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EFFECT OF LIVELIHOOD FACTORS ON CLIMATE CHANGE ADAPTATION PRACTICES AMONG FARMERS IN SOUTH-EAST NIGERIA: QUANTITATIVE APPROACH

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Abstract
The study investigated livelihood factors that affect climate change adaptation practices of farmers in Southeast Nigeria. Primary data were used in the study, and analysed using descriptive statistics, activity-based adaptation index (AAI) and multiple regression. The farm practices of the farmers were 74% effective for climate change adaptation, while water management was their most effective (82%) climate change adaptation strategy. Their level of climate change adaptation was 64%, which was significantly influenced by the occurrence of natural disasters, farm size, access to healthcare centres, credit facilities, age, farming experience, membership of cooperatives and income. The study recommends the adoption of more effective climate change adaptation practices, and increased farmers' access to more lands for farming, extension contact, credit at little or no interest rates and healthcare centres.

Keyword: Activity-based adaptation, water management, livelihood factors, and Southeast Nigeria

Introduction

Climate change is one of the worst tragedies that has befallen humanity, as it has continuously posed frightening dangers and challenges to the economic, cultural, social, environmental and political life and wellbeing of man. IPCC (2007) described climate change as a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, persisting for an extended period typically decades or longer. This manifests in extreme conditions of flooding, temperature rise (heat waves), rises in sea levels, drought and desertification, wind storms, and the drying up of streams and rivers (NEST, 2004; Ozor *et al.,*2010). These conditions severely undermine livelihoods in sub-Saharan Africa (SSA), worsening the state of hunger, malnutrition, food and social insecurity, and resulting in rising cases of civil unrest, violent crimes, and massive and unplanned emigration of young and able-bodied men and women from the region.

Sub-Sahara Africa is characterised by poverty, hunger, rurality and insecure livelihood. Livelihood comprises the capabilities, assets and activities required for a means of living (Chambers, 1987; IDS, 1996). Such livelihood is secured and sustainable when it can cope with and recover from stress and shock, maintain or enhance its capabilities and assets, while not undermining its natural resource base (Chambers and Conway, 1992; UNDP, 1999). These conditions are very far from being met in the region. The State of Food Insecurity in the World reported that more than 90% of the 260 million hungry people in Africa live in SSA, representing 22.8% of its population (FAO, IFAD, UNICEF, WFP and WHO, 2019). Worse still, the region has one of the highest population growth rates in the world, estimated at about 2.7% in 2018 (World Bank Group, 2019). Concerted efforts aimed at hunger and poverty eradication in the region, require proper understanding of the livelihood of the poor (Oti *et al*., 2019a). The sustainable livelihood (SL) provides a holistic framework for effective livelihood analysis, by showing the dynamic linkages and interrelationships among the various capabilities, assets and activities required for a means of living (Carney, 1999; DFID, 1999; Sukendra, 2010). This consists of five components: poverty identification (analysis), livelihood assets, service providers and enabling agencies, vulnerability context, and livelihood aspirations and opportunities (IFAD, 2015; Oti *et al*., 2019a).

Poverty analysis involves the proper identification of the poor, taking into cognisance gender issues, age, ability, ethnic, personal background and history, and the features of the location and agro-ecological zones where they live (IFAD, 2015). Livelihood assets include personal assets (e.g. perceptions, motivations), human assets (e.g. good health), social assets (e.g. kinship and family ties), natural assets (e.g. land, water), financial assets (e.g. wages, savings) and physical assets (infrastructure, technology). The service providers mostly in the private and public sectors, provide the people with goods and services that they need but are beyond their control, based on sets of rules, norms and regulations made by the enabling agencies such as policy makers, law-makers and institutions. The vulnerability context describes the external environment of the poor, which are usually outside their control such as shocks, trends and seasonality (DFID, 1999). Livelihood aspirations and opportunities describe people's expectations from life based on their livelihood components, the actions they take to secure their livelihood and the results of such actions.

In Nigeria, the poor and insecure livelihood situation in the country is even messier. The country not only has the highest population in the sub-region, but also the highest number of poor, hungry and malnourished people in the world (Adebayo, 2018; Worldometers, 2019; Oti *et al*., 2020). More so, within the country, the incidence of poverty is highest among farming households (Babatunde 2008; Idowu, 2013; Oti *et al*., 2019a), which constitute over 70 percent of the country's population (Oni and Yusuf, 2008; Sallawu *et al*., 2016). This is evident in the report of Oti *et al*. (2017) that 54 percent of farm households in Enugu State were food insecure on a monthly food security line of N2,533.79 ($7.03 US), which is far less than World Bank's benchmark for extreme poverty of $1.9 US per day..

The sub-region no doubt, is cut in the crossfire where poverty and poor livelihood is both the cause and effect of its high vulnerability to climate change. Climate change adaptation involves adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2001). Such adjustments could be human, ecological or physical response to climate change vulnerability (CCV) (Adger *et al*., 2007; Oti, 2013). As a result, the need to develop and build the adaptive capacity of the sub-region in response to climate change has become more urgent than ever before (CARE, 2011). Several research efforts have been made in this direction aimed at understanding the climate change adaptation behaviour of farmers (Apata *et al*., 2009; Farauta *et al*., 2012; Oti, 2013; Balew *et al*., 2014; Oti, 2017). However, most of these efforts were limited either in methodology or scope (Apata *et al*., 2009; Farauta *et al*., 2012; Oti, 2013; Oti, 2017; Oti *et al*., 2019b), making robust and comprehensive evidence-based policies difficult.

Many of such studies were unable to quantify climate change adaptation; rather they relied on qualitative measurement of adaptation (Apata *et al*., 2009; Farauta *et al*., 2012; Balew *et al*., 2014). Qualitative measurement of adaptation into high, moderate or low adaptation, does not sufficiently address the complex, forward looking and site-specific characteristics of adaptation processes (Below *et al*., 2012; Hinkel, 2011). A better understanding of what determine farmers' adaptation behaviour requires precise and quantitative measurement of their adaptation practices (Below *et al.,* 2012). Yohe and Tol (2002) noted that studies that quantified climate change adaptation were limited in empirical literature. Quantification will make for a better understanding, classification, assessment, comparison and recommendation of adaptation practices. As a result, the study developed an activity-based adaptation index (AAI) following Below *et al*. (2012), to measure farmers' climate change adaptation, quantitatively. This makes for a better understanding of the processes that shape farmers' climate change adaptation, which Rishi *et al.*(2010) and Madu (2012) described as urgent and important, due to the high level of deficiencies in adaptive capacity in the Sub-Saharan Africa region.

Furthermore, there are limited studies that incorporated livelihood variables in explaining farmers' adaptation behaviour. Most of these studies used mainly socio-economic and farm variables. Socio-economic and farm factors are necessary but not sufficient in explaining the adaptation behaviour of farmers, considering the level of poverty among farmers. This is more so, if the underlying factors influencing their adaptation behaviour are to be properly understood. Hence the study identified the effectiveness of climate change adaptation practices of the farmers, examined the level of the climate change adaptation of the respondents and determined the livelihood factors that affect the farmers' level of climate change adaptation in the study area.

Methodology

Study Area

This study was carried out in southeast region of Nigeria, which consists of five states namely Abia, Anambra, Ebonyi, Enugu and Imo. It is located East of River Niger, between Longitudes 6 - 8^0 East of the Greenwich Meriden and Latitudes 5 - 7^0 North of the Equator on a landmass of 40,000km^2 (16,000 square miles) on an elevation ranging from zero metres (0 ft) to 1,000m (3,300ft) (NBS 2014).

Sampling Technique

Primary data were used in the study. The data were collected using two sets of structured questionnaire administered to two sets of respondents. The respondents were selected through a multistage random sampling technique. For the first set of respondents, 360 households were selected. This involved firstly, a random selection of three States (Abia, Ebonyi and Enugu) in the region, followed by another random selection of two agricultural zones from each of the selected states. Subsequently, two local government

areas (LGAs) were randomly selected from each of the agricultural zones, from where two communities were randomly selected. Finally, 15 farm households were randomly selected from each of the selected communities. Only responses from 348 respondents were useful for the analyses. In the second sample, purposive sampling technique was used to select 28 stakeholders, who have expert knowledge in agricultural production, climate change research and farm practices of farmers as they relate to climate change adaptation. These experts were drawn from Universities, Research Institutes, State Ministries of Agriculture and Agricultural Development Programme (ADP). The responses from 23 of the experts were however used in the analyses.

Method of Data Analysis

The level of climate change adaptation of the farmers was achieved using activity-based adaptation index (AAI). The AAI involved the compilation of agricultural practices used by farmers as indicating variables for adaptation index. These indicating variables are traditional farm practices of farmers, and as such, the AAI measures farmers' increased use of these practices in response to climate change (Below *et al*., 2012). Weights were assigned to the indicating variables by experts and stakeholders in agricultural production and climate change research based on a 5-point scale. The weights were assigned to the indicating variables in increasing order of importance and suitability as climate change adaptation practices. Farmers also provided complimentary assessment on the suitability or otherwise of each indicating variable as a climate change adaptation measure.

The AAI of the farmers is directly related to the suitability of the increased use of these agricultural practices as measures of climate change adaptation (Below *et al.,* 2012). As such, the higher the AAI of the farmer, the more effective the increased use of these farm practices are, in climate change adaptation. The adapted index was specified in Equation 1 following Below *et al*. (2012).

$$AAI_j = W_1P_{1j} + W_2P_{2j} + W_3P_{3j} + \cdots + W_nP_{nj} \ldots (1)$$

where,

AAI_j = activity − based adaptation index of j^{th} household

W_1 = weight of indicating variable (5 − very effective; 4 − effective; 3 − moderately effective; 2 − poorly effective; 1 − not effective

P_{1j} = j^{th} household's assessment of the suitability of indicating variable for climate change adaptation (1, if suitable, 0 if otherwise)

The factors that affect the farmers' level of climate change adaptation was achieved using regression analyses. The multiple regression analysis model is specified in Equation 2.

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_{19}X_{19} + e_i \ldots (2)$$

where:

Y = AAI

β_0 = constant

X_1 = age (years)

X_2 = marital status (1 if married, 0 otherwise)

X_3 = household size (number)

X_4 = level of education (years)

X_5 = farm size (ha)

X_6 = distance of farm from home (km)

X_7 = farming experience (years)

X_8 = market distance from home (km)

X_9 = membership of cooperative society (1 = Member of cooperative, 0 = Not member)

X_{10} = access to credit facilities (amount of loan received in the last 5 years in ₦)

X_{11} = remitances (total amount of money received from relatives in the last 5 years in ₦)

X_{12} = extension visits (number of visits from agricultural extension officers in the last 5 years

X_{13} = access to forest resources (1 if access, 0 otherwise)

X_{14} = access to good drinking water (1 if access, 0 otherwise)

X_{15} = access to health care centre in your community (1 if access, 0 otherwise)

X_{16} = occurence of resource conflict (number of times there have been conflict in your community over the use of natural or communal resources in the last 5 years)

X_{17} = occurrence of natural disasters (number of natural disasters that have occurred in your community e. g. floods, erosions, etc. in the last 5 years)

X_{18} = farm income (₦)

X_{19} = non − farm income (₦)

e_i = error term

Results and Discussion

Effectiveness of Climate Change Adaptation Practices of Farmers

The effectiveness of the climate change adaptation practices of farmers is presented in Table 1. The result shows that on the average, the effectiveness of the adaptation practices of farmers was 74 percent. This implies that the farm practices of the farmers were appropriate for climate change adaptation. It also implies that there is opportunity for improvement on the effectiveness of the farmers' adaptation practices by about 26 percent. Further results showed that water management was the most effective (82%) climate change adaptation of the farmers, while water harvesting and storage was their effective (93%) adaptation practice. In SSA like Nigeria, agricultural production is predominantly rain-fed, contributing immensely to the seasonality of its production. This little period of production is being further shortened by delay in the onset of rains, and drying up of rivers and streams arising from climate change. As a result, adaptation efforts aimed at providing water (irrigation) for agricultural production will be very effective in reducing the adverse effects of climate change.

Table 1: Effectiveness of farm practices of farmers as strategies for climate change adaptation

Adaptation Practices	Weighted Ratings	Level of Effectiveness (%)
Land/Soil Management		
Land rotation/bush fallow	3.67	73.4
Avoiding bush burning	4.70	94.0
Raising of mounds and ridges across slopes	2.33	46.6
Prompt physical weeding and removal of insects	3.0	60.0
Use of insecticides and weedicides	2.85	57.0
Organic manure application	3.27	65.0
Fertilizer application	3.0	60.0
Agro-forestry practices	4.33	86.6
Sub-total	27.15	542.6
Sub-average	3.39	67.8
Water Management		
Mulching	4.0	80.0
Physical irrigation	4.4	88.0
Use of cover crops	3.67	73.4
Water harvesting and storage	4.66	93.2
Prevention of forest losses along water bodies	4.5	90.0
Construction and maintenance of water paths	4.2	84.0
Tree planting	3.39	67.8
Sub-total	28.82	576.4
Sub-average	4.12	82.3
Crop Management		
Crop rotation	3.67	73.4
Cultivation of early maturing crops	4.80	96.0
Cultivation of improved crop varieties	4.33	86.6
Cultivation of disease-resistant crops	4.18	83.6
Cultivation of drought-resistant crops	4.0	80.0
Multiple cropping/mixed farming	2.32	46.4
Changing of planting dates	4.05	81.0
Use of weather forecast	3.3	66.0
Sub-total	30.65	613
Sub-average	3.83	76.6
Livelihood Diversification		
On-farm employment	2.65	53.0
Off-farm employment	3.21	65.6
Artisans	3.28	64.2
Trading	3.47	69.4
Sub-total	12.61	252.2
Sub-average	3.15	63.1
Total Weight	**99.23**	
Average Weight	**3.68**	**73.6**
Potential Weight	**135**	
Total Number of Observations, N		23

Source: Field survey, 2018.

Level of Climate Change Adaptation among Farmers

The level of climate change adaptation of the farmers is shown in Figure 1.The result shows that the average activity-based adaptation index of the farmers was 86.25. This implies that the average level of climate change adaptation of the farmers was 64 percent. In other words, there is room for improvement in the level of adaptation of the farmers. Disparities in number and effectiveness of adopted practices of farmers could have influenced this level of adaptation of the farmers. Farmers belong to distinct households with diverse and distinct assets and capabilities, such that they are unlikely to adopt the same number and type of adaptation practices. Also, evidence from literature suggests that farm practices that are widely and highly adopted by farmers are usually not effective for climate change adaptation (Oti *et al*., 2019b).

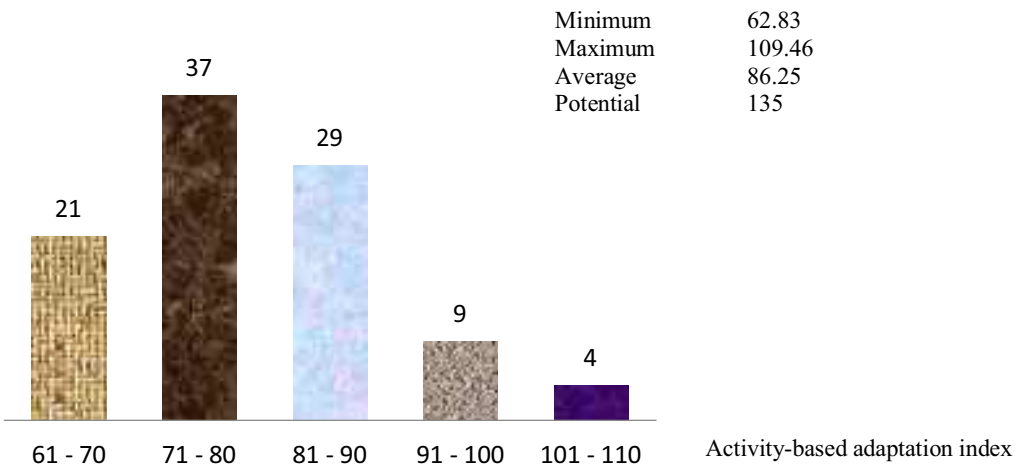

Figure 1: Frequency distribution (%) of farmers according to their level of climate change adaptation
Source: Field survey, 2018

Livelihood Factors Affecting Farmers' Level of Climate Change Adaptation

The livelihood factors that affect the level of climate change adaptation of the farmers Table 2.

Table 2: Regression estimates of factors that affect farmers' level of climate change adaptation

Livelihood factors	Coefficients	Standard error	t-ratio
Constant	51.624	20.096	2.569***
Age	-0.235	0.102	-2.304**
Marital status	-0.190	0.230	-0.826
Household size	-0.153	0.256	-0.598
Level of education	0.450	0.378	1.190
Farm size	0.881	0.499	1.962*
Farm distance	1.537	1.252	1.228
Farm experience	-0.097	0.043	-2.256**
Market distance	-0.727	1.564	-0.465
Membership of cooperative societies	0.509	0.170	2.994***
Access to credit facilities	0.087	0.047	1.851*
Remittances	0.101	0.112	0.902
Access to extension services	0.549	0.171	3.211***
Access to forest resources	0.159	0.162	0.982
Access to good drinking water	1.462	1.630	0.890
Access to health care centre	0.385	0.215	1.791*
Resource conflicts	-0.087	0.213	-0.404
Natural disasters	0.408	0.166	2.458**
Farm income	0.922	0.187	4.930***
Non-farm income	0.288	0.749	0.385
R^2		0.632	
F-value		4.205***	
Total Number of Observations		348	

***, **, * **is significant at 1%, 5% and 10% level respectively.**
Source: Field survey, 2018

Age

The effect of age on the level of climate change adaptation was negative and significant at 5% level. This implies that the level of climate change adaptation of the farmers decreases as they get older. Climate change adaptation involves risks, and older people are more risk averse than younger ones. The result aligns with Owombo *et al*. (2014) who reported that age negatively affected the choice of irrigation as a climate change adaptation technique relative to no adaptation.

Farm Size

The effect of farm size was positive and significant at 10% level, implying that the level of climate change adaptation of the farmers increases as their farm sizes increase. Large farm size enjoys economies of scale, which boost agricultural productivity. This agrees with the findings of Anyoha *et al*. (2013), which reported that

farm size positively affected the adaptation strategies of farmers in Umuahia South Local Government Area of Abia State, Nigeria.

Farm Experience

Farm experience had a significant (at 5% level) and negative effect on the level of climate change adaptation. In other words, the level of climate change adaptation of the farmers decreases as their farm experience increases. Farming experience comes with age, but older farmers with more experience are less likely to adopt new innovations because of their inherent risks and uncertainties, compared to younger farmers. This result is in one accord with Ibrahim *et al*. (2011) who reported a negative effect of farm experience on the choice of multiple strategies over non-adaptation, among arable crop farmers in Ogun State.

Membership of Cooperative Societies

The effect of membership of cooperative society on the level of climate change adaptation was positive and significant at 1% level. This implies that the level of effective climate change adaptation of the farmers increased as their membership of cooperative societies increased. Farmers leverage on cooperatives to pool their resources together to take advantages of opportunities or reduce the severity of losses. Through cooperative societies farmers are trained on emerging farm technologies and techniques, and are able to access loans, grants and support from government and development partners. These could not have been possible for individual farmers who are highly resource-poor, considering that the incidence of poverty in Nigeria is highest among agricultural households (Babatunde, 2008; Idowu, 2013; Oti *et al*., 2019a). This result is in concordance with Balew *et al*. (2014), who reported that membership of cooperative society positively affected climate change adaptation among farmers in some regions in Central Ethiopia.

Access to Credit Facilities

The effect of access to credit facilities on the level of climate change adaptation was positive and significant at 10% level, implying that as access to credit facilities increases, farmers' level of climate change adaptation also increased. Finance plays central role in farming operations, especially in climate change adaptation. As such, providing farmers credit facilities in the form of loans and/or grants would enable them to develop better adaptation to climate change. This result is in line with the report of Ibrahim *et al*. (2011), who noted that access to credit facilities increases the probability of farmers in choosing good soil conservation technique over no-adaptation.

Extension Services

Access to extension services had a positive and significant (at 1% level) effect on the level of climate change adaptation. This implies that any increase in access to extension services will lead to a corresponding increase in farmers' level of climate change adaptation. Extension services provide very good medium for informing, educating and transferring of new innovations, ideas and technological breakthroughs to farmers. These technologies have the capacity to enhance farmers' level of climate change adaptation. This result is in tandem with the report of Ibrahim *et al*. (2011), who observed that access to extension services positively affected arable crop farmers' choice of good soil conservation, over non-adaptation in Ogun State, Nigeria.

Access to Healthcare Centre

The effect of access to healthcare centre on the level of climate change adaptation was positive and significant at 10% level. This implies that any increase farmers' level of climate change adaptation will lead to a corresponding increase in their access to health care centre. Increased access to health care centres enhances the health of farmers, as farmers could easily access good medical treatment. Healthy farmers are also wealthy farmers, and as such, will be more equipped to adopt effective climate change adaptation measures.

Occurrence of Natural Disasters

The effect of occurrence of natural disaster on climate change adaptation was positive and significant at 5% level. This implies that the level of climate change adaptation of the farmers increases with increase in the occurrence of natural disasters. The regular occurrence of natural disasters inputs uncommon resolve and determination in farmers to survive. This makes them go all out to adopt measures that will reduce the adverse effects of the natural disasters, thereby enhancing their level of climate change adaptation.

Farm Income

Farm income had a positive and significant (at 1% level) effect on the level of climate change adaptation of the rural farm households. This suggests that any increase in farm income will lead to a corresponding increase in the level of climate change adaptation of the farmers. The primary objective of any farming activity just like any other economic activity is to make money (profit). As such, farmers would likely invest more in climate change adaptation, if they will earn more income from it. This result agrees with Temesgen *et al*. (2014), who reported that farm income had a positive effect on the probability of choosing various climate change adaptation techniques.

Conclusion

Water management was the most effective climate change adaptation measure of the farmers which included water harvesting and storage, prevention of water losses along water bodies, physical irrigation, and construction and maintenance of water paths. Other effective climate change adaptation practices comprised avoidance of bush burning, agro-forestry practices, cultivation of improved-early-maturing-disease-and-drought-resistant crop varieties, changing of planting dates, trading and off-farm employment. These farm practices were 74 percent effective for climate change adaptation. The level of climate change adaptation of the farmers was 64 percent, which was positively affected by the occurrence of natural disasters, farm size, access to healthcare centres, credit facilities and extension

services, membership of cooperative societies and farm income, while the effects of age and farm experience was negative. Therefore, improving the level of climate change adaptation of farmers would require policies that encourage youths' engagement in agricultural production, while enhancing farmers' access to farm size, healthcare centres, credit facilities and membership of cooperatives through extension agencies. Furthermore, there is need for integrated approach that will be geared towards increasing the effectiveness of climate change adaptation practices of farmers. Such an approach would enable the ease of adoption of more effective climate change adaptation practices such as water harvesting and storage, prevention of water losses along water bodies, physical irrigation, construction and maintenance of water paths, avoidance of bush burning, agro-forestry practices, cultivation of improved, early maturing-disease and drought-resistant crop varieties, changing of planting dates, trading and off-farm employment. The implications of these policies on increased agricultural production and productivity in the sub-Saharan African region are enormous, as they will contribute towards improving the livelihood conditions of rural households, which constitute the bulk of the region's populace, majority of whom are predominantly peasant farmers.

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