CAUSAL EFFECT OF CREDIT AND TECHNOLOGY ADOPTION ON FARM OUTPUT AND INCOME: THE CASE OF CASSAVA FARMERS IN SOUTHWEST NIGERIA

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ABSTRACT

This study examined credit accessibility, technology adoption and the impact on output and income of cassava farming households in Southwest Nigeria. Data were collected using structured questionnaire through a multi-stage sampling procedure. Ondo and Ogun states were randomly selected from the six States in Southwest, Nigeria. The next stage involved the random selection of four Local Government Areas from each State. Finally, a total of five hundred and forty cassava farmers were randomly selected from both States. Propensity Score Matching, descriptive statistics and Tobit regression model were employed in the analysis. There were 387 respondents with similar characteristics. Majority of the farmers were males with mean household size of six members. Average area of land cultivated was about 1 hectare. Credit accessibility was higher among the adopters. Credit access had a positive and significant ($p<0.01$) influence on level of adoption. Cassava yield and income (14.92 tonnes/ha and ₦321,758.00 respectively) of adopters with credit was higher than their counterparts (13.06 tonnes/ha and ₦287,110.90) without credit access. The impact of technology adoption was higher among adopters with credit access. Technology adoption increased cassava yield and income of adopters with credit access by 4.68tonnes/ha and ₦64,945.19 respectively compared with 2.57 tonnes/ha and ₦33,964.79 for those without access. This suggests that access to credit and technology adoption have the potential to transform smallholder agriculture in Nigeria. The study recommends that government should invest more on technology advancement and dissemination among smallholder farmers. Policy measures should also be oriented towards the improvement of rural credit.

Key words: Cassava, Credit, Income, Technology, Southwest Nigeria.

1.0 INTRODUCTION

The efficiency of the agricultural sector has a multiplier effect on economic development. A potent agricultural sector is instrumental to self-sufficiency in food production, generation of employment, foreign exchange earnings and provision of raw materials for agro-allied industries. In Africa, agriculture accounts for over 32% of the Gross Domestic Products (GDP) and more than 70% of African population engages in agriculture. However, despite the continent's huge potentials in agricultural production, it is alarming that most of the African countries still depend on food importation (Salami and Arawomo, 2013).

In Nigeria, prior to the discovery of oil, agricultural sector was the major source of foreign exchange contributing over 60% of the GDP. However, with the advent of oil, there has been a decline in the contribution of agriculture to the GDP to 22.90% (NBS, 2014). This was as a result of the neglect of the sector and the negative impact of oil boom. Despite this, agriculture still plays significant role in the nation's economy. It employs two-third of total labour force and provides livelihood for over 90% of the rural population. Moreover, with the dwindling oil price in the world, there is need to diversify the nations revenue source, hence government has to shift

attention towards the agricultural sector which remains a fundamental instrument for spurring growth and overcoming poverty.

The agricultural sector is dominated by small-holder farmers accounting for over 90% of the total output while more than half of the farmers produce only food crops including cassava (IFAD, 2010). Cassava serves as an important food source for an estimated 200 million people or averagely one-third of the population of sub-Saharan Africa (IITA et al., 2003). It plays a vital role in the rural economy of the southern agro-ecological zones and increasingly gaining value in other parts of Nigeria (FMARD, 2002). However, farming population comprises predominantly of resource-poor peasants, cultivating an average of about two hectares of land usually on scattered holdings with rudimentary farming system, low capitalization and declining productivity resulting to high food insecurity and poverty. Consequently, increasing agricultural productivity in the country is an urgent necessity and one of the fundamental ways of improving agricultural productivity is through introduction and use of improved agricultural technologies (Braun *et al*, 2008).

In this wise, improving agricultural productivity has become an urgent need. There is the desire to achieve this improvement in productivity while facing the contemporary challenges of global environmental change: global warming, land degradation, water pollution and scarcity, and biodiversity loss (World Bank, 2007). Therefore, properly tailored incentives and policies will be needed to ensure that future efforts to increase agricultural productivity do not compromise environmental integrity and public health (Tilman *et al.*, 2002). Introduction of, access to and the use of improved agricultural technologies and management practices are tools needed to improve agricultural productivity which serves as the key to global food security and fight against poverty. (McCalla, 2001) but it remains a challenge for agricultural researchers to understand how these technologies are used and with what impacts (Braun *et al*, 2008).

. Furthermore, agricultural development is undermined by poor access to modern improved technologies and low investment or finance (Salami *et al*., 2010). In other words, agricultural growth and development is not possible without yield-enhancing technological options because merely expanding the area under cultivation (except in a few places) to meet the increasing food needs of growing populations is no longer sufficient. Hence, the need to prioritise investment in agricultural technology in Africa. Research and adoption of technological improvement are critical to improving agricultural productivity which serves as a panacea to alleviating poverty and food insecurity especially among smallholder farmers. However, credit is a major factor in technology adoption, playing a crucial role in the transformation of smallholder agriculture into commercial scale which engenders agricultural development (Abayomi and Salami, 2008).

Credit provision has been put forward as one of the principal components of rural development, which helps to attain rapid and sustainable growth of agriculture. Rural credit is a temporary substitute for personal savings, which catalyses the process of agricultural production and productivity. To boost agricultural production and productivity farmers have to use improved agricultural technologies, however the adoption of these technologies is relatively

expensive and small-holder farmers cannot afford to self finance it. As a result, the use of agricultural technologies is very low. Therefore, enhanced provision of rural credit would accelerate agricultural production and productivity (Odoemenem and Obinne, 2010). According to Enhancing Financial Innovation and Access (EFInA) (2008), 23 percent of the adult population in Nigeria has access to formal financial institutions, 24 percent to informal financial services, while 53 percent are financially excluded. Furthermore, the importance of credit in agricultural production notwithstanding, farmers in rural areas find it difficult to access it even when available (FARM, 2006). It is therefore imperative for policy-makers and development agencies to consider the specific needs of small-holder farmers in accessing credit and technology adoption in order to effectively spur agricultural development.

There have been empirical studies on credit accessibility (Khalid, 2003; Lawal *et al*., 2009; Adegbite and Adeleye, 2011); technology adoption and agricultural productivity in Nigeria (Saka and Lawal, 2009; Olagunju and Salimonu, 2010; Awotide et al, 2012) but there is still a dearth of studies on causal effect of credit on agricultural production. Furthermore, most studies on impact assessment of adoption of high yielding variety and technologies in Nigeria were carried out by using descriptive, inferential statistics and regression models (Udoh and Omonona, 2008; Ater et.al., 2007; Awoniyi and Awoyinka, 2007), these studies are relevant because they help in knowing the effect of adoption of new technologies and high yielding varieties but failed to identify the causal effect of adoption (Heckman and Vytlacil, 2005; Lee, 2005; Rosembaum, 2002) and get the counterfactual outcomes, that is, the outcomes of the participant if he had not adopted the technology. This study used propensity score matching (PSM) to address the evaluation problem and employed the counterfactual outcome framework to show the impact of the outcome defined in the modern policy evaluation literature as the average effect of the treatment on the treated (ATT) which helps to reduce biased estimates.

Therefore, this study examines the causal effect of credit accessibility and technology adoption on cassava yield and income among small-holder farmers in rural Nigeria.

2.0 MATERIALS AND METHODS

2.1 The Area of Study

The study was carried out in Southwest, Nigeria. South west is one of the six geopolitical zones in Nigeria. It falls on latitude 6^0 to the North and latitude 4^0 to the South while it is marked by longitude 4^0 to the West and 6^0 to the East. It is bounded in the North by Kogi and Kwara States, in the East by Edo and Delta States, in the South by Atlantic Ocean and in the West by Republic of Benin. The climate is equatorial with distinct wet (rainy) and dry seasons with relatively high humidity. The mean annual rainfall is 1480mm with a mean monthly temperature range of 18^0-24^0C during the rainy season and 30^0-35^0C in the dry season. Southwest Nigeria covers approximately an area of 114,271 kilometer square that is approximately 12 percent of Nigeria's total land mass and the vegetation is typically rainforest. The total population is 27,581,992 as at 2006 and the people are predominantly farmers. The climate in the zone favours the cultivation of crops like maize, yam, cassava, millet, rice, plantain, cocoa, kola nut,

coffee, palm produce, cashew etc (NPC,2006). The zone comprises of six states namely: Ekiti, Lagos, Ogun, Ondo, Osun and Oyo States.

2.1 Data Collection and Sampling Procedure

Primary data were collected for the purpose of this study using structured questionnaire. Some of the data include: socio-economic and demographic characteristics, credit accessibility, cassava production technology, cassava production as well as returns to cassava production.

Multistage sampling technique was employed in this study. The first stage was the random selection of Ondo and Ogun States from the six States in Southwest, Nigeria. The second stage involved the random selection of four LGAs from each state. Finally, 540 cassava farmers were randomly selected. However, a total of 482 were retrieved and completely filled from the field.

2.2 Analytical Techniques

Analytical techniques employed in this study includes: descriptive statistics (tables, mean, frequency and percentages), Tobit regression model and Propensity Score Matching (PSM). Following (Tiamiyu *et al*, 2009) and adapting it to this study, technology-use ranked score was computed for each respondents based on the identified elements of the technology package (improved varieties, recommended spacing, timely maintenance, fertilizer and application) and adoption index was generated for individual farmer. Adoption index of individual farmer was calculated as follows:

$$AI_i = \frac{TS_i}{TTS} \text{.....(1)}$$

$$AAI = \sum_{i}^{n} \frac{AI_i}{N} \text{.....(2)}$$

Where,

AI_i= Adoption index of the ith farmer

TS_i= Technology-use score of the ith farmer

TTS= Total technology-use score obtainable

AAI= Average adoption index

Tobit regression model

Tobit regression model was used to analyze the effect of credit access and other socio-economic factors on technology adoption, Following Negash, (2007), the Tobit model for the continuous variable adoption level, can be expressed as:

$$AL_i^* = \beta_0 + \beta_i X_i + \mu_i$$

$$AL_i = AL_i^* \quad if\ \beta_0 + \beta_i X_i + \mu_i > 0 \text{.....}(3)$$

$$= 0 \quad if\ \beta_0 + \beta_i X_i + \mu_i \leq 0$$

Where, AL_i^* = the latent variable and the solution to utility maximization problem of level/ extent of adoption subjected to a set of constraints per household and conditional on being above certain limit

AL_i = Adoption level for ith farmer

X_i = vector of factors affecting adoption and level of adoption

β_i = vector of unknown parameters

μ_i = error term

Selection of explanatory variables

The explanatory variables specified as determinants of adoption level of the improved production technology were selected according to Chilot *et al*, (1996); Asfaw *et al*, (1997); Nkonya *et al* (1997); Mulugeta (2000); Mesfin(2005); Omonona *et al*,(2006) and Negash (2007) The variables are defined as follows:

X_1= Age of the household head (years)

X_2= Age square of the household head (years)

X_3= Gender of the household head (male=1, 0 otherwise)

X_4= Marital status of the household head (married=1,0 otherwise)

X_5= Participation in off-farm activity (yes= 1, 0 otherwise)

X_6= Level of education of household head

X_7= Years of experience of household head in cassava production (years)

X_8= Main occupation (farming = 1,0 otherwise)

X_9= Household size (numbers)

X_{10}= Land area cultivated (ha)

X_{11}= Distance of farm to nearest market (km)

X_{12}= Access to credit of the household head (yes=1, 0 otherwise)

X_{13}= Cassava yield (tonnes/ ha)

X_{14}= Contact with extension agents (yes=1, 0 otherwise)

Table 1: A priori Expectations of the Explanatory variables used in Adoption Analysis Model

Variables	Description	Expected Signs	Literature
Age	Discrete	+/-	Techane,2006; Omonona *et al*, 2006
Male Gender	Dummy	+	Mesfin,2005
Marital status	Dummy	-	Omonona *et.al*,2006
Level of education	Discrete	+	Chilot,1994
Household size	Discrete	+/-	Omonona *et.al*,2006; Udoh and Omonona,2008
Main occupation	Dummy	+	Degnet *et al.*, 2001
Non-farm Activity	Dummy	+	Chilot *et.al*,1996
Market distance	Continuous	-	Hailu, 2008
Land cultivated	Continuous	+	Belay, 2003
Years of experi-ence	Discrete	+	Chilot *et.al*, 1996
Yield	Continuous	+	Omonona *et.al*,2006
Access to credit	Dummy	+	Mulugeta, 2000
Extension agent contact	Dummy	+	Omonona *et.al*,2006

Source: Author's compilation from past literature

Propensity Score Matching

Propensity Score Matching, one of the most commonly used quasi-experimental methods was used to address the evaluation problem (Mendola, 2007; Nkonya *et al*, 2007; Akinlade *et al*, 2011). The sample collected was matched using PSM; the aim of PSM is to find the comparison group from a sample of non-adopters that is closest to the sample of adopters so as to get the impact of the technology on the adopters. Though, the beneficiary and comparison groups may differ in unobservable characteristics even if they are matched in terms of observable characteristics, however, it has been put forward that selection on unobservable is empirically less important in accounting for evaluation bias (Baker, 2000). Also in a situation where the same questionnaire is administered to both groups (so that outcomes and personal characteristics are measured in the same way for both groups) and the participants and controls are placed in a common economic environment (such as the case in this study), matching substantially reduce bias (Heckman *et al*, 1996).

Main steps involved in the application of statistical matching to impact evaluation are: estimating the propensity score, matching the unit using the propensity score, assessing the quality of the match and estimating the impact as well as its standard error.

Out of 482 respondents, only 387 adopters and non-adopters that had comparable propensity scores were matched. After matching, the testing of comparability of the selected groups was done and the result shows statistically insignificant difference in the explanatory variables used in the probit models between the matched groups of adopters and non-adopters.

Since the match has been deemed of good quality, this study then used the matched sample to compute the Average Treatment Effect for the Treated (ATT) to determine impact of the technology adoption. This is defined by Rosembaum and Rubin (1983) as follows:

$$E\left(Y^1 - Y^0 / D = 1\right) = E\left(Y^1 / D = 1\right) - E\left(Y^0 / D = 1\right) \quad (4)$$

where, $E\left(Y^1 / D = 1\right)$ is the observed outcome of the treated, that is, the expected income earned by programme beneficiaries while participating in the programme and $E\left(Y^0 / D = 1\right)$ is the counterfactual outcome - the expected income they would have received if they had not participated in the project. The counterfactual outcome represents outcome of the non-beneficiaries since they have similar characteristics with beneficiaries. Standard errors were computed using bootstrapping method suggested by Lechner (2002) to generate robust standard errors in light of the fact that the matching procedure matches control households to treatment households with replacement.

3.0 RESULTS AND DISCUSSION

3.1 Statistical Matching of Respondents

Probit regression model was employed in the estimation of the propensity scores used in matching of respondents. The adopters compared with the non-adopters. The dependent variable in the models is a binary variable indicating whether the farmer is an adopter or not.

Observations that were not in the common range of propensity scores for both groups (that is, lack "common support") were dropped from the analysis. Out of 482, only 157adopters and 230 non-adopters (387 respondents) that had comparable propensity scores were matched. After matching, the comparability test of the selected groups was done and the results show statistically insignificant difference in the explanatory variables used in the probit models between the matched groups of the adopters and non-adopters, indicating that the propensity score matching assured comparability of the comparison groups (Table 2 & 3).

Table 2: Probit Regression Estimates After matching

Explanatory variables	Coefficients	Standard Errors	P>/z/
Gender (male=1, female=2)	0.3195	0.1786	0.8581
Age	-0.0087	0.0069	0.2054
Marital status	0.0966	0.0895	0.2802
Household Size	0.0594	0.0406	0.1432
Years of education	0.0020	0.0159	0.9510
Land area cultivated	-0.1451	0.1427	0.3093
Constant	-0.1761	0.4468	0.6930
Sample size	387		
Pseudo R^2	0.74		
Prob> chi^2	0.69		
Log likelihood	-261.54		

Table 3: Estimates of Test of Comparability After Matching

Variables	Mean		%bias	P>/t/
	Treated	control		
Gender	0.7462	0.7604	-1.0	0.702
Age	45.362	45.081	2.5	0.832
Marital status	1.3875	1.3954	-0.9	0.929
Household Size	5.7188	5.5479	8.6	0.832
Education years	8.1563	8.6879	-11.8	0.478
Land cultivated	0.9788	1.0054	3.5	0.847

3.2 Distribution of Respondents by Socio-economic Characteristics

Table 4 shows the distribution of the respondents by socio-economic characteristics across the two types of respondents considered which are: adopters and non-adopters. The average values of their socio-economic characteristics are within the same range due to propensity score matching (PSM) used in selecting the respondents with similar observable characteristics. Majority (74.63%) of the adopters are males while only 25.37% are female. The average household size was 6. The majority of the respondents have their household sizes falling within the range of 5 to 9 people, with the average age of the respondents being 44 and 45 for adopters and non-adopters respectively. Implicit in these findings is that a large proportion of the respondents were below 50 years and can therefore be regarded as active, agile and with more energy to dissipate and concentrate on productive effort. The average years of experience in cassava farming was 16 years for all respondents. The average area of land cultivated was about 1 hectare for all the respondents. Accessibility to credit facility was higher among adopters, 82.5% of the adopters had access to credit compared to 48.26% of the non-adopters. Participation in off-farm activity was higher among adopters compared to non-adopters.

Table 4: Distribution of Respondents by Socio-economic characteristics

Characteristics	Categories/ Statistics	Adopters Percentage	Non-adopters percentage
Gender	Female	25.37	22.17
	Male	74.63	77.83
	Total	100	100
Household size	0-4	16.25	26.09
	5-9	77	68.26
	>9	6.75	5.65
	Total	157	230
	Mean	6	6
	SD	1.9942	1.9576
Age	≤30	13.12	6.09
	31-40	30.25	26.09
	41-50	35.63	36.95
	>50	21	30.87
	Total	157	230
	Mean	44.2685	45.1913
	SD	10.1317	10.7219
Level of education	No formal	35.67	26.09
	Primary	51.59	36.52
	Secondary	12.74	37.39
Credit access	Yes	82.50	48.26
	No	17.50	51.74
Area of land cultivated(ha)	≤0.5	26.75	22.17
	0.6-1.0	64.33	50.00
	1.1-1.5	8.92	28.63
	Total	157	230
	Mean	0.98	1.01
	SD	0.35	0.56
Off-farm activity	Yes	73.13	57.78
	No	26. 87	42.22

3.3 Credit Accessibility and Technology Adoption Level

The adoption level refers to the intensity of use of improved technology by the farmers. The adoption index generated shows to what extent the farmers have adopted a technology package. The level of adoption of cassava improved production technology by credit accessibility revealed that adoption level was higher among those with access than their counterparts without credit access. From Table 5, the mean adoption index of the adopters with credit access was 0.86 while that of their counterparts without access was 0.65. This implies that adoption level of farmers with credit access was 21% significantly ($p > 0.001$) higher than those without credit access.

Table 5: The Adoption Index by Credit Accessibility

Credit accessibility	Percentage	Mean adoption index	Probability value
Access	82.50	0.86	0.0010
No access	17.50	0.65	

3.4 Effect of credit accessibility and other socio-economic characteristics on Adoption Level of cassava Improved Production Technology

The result of the determinants of adoption level of cassava improved production technology by farming households in the study area is shown in Table 6. The result of the Tobit regression model shows that the log likelihood is -199.69 and is significant at 1% level of significance. This indicates that the model has a good fit to the data. The result shows that out of the 14 explanatory variables included in the model, credit accessibility and seven other variables were found to significantly influence level of adoption. These are gender, distance to input market, land area cultivated, years of experience in cassava production, cassava yield, off-farm activity and level of education. A positive sign on a parameter indicates that the higher the value of the variable, the higher the adoption level and vice-versa.

Access to credit has positive and significant influence ($p<0.01$) on the adoption of improved cassava production technology. From the result of this study, access to credit facilities leads to 15.82% increase in the adoption level. This is attributed to the fact that credit increases the farmers' economy to purchase improved seed, fertilizer and other inputs. This is in agreement with Mulugeta (2000) and Tesfaye *et al* (2001). Participation in off-farm activity has a positive and significant ($p<0.05$) influence on level of adoption. During slack periods many farmers can earn additional income by engaging in various off-farm activities. This is believed to raise their

financial position to acquire new inputs. Participation in off farm activity will increase adoption level by 0.0468. This concurs with Chilot *et al* (1996). The gender of the farmer is significant ($p<0.01$) and has a positive sign implying that male household heads are more likely to adopt the use of improved cassava production technology than their female counterparts. From the result, being a male household head will increase the level of adoption by 13.83%. This shows that male headed households have better access to information and other resources on improved cassava production technology and are more likely to adopt new technology than female headed households. This result is in agreement with Tesfaye *et al* (2001); Mesfin (2005) and Omonona *et al* (2006).

The coefficient of years of experience in cassava production is positive and significant ($p<0.01$). A unit increase in years of experience in cassava production will increase the adoption level by 0.0506. This is due to the fact that farmers with higher experience in cassava production appear to have full information and better knowledge hence able to evaluate the advantage of the technology. The level of adoption of improved cassava production technology is significantly but negatively influenced by distance to the nearest input market. Market distance significantly ($p<0.01$) reduced adoption level. This indicates that farmers nearer to the markets have more access to input. The result from this study showed that a unit decrease in market distance will increase the likelihood of adopting technology by 0.0180. This concurs with Mesfin (2005); Tesfaye (2006) and Hailu (2008) who reported that market distance is negatively and significantly associated with adoption of crop technologies in different parts of Ethiopia.

The level of education of the household head positively and significantly ($p<0.05$) influenced adoption level of improved production technology. Educational level will increase adoption level by 0.1755. Education increases farmers' ability to obtain, process, and use information relevant to technology adoption.

The coefficient of land cultivated is positive and significant ($p<0.01$). From the result of this study, a unit increase in land cultivated will increase adoption level of improved production technology by 0.6345. Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. It is frequently argued that farmers cultivating larger farm land are more likely to adopt an improved technology (especially modern varieties) compared with those with small farmland. This finding is consistent with Hailu (2008) that farm size exerts a positive influence on adoption of improved teff and wheat production technology in northern and western shewa zones of Ethiopia. Cassava yield has a positive and significant ($p<0.01$) influence on adoption level. A unit increase in last season's yield will increase the adoption level of improved production technology by 0.1431. This is in agreement with Omonona *et al* (2006).

Table 6: Estimates of Tobit Regression for the Determinants of Adoption Level

Variables	Marginal effect	Standard error	t- value
Gender	0.1383***	0.0515	2.69
Age	-0.0223	0.0239	-0.93
Marital status	0.1834	0.1759	1.04
Level of education	0.1755**	0.0834	2.10
Main occupation	0.0248	0.0430	0.58
Off- farm activity	0.0468**	0.0229	2.04
Distance to market	-0.0180***	0.0058	-3.09
Land cultivated	0.6345***	0.1375	4.61
Year of experience	0.0506***	0.0086	5.88
Cassava yield	0.1431***	0.0115	12.41
Credit access	0.1582***	0.0567	2.79
Extension agent	0.0126	0.0566	0.22
Household size	0.0021	0.0048	0.08
Age square	0 .0003	0.0003	1.15
Constant	-1.2732 ***	0.3942	-3.23
Sigma	0.5806	0.0319	
Prob>chi2	0.0000		
Pseudo R2	0.4458		
Log likelihood	-199.69		

*,**,*** are significant levels at 5% and 1% respectively

3.5 Cassava Yield (tonnes per ha) of Respondents and Impact by Credit Accessibility

Table 7 reveals that the mean yield of all the respondents varied by credit accessibility with the adopters having a higher mean yield than the non-adopters. The mean cassava yield of the respondents with access to credit was higher than those without access. This is likely due to the fact that credit accessibility increases adoption level of improved technology. For those with

credit access, the mean yield was 14.92tonnes and 10.69tonnes for adopters and non-adopters respectively while it was 13.06tonnes and 8.02tonnes for their respective counterparts without credit access. Furthermore, Table 7 presents the impact of the technology on the beneficiaries due to adoption when compared with the non-adopters. For those with credit access, production technology had a significant ($p<0.01$) positive impact on the yield of the adopters. Technology adoption led to 4.68 tonnes increase in yield of beneficiaries with access to credit while the impact on the mean yield was 2.37 tonnes on the adopters without credit access. This indicates that credit accessibility enhances technology adoption and its impact on farmers' yield.

Table 7: Cassava Yield (Tonnes per ha) and Impact on Respondents by Credit Accessibility

Type of respondent	Statistics	Yield	ATT
ADOPTERS			
Credit access	Mean	14.92	4.6774***
	SD	1.2964	(1.3893)
No access	Mean	13.06	2.3659
	SD	1.3411	(0.2900)
NON-ADOPTERS			
Credit access	Mean	10.69	
	SD	1.0291	
No access	Mean	8.02	
	SD	1.0025	

*** is significant level at 1%. The values in parenthesis are standard errors.

3.6 Level of Income of Respondents and Impact by Credit Accessibility

Table 8 reveals that the mean income of all the respondents varied by credit accessibility with the adopters having a higher mean income than the non-adopters. The mean income of the respondents with access to credit was higher than those without access. For those with credit access, the mean income was ₦321,758.50 and ₦273,013.50 for adopters and non-adopters respectively, while it was ₦287,110.90 and ₦248,495.50 for their respective counterparts without credit access.

Furthermore, Table 8 presents the impact of the technology on the adopters' income. For those with credit access, the production technology had a significant ($p<0.05$) impact on the income of the adopters. Technology adoption increased the income of adopters with access to credit by ₦64,945.19 while the impact on the mean income was ₦33,964.79 for those without credit access.

Table 8: Level of Income of Respondents and Impact by Credit Accessibility (Per Annum)

Type of respondent	Statistics	Income	ATT
ADOPTERS			
Credit access	Mean	321758.50	64945.19**
	SD	188906.80	(19906.05)
No access	Mean	287110.90	33964.79
	SD	174359.30	(25773.32)
NON-ADOPTERS			
Credit access	Mean	273013.50	
	SD	145538.30	
No access	Mean	248495.50	
	SD	150145.70	

**significant levels at 5% . The values in parenthesis are standard errors.

4.0 Conclusion, Policy Implications and Recommendations

This study centred on causal effect of credit access and technology adoption on yield and income of cassava farming households in Nigeria. Empirical evidence from this study revealed a higher adoption level and impact of improved cassava technology on those with access to credit. Credit accessibility, participation in off-farm activity, distance to nearest market, level of education, among other factors significantly influenced technology adoption. The cassava yield of the adopters with credit access was higher than their counterparts without access. Though, there was increase in income of all the adopters, implying that improved production technology has the potential to enhance income of small-holder farmers, however, the impact was higher on the income of those with credit access.

Hence, policy measures should be oriented towards the improvement and support of rural credit in Nigeria. Improving credit or grant access should be considered as a core component of

any development intervention for small-holder farmers. Government should review the procedures for securing loans in order to make it farmer-friendly and collaterals should be relaxed. The appropriate government agencies should mobilize farmers to form co-operatives or thrift societies within themselves. Furthermore, government should invest more on technology advancement and there should be wide dissemination of technology among farmers to improve their productivity and welfare. Effective extension services should be put in place to give some levels of trainings to farmers. Rural development policies should promote the creation of enabling environment through the provision of social infrastructure especially access roads to market in order to enhance technology adoption.

REFERENCES

Abayomi, S.& Salami, O.A. (2008). Impact of Commercial Bank Lending on Agricultural Production and Productivity in Nigeria. *Journal of Agricultural, Food,Water and Drugs*, 2 (1), pp. 23-30

Adegbite, D.A. & Adeleye O.A. (2011). Determinants of Farmers' Access to Micro-credit in Oyo State, Nigeria. *Journal of Agricultural Research and Development*, 10 (1)

Akinlade, R..J, Yusuf, S.A, Omonona, B.T and Oyekale A.S. (2011). Poverty Alleviation Programme and Pro-poor Growth in Rural Nigeria: Case of Fadama II Project. *World Rural Observations*, 3(1), Pp 27-33.

Awotide, B.A, A. Diagne & T.T Awoyemi (2012). Agricultural Technology Adoption, Market Participation and rural farming households' welfare in Nigeria. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

Asfaw, N., Gungal, K., Mwangi, W. and Beyene S. (1997). Factors Affecting Adoption of Maize Production Technologies in Ethiopia. Ethiopian Journal of Agricultural Economics, 2: 52-69.

Asfaw, A. and Admassie, A. 2004. The role of education on the adoption of chemical fertilizer under different socioeconomic environments in Ethiopia. *Agricultural Economics*, 30: pp 215-228.

Ater P.I., J.C. Umeh, and W.L. Lawal 2006. Comparative analysis of the impact of World Bank Root and Tuber Expansion Programme on poverty alleviation of periurban and rural communities in Benue State, Nigeria. Poster paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia.

Baker, J.L. (2000). Evaluating the impact of development projects on poverty. A handbook for practitioners. The International Bank for Reconstruction and Development/ The World Bank, 1818 H street, N.W, Washington, D.C.20433. ISBN 0-8213-4697-0

Belay, K. (2003). Agricultural extension in Ethiopia: The Case of participatory demonstration and training extension system. *Journal of Social Development* in Africa; Harare, 18(1).

Braun,J.V, Fan, S., Meinzen-Dick, R., Rosegrant, M.W. and Pratt. A.N. (2008). "International Agricultural research for food security, poverty reduction and the environment". International Food Policy Research Institute.

Chilot, Y., B.I. Shampiro, and M. Demeke (1996). Factors Influencing adoption of new wheat technologies in Wolmera and Addis Alem Areas of Ethiopia. *Ethiopian Journal of Agricultural economics*, (1): pp 63-83

EFInA (Enhancing Financial Innovations and Access). 2008. Access to financial services in Nigeria: Key findings. http://www.efina.org.ng/Key_Findings.pdf

FARM, 2006 in Adegbite, D. A, O.J Olaoye & A. Oloruntoba (2008). Performance Assessment of Ogun State Agricultural And Multi-Purpose Credit Agency (OSAMCA) In Credit Delivery and Operation (2004-2006) ASSET Series C, 3 (1): 21-38.

International Fund for Agricultural Development (2010). Investing in Rural People. International Fund for Agricultural Development, Via Paolo di Dono 44 00142, Rome, Italy.

Khalid, M. (2003). Access to formal and quasi formal credit by smallholder farmers and artisanal fishermen: a case of Zanzibar. Repoa research report No 03.6, Business and Economics, Mkuki na Nyota Publishers

Lechner,M. and J.Smith (2002). Some Exogeneous Information Should Not Be Used in Evaluation, mimeo

Mendola, M. (2007). Agricultural technology adoption and poverty reduction. A propensity Score matching analysis for rural Bangladesh. *Food policy*, 32: 372-393.

Mesfin A.(2005). Analysis of factors Influencing Adoption of Triticale and its Impact.The Case Farta Wereda. Msc. Thesis (Unpublished) Presented to School of Graduate Studies of Alemaya University.

Mulugeta E.(2000). Determinants of Adoption of soil Conservation Practices in Central Highlands of Ethiopia. The case of three districts of Selale. M. Sc. Thesis AU

National Population Census (NPC) (2006). National Bureau of Statistics Official Gazette (FGP 71/52007/2,500(OL24) Abuja. URL http://www.nigerianstat.gov.ng

Negash R. (2007). Determinants of Adoption of Improved Haricot Bean Production in Alaba SpecialWoreda Southern Ethiopia. M Sc. Thesis Submitted to the Department of Rural Development and Agricultural Extension, School of Graduate Studies Haramaya University

Nkonya, E., T. Schroeder and D. Norman (1997). Factors affecting adoption of improved maize seed and fertilizer in North Tanzania. *Indian j. Agri.econ*., 48(1):1-12

Odoemenem, I.U. and C.P.O Obinne. (2010). Assessing the factors influencing the utilization of improved cereal crop production technologies by small scale farmers in Nigeria. http://www.indjst.org/archive/vol.3.issue.2/innocent- 17.pdf

Olagunju, F.I and K.K. Salimonu (2010). Effect of adoption pattern of fertilizer technology on small scale farmer's productivity in Boluwaduro Local Government Area of Osun State.

Omonona, B.T, O.A. Oni and O.A Uwagboe. (2005) Adoption of improved Cassava varieties and its Impact on Rural Farming Households in Edo State, Nigeria. *Journal of Agriculture and Food Information*, 7(1) pp40-45

Núñez, J. T. (2005). "The Adoption of Manure Management Practices." Unpublished M.Sc. Thesis, University of Missouri-Columbia.

Rosenbaum P.R, and Rubin D.R. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Bometrika* 70: 41-55.

Tiamiyu, S.A., J.O Akintola and M.A.Y Rahji (2009). Technology Adoption and Production Difference among Growers of New Rice for Africa in Savanna Zone of Nigeria. *Tropicultura*, 27(4) pp 193-197

Saka J.O and B.O. Lawal (2009). Determinants of Adoption and Productivity of improved rice varieties in Southwestern Nigeria. *African Journal of Biotechnology*, 8(19) Pp 4923-4932

Salami A. And Arawomo D.F. (2013). Empirical Analysis of Agricultural Credit in Africa: Any role for institutional factors? Working Paper Series No 192, African Development Bank, Tunisia

Salami, A.; Kamara, A. B. and Brixiova, Z. (2010), 'Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities', African Development Bank Working Paper No 105

Udoh, E.J and B.T. Omonona 2008. Improved rice variety adoption and its welfare impact on rural farming households in Akwa Ibom State of Nigeria. *Journal of New seeds*, 9 (2) 156-169

World Bank, 2007. World development report 2008: Agriculture for development. The World Bank,Washington, DC.