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ADOPTION OF IMPROVED CASSAVA VARIETIES AMONG SMALL SCALE FARMERS IN APAC DISTRICT

Oryemo Bonny[1*] Mbatudde Maria, Simon Zziwa[1,2,4], Lydia Nabatanzi[2,3], David Talengera[1,2], Barungi Davis[1], Najjuma Vivian[4] and Nafula Marveen[3]

[1]Faculty of Environment and Agricultural Science, Ndejje University, P.O. Box 7088, Kampala, Uganda

[2]Cereals Research Program, National Crop Resources Research Institute, P.O. BOX 7084, Kampala, Uganda

[3]GuluUniversity, Faculty of Agriculture and Environment, P.O.BOX 166, Gulu, Uganda

[4]Makerere University, College of Agriculture and Environmental Sciences, P.O. BOX 7062 Kampala, Uganda
*Corresponding author

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ABSTRACT

Low adoption of modern agricultural technologies amongst farmers in Uganda has been identified as one of the main reasons for the low agricultural productivity and increase in poverty level. The general objective of this study is to assess the adoption of improved cassava varieties among small scale farmers in Apac District, Uganda. It utilized cross-sectional farm household level data collected in 2020 from a randomly selected sample of 120 cassava producing households from four sub-counties. Data were subjected to descriptive and inferential statistical analysis such as frequencies, means, Chi-square test, Tobit and Logit regression models. Results revealed that majority (66.7%) of the respondents grow improved cassava varieties. NASE 14 is the most (59.2%) highly adopted compared to NASE2 (9.2%), NASE1 (9.2%), NAROCAS1 (6.6%) and NAROCAS2 (15.8%) varieties. Farmer's level of education, access to extension services and marital status showed a positive and significant ($P \leq 0.01$), ($P \leq 0.01$), and ($P \leq 0.05$) influence on adoption of improved cassava varieties, respectively. Years of farming, access to credit, farm size, and farmer's age showed a negative relationship with adoption improved cassava varieties. Coefficient of access to extension services ($P \leq 0.01$), farm size ($P \leq 0.05$) and farming experience ($P \leq 0.05$) positively and significantly influenced perception of farmers towards improved cassava varieties, whereas distance from the nearest market ($P \leq 0.05$) and age ($P \leq 0.05$) negatively and significantly influenced perceptions for farmers.

KEYWORDS: Adoption, Perception and improved cassava varieties

1. INTRODUCTION

Cassava is an important staple food crop for more than 800 million people globally (FAO, 2013; Alou et al., 2014; Abdoulaye et al., 2014; FAO, 2016) and for an estimated 14 million people in Uganda (Kizito et al., 2006). The per capita consumption of cassava in Uganda is 12.0 kg and is cultivated in 96.2% of the districts which makes it an important staple food crop in the country (UBOS, 2010; Alou et al., 2014). It is ranked the second most important crop next to banana for food and income security of households in Uganda (Kalungi et. al., 2005; National Cassava Policy (NCP), 2013; Nakabonge et al., 2018). Cassava has multiple uses and products such as bread, alcohol or brew, vegetable source, starch, animal feed and fuel wood which signify the socio-economic value of the crop to the localm population in Uganda (Anyiro and Onyemachi, 2014; Ndubueze-Ogaraku and Edema, 2015; Iragaba et al., 2020). Despite the multiple values of cassava, crop productivity on farms in still low (Iragaba et al., 2020). On average, a Ugandan farmer harvests approximately 20% less cassava per hectare than the world average of 12.2 Mt ha-1 and yet there is potential for higher yields of 15 - 40 Mt ha-1 on farms (Fermont, 2009). Most farmers in Uganda depend on local landraces which are low yielding and are susceptible to pests and diseases but the same varieties are preferred to modern ones for various reasons (Adriko et al., 2012; Teeken et al., 2018) among others better taste and storage of tubers. Technological improvement (such as improved cassava varieties) is the most important factor in increasing agricultural productivity and reduction of poverty in the long-term (Solomon 2010; Solomon et al., 2011; Adofu et al., 2013). The development of new cassava varieties in Uganda for instance NASE series, was driven by the need to improve such quality attributes like quick maturity, disease resistance and sweet taste of tubers (DFID, 2005). Over time, National breeding programs in Uganda have developed modern cassava varieties to combat abiotic stresses like emerging pests and diseases (Alou et al., 2014; Manano et al., 2018). Nonetheless, the rate of adoption of some improved cassava varieties is still very low most especially in locations where certain biotic stresses are severe (Alene et al., 2013; Alou et al., 2014; Afolami et al., 2015; Bechoff et al., 2018; Nakabonge et al., 2018). To increase productivity, technology must be adopted in the production process and the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies and socioeconomic characteristics of farmers (Shideed and Mohammed 2005; Nata et al., 2014; Challa and Tilahun, 2014). Therefore, this study sought to assess the adoption of improved cassava varieties among small scale farmers in Apac District.

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MATERIALS AND METHODS

Research Design

A cross sectional survey design was used where data was collected at one time. In-depth, face-to-face interviews were carried out while using a pre-tested and structured questionnaire as a survey instrument to collect quantitative data.

Study Area

The study was conducted in Apac (01°59′N 32°32′E) of Lango Sub region in Northern Uganda. It is bordered by Oyam District to the north-east, Kole District to the north, Lira District to the north-east, Dokolo District to the east, Amolatar District to the south, Nakasongola District to the south-west, and Kiryandongo District to the west. (www.apac.go.ug). It covers a total land area of 3,255.9 km2 (1,257.1 sq mi) partitioned in to 10 sub counties, 52 parishes and 688 villages (UBOS, 2015). Its current population is estimated to be around 349,000 individuals, which makes 10.25% of the overall national population (UBOS, 2015). The choice of the study area was guided by the fact that it is among the highest cassava producers in the region. The 2014 census revealed that more than two thirds (69%) of households derive their livelihoods from subsistence farming as the main source of earning. In terms of employment, the majority of the working population (65%) is subsistence farmers (UBOS, 2015).

Figure 1: Map of Apac District showing the location of Sub-counties
Sources: http//:apac.go.ug/

Sampling Technique and sample size determination

Two-stage sampling technique was employed. The first stage involved purposive selection of Apac district due to its status of cassava production. This was followed by purposive selection of four sub-counties (Apac, Chegere, Ibuje, and Akokoro) which are intensively involved in cassava production from which cassava farmers were selected randomly following simple random sampling technique. A total of 120 respondents were selected from a target population of 122 farmers by using simple random sampling procedure using a sample determination table developed by Krejcie and Morgan (1970). An equal number of 30 respondents were selected per sub-county, and the number of participants that involved in the study was determined according to a formula provided by Yamane (1967).

$$n = \frac{N}{[1 + N(e^2)]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (I)$$

Where;

n: Sample size,

N: Population size,

e: Level of precision.

Data collection and analysis

Data was collected on socio-Economic variables (age, sex, marital status, education level, among others), farmers' knowledge, attitude and practices in production of improved cassava varieties, and level of adoption of improved cassava varieties. Socio-Economic data was subjected to descriptive statistics such as frequencies, percentages, means, and standard deviation by employing Stata 13. These would be further subjected to t-test and chi- square test. Level of adoption of individual farmer was calculated following procedures of Tadasse (2008). This was measured by an adoption quotient (number of varieties adopted by ith farmer over the total number of varieties in the package).

$$Level\ of\ adoption = \frac{Number\ of\ varieties\ adopted\ by\ ith\ farmer}{Total\ number\ of\ varieties\ in\ the\ package} \ldots\ldots\ldots\ldots\ldots\ldots (II)$$

Tobit model regression was used to assess factors influencing level of adoption of improved cassava varieties as presented below;

$$\beta_O + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots\ldots . \beta_n X_n + U \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (III)$$

Where;

Y: Dependent variable (Level of adoption of improved cassava varieties),

β_0: Intercept, β_1-n: coefficient of the explanatory variables,

X_1-n: Explanatory variables (social, economic and institutional variables). Variables considered included: X_1 = Age, X_2 = Marital status, X_3 = Household size, X_4 = Gender, X_5 = Farm size, X_6= Education, X_7= Annual income and εi=error or disturbance term with zero mean and constant variance.

Perception of farmers towards improved cassava varieties were recorded using Likert scale following procedures of Likert (1932). (Strongly agreed, agree undecided/neutral, disagree and strongly disagree). Arithmetic means were calculated from the Likert scale to get the overall perception of farmers. The data were then dichotomized to get binary responses. This was done through collapsing responses 1, 2 and 3 from the original scale to 0=disagree (negative perception) and 4 and 5 to 1= agree, following procedures of Jeong and Lee, 2016. The rationale for rubric dichotomization was that people who answered higher than or equal to 4 where positive while those who were green and those who scored below 4 where negative. The binary logistic econometric model was applied for analyzing factors influencing perception of farmers towards improved cassava varieties. Logit model was used to determine the relative influence of various explanatory variables (socio-economic and institutional factors) on the dependent variable (Perception).

$$Pi = E(Y = 1|\chi_i) = \beta_o + \beta_i\chi_{i\rho} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (IV)$$

Where;

Y=1 perception of farmers,

Xi is a vector of independent variables,

β_o is a constant and β_i=1, 2…n are the coefficients of the independent variables to be estimated.

$$i = Z(i) = \beta_o + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 \dots + \beta_4\chi_4 + U \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (V)$$

RESULTS AND DISCUSSION OF RESULTS

Socio-economic and institutional characteristics of the cassava farmers

Results showed that most (38.3%) of the cassava farmers were within the range of 36 to 55 years (Table 1). This indicated that farmers in the active age dominate cassava production in the area. The assumption was that younger people are likely to adopt improved practices than old people. Present findings are in line with those of Kadafur and Oyakhilomen (2017) who reported that the active farmers were within the same age and referred to them as young and energetic. These are agile and active to withstand the rigors

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of technology (Okunlola et al., 2011). 65.00% of the farmers were males while females were only 35.00%. This shows that cassava production in study area was dominated by males. This is consistent with the findings of Chekene and Chancellor (2015) and Dontsop-Nguezet et al. (2011) whose results indicated that rice farming was dominated by males.

Table 1: Socio-economic and institutional characteristics of the cassava farmers

Variable	Frequency	Percentage	Variable	Frequency	Percentage
Education level			**Age**		
Primary level	45	37.50	20-35	24	20.00
Secondary level	67	55.80	36-45	46	38.30
Tertiary education	01	0.80	46-55	41	34.20
No formal education	07	5.80	56 and above	09	7.50
Gender			**Access to extension**		
Male	78	65.00	Yes	38	35.50
Female	42	35.00	No	79	64.50
Farm size (Ha)			**Access to credit**		
Less than 1	72	61.54	Yes	38	32.70
2.5 - 4.5	27	23.08	No	79	67.30
4.6 – 7.4	15	12.82			
7.5 - 9.5	03	2.56			
Marital status			**Years of farming**		
Married	104	86.70	0-15	93	79.00
Single	08	26.70	16-30	19	17.00
Divorced	05	4.10	31-45	05	4.00
Widowed	03	2.50			
Household size			**Household annual income (Ugx)**		
Less than 2	04	3.33	Less than 100000	90	75.00
1-5	86	71.67	100000-300000	10	8.33
6-9	10	8.33	300000-500000	15	12.50
10 and above	20	16.67	510000 and above	05	4.17

Source: Survey 2020

Furthermore 86.70% of the farmers were married. Similar results were also observed by Chandio and Yuansheng, (2018) in their study on determinants of adoption of improved rice varieties in Northern Sindh, Pakistan. Marriage aids in creating family labour since both women and children can participate in crop production and use of technologies (Ogunlade et al., 2012). Additionally, 79.00% of the respondents

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were ranging between 1-15 years of farming. This indicates that as experience exceeds 15 years, farmers' involvement in cassava production tends to diminish. An average of 10 years' experience in cassava farming was advantageous since it encourages prompt adoption of improved cassava production practices. Results revealed that secondary level was the highest level of education (55.80%) attained by most farmers followed by primary (37.50%). This implies that most of the farmers had attained formal education which puts them in a better position to understand and adopt a number of improved cassava varieties. Further findings showed that the mean farm size was 1.86 hactares, which indicates that the study area consisted of generally small-scale farmers. This agrees with Mugagga (2017) who reported that in a rural area like Kaato of mount Elgon region eastern Uganda, small scale farmers were dominant in the cassava production of the area. Only 35.5% of respondents had access to extension officers, whereas 67.3% had none. Extension services help in revealing opportunities of adopting agricultural technologies to farmers. However, limited extension contacts by farmers hinder their access to information on adoption decision. Furthermore, 32.7% of the respondents could access agricultural credit, meaning majority of respondents (67.3%) could hardly obtain any credit for cassava production. This in line in what Muggaga (2017) reported in Kaato sub county of Manafwa District, Eastern Uganda. Access to agricultural credit is very crucial for acquisition of the most essential agricultural inputs for example inorganic fertilizer and farm implements since they help in agricultural productivity.

Adoption of improved cassava varieties

Findings in figure 1 indicated that majority (66.7%) of the respondents grow improved cassava varieties and 33.3%) of the respondents grow local cassava varieties. This could be attributed to the fact that improved varieties are higher yielding with durable degree of disease resistance. Present findings are related with Nakabonge et al., 2018.

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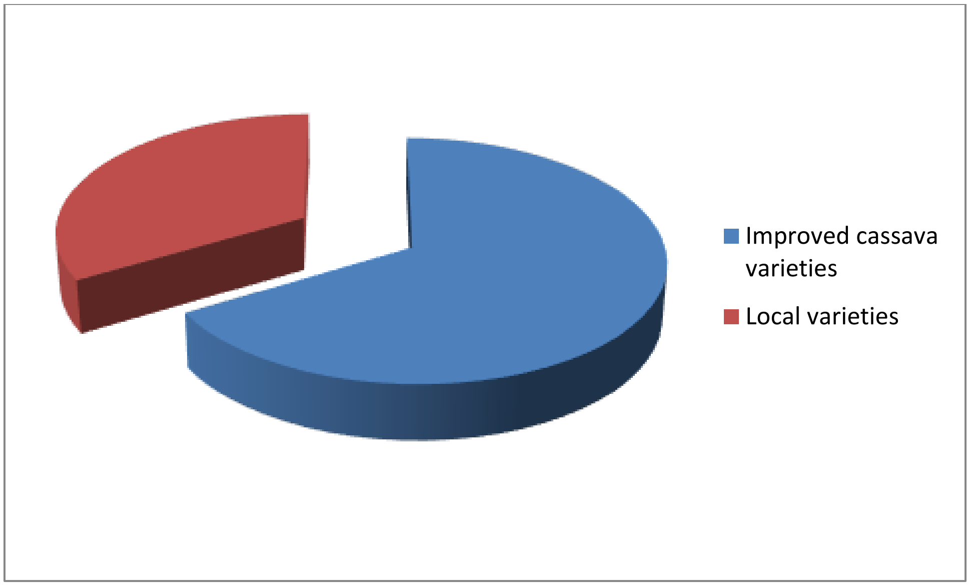

Figure 1: Adoption of improved cassava varieties

Results in figure 2 revealed that majority of the respondents highly adopted NASE 14 (59.2%) compared to other varieties. This could be attributed to its high yield, enhanced shelf life, ease of harvest, color of peeled tuber, early maturity, pests and disease resistance. The finding was consistent with findings by Anywe and Anyaeche (2007) who noted that farmers' adoption of improved cassava varieties could be determined by the extent to which they possess desirable qualities. On contrary, NASE2 (9.2%), NASE1 (9.2%), NAROCAS1 (6.6%) and NAROCAS2 (15.8%) were the least adopted improved cassava varieties by cassava farmers. This could be attributed to the inadequate knowledge on the varieties. Andersson and D'Souza, 2014; Tittonell et al., 2010 had similar findings.

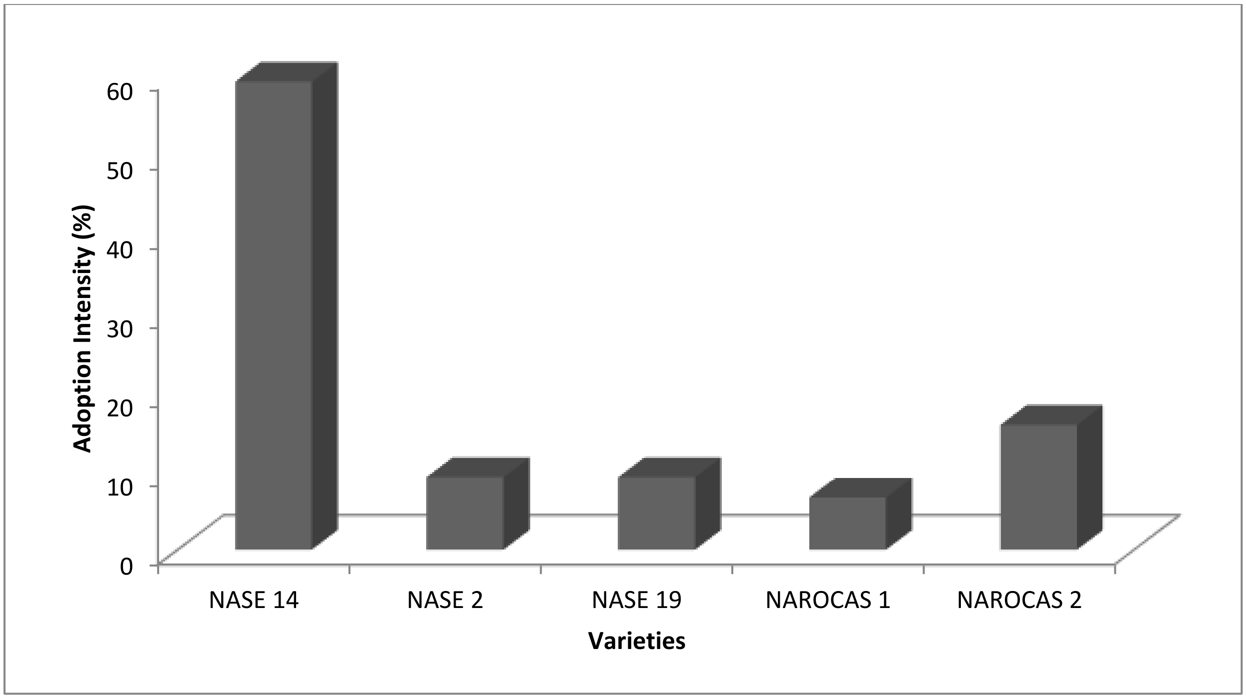

Figure 2: Adoption of improved cassava varieties

Source: Survey 2021

Factors Influencing level of adoption of improved cassava varieties

Results for Tobit estimate of factors influencing level of adoption of improved cassava varieties were presented in table 2. Farming experience was anticipated to have a positive effect on level of adoption of improved cassava varieties since experienced farmers were thought to have accumulated technical know-how over time and therefore were in a better position to adopt the technologies. However, results in the current study indicated that farming experience had a negative relationship with level of adoption of improved cassava varieties. This inverse relationship with level of adoption was in contrary with (Zakaria et al., 2020 and Mudzonga (2011). Present results highlighted the point that several experienced farmers feel more comfortable and secure with the conventional technologies which they have been practicing over time. Extension contact positively and significantly ($p \leq 0.01$) influenced the extent of adoption of improved cassava varieties in the study area. This implied that, frequency of extension visits for dissemination of information and advisory services would give the farmers more confidence to sustain the adoption of improved cassava varieties. This is in line with Mugagga (2017 and Mudzonga (2011) who reported that extension contacts have a positive and significant impact on intensity of adoption. Zakaria etal (2020), in a study carried out in northern Ghana, reported a positive effect of extension contacts on intensity of adoption of climate smart agricultural technologies among rice farmers. Danso-Abbeam et al.

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(2017) also reported a significant and positive effect of extension contacts on the adoption of improved maize variety in northern Ghana.

Table 2: Tobit estimate for factors influencing level of adoption of improved cassava varieties

AI	Coefficient	Std. Err.	P>t
Credit	-8.41E-08	6.06E-08	0.109*
Extension services	0.007594	0.011419	0.007***
Marital status	0.040675	0.019067	0.035**
Years of farming	-0.00096	0.00175	0.586
Age	-0.00014	0.00181	0.938
Education	0.00014	2.41E-05	0.000***
Gender	0.02552	0.030694	0.408
Farm size	-0.01712	0.019438	0.380
Constant	0.579924	0.098821	0.000***

***, **, * indicates significance at 1%, 5% and 10% respectively; Number of observation = 117; F (9, 108) = 8.17; Prob > F = 0.0000; Log pseudo likelihood = 59.706905; Pseudo R^2 = -0.6739; Obs. summary: 14 left-censored observations; 97 uncensored observations; 6 right-censored observations

Source: Survey, 2020

Education level showed a positive and significant (P≤0.01) influence on level of adoption of improved cassava varieties. Educated farmers tend to have better access to research output reports and generally to update information about the risks associated with improved production technologies and hence tend to spend more time and money on that. This is consistent with findings of Abegunde (2019) and Wamalwa (2017). Alene et al., (2000) similarly found in their study in the Central highlands of Ethiopia that adoption and intensity use of improved maize varieties was determined and significantly influenced by the education level of the farmers. Literate farmers also oftenly serve as contact farmers for extension agents in disseminating information about agricultural technologies from government agencies (Adeola et al (2019). However, Kolady et al (2020) presented a diverging finding where education was insignificant in adoption of agricultural technologies in their study of determinants of adoption and adoption intensity of precious agriculture technologies in South Dakota, USA. Results showed a negative effect of credit on level of adoption of improved cassava varieties. This denotes that as farmers' access to credit increases, their desire to venture into other non-farm profit making enterprises also increases, and this eventually limits their investment in cassava production. This could also be attributed to the unpredicted rainfall and temperature patterns of the area which puts farm enterprises at a risk. This observation was consistent with Aryal et al (2018) and Zakaria et al (2020) who reported diversion of farm credit to non-farm activities by farmers in the Indo-Gangetic Plains of India and Northern Ghana, respectively. The negative effect of credit was in contrary with a study by Mugagga (2017) and Mudzonga (2011) who reported a significant and positive impact of credit on perceptions and response actions of smallholder cassava farmers to climate variability in montane ecosystems and farmers' adaptation to climate change in Uganda and Zimbabwe, respectively. Results further showed a negative influence of farm size on adoption of improved cassava varieties. This implies that as land size increases, use of climate smart agriculture practices decreases. However, this is in contrary to the findings of Abegunde (2019) (Wamalwa, 2017) Tesfay (2014) who reported that farm size is also a statistically significant to adoption intensity of agricultural technologies. They indicated that there was positive and significant relationship between farm size and agricultural innovation utilization. Similar result was reported by Mugagga (2017) in a rural area of Kaato of Mount Elgon region Eastern Uganda. Furthermore, the study findings revealed that age had negative relationship with level of adoption of improved cassava varieties in the study area. The findings are in line with Wamalwa (2017) and Kolady et al (2020) who reported that age was insignificance in the adoption of improved practices. Adeola et al (2019) had similar findings in their study of investigating the determinants of adoption intensity of improved sweet potatoes varieties among farmers in Nigeria. However, findings in this study showed that level of adoption of improved cassava varieties was irrespective of gender. This was consistent with the study of Alene et al., (2000) who reported that parameter of age of the farmer was statistically insignificant. Lungu (2019) similarly showed that gender played no significant role in the adoption decision of the household. This was quite a contrast from many other gender studies that have consistently found that men generally have greater control over household resources than women do, and as such, adoption gaps exist between men and women. Farmers' marital status had a positive and significant ($P \leq 0.05$) relationship with level of adoption improved cassava varieties. Marriage aids in creating family labour since both women and children can participate in crop production and use of technologies (Ogunlade et al., 2012). The family determines how much family labour will be used on the farm. (Tiamiyu et al., 2009).

Perception of farmers towards improved cassava varieties

Most (71.21%) positively perceived the adoption of improved cassava varieties in study area. On contrary, 28.79% perceived it negatively (figure 3)

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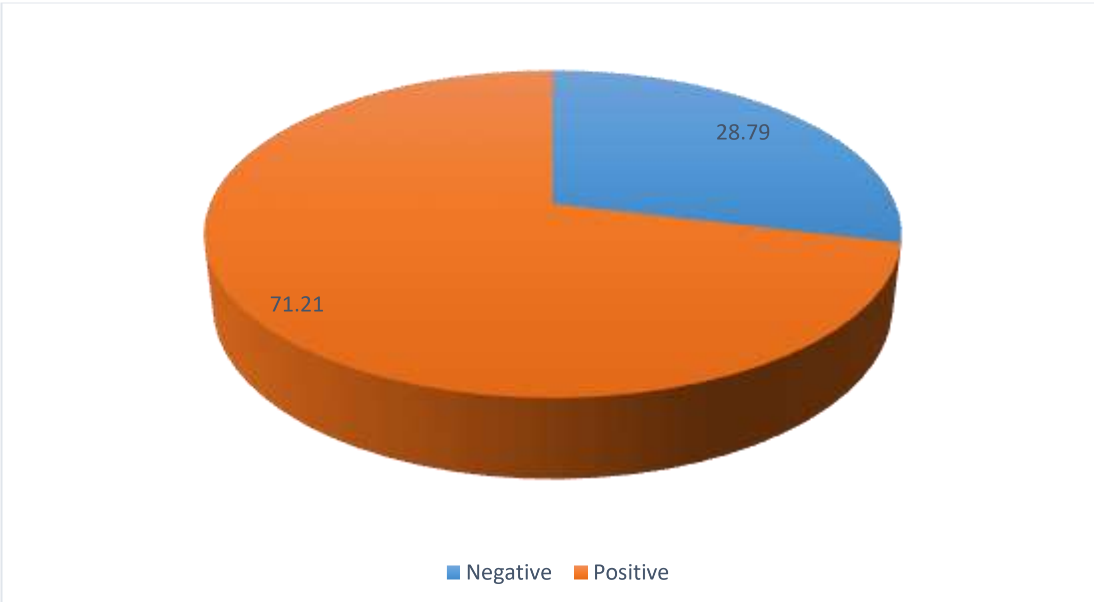

Figure 3: Perception of farmers towards adoption of improved cassava varieties

Factors influencing perception of farmers towards adoption of improved cassava varieties

Results from a logistic regression analysis in table 3 show that age of the household head negatively and significantly ($p<0.05$) influenced farmers' perception towards adoption of improved cassava varieties. The findings are contrary to those of Adesina and Forson (1995) and Gbetibouo (2009) attest to these findings when, in their respective studies, they observed a positive relationship between age of the household head and the adoption of improved agricultural technologies. They have noted that older farmers have more experience in farming and are better able to assess the attributes of modern technology than younger farmers. Hence, older farmers have a higher probability of perceiving and adapting to climate change. The study established that the probability of more educated farmers to perceive ADOPTION OF IMPROVED CASSAVA VARIETIES was higher than that of less educated farmers (0.356274, $p<0.05$). More educated farmers were also more likely to positively perceive ADOPTION OF IMPROVED CASSAVA VARIETIES than farmers with not as much education (0.356274, $p<0.05$). This is because higher education is likely to expose farmers to more information on ADOPTION OF IMPROVED CASSAVA VARIETIES. Komolafe et al. (2014) also found that farmers with high level of education adopt new technologies easily and use them effectively while farmers with more years of farming experiences will be more efficient in farm production. These findings agree with those by Norris and Batie (1987) and Igoden et al (1990) who have noted that higher levels of education is likely to enhance information access to the farmer for improved technology up take and higher farm productivity. They have also observed that

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education is likely to enhance the farmers' ability to receive, interpret and comprehend information relevant to making innovative decisions in their farms.

Table 3: Logistic regression model for factors influencing farmers' perception towards adoption of improved cassava varieties

Variables	Coefficient	Std. Err.	P>z
Gender	0.77226	1.04377	0.459
Age	-0.10533	0.07466	0.018**
Education level	0.35628	0.16636	0.032**
Farm size	0.04863	0.21003	0.017**
Farming experience	0.03491	0.06677	0.601
Off farm activities	0.12561	0.75495	0.868
Credit	0.91024	0.89116	0.307
Extension services	0.54733	0.76402	0.007***
Distance to the nearest market	-0.0012	0.02347	0.053**
Membership in a farmers' group	1.13665	0.85399	0.183
Constant	6.76974	4.25002	0.001***

Number of obs = 66; Prob > chi2 = 0.0054; Log likelihood = -69.534436; Pseudo R2 = 0.6195; Sig. Code *** (1%), ** (5%), and *(10%)
Source: Survey, 2020

Farm size had a positive and significant (0.04863, p<0.05) relationship with perception of FARMERS towards ADOPTION OF IMPROVED CASSAVA VARIETIES. This implies that the larger the farm size, the higher the probability of FARMERS to positively perceive ADOPTION OF IMPROVED CASSAVA VARIETIES. Similar to the findings of this study, Bawa and Ani (2014) and Olusegun et al. (2014) reported that farm size had a bearing on the capacity of farmers to utilize agricultural innovation and new farm practices. They indicated that there was positive and significant relationship between farm size and agricultural innovation utilization. However, these results contradict with findings of Idris et al. (2012) who found out that farm size had nothing to do with adoption.

The study indicates that FARMERS residing far away from the nearest input/output market were less likely to perceive ADOPTION OF IMPROVED CASSAVA VARIETIES than FARMERS residing closer to the market (-1.13665, p<0.05). These results are in line with an observation made by Madison (2006) that long distances to markets decrease the probability of farm adaptation in Africa and that markets

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provide an important platform for farmers to gather and share information. Nyangena (2007) made a similar observation that in Kenya, long distances to the markets negatively and significantly influence the adoption of agricultural technologies of soil and water conservation. The accessibility to extension services by FARMERS had positive and significant (0.54733, $p<0.01$) relationship with PERCEPTION of ADOPTION OF IMPROVED CASSAVA VARIETIES. Several studies agree with these results such as those by Adesina and Forson (1995), Gbetibouo (2009), Maddison (2006) and Nhemachena and Hassan (2007) who have separately noted that farmers' access to information on climate change is likely to enhance their probability to perceive climate change, and hence adopt of new technologies and take-up adaptation techniques. Distance from market had a negative coefficient (-0.1344723) and significant ($P\leq0.05$). The closer they are to the nearest market, the more likely it is that the farmer will receive valuable information (Roy et al., 1999). This agrees to Rahimeto (2007) who opined that adoption of technologies is expected to increase as distance to market decreases.

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