E-ISSN: 2346-7290

Effect of climate change adaptation measures on the income of rice farmers under the IFAD-VCDP in Katcha Local Government Area, Niger State, Nigeria

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ABSTRACT

The effect of climate change adaptation measures on the income of farmers was investigated using multiple regression. Data were generated using questionnaire from a sample of 120 rice farmers across four villages where rice production was predominant using the multi- stage random sampling techniques. The results showed that rice farmers adapted to climate change through the use of changing variety, building water scheme and conservation scheme, early planting, livestock production, change in size of land and irrigation practices. The size of farm (β=21.479 , $p<0.01$),Quantity of seed planted (β= 0.892, $p<0.01$), change in crop variety (β= 29.449, $p<0.05$), number of extension visit (β= 1.676, $p<0.05$), change in size of farmland under cultivation (β= 1.740, $p<0.10$), early planting (β= 17.345, $p<0.10$ and credit (β= 0.000306, $p<0.10$) were the factors that influenced rice farming income positively while diversification from rice farming to other crop farming (β=-38.727, $p<0.01$), household size (β= -2.449, $p<0.01$), labour (β= -0.184, $p<0.01$), diversification to livestock production (β= -28.340, $p<0.05$) and non-farm activities (β= -2.449, $p<0.05$ were found to have a negative effect on the income of rice farmers. Constraints faced by farmers were shortage of labour, inadequate technical know-how, theft, fluctuation in output prices and changes in government policy. The study recommends policies that will encourage local production, such as strengthening and encouraging the existing extension services. The Federal and State government can set up guarantee minimum prices in order to ensure that farmers have good prices for their products. Relevant climatic agencies should share information on weather and climate to farmers. This will enable farmers to develop better adaptation strategies.

Keywords: Climate adaptation, IFAD- VCDP, Tobit regression, rice farmers.

INTRODUCTION

Agriculture in Nigeria is a major branch of the economy which provides employment for 70% of the population (Onyeweaku and Nwara, 2005). The sector is being transformed by commercialization at the small, medium and large-scale enterprise level. Over the years there has been many factors affecting agriculture such as soil factors, climatic factors, population size, technology, government policy etc. There are certain challenges faced by agricultural sector such as low productivity, environmental degradation, limited access to productive asset, inadequate market and rural infrastructure, post-harvest losses, limited access to financial services, inadequate support services. Climate change is the latest challenge to sustainable human development (Anik and Khan, 2012) and is likely to have negative impacts on efforts to achieve Nigeria's development objectives, including the targets set out in Nigeria Vision 20:2020 (World Bank, 2008). In particular, climate change will impede efforts to reduce the poverty experienced by the majority of Nigerians and it will likely lead to other changes such as ecosystem degradation and reduced availability of water and food. It is therefore likely to become a major driver of increased human conflict.

Weather-related disasters have become more frequent in the past four decades and the trend continues and this disasters are putting Nigeria's agricultural systems especially crop production under serious threat and stress (Ayinde, Muchie and Olatunji, 2011). The nation's natural and agricultural ecosystems, including freshwater and coastal resources, are highly susceptible to the effects of climate change. These vulnerability factors make clear the urgent need to respond to the challenges of climate change in a comprehensive and systematic manner that addresses broader development priorities while taking account of the gender-differentiated needs and roles of the society. Climate change affects agriculture in several ways, one of which is its direct impact on food production (Kuta, 2011). It brings additional perspective to the national challenge of increasing agricultural production to keep pace with the rising population while keeping high standards of environmental protection. As reported by the Commission of the European Communities (CEC), negative effects on agricultural yields will be exacerbated by more frequent extreme weather events (CEC, 2009).

Adaptation to climate change and climate variability at the farm-level by the farmers especially through the modification of agricultural practices and farming systems has been recognized as the main coping strategies. It is believed that these strategies are supposed to help the farmers improve their personal productivity and efficiency in food crop production and also raise their returns to farming as a business. Adaptation to climate change is an adjustment made to human, ecological or physical system in response to vulnerability (Adger et al., 2003; Quan & Dyer, 2008 and Idoma et al., 2017). Climate change adaptation through the modification or improvement of agricultural practices will be imperative to continue meeting the growing food demands of modern societies (Rosegrant, 2008). Adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including volatile short-term changes in local and large-scale markets (Kandlinkar and Risbey, 2000). Adaptation is therefore critical and of concern in developing countries, particularly Africa (including Nigeria) where vulnerability is high because the ability to adapt is low.

Many programs have being initiated to boost up the agricultural sector (e.g. Youth Initiative for Sustainable Agriculture (YISA) and Value Chain Development (VCDP)). The VCDP program seeks to adopt a holistic and demand-driven approach to address constraints along the cassava and rice value chains. This necessitates an inclusive strategy of a capacity strengthening of actors along the chain, as well as enablers (regulatory environment, service providers etc.). The program strategy is anchored in a long term vision of value chain development to adapt to climate to improve economic growth, poverty reduction, increase production and productivity. To address these challenges, the Government of Nigeria and IFAD contrived the VCDP, adopting the value chain approach, to enhance productivity increase, promotion of agro-processing, access to market to facilitate improved engagement of private sector. Therefore, this study assessed the effect of climate change adaptation strategy on the income of the rice farmers under the IFAD-VCDP in the study area.

The results of this study is expected to give direction to policy makers in designing appropriate public policies in order to increase agricultural productivity and adaptation effects of climate change on rice production in Nigeria especially in the North central. It will also provide a useful guide to international and local donor agencies, researchers and farmers interested in climate change mitigation and adaptation in their provision of grants and funds for environmental and resource management studies.

METHODOLOGY

The study was conducted in Katcha local Government area of Niger state, Nigeria. Niger state is located between Latitude $8^{o}22'N$ and $11^{o}30'N$ and Longitude $3^{o}30'E$ and $7^{o}20'E$. Niger state has a land capacity of 76,363 square meters and a population of 4,082,558 people (NBS, 2015). The state is agrarian and well suited for the production of arable crops (e.g. rice, cowpea, yam, guinea corn, millet, potatoes, maize, soy bean, cassava and with favorable climate conditions. The annual rainfall is between 1100mm to 1600mm and usually start by April and ends by October annually with average monthly temperature range from $23^{0}C$ and $37^{0}C$ (Niger State Agricultural Mechanization Development Agency (NAMDA, 2016)). The vegetation consists of short grasses, shrubs and scattered trees as characteristic of the North Central Zone of Nigeria.

Sampling procedure: A multi-stage sampling method was utilized to select 120 rice farmers of the IFAD-VCDP in Katcha LGA. In the first stage, four (4) villages were randomly selected while the second stage involved a random selection of 120 farmers under IFAD- VCDP program from a total of 172 rice farmers in the LGA using the Yamane's formula at 5% limit or tolerable error. The formula is expressed in equation 1 as:

$$n = \frac{N}{1 + N(e)^2} \quad \text{---------- eqn.1}$$

Where :

n = sample size

N = study population

1 = constant

e = limit/toleranceerror (0.05)

Table 1: Distribution of sample size from sample frame

VILLAGES	SAMPLE FRAME	SAMPLE SIZE
Gbakogi	55	39
Kutigi	59	41
Mayaki	35	24
Elegi- zuzungi	23	16
TOTAL	**172**	**120**

Source: NAMDA (2016)

Data were collected from IFAD- VCDP rice farmers using structured questionnaire and oral interview. Data for this study was analyzed using descriptive statistics such as means, frequency, standard deviation, and Tobit regression analysis. To analyze the effect of climate change adaptation measures on the income of rice farmers, Tobit model was used. Owing to the restrictions imposed on the values taken by the dependent variable, the Tobit model is often referred to as limited dependent variable regression model.

Let Y be a variable that is essentially continuous over strictly positive values but takes on zero with positive probability. The Tobit model is defined as a latent variable model:

$Y_i^* = X_i^* \beta + \varepsilon_i$ Yi * ----------eqn. 2

$Y_i = \max\ (0, Y^*)$ ----------eqn.3

Then, Yi = 0 if Y* ≤ 0 and Yi = Yi* if Yi* > 0

The latent variable Y* satisfies the classical linear assumptions of normality and homoskedastic distribution with a linear condition mean. It also implies that the observed variable Yi equals Y* when Y* > 0, but Y = 0 when Y* ≤ 0. The estimated coefficients in a Tobit model cannot be interpreted the same way as in a Linear Regression Model. For discrete categorical variables, the marginal effects are used to calculate percentage changes in dependent variables when the variable shifts from zero to 1, while for continuous variables, the marginal effects are used to calculate elasticity at complete means.

$\frac{\partial \mathrm{E}[Y^*]}{\partial \chi \kappa} = \beta_k = \beta \mathrm{k}$ ----------eqn.4

The implicit model was specified as

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, e)$----------eqn.5

Where Y = Income (₦)

X_1: Change in crop variety (1=yes, 0= No),

X_2: Change in size of farm land under cultivation (1=Yes, 0= No),

X_3: Diversification to livestock production (1= yes, 0= No),

X_4: Diversification from rice farming to other crop farming (1= Yes, 0=No),

X_5: Irrigation for access to water (1= Yes, 0= No),

X_6: Early planting (1= Yes, 0= No),

X_7: Marital status (Dummy, married =1, not married =0)

X_8: Age (years)

X_9: Access to extension services (Number of visits)

X_{10}: Education Level (years)

X_{11}: Farming experience (years)

X_{12}: Size of farm (hectare)

X_{13}: Labour (mandays)

X_{14}: Quantity of seed planted (Kg)

X_{15}: Non -farm activities (Dummy, 1= diversion to non -farming activities, 0 = otherwise)

X_{16}: Household size (Number of persons)

X_{17}: Credit (₦)

e: error term

Adaptation measures utilized by rice farmers in the study area

Table 2 shows the climate change adaptation measures utilized by farmers. Seven adaptation measures were identified in the study area. Ninety six percent of the respondents changed the seed variety planted. In addition, 95.0% used irrigation while 91.7% diversified into livestock production.

The empirical Tobit model is explicitly specified as:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + b_{12}x_{12} + b_{13}x_{13} + b_{14}x_{14} + b_{15}x_{15} + b_{16}x_{16} + b_{17}x_{17} + e$$ ---------eqn. 6

Where Y_1, X_1- $X_{17}$are as defined in the implicit form

$b_1 – b_{17}$= regression coefficient

a = constant term

e = error term

RESULTS

Table 2: Distribution of respondents according to adaptation measures utilized

Adaptation measures	Frequency	Percentage
Change variety		
Yes	116	96.7
No	4	3.3
Build water scheme		
Yes	114	95.0
No	6	5.0
Diversification crop		
Yes	3	2.5
No	117	97.5
Diversification livestock		
Yes	110	91.7
No	10	8.3
Early planting		
Yes	102	85.0
No	18	15.0
Change in size of land		
Yes	110	91.7
No	10	8.3
Irrigation		
Yes	103	85.2
No	17	14.8

Source: Field survey, 2018

Effect of Climate Change Adaptation Measures on the income of Rice Farmers

The likelihood ratio statistic as indicated by Table 3 statistics (65.09) was significant at the 0.01 probability level, (prob. > chi = 0.0000) suggesting that the model had a strong explanatory power. The results showed that size of farm (β=21.479 , p<0.01), quantity of seed planted (β= 0.892, p<0.01), change in plant variety (β= 29.449, p<0.05), number of extension visit (β= 1.676, p<0.05), change in size of farmland under cultivation (β= 1.740, p<0.10), early planting (β= 17.345, p<0.10 and credit (β= 0.000306, p<0.10) were the factors that influenced rice farming income positively, While diversification from rice farming to other crop farming (β=-38.727, p<0.01), household size (β= -2.449, p<0.01), labour (β= -0.184, p<0.01), diversification to livestock production (β= -28.340, p<0.05) and non-farm activities (β= -2.449, p<0.05 were found to have a negative influence on the income.

Table 3: Effect of Climate Change Adaptation Strategy on Income of Rice Farmers in the Study Area

Variables	Coefficient	Standard error	Z
Constant	118.374	34.216	3.46
Change in crop variety	29.449	11.953	2.460**
Change in size of farm land under cultivation	20.138	11.576	1.740*
Diversification to livestock production	-28.34	11.566	-2.450**
Diversification from rice farming to other crop farming	-38.727	10.79	-3.590***
Irrigation for access to water	9.813	19.59	0.5
Early planting	17.345	9.007	1.930*
Marital status	0.263	0.385	0.68
Age	0.272	0.768	0.35
Number of extension contact	1.676	0.784	2.140**
Educational level	-0.38	0.507	-0.75
Farming experience	-0.385	1.191	-0.32
Size of farm	21.479	4.632	4.640***
Labour (mandays)	-0.184	0.063	-2.910***
Quantity of seed planted	0.892	0.307	2.910***
Non- farm activities	-18.228	8.812	-2.070**
Household size	-2.449	0.871	-2.810***
Credit	3.060E -05	1.790E- 05	1.710*

Log likelihood= -581.94156; LR Chi^2 (9) = 65.09*** (prob> Chi^2 = 0.0000);
Pseudo R^2 = 0.0530, number of observations = 117
*** p< 0.01, ** p< 0.05 and * p< 0.10 significant level.

Source: Computer output, 2018

Constraints faced by the rice farmers:

The constraints faced by rice farmers are presented in Table 4. The results showed that inadequate capital was the major (39.9%) constraint among rice farmers in the study area. Others are shortage of labour (13.0%), inadequate technical know-how (12.2%), theft, fluctuation in output prices and changes in government policy were problems encountered by 9.7%, 8.4% and 5.9% of the respondents in the study area respectively. The problem of agricultural development had been inadequate capital which hinders farmers from practicing commercial agriculture.

Table 4: Distribution of respondents according to Constraints

Constraints	Frequency	Percentage
Theft	23	9.7
Inadequate capital	94	39.5
Lack of knowledge on weather and climate forecast	14	5.9
Inadequate water for irrigation	11	4.6
Fluctuation in output prices	20	8.4
Inadequate technical know how	29	12.2
Shortage of labour	31	13.0
Changes in government policy	16	6.7
Total	**238 ***	**100**

Source: Field survey, 2018; * = Multiple response

DISCUSSION

Majority of the farmers adopted improved variety of rice probably because most improved variety of rice have a higher capacity to cope with climate change as reported by Kawasaki and Herath (2011). This finding corroborates the findings of Arimi (2014) and Idoma *et al.* (2017) who also reported that rice farmers in Southwest and Benue State Nigeria respectively cultivated improved varieties as a means of mitigating the effect of climate change. In addition, rice farmers used irrigation and diversified into livestock production. Farmers use these practices as a means of combating the risk of crop failure. This finding points to the fact that rice farmers under the IFAD- VCDP had knowledge of various adaptation strategies and practiced them. This could be attributed to the fact that a good number of the farmers have received trainings on climate change and ways of combating the menace. Also, a good number of the farmers are educated and have access to radio, Television and cell phone through which they get information on climate change and some coping strategies.

The use of climate change adaptation strategies such as change in crop variety, change in size of farm land, early planting helped the rice farmers to reduce the effect of climate change and this further translated into increased income. This implies that the adaptation measures utilized by the farmers were very effective and rice farmers in the study area relied on the strategies to cope with the adverse impacts of the climate change on rice production. Furthermore, use of these adaptation strategies could enhance food security for the farming households as well as reduce the huge foreign exchange expended on rice importation. This finding is in agreement with Mabe *et al.* (2012) who reported that farmers who had higher adaptive capacity had higher rice output and hence higher income.

Also, farmers who had more extension visits had higher income. This could be because extension agents pass information concerning new and innovative techniques that can help the rice farmers to minimize the harmful effect of climate change. In addition the positive coefficient of farm size, credit and quantity of seed cultivated showed that an increase in these variables will lead to increase in the income whereas

an increase in the labour will lead to reduction in the level of income of the farmers in the study area. This could be because rice farming is labor intensive and the use of labor implies higher wage bill and hence reduction in the gross margin and a further reduction in income. Credit is needed for proper management, practicing necessary adaptation strategies and enlargement of rice farm from small scale to large scale which in result increase in the income of the farmers. This findings are in line with Ayoola and Dangbegnon (2011); Mabe, Sarpong and Osei-Asare (2012) and Hoque and Hoque (2014), who also reported that farming experience and farm size had positive influence on income in Northern Guinea Savanna of Nigeria, Northern Region of Ghana and Bangladesh respectively.

Conversely, adaptation strategies such as diversification to livestock production, diversification from rice farming to other crop farming, non- farming activities negatively influenced the income of farmers. Probably because of the deviation from rice farming to other activities. Distribution of inadequate farm resources to different enterprises could also lead to low productivity hence low income.

The constraints faced by rice farmers which include inadequate capital, shortage of labour, inadequate technical know-how, theft, fluctuation in output prices and changes in government policy were problems encountered by the respondents in the study area respectively. These factors are the sources of risk in agriculture (Jirgi, 2013). The problem of agricultural development had been inadequate capital which hinders farmers from practicing commercial agriculture. Farmers who have cooperative societies can improve on their savings and investment through group farms and marketing of agricultural produce. Shortage of labour could lead to delay in farm operations and consequently low yield. Farmers can plan and organize group labour. In addition the use of agrochemicals could also minimize demand for labour. The constraint of technical know-how can be addressed through improvement in the training on good agronomic practices by the IFAD-VCDP extension agents. The fluctuation in output prices can be combated through price regulations such as maximum and minimum price control as the case may be. With regards to changes in government policy government should be consistent in their agricultural policies and ensure continuity of such policies.

CONCLUSION

Based on the findings, the study concluded that rice farmers in the study area were aware of climate change and had devised means to mitigate its effect and the utilization of these strategies had led to increase in income. Also, farmers who had higher farming experience and extension visits had higher income. Inadequate funds, fluctuation of output prices and lack of knowledge on weather and climate forecast are among the constraints reported by the rice farmers. Hence, the study recommended those policies that will encourage local production, such as strengthening and encouraging the existing extension services in the state. The federal and state government can set up guarantee minimum prices in order to ensure that farmers have good prices for their products. Relevant climatic agencies should share information on weather and climate to farmers this will enable farmers to develop better coping strategies.

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