International Journal of Intellectual Discourse (IJID)
ISSN: 2636-4832 Volume 6, Issue 2. June, 2023

Impact of AFDB-community based agricultural and rural development project adoption on rural maize farmer's income in Kaduna state - Nigeria

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Abstract
This study assessed the impact of AFDB-community based agricultural and rural development project adoption on rural maize farmer's income in Kaduna State, Nigeria. In this study, rural maize farm income (RFY) represented the dependent variable, while; Improved Maize seedlings (IMS), farm labour wage (FLW), Fertilizers (FET), Agro-chemicals (AGC), and improved agricultural technology (AGT), are the independent variables. Three rural village areas (RVAs) were drawn from each of the three participating local government areas selected for the study. A well-structured questionnaire was used in data collection from the respondents. Thereafter, logit regression method was applied through binary logistic regression model. The result found that IMS, FLW, FET, and AGT have a positive and significant relationship with the rural maize farmers' income (RFY). This means that a unit increase in the amount of IMS, FLW, FET, and AGT leads to 2.5, 1.3, 3.6, and 2.77 respectively rise in rural maize farm income. However, AGC was found to exert negative effect on rural maize farm income. Based on the findings, the study concluded that adoption of agricultural development project influences rural maize farm income positively. As such, the study recommended that farmers' education and capacity development, through collaboration between federal, state and local government is critical. Furthermore, improvement on rural-urban roads in these agricultural zones, through the collaboration of the three tier governments would also provide impulse to stimulating rural farmers' income. Notwithstanding, it will enhance the agricultural value chain business, enables farmers to easily access the needed farm inputs like fertilizer and thus stimulate the income of the farmers, via easy movement of their farm produce to the market.

Keywords: Logit, Rural area, Maize farmers, Rural income, improved seedlings

1. Introduction

The rural areas of Nigeria are predominantly occupied by low-income earners, whose main source of income and economic activities is primarily agriculture. Therefore, the development of the agricultural sector in the rural areas is of critical significance. Thirlwall (2002), noted that development implies achieving good life. Hence, the fundamental goal of development must be to lift individuals and society as a whole out of poverty (low income earning position) and to meet basic necessity of life. In this regard, Thirlwall, argued that development occurs through the process of empowerment.

Consequently, the adoption of sustainable agricultural practices that enhance agricultural productivity remains the most pragmatic option for achieving increased farm income, food security and poverty alleviation. This underscores the role of agricultural intervention and technological improvements that targets smallholder farmers (households that cultivate 2 hectares of land or less), the environments within which they operate, and their most common crops (Maurice & Wilfred, 2015).

However, technology development is inadequate because its adoption may be totally absent, partial or even reversed due to dis-adoption.

In Nigeria, increased productivity of agricultural produce such as maize is vital for food security, enhanced income earning and poverty reduction due to its economic significance. However, within the agricultural zones in Nigeria, Kaduna State came first in maize produce. Hence, maize is the most widely grown staple crop, given its comparative advantage, the state produces the highest tonnes of maize, with 2,166,799.8 tonnes produced in 2016 (KASS 2017). This indicates that the state produces 22% of Nigeria's total maize production (KASS 2017). However, the agricultural produce of maize in the state runs backward as easily as forward. Incidentally, due to the increasing demand for animal feeds and bio-energy, the demand for maize is growing exponentially and is expected to double by 2050 (Rosegrant et al. 2007).

Consequently, the community-based development (CBD) program was adopted in 2003 by the Nigerian government. The community-based development (CBD) program is a type of development that happens inside a community by engaging as numerous people as possible in the planning and implementation of a project that improves the community. In this regard, the African Development Bank (AfDB) devised a Community-Based Agriculture and Rural Development Project (CBARDP) intervention programme for the country in partnership with the government. The project was implemented in some states in Northern Nigeria selected by AFDB with the highest indices of rural poverty, covering the states of Adamawa, Bauchi, Gombe, Kaduna, and Niger State. As such, in Kaduna State, the participating local government areas include; Birnin Gwari, Kaduna South, Igabi, Ikara, Sabon Gari, Zaria, Kachia, Jaba and Sanga with 27selected rural village areas (RVAs). Kaduna State, being one of the Northern states where AFDB-CBARDP was implemented due to widespread of poverty, has a population of about 6 million people (NPC, 2006), of which 62.1 percent live in the urban areas and 37.1 in rural areas, with agriculture serving as their primary source of income and livelihood (KASS, 2017).

The programme was expected to lift about 1.6 million rural residents in the participating states out of poverty. Since the inception of the AFDB-CBARDP in 2005, numerous agricultural technologies have been launched and delivered to farmers in the five participating states under eight schemes that cover crop, poultry, livestock, processing, and cow rearing, among others. Goat, ram/sheep, pig upgrade, as well as fattening of goat, ram/sheep, and local pigs were among the livestock technologies introduced, while crop technologies such as extra early maize, cassava, and yam types with their agronomic techniques were introduced under the agricultural program. Artificial insemination, pregnant cow housing and feed rations, value addition on cassava and maize, and the introduction of agro processing machines were also supplied to farmers by the AFDB-CBARDP (Solomon, Esther, & Michael, 2020).

The development goal of the AFDB-community-based agriculture and rural development project, according to the World Bank description (2012), is to improve the living conditions of rural dwellers in terms of sustainable income growth, access to basic socioeconomic services, and improved natural resource management practices. Therefore, this study aimed at evaluating the impact of AFDB-community based agricultural and rural development project adoption on rural maize farmer’s income in Kaduna State, Nigeria.

2. Literature Review

Theoretical Literature

This study is anchored on the modernization theory as opined by Schultz (1964). According to Schultz (1964), primordial agriculture cannot grow rural economy (i.e, alleviate rural poverty) while utilizing crude production factors, except at a very high production cost only. Schultz recommended alternative new production factors are critical to stimulating the productivity of rural agrarian society. Schultz held that it does not pay to invest in the crude method of farming already in existence in the rural agrarian society. As such, Schultz postulated that efficient modern factors should be adopted, but this is only possible if the farmers possess the capacity to do so.

In Schultz theory, farmers and their ability form the central nervous system. Schultz stressed that rural agrarian farmers are mostly poor and as such, marginal productivity of labour is low and incentives to save is zero, because of low marginal productivity of capital. The dominant thinking in Schultz proposition is the idea that rural farmers are profit maximizers in the conventional economic sense. That is, given the inputs prices, they will choose the locus of output and input combination that guarantee profits maximization. As such, under perfect competition, the marginal value of product of a factor (q) in a given use (i) must equal the marginal cost of using the factor, which in turn, equals the price of the factors. Therefore, more of the factors are combined so long as it yields more than its cost. Fulfilment of this condition means that two factors (say, q and x) are joined in such quantities as to yield the minimum cost combination in each use (i). Consequently, supposing under perfect competition, two factors cost the same price per unit of output, they must generate similar marginal physical product (MPP) in a particular production line. Else, its profitable to augment the use of the factors that generate higher-yielding at the detriment of the other factors. If on the other hand, the factors cost different prices per unit, the marginal physical products (MPP) of the factors must be equal to each other as their prices per unit.

Consequently, the cost of adopting AFDB-CBARDP agricultural development project tools to stimulate production and boost the income of the farmers must be less than the unit price of output produced. Otherwise, the marginal physical product (MPP) of each factor will be greater than price. Since, farmers are rational economic agent, they will seek to adopt agricultural development projects tools so long as the generated output is more than the cost of adoption.

Empirical Literature

Wordofa, Hassen, Endris, Aweke, Moges & Rorisa (2021) conducted a study on the adoption of improved agricultural technology and its impact on household income in Eastern Ethiopia. The study's objective was to look at the impact of improved farming technologies on farm household income. Primary data were collected from a random sample of 248 rural homes, with 119 users and 129 non-users of upgraded technology. Propensity score matching (PSM) approach was used. The empirical result showed that households using improved agricultural technologies had higher annual income than those who did not.

Michael (2021) conducted a study on the level of rural dwellers participation in community-based development project in Gombe state, Nigeria. Michael (2021) adopted multistage sampling technique to sample 71 respondents from 3 selected rural village areas (RVAs). The finding showed that those who participated on the programme had higher income than those who did not. The study recommended that appropriate source of information should be employed when introducing a development project to rural dwellers.

Muluken, Jemal, Getachew, Chanyalew, Dereje & Debbebe (2021) examined the adoption of improved agricultural

technology and its impact on household income: a propensity scores matching estimation in eastern Ethiopia. Muluken et al., obtained Primary data for the study from a random sample of 248 rural households, out of which 119 are improved technology users and the rest are non-users. The study, utilized the Propensity Score Matching (PSM) in the analysis of the data obtained from the respondents. The econometrics results indicate that households using improved agricultural technologies had increase in their income. The study recommended that rural technology generation, dissemination and adoption interventions be strengthened.

Abubakar, Atala, Musa, and Sanni (2021) examined impact of agricultural technologies on Sorghum farmers' livelihoods in Kaduna state and Kano state, Nigeria. The study utilized multi-stage sampling technique and structured questionnaire for data collection from 237 participating farmers and 237 non-participants. As such, data generated were analyzed using descriptive statistics and propensity score matching analyses. The analysis showed that, 95% of farmers have a high level of enhanced technology usage. While, technology adoption, on the other hand, had no discernible impact on living standards. The research recommended that government should play a bigger role in raising awareness and investing in agriculture.

Chikezie, Omokore & Akpoko (2018) carried out a study on the adoption of AFDB-CBARDP crop production project among beneficiaries in Kaduna and Bauchi state Nigeria. Therefore, 746 participants and 746 non-participants were randomly selected. Hence, descriptive statistics and chow-test was used in the data analysis. As such, the result showed, at the 1% level of probability, agricultural output, crop yield, income, and living standard are all statistically significant.

Ebojei, Ayinde and Akogwu (2012) examined socioeconomic factors influencing the adoption of hybrid maize in Giwa local government area of Kaduna State, Nigeria. The study utilized maximum likelihood estimate of logit model in determining the factors affecting famers adoption of hybrid maize. The result showed that the average predicted probability of technology adoption was age (x1) $P<0.013$, income (x5) $P<0.034$, education (x6) $P<0.001$ and extension visit (x7) $P<0.017$. More so, farming experience, family size, and farm size were found to have no significant influence on participation in hybrid maize. As such, the study recommended the need for special training, seminars, field demonstrations, and technical support for maize farmers.

Consequently, empirical discussion on the issue of improved agricultural technology adoption on rural maize farmers' income in Kaduna State has not been effectively discussed in the body of existing literature. Specifically, since the inception of this program AFDB-CBARDP in Kaduna State, only a few studies have attempted to examine the effect of the program with respect to its objective. Incidentally, these studies failed to utilize the tools introduced by the program as a measure to examine its effect on poverty. As such, this study is critical in filling this research void. What makes this study unique is that the tools introduced by the program (AFD-CBARDP) were employed as the independent variables to examine the key objective of the program (poverty).

3. Methodology

The study was conducted in three local governments, drawn from the three senatorial zones of Kaduna State. As such, the syndicate local governments include; Igabi, Zaria and Kachia Local Government Area. These syndicate study areas are among the Local Governments Areas covered by the African Development Bank Community-Based Agriculture and Rural Development Project (AFDB-CBARDP) program in Kaduna State. Three (3) Rural

Village Areas (RVAs) was drawn from each of the three syndicate LGAs. Consequently, using Kothari (2004) formula, the sample size that was selected from the population frame of 5892 rural maize farmers that participated on AFDB-CBARDP was 361. More so, to provide information for comparison, 361 respondents were purposively selected from the population frame of non-participants.

Model Specification

In the adoption study, different techniques have been used. Some used Propensity Score Matching, while others used logit and probit modeling to study it. However, in this study a Binary choice modeling was adopted. The functional form of the model is specified as;

Adoption = f(Xi) …… (1)

Equation (1) above shows the relationship between the probability of an increase in rural maize farmers' income and its determinants Xi, the specific factors hypothesized are presented in equation (2) below;

$RFY = \beta_0 + \beta_1 IMS + \beta_2 FLW + \beta_3 FET + \beta_4 AGC + \beta_5 AGT + e_i$ …….... (2)

Where;

RFY= rural maize farmer's income,
IMS= Improved Maize seedlings,
FLW= farm labour wage,
FET= fertilizer,
AGC= agro-chemicals, and
AGT= agro-technology,

Consequently, the logit model employs cumulative distribution function (CDF) to run regressions where response variables are dichotomous taking 0 – 1 value. The CDF commonly chosen to represent 0 – 1 response models are logistic and the normal, the former giving rise to logit and the latter to Probit (or Normit) Model. The Logit cumulative probability model for this study can be written as follows:

$L_i = In\left[\frac{P_i}{1-P_i}\right] = RFY = \beta_0 + \beta_1 IMS + \beta_2 FLW + \beta_3 FET + \beta_4 AGC + \beta_5 AGT + e_2$…….. (3)

This is known as the Logit or Logit probability model. The adoption or non-adoption of AFDB-CBARDP is directed as a decision involving dichotomous response variable. The explanation of logit model is such that the slope β measures the change in L_i for a unit change in X_i, the intercept β_0 is the value of log odds in favor of every happening if X_i is zero. Consequently, as cited by Mukhtar (2013), Logit estimation is used in this study because it provides a better fit in the presence of extreme independent variable levels (Finney, 1952). Therefore, in model 3 above, RFY, is measured as 1 if income is greater than or equal to relative poverty threshold and 0 if less than. The Relative Poverty line is the line that separates the poor from the non-poor. All persons whose per capita expenditure is less than the above are considered to be poor while those above the stated amount are considered to be non-poor. Hence, according to the Nigeria Beaure of statistics (NBS,2010), the Relative Poverty line is ₦66, 802.20. IMS is the adoption or non-adoption of improved maize seedlings, it is measured as 1= adoption and 0 if otherwise. FLW is the adoption or non-adoption of farm labour wage, it is measured as 1= adoption and 0 if otherwise. FET is adoption or non-adoption of fertilizer; it is measured as 1=adoption and 0 if otherwise. AGC is the adoption or non-adoption of agro-chemicals, it is measured as 1=adoption and 0 if otherwise. AGT is the adoption or non-adoption of agro-technology, its measures as 1=adoption and 0 if otherwise). The agro-technologies considered here are ox-plough and sprayers. The apriori expectations of the parameters are that; β0, β1, β2, β3, and β5 >0.

4. Results and Discussion

4.1 Socio-Economic Characteristics of the Rural Maize Farmers

The descriptive statistics showed that the mean age of maize farmers is 34 years for participant, and 36 years for the non-participants. More so, a greater number of the AFDB-CBARDP beneficiaries are

female with (53.2%), compared to male beneficiaries of (46.8%). A greater percentage of them are married (91.1%). The result also showed that majority of the farmers (66.3%) has a household size of 6-8. The descriptive result further revealed that majority of the farmers (54.3%) attained up to secondary education. On the average, maize farmers had a farming experience of 39 years with labour force (65.2%) primarily sourced from family. Additionally, majority of the farmers cultivate (58.8%) less than, <1.00 hectare of farm land size, indicating that 0.41% hectares of land on the average were cultivated by the rural farmers.

The implication of this findings is that farming enterprises in the syndicate study areas are family-based, hence, AFDB-CBARDP technology adoption is expected to enhanced the productivity of agricultural produce of maize, given the fact that the rural farmers attained a minimum level of education that can guaranteed optimum application and usage of those technologies. In this regard, efforts should be intensified through a workable policy framework that is rural based, to evolved new technologies that are adequately tailored towards igniting the interest of the farmers in adopting them, so as to scale up the size of farm land been cultivated.

4.2 Contingency Table (Cross tabulation)

The tables below present a summarized relationship between the dependent variable (income) and the various independent variables, using the Pearson correlation coefficient.

H_0: there is no significant relationship between the dependent (income) and independent variable.

Table 2a: Relationship between Improved Maize Seedling Adoption and Rural Maize Farmers Income

Observed	Do you adopt improved maize seedlings		Total	γ_s ($p-value$)
	NO	YES		
Less than ₦66,802.20	8 57.1 %	6 42.9 %	14 (100 %)	.241 0.000*
Greater than ₦66,802.20	45 14.8 %	300 85.2 %	345 (100 %)	
Total	**53 14.8 %**	**306 85.2 %**	**359 (100 %)**	

Source: Survey 2022.
* denote Significance of the Spearman's coefficient at 0.005 Level of Significance.

In Table 2a, above, the cross-tabulation result showed that the Pearson correlation p -values for (improved maize seedlings adoption) is <0.05, indicating the rejection of the null hypothesis and the acceptance of the alternative hypothesis that a significant relationship exists between the adoption of improved maize seedlings, and rural maize farmers' income. Yet, the results show that 14.8% of farmers who did not use enhanced maize seedlings made more than N 66,802.20 in revenue. This result might be attributed to elements like market conditions, which can sometimes have a beneficial or negative impact on products. The farmers that did not adopt improved maize seedlings but nevertheless made income greater than ₦ 66,802.20 may have done so as a result of a favourable market.

Table 2b: Relationship between Farm Labour Wage Adoption and Rural Maize Farmers Income

Observed	Do you adopt Farm Labour Wage		Total	γ_s ($p-value$)
	NO	YES		
Less than ₦ 66,802.20	8(57.1%)	6(42.9)	14(100.0%)	.135 (0.010*)
Greater than ₦ 66,802.20	90(26.1%)	255(73.9%)	345(1000%)	
Total	**98(27.3%)**	**261(72.7%)**	**359(100.0%)**	

Source: Survey 2022. * denote Significance of the Spearman's coefficient at 0.005 Level of Significance.

In Table 2b, above, the cross-tabulation result showed that the Pearson correlation p_values for (farm labour wage adoption) is <0.05, indicating the rejection of the null hypothesis and the acceptance of the alternative hypothesis that a significant relationship exists between the adoption of farm labour wage adoption, and rural maize farmers' income. The findings revealed that 27.3 percent of those who do not adopt agricultural labor wages but have higher incomes of more than ₦ 66,802.20 may be due to factors like polygamy. A farmer with a big family should have the lowest agricultural expenses. So, this could be blamed for the outcome.

Table 2c: Relationship between Fertilizer Adoption and Rural Maize Farmer's Income

Observed	Do you adopt Fertilizer		Total	γ_s ($p-value$)
	NO	YES		
Less than ₦ 66,802.20	8(57.1%)	6(42.9%)	14(100.0%)	.248 (0.000*)
Greater than ₦ 66,802.20	43(12.5%)	302(87.5%)	345(100.0%)	
Total	**51(14.2%)**	**308(85.8%)**	**359(100.0%)**	

Source: Survey 2022. * denote Significance of the Spearman's coefficient at 0.005 Level of Significance.

In Table 2c, above, the cross-tabulation result showed that the Pearson correlation p_values for (fertilizer adoption) is <0.05, indicating the rejection of the null hypothesis and the acceptance of the alternative hypothesis that a significant relationship exists between the adoption of fertilizer and rural maize farmers' income. Incidentally, a total of 14.2 percent of farmers who do not adopt fertilizer was revealed to have income greater than ₦ 66,802.20. (KASS, 2017) claims that Kaduna State has fertile soil that is conducive to maize, which incidentally may be responsible for this result.

Table 2d: Relationship between Pesticide Adoption and Rural Maize Farmer's Income

Observed	Do you adopt Pesticide NO	YES	Total	γ_s ($p-value$)
Less than ₦ 66,802.20	4(28.6%)	10(71.4%)	14(100.0%)	.002 (0.970*)
Greater than ₦ 66,802.20	97(28.1%)	248(71.9%)	345(100.0%)	
Total	**101(28.1%)**	**258(71.9%)**	**359(100.0%)**	

Source: Survey 2022. * denote Significance of the Spearman's coefficient at 0.005 Level of Significance.

In Table 2d, above, the cross-tabulation result showed that the Pearson correlation p_values for (pesticide adoption) is > 0.05, indicating the acceptance of the null hypothesis and the rejection of the alternative hypothesis. This implies that the adoption of pesticides exerts no relationship with rural maize farmers' income, given the p_value (>0.970). Consequently, the no relationship outcome of this result (given the Pearson correlation p-value) might be pointing to the need for farmers education and training on farm chemical handling and application. Incidentally, the result also revealed that 71.9 percent of farmers who adopt pesticide had income greater than ₦ 66,802.20. This could mean that these farmers had better knowledge on the usage and application of pesticides on maize farm, in addition to the quality of maize seedlings adopted. The application of fertilizer on maize farm varies with the type of fertilizer and maize seedling.

Table 2e: Relationship between Improved Agro-Technology Adoption and Rural Maize Farmer's Income

Observed	Do you adopt Improved Agro-Technology NO	YES	Total	γ_s ($p-value$)
Less than ₦ 66,802.20	2(14.3%)	12(85.7%)	14(100.0%)	.141 (0.008*)
Greater than ₦ 66,802.20	8(2.3%)	337(97.7%)	345(100.0%)	
Total	**10(2.8%)**	**349(97.2%)**	**359(100.0%)**	

Source: Survey 2022. * denote Significance of the Spearman's coefficient at 0.005 Level of Significance.

In Table 2e, above, the cross-tabulation result showed that the Pearson correlation p_values for (Improved agro-technology adoption) is <0.05, indicating the rejection of the null hypothesis and the acceptance of the alternative hypothesis that a significant relationship exists between the adoption of improved agro-technology and rural maize farmers' income. The 2.8 percent of farmers who do not adopt improved agro-technology but had income greater than ₦ 66,802.20 could be attributed to reduction in marginal cost. Farmers who do not adopt pesticide, may not require sprayers, which amounts to reduction of farm cost.

Table 3: Classification Accuracy Table

AFDB-CBARDP Beneficiaries				**Non-Beneficiaries**		
	Observed		**Over All Percentage**	**Observed**		**Over All Percentage**
Step 1	Farm Income	Less than ₦66,802.20	97.1	Farm Income	Less than ₦66,802.20	63.5
		Greater than ₦66,802.20			Greater than ₦66,802.20	

a. The cut value is .500

Source: Survey 2022, SPSS 25.

The Table 3 above showed the binary logistics classification accuracy of the model. Hence, the cut-off value for this investigation is 0.5. Based on the result obtained for the AFDB-CBARDP beneficiaries, model 1 recorded 97.1%. While, for non-beneficiaries, model 1 recorded 63.5%. By implication, this shows that model 1 with 97.1% classification correctness, is accurately predicting the influence of AFBD-CBARDP adoption on rural maize farmers' income. Consequently, adoption of improved maize seedlings (IMS), adoption of farm labour wage (FLW), adoption of fertilizer (FET), and adoption of improved technologies (AGT) are significant determinants of income probability increase (i.e probability of increasing rural maize farmer's income (i.e. either Less than ₦66,802.20 or greater than ₦66,802.20) for AFDB-CBARDP beneficiaries. While for the non-beneficiaries, adoption of improved maize seedlings (IMS), adoption of farm labour wage (FLW), and adoption of fertilizer (FET) and adoption of agro-chemicals (AGC) are vital determinants on the probability of a significant rise in income (i.e probability of increasing rural maize farmers' income (i.e., either Less than ₦66,802.20 or greater than ₦66,802.20).

Table 4: Model Summary of the Logistic Regression

	AFDB-CBARDP Beneficiaries			**Non-Beneficiaries**		
Step 1	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
	106.616[a]	.115	.408	676.716[a]	.062	.082

Source: Survey 2022, SPSS 25

The contribution of the AFDB-CBARDP adoption to the income of rural maize farmers is shown in Table 4. The result showed that, the value of R Square value is high, i.e., it's Cox & Snell and Nagelkerke coefficients are 0.115 (11.5%) and 0.408 (40.8%), respectively, with a Log-likelihood value of 106.616. This means that the binary logistic regression model used has a greater impact on rural farmers' maize income than the non-included variables. More so, the result for the non-beneficiaries also showed a high R Square value, that is, its Cox & Snell and Nagelkerke coefficients are 0.062(62%) and 0.082(82%), respectively with a Log-likelihood value of 676.716. This implies that, the logistic regression model of step 1 has more influence on income, for the non-beneficiaries.

4.3: Binary Logistic Regression Result

Table 5: (Variables in the Equation)

	AFDB-CBARDP Beneficiaries				Non-Beneficiaries			
Step	**Observed Variables**	**B**	**Sig.**	**Exp(B) (Odd Ratio)**	**Observed Variables**	**B**	**Sig.**	**Exp(B) (Odd Ratio)**
Step 1[a]	IMS	2.478	.000	11.920	IMS	.228	.255	1.256
	FLW	1.256	.031	3.510	FLW	-.248	.189	1.281
	FET	3.570	.000	35.523	FET	-.843	.000	2.324
	AGC	-.483	.410	0.617	AGC	.153	.507	1.165
	AGT	2.777	.010	16.068	AGT	-.342	.088	.710
	Constant	-1.151	.001	0.043	Constant	-3.535	.023	.258

Source: Survey 2022, SPSS 25

RFY= -1.151 + 2.478IMS + 1.256FLW + 3.570FET - 0.483AGC + 2.777AGT + ei
(.001) (.000) (.031) (.000) (.410) (.010)

Table 5 above, provides comprehensive estimates of the binary logistic regression model generated in step one (1). Applying the cut-off value, if the estimated p-value is not above 0.50, we conclude that adoption is significant and vice-versa.

Therefore, the coefficients are interpreted as the change in the probability of an increase in income with respect to a unit change in the adoption of the independent variables. The result revealed that the coefficients IMS, FLW, FET and AGT are positive and statistically significant at 5% level of significance. While the constant term was also found to be statistically insignificant at 5% level of significance. This implies that all things being equal, non-adoption of the coefficients of IMS, FLW, FET and AGT will impacts negatively on rural maize farmers' income by about (1.2%) for AFDB-CBARDP beneficiaries, and about (3.5%) reduction for the non-beneficiaries.

The coefficients of improved maize seedlings (IMS), farm labour wage (FLW), fertilizer (FET) and agro-technologies (AGT) are positive and statistically significant given their respective p-values of (.000, .031,.000 and .010) which are less that <0.005. This implies that a one percent increase in the adoption of these coefficients will stimulate the probability that income would rise is 2.5%, 1.3%, 3.6% and 2.8% respectively for the AFDB-CBARDP beneficiaries. In addition to this finding, is the results odd ratio. The odd ratios of the variables (IMS, FLW, FET and AGT) for the AFDB-CBARDP beneficiaries indicates that rural maize farmers had 11%, 3.5%, 35.5%, and 16% odd of having increase in income, for every unit increase in the adoption of IMS, FLW, FET and AGT. The odd ratio's positive value also implies that IMS, FLW, FET and AGT adoption and rural maize farmer's income have a favorable relationship. However, the coefficient of agro-chemical (AGC) was found to be negative (-.483). This revealed that a one percent increase in the adoption of this variable reduces rural maize farmers income by about 0.5%. This result outcome may be attributed to either wrong application of the agro-chemical, or perhaps, could be a result of the fact that most of the improved maize seedlings are pest resistant. As such, any application of pesticides on the farm may have adverse effect on the maize, and ultimately income. Though, this finding is statistically not significant. While the odd ratio indicates that rural maize farmers had 0.6% odd of not having increase in income, if AGC

adoption is increased by one unit. Consequently, the result outcome of Muluken et al, (2021), Wordofa, et al, (2021), and Abubakar, et al, (2021), supports the findings of this study. In that the results by the former found that adoption of improved agricultural technology impacts positively on household income, and improved living standard of the rural farmers.

In addition, the findings of this study are consistent with the theory of modernization on which the study is anchored. The modernization theory, according to Schultz's, held that agricultural development in rural areas is crucial for higher production. Schultz contends that efficient modern factors should be adopted to transmute agricultural activities in the rural area into a high productive type of income. Consequently, this finding indicates that for every one unit of adoption of MIS, FLW, FET and AGT agricultural activities of maize will positively stimulate rural maize farmer's income.

While for the non-beneficiaries, the empirical result revealed that, the coefficient of IMS and AGC are positive and statistically not significant. This implies that, a one percent increase in the adoption of IMS and AGC respectively will result to 0.2% and 0.2% respectively rise in rural income of the non-beneficiaries. More so, the odd rations revealed that a 1 percent rise in the adoption of IMS and AGC respectively will result to 1.3% and 1.2% odd of having increase in income. However, the coefficients of FLW, FET, and AGT were found to be negative and statistically not significant. The implication of this finding is such that, a one percent rise in the adoption of FLW, FET, and AGT by the non-beneficiaries of the AFDB-CBARDP will result to 0.2%, 0.8% and 0.3% respectively decrease in the income of the rural maize farmers. The reason for the outcome may be attributed to poverty and hi cost of agricultural factor inputs. The odd ratio of these coefficient revealed that the farmers had 1.3%, 2.3% and 1.7% odd of decrease in income if FLW, FET, and AGT is increased by one percent. Consequently, it can be seen from this finding that this result is also in tandem with the postulation of Schultz theory of modernization, as well as, the findings of Chikezie, et al (2018).

Table 6: Goodness-of-Fit on each Model (Hosmer and Lemeshow Test)

	AFDB-CBARDP Beneficiaries			Non-Beneficiaries		
Step	**Chi-square**	**Df**	**Sig.**	**Chi-square**	**Df**	**Sig.**
1	15.364	8	.082	14.405	8	.072

Source: Survey 2022, SPSS 25

The Hosmer and Lemeshow statistic reveal important information about the model's standardization and correctness. Consequently, Hosmer and Lemeshow test of the goodness of fit for AFDB-CBARDP beneficiaries, suggests the step/model (1) is a good fit to the data as *p=0.082 (>.05).* While for non-beneficiaries, Hosmer and Lemeshow test of the goodness of fit showed the data as *p=0.072 (>.05).* The significance level of the step/model coefficient specifies approval of the null hypothesis of the step/model, implying that there is no difference between predicted and observed values.

Table 7: Omnibus Tests of Model Coefficients (Forward Stepwise (Wald)

		AFDB-CBARDP Beneficiaries			Non-Beneficiaries		
	Observed	Chi-square	Df	Sig.	Chi-square	Df	Sig.
Step 1	Step	62.296	6	.000	32.683	6	.000
	Block	62.296	6	.000	32.683	6	.000
	Model	62.296	6	.000	32.683	6	.000

Source: Survey 2022. SPSS 25.

The result in Table 7 above showed that, omnibus test statistics for step 1 model is highly significant at the 0.05 percent level of significance, for AFDB-CBARDP beneficiaries as it exhibited (chi-square=62.296, df=6, p<.000). This means that the step 1 model classification accuracy and suitability for forecasting the adoption of the AFDB-CBARDP on rural maize farmers' income is highly correct. While for non-beneficiaries, the omnibus statistics is highly significant at 0.05 percent level of significance. It showed that (chi-square= 32.683, df=6, p<.000).

5. Conclusion and Recommendations

The problem of low income earning (poverty) is a challenge that bedevils rural maize farmers in Kaduna State. Hence, the study revealed that the factors that determined the likelihood of increase in rural maize farmers' income in Kaduna State includes; improved maize seedlings (IMS), farm labour wage (FLW), fertilizer (FET), and agricultural technologies (AGT). More so, the study showed that, the beneficiaries of AFDB-CBARDP in the syndicate study area had higher odd ratio to rise in income than, the non-beneficiaries. Additionally, the negative and statistical insignificance of the AGC coefficient may be attributed to wrong application and use of agro-chemicals. Consequently, it can be inferred that the adoption of IMS, FLW, FET and AGT stimulates the likelihood of an increase in income of rural maize farmers. The implication of this research finding is that intervention programmes such as the AFDB-CBARDP is critical in stimulating rural maize farmers' income. As such, it can be concluded that the adoption of the improved agricultural development project (AFDB-CBARDP) increased the propensity of better economic prospects/welfare of the beneficiaries than the non-beneficiaries in Kaduna State. Based on the findings, the study recommends the following:

First, the federal, state, and local government should collaborate more and come up with a workable framework that recognizes and interface with sub-group farmer's union, since for instance maize farming requires some sort of differentiated farming technologies and skills from those who engages in the cultivation of other food crop. This will increase their odd of having access to require assistance, technology, and knowledge based that are critical in maintain a steady flow of increase in output and income.

Second, the government and other stakeholders should collaborate and design a rural farmer's education policy. The policy should be rural based and flexible for both male and female farmers. Since for instance, handling of agro-chemicals, soil variation, weather conditions and seed types requires some agro knowledge and skills to determine their types and right application of agro chemicals (pesticides) to avoid harm, on both human and crops. This may be achieved by investing in farmers training through organizing agricultural seminars/workshops and farmer field schools. At this point, extension service agents are very important as it bridges the gap between researchers and farmers.

Third, investments in farmer's education without appropriate dissemination techniques may not cause desired impacts. As such, it would also be beneficial if the rural-urban roads are improved upon

through collaboration between the three tire governments. This will enhance agricultural value chain business, enables farmers to easily access the needed farm inputs like fertilizer and thus stimulate rise in income of the farmers, via easy movement of their farm produce to the market.

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