greater propensity to adopt and use. This underscores the need to encourage farming as attractive occupation capable of providing the practicing farmers the joy and incentive to last in it. Enabling environment should be provided for genuine farmers to undertake to farming as a business venture with high returns on investment. Among other things, making farming attractive and desirous for farmers would require provision of soft credit facilities at special interest rate and improved access to tractors, machineries, and agro-inputs. Constant training of the farmers on the best production and farm management practices would foster adoption and use of improved technologies to promote their wellbeing. Interactions among farmers during meetings of co-operatives, and other non-formal associations are no doubt good networks for promoting farmer-to-farmer dissemination of information, however, modalities would be put place to ensure that only the right messages were being circulated to avoid distortion and counterproductive outcome.

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