

## **ADAPTIVE CAPACITY OF SMALLHOLDER FARMERS TO CLIMATE CHANGE: A SUSTAINABLE LIVELIHOOD APPROACH FOR RURAL NIGERIA**

**ODOZI, J.C**

\*Department of Agricultural Economics and Extension, Faculty of Agriculture, Ajayi Crowther University, Oyo, Nigeria  
Correspondence: jc.odozi@acu.edu.ng, 07043932764

### **ABSTRACT**

*Agricultural production in Nigeria and sub-Saharan Africa is generally at the center of multiple risk factors: natural, ecological, climate change, social, and economic. Climate change compounds the problem. Hence, several concepts and frameworks have emerged in the literature to analyze farmers' vulnerability, adaptive capacity, and resilience. The study utilized the Sustainable Livelihood Framework (SLF) to analyze the distribution and determinants of farmers' adaptive capacity. Data were sourced from the National Bureau of Statistics and subjected to a multi-criteria decision and Tobit regression analyses. Access to community infrastructure, asset ownership, social capital, and support from family members were the highly weighted indicators of farmers' adaptive capacity upon which farm households were classified. The results show that, in comparison to the other distribution patterns, rural Nigeria has a disproportionately low adaptive capacity. Male-headed households had poor adaptation ability, whereas farm households associated with urban areas showed moderate adaptive capacity. Nonetheless, compared to households with poor adaptive ability, fewer households have intermediate adaptive capacity. The Tobit Regression showed that the following factors were statistically significant in increasing farmers' adaptive capacity: school feeding program ( $p < 0.01$ ), government economic support programs (N-power) ( $p < 0.05$ ), e-wallet input subsidy ( $p < 0.05$ ), growth enhancement scheme ( $p < 0.05$ ), remittances from overseas ( $p < 0.05$ ), tractor use ( $p < 0.01$ ), and livestock ownership ( $p < 0.01$ ). Years of schooling ( $p < 0.01$ ), farmers' cooperative ( $p < 0.01$ ), and saving cooperative ( $p < 0.01$ ) are other statistically significant factors. However, small farmers' adaptive capacity was reduced by being male headed ( $p < 0.01$ ), utilizing a plough ( $p < 0.01$ ), and losing a household job ( $p < 0.01$ ). The study revealed the structure of farm households' poor adaptive ability in rural Nigeria, and the need for institutional support to increase adaptive capability.*

**Keywords:** *Adaptive capacity, vulnerability, sustainable livelihood, institutional change, climate change.*

### **INTRODUCTION**

Nigeria's agriculture depends on the climate, which raises concerns about how vulnerable the agri-food sector is to climate change. The severity of climate change is predicted for regions such as sub-Saharan Africa, including Nigeria. In such regions, climate change deepens the vulnerability of the agricultural systems, and smallholder farmers are expected to bear the brunt of climate change (AGRA, 2014; Abdul-Razak and Kruse, 2017). The effects on the agricultural

system are directly through temperature and rainfall variability changes, dry spells, late onset of rain, flooding, and drought. Also, indirectly through a reduction in food availability, loss of food, fluctuation of income streams, chronic illness and poor nutrition, death of individuals and livestock, and violent conflict.

The International Panel on Climate Change (IPCC, 2007) defines adaptive capacity as “the ability of a system to adjust to climate

*change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences”*(Parry et al. 2007). The concept of adaptive capacity aligns with Sen’s theory of capability or entitlement. The theory views resource availability, opportunities, and system functionality as essential determinants of a system’s capability (Sen, 1981). It recognizes the influence of broader external factors on individuals’ ability to adapt to climate change (Odozi, 2025). This theory is linked to the adaptive capacity concept with its emphasis on the role of the human system to moderate the potential damage of climate change.

Deepening human capacity to withstand climate change constitutes an important focus in the policy strategies of national and global vulnerability interventions. Issues of adaptive capacity, such as economic cost( Datta and Behera, 2022;Pande and Savenije , 2016), control over resources(Hogarth and Wójcik, 2016; Dixon et al., 2014), access to extension services, and credit facilities (Khanal et al., 2018; Pickson and He, 2021) have been linked to the slow uptake of adaptation strategies. While there is an increased analysis of the uptake of adaptation action in agriculture, such as Climate Smart Agriculture (CSA) technologies, the ability of a household to use these technologies and other climate change mitigation opportunities is less explored empirically.

There are various scales at which the adaptive capacity of agricultural systems can be analyzed. Earlier efforts at the analysis of adaptive capacity focused on the definition of the concepts and the development of frameworks for the cross-country analysis of the issue (Zanmassou et al., 2020). There is a dominant literature that focuses on the country level analysis of adaptive capacity to climate change(see Yohe and Tol, 2002;

Vincent, 2007; Kelly and Adger, 2000; Haddad, 2005; Brooks et al., 2005; Brooks and Adger, 2004; Adger et al., 2004). In Nigeria and elsewhere in Africa, the empirical analysis on adaptive capacity at the household level is scant. A few studies, including Abdul-Razak and Kruse (2017), investigated the adaptive capacity of smallholder farmers to climate change in Northern Ghana. They used primary data and an indicator framework built on multiple dimensions of a farmer’s adaptive capacity to evaluate the nature of the adaptive capacity at the farmer level in the region, which was found to be low.

Related to the empirical analysis of adaptive capacity is the analysis of the vulnerability of a human system. For example, Gbetibouo and Hassan (2010) for South Africa and Madu (2012) for Nigeria examined the issue of vulnerability of households to climate change. These studies ranked states/regions using indicators of vulnerability. The concept of vulnerability views the process of adaptation of a human system as a composite function of exposure, sensitivity, and adaptive capacity, and thus broader. Ojo et al. (2024) identified little work on adaptive capacity analysis. Little attention has been given to the identification and determinants of adaptive capacity at the smallholder farmer level for rural Nigeria. Munthali et al (2025) noted the centrality of the Sustainable Livelihood concept in many of the frameworks of adaptive capacity. The sustainable livelihoods framework (SLF) emphasizes how human behaviour and the environment interact to shape livelihoods and identifies institutions and policies that condition livelihood opportunities (Serrat 2017). While there are many reasons for the paucity of studies on adaptive capacity at the household level, the complexity of the concept of adaptive capacity has been highlighted as critical. The indicators of adaptive capacity are often interrelated, path-

dependent, dynamic, and with varying coping ranges (Smit and Wandel, 2006).

This study aims to assess the adaptive capacity of smallholder farmers using a sustainable livelihood framework. The specific objectives are: first, to determine the relative importance of adaptive capacity indicators; second, to classify households' adaptive capacity using a composite index; and third examine the determinants. This paper is closely related to the strand of literature focusing on the composite analysis of vulnerability or the specific vulnerability issue of adaptive capacity. The study sheds light on the specific attributes of a household with the potential to increase farmers' uptake of adaptation opportunities and increase the adaptive capacity to climate change. It contributes to building smallholder farmers' adaptive capacity as a channel of reducing their vulnerability to climate impacts and enhancing their resilience by enabling adaptation and transformation. The remainder of the article is divided into four sections. A brief methodology is presented in Section 2. Section 3 presents the results and discussion, and Section 4 concludes.

## **METHODOLOGY**

### ***Sources of data***

The paper used secondary data sourced from the National Bureau of Statistics (NBS). The National Living Standard Survey (NLSS) data module collected in 2018 was used. The NLSS data module is collected every 3-5 years in collaboration with the World Bank and has national coverage. The sample size is 22,200 households, and compared with the GHS data set, it is larger but cross-sectional in nature. Since it focuses on tracking the socioeconomic conditions of households in both rural and urban areas of the country, and for the benchmarking of the Sustainable Development Goals, I found it appropriate for this study. Although between 2022 and 2023, a new data set was collected, it was not

available to the public until the tail end of 2025 and thus prevented its use for this paper. Compared to the previous data set collected in 2010, the collection of the data set in 2018 made use of the Computer-Assisted Personal Interviewing (CAPI) devices and is believed to be more accurate since it can eliminate errors and be more efficient in terms of time use.

The data set is structured into household and community modules, each with different files. In the household module, there are files on the socioeconomic and demographic characteristics of households, education, health and basic services, employment, assets, and income. The community module contains files on infrastructure, network groups, prices, and conflict and land. The relevant files from both modules were merged in the Stata application into a unified file for the analysis. The unified file can be disaggregated for rural and urban areas using Stata application commands. The analysis was based on the file for rural areas and the pooled for comparison. The indicators of adaptive capacity selected for the analysis and the associated means and standard deviations are presented in Table 4 in the results and discussion section of the paper. The choice of these indicators was informed by the Sustainable Livelihood framework

### ***Analytical framework***

We used the theory of the Sustainable Livelihood Framework to identify the empirical components and sub-components of an adaptive capacity construct of smallholder farmers in rural Nigeria. The indicators and sub-dimensions are presented in Table 1. In the table, FC denotes financial capital to be constructed on household employment (wage, farm, nonfarm, and unpaid work), productivity (total hours worked), income sources, access to loans, remittances, and asset ownership. PC denotes physical capital consisting of farm assets and

community infrastructure. Human capital is denoted as HC and consists of indicators on education, migration and health. Social capital is denoted by SC and captured by the presence of various social networks in the

community. NC is a natural capital and captured by household access to forests, natural and common sources of water and land access.

**Table 1: Dimensions and Sub-Dimensions of Adaptive Capacity Construct**

<b>Adaptive Capacity Dimensions</b>	<b>Sub-Dimensions</b>
Financial Capital (FC)	Employment, Hours worked/crop income, remittances (ER) Asset ownership (AO) Safety net opportunities from the government and private organization (SOP)
Physical Capital (PC)	Farm Assets (FA) Community Infrastructure (CI)
Human Capital (HC)	Education/migration/Health (HC)
Social Capital (SC)	Number of Network associations (SC)
Natural Capital (NC)	Access to firewood from forest and natural and public water sources (NC)

The adaptive capacity framework is grounded on the theory of Sustainable Livelihood and also correlates with the theory of human capability. The framework views resource availability, opportunities, and system functionality as essential determinants of a smallholder farm's adaptive capacity. Several studies have used the Sustainable Livelihood framework (Babulo et al., 2008; Aulong et al., 2011; Reddy et al., 2004; Eakin, 2008) to identify and select the indicators of adaptive capacity. The framework links the resource attributes of households to their ability to maximize welfare goals and risk minimization within a social and political context.

To address objective one of the papers, which aims to evaluate the relative importance of the indicators, the statistical weighting approach was applied. There are various approaches, but the Factor Component Analysis (FCA) and Principal Component Analysis (PCA) have been commonly used. These statistical approaches also serve as a tool for reducing the number of original indicators to a few indicators. Having identified the indicators theoretically, a range function is used to transform the selected indicators into a uniform scale of 0 to 1<sup>1</sup>. A Cronbach's Alpha reliability test is also used to validate the reliability and internal consistency of the transformed indicators. Table 2 shows Cronbach's Alpha reliability

<sup>1</sup> The aim of the normalization is to guarantee adequate comparison and aggregation between the

resilience indicators by transforming the values of the original variables into 0 to 1 scale.

test of the validity and internal consistency of the indicators for each of the adaptive capacity sub-dimensions. The Cronbach’s Alpha reliability test is satisfactory for Asset ownership sub-dimensions with an alpha of 0.85. This estimate is considered good (Daud et al., 2018). Though Cronbach’s Alpha reliability test for the farm assets sub-dimension is 0.67 and falls short of the 0.7 threshold, it can be considered as satisfactory since it is close to 0.7. The Factor Component

approach through a statistical function is used to generate a vector of weights and is used to evaluate the relative importance of each indicator. The approach also serves as a tool for reducing the number of original indicators to a few indicators. The weights can be used to evaluate the relative importance of the indicators or the substitution between indicators (Greco et al. 2017). In this paper, the weights reflect the relative importance of the indicator.

**Table 2: Alpha Test estimates of Adaptive capacity Dimensions and Sub-Dimensions**

<b>Adaptive Capacity Dimensions/Sub-Dimension</b>	<b>Alpha Test</b>
Asset ownership	0.8543
Employment/productivity, remittances	0.4572
SOP	0.6448
Farm Assets	0.6686
Community Infrastructure	0.7979
Human capital	0.7082
Social Capital	0.7855
Natural Capital	0.464

To address objective two of the paper, which aims to aggregate the weighted indicators into a composite index of adaptive capacity, a generalized family of distance measures by Zelany (1974) was used. The approach defines two points: the “ideal” and the “anti-ideal.” The Ideal is thought to possess the most desirable value of adaptive capacity, and the anti-ideal the worst value. Eakin (2008) suggested the use of 1 as the ideal point. As noted in Eakin (2008), if vulnerability is viewed as anti-ideal, then the level of adaptive capacity can be conceptualized as the distance from the anti-ideal. The greater the distance, the higher the adaptive capacity. The optimal solution is the solution closest to the ideal value.

Formally, given a household *i* characterized by *j* indicators of adaptive capacity and a distance to a reference score denoted as  $d_i$ . Let  $\hat{r}_j$  denote the transformed  $j^{th}$  indicator of  $i^{th}$  household. This is expressed as follows:

$$d_i = \left[ \sum_j w_j^\beta (1 - \hat{r}_{ij})^\beta \right]^{1/\beta} \dots\dots\dots(\text{eq1})$$

Where  $w_j$  is the weight of the  $j^{th}$  indicator, while  $(1 - \hat{r}_{ij})$  is the deviation from the reference score.  $\beta$  is the parameter of substitution between pairs of indicators. Several studies have assumed the constant substitution between pairs of indicators using the parameter  $\beta=1$  (Freudenberg 2003; OECD 2008; Bandura 2008, 2011; Decancq and Lugo, 2013). As noted in Lugo (2007),  $\beta = 1$ , reflects that the constructed composite index is a linear function of the *j* attributes and that the attributes are perfect substitutes, so that low levels of one of the attributes can be perfectly compensated by high levels of another. Many of these indicators are correlated with each other. That is, the deficiency in any one indicator of an adaptive capacity unit is compensated for by a gain in another indicator. For example, social capital

may enhance financial capital, which in turn facilitates investments in new technologies and human capital accumulation.

To address objective three, which is the determinants of adaptive capacity, we used a Tobit regression analysis and not the Ordinary Least Squares regression because of missing information in the sample data, and thus the problem of data sample censoring. “The leading case of censoring is that in which the data are left censored only  $L=0$ ” (Cameron and Trivedi, 2015). That is, there are households with no information on the constructed adaptive capacity. Thus, the Tobit regression is specified as an unobserved latent household adaptive capacity,  $AD^*$  expressed as:

$$AD_i^* = x_i'\beta + \varepsilon_i, i = 1 \dots, N \dots\dots\dots(\text{eq2})$$

Where  $AD_i^*$  denote the latent unobserved adaptive capacity status of a household  $i$  until some known constant threshold, denoted by  $L$ , is exceeded. In which case  $AD_i^*$  is

observed when  $AD_i^* > L$ , then a household with no adaptive capacity information is interpreted as left censored with information equal to zero when  $AD_i^* \leq L$ . Since  $AD_i^*$  is unobserved, it is impossible to estimate  $(\beta, \sigma^2)$  by OLS in the usual way (Cameron and Trivedi, 2015). Hence, the Tobit model is more appropriate compared to OLS.  $\varepsilon_i \sim N(\beta, \sigma^2)$ , and  $x_i$  denote the  $(K \times 1)$  vector of the determinants of adaptive capacity that is fully observed.

The observed  $AD_i$  for household  $i$  is related to the latent  $AD_i^*$  through the observation rule:

$$AD_i = \begin{cases} 1 & \text{if } AD_i^* > 0 \\ 0 & \text{if } AD_i^* \leq 0 \end{cases} \dots\dots\dots(\text{eq3})$$

The dependent variables are denoted by  $AD_i$  consists of the adaptive capacity level of a household  $i$ . Adaptive capacity of a household  $i$  is hypothesized to be influenced by the following factors, independent variables:

**Table 3: Hypothesized factors influencing the adaptive capacity of a farmer**

Symbol	Variables	Nature
X1	Gender	Dummy: male=1, female=0
X2	Migrant household member	Dummy
X3	Ever attended School	Dummy
X4	Employed	Dummy
X5	Remittances(abroad)	Dummy
X6	Access to loan	Dummy
X7	Land access	Dummy
X8	Use of inorganic fertilizer	Dummy
X9	Use of tractor	Dummy
X10	Use of plough	Dummy
X11	Ownership of livestock	Dummy
X12	Ownership of smart phone	Dummy
X13	Loss of job	Dummy
X14	N-power support	Dummy
X15	School feeding programme	Dummy
X16	Growth enhancement scheme	Dummy
X17	E-wallet input subsidy programme	Dummy

<b>X18</b>	Saving credit association	Dummy
<b>X19</b>	Farm cooperative	Dummy
<b>X20</b>	Age in years	Continuous
<b>X21</b>	Years lived in the community	Continuous
<b>X22</b>	Years of schooling	Continuous
<b>X23</b>	Total hours worked	Continuous

**RESULTS AND DISCUSSION**

**Descriptive Statistics of the selected indicators**

Table 4 presents the summary statistics of the indicators of the various sub-dimensions. The summary statistics include the mean, standard deviation, and uniqueness of the

indicators. The uniqueness parameter of the indicators measures the proportion of the variance not shared but unique to the indicator. It also reflects the indicator's communality since both proportions sum to one.

**Table 4. Summary statistics of selected indicators**

	Indicators	Mean	SD	Uniq
<b>X1</b>	Sofa	0.264	0.441	0.718
<b>X2</b>	Gas cooker	0.077	0.266	0.73
<b>X3</b>	Fridge	0.152	0.359	0.606
<b>X4</b>	Freezer	0.072	0.259	0.714
<b>X5</b>	Generator	0.206	0.405	0.626
<b>X6</b>	Fan	0.378	0.485	0.45
<b>X7</b>	Iron	0.329	0.47	0.543
<b>X8</b>	TV set	0.384	0.486	0.384
<b>X9</b>	DVD player	0.287	0.452	0.511
<b>X10</b>	Satellite dish	0.119	0.324	0.604
<b>X11</b>	Smart phones	0.236	0.424	0.67
<b>X12</b>	Received cash from an institution	0.021	0.143	0.584
<b>X13</b>	Received food assistance	0.164	0.37	0.314
<b>X14</b>	Received assistance in kind	0.013	0.115	0.77
<b>X15</b>	Assistance from the school feeding program	0.788	0.409	0.17
<b>X16</b>	Assistance from the state government	0.064	0.245	0.856
<b>X17</b>	Assistance from a religious body	0.054	0.226	0.842
<b>X18</b>	Assistance from an NGO	0.063	0.243	0.853
<b>X19</b>	Employment	0.428	0.495	0.4
<b>X20</b>	workers' productivity (hours worked)	0.11	0.141	0.404
<b>X21</b>	Use plough	0.395	0.489	0.621
<b>X22</b>	Own cattle	0.298	0.457	0.718
<b>X23</b>	Own sheep	0.408	0.491	0.66
<b>X24</b>	Distance to private hospital	0.025	0.07	0.003
<b>X25</b>	Distance to private clinic	0.01	0.071	0.005
<b>X26</b>	Distance to a private doctor	0.028	0.082	0.004
<b>X27</b>	Distance to midwife	0.004	0.032	0.015

<b>X28</b>	Distance to a dentist	0.055	0.114	0.006
<b>X29</b>	Distance to a pharmacy	0.006	0.031	0.004
<b>X30</b>	Distance to post office	0.034	0.075	0.008
<b>X31</b>	Distance to main access	0.004	0.044	0.014
<b>X32</b>	Distance to a formal bank	0.018	0.045	0.003
<b>X33</b>	Distance to microfinance	0.014	0.041	0.016
<b>X34</b>	Distance to a fire station	0.043	0.108	0.023
<b>X35</b>	Able to read and write English	0.453	0.498	0.462
<b>X36</b>	Able to read and write Nigerian language	0.384	0.486	0.635
<b>X37</b>	Ever attended school	0.788	0.409	0.393
<b>X38</b>	Days suffered illness	0.368	0.303	0.181
<b>X39</b>	Presence of village development committee	0.672	0.469	0.73
<b>X40</b>	Business association	0.405	0.491	0.721
<b>X41</b>	Women's group	0.69	0.463	0.678
<b>X42</b>	Youth group	0.858	0.349	0.774
<b>X43</b>	Political group	0.842	0.365	0.875
<b>X44</b>	Health committee	0.44	0.496	0.639
<b>X45</b>	school committee	0.541	0.498	0.745
<b>X46</b>	Prent-teacher association	0.768	0.422	0.697
<b>X47</b>	Community policy watch	0.738	0.44	0.793
<b>X48</b>	collect firewood and other natural products	0.237	0.425	0.7119
<b>X49</b>	fetch water from natural and public sources	0.4357	0.4958	0.7787
<b>X50</b>	Land access	0.7849	0.41087	0.9157

Table 5 presents the summarised indicator weights across the various sub-dimensions. The indicators in each of the sub-dimensions explained at least 70% of the variability in the original indicators and satisfied the Kaiser Criterion of a variance equal to or greater than (Filmer and Pritchett, 2001). From the table, the first linear principal factor component predicts community infrastructure (0.317), human capital (0.088), employment/productivity/remittances (0.045), and asset ownership (0.201) as relatively important adaptive capacity indicators across farm households. The others are farm assets (0.05), Assistance received by households (0.117), and social capital (0.132). The implication of these estimates is that access to community infrastructure, asset ownership, social capital

and assistance received by households are the key components determining differences in farmers adaptive capacity. Combining all indicator values and their corresponding weights, composite indices for each of the sub-dimensions were generated, and the overall. Some studies have gone ahead to classify the index into low, moderate, and high levels of adaptive capacity. Other studies have used the fuzzy set to classify the index. While we are not able to use the fuzzy set for this paper, we converted the composite adaptive capacity index into a fuzzified ordinal value between 0 and 1 using the stata egen cut function. This allowed the ranking of households into four categories of adaptive capacity groups: (1) Lowest, (2) Low, (3) Moderate, and (4) High.

**Table 5: Summary of Weights, Eigen Values of Indicators Sub-Dimensions.**

<b>Adaptive Capacity Dimensions/Sub-Dimension</b>	<b>Weights</b>	<b>Alpha Test</b>	<b>Eigen</b>	<b>%</b>	<b>No. of indicators</b>
<b>Asset ownership</b>	0.201	0.854	6.67	75	36
<b>Employment/productivity, remittances</b>	0.045	0.457	1.47	72	10
<b>Assistance received by households</b>	0.117	0.645	2.82	43	17
<b>Farm Assets</b>	0.050	0.669	1.96	86	15
<b>Community Infrastructure</b>	0.317	0.798	10.9	70	16
<b>Human capital</b>	0.088	0.708	2.42	72	12
<b>Social Capital</b>	0.132	0.786	3.1	91	12
<b>Natural Capital</b>	0.038	0.812	0.59	1.75	3

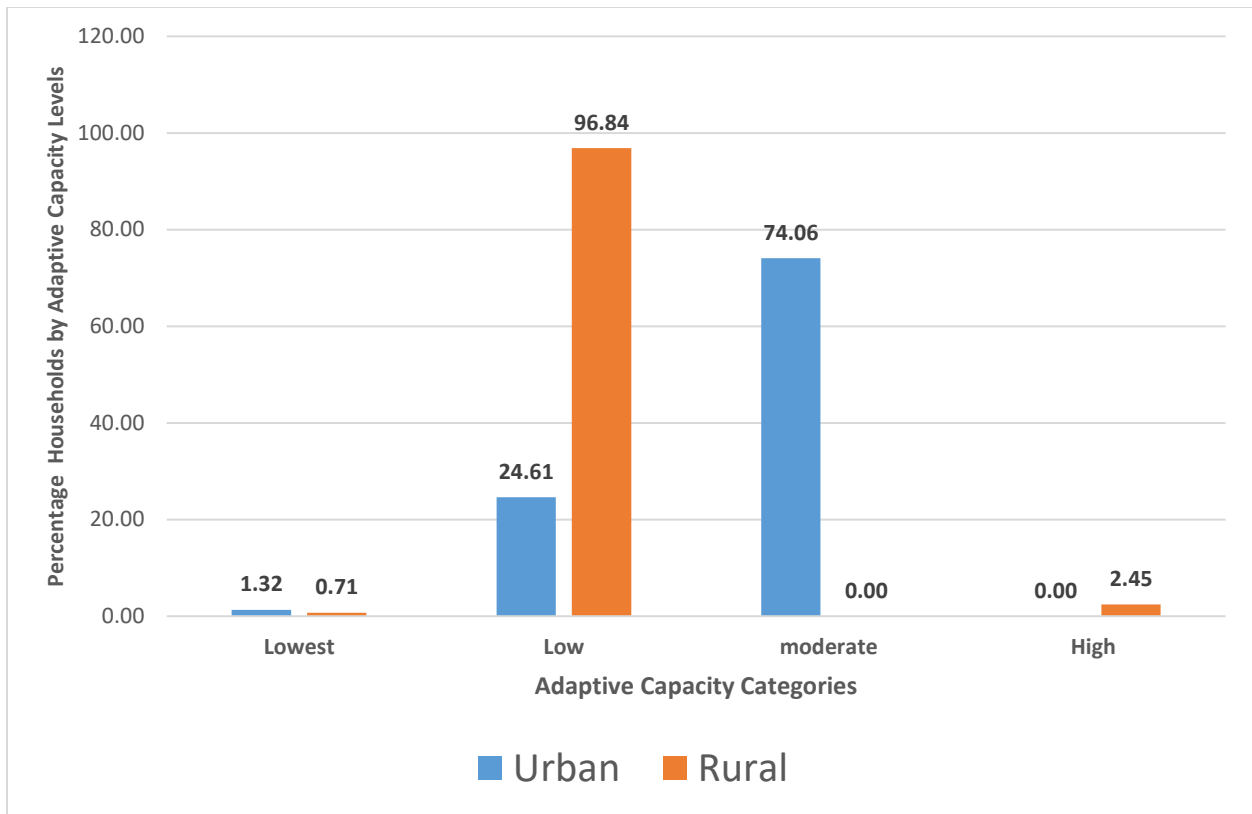
***Percentage Distribution of Households Across Adaptive Capacity Categories***

Figure 1 shows the distribution of farm households in percentage by rural and urban sub-populations and across categories of adaptive capacity. The four categories of adaptive capacity are (1) Lowest, (2) Low, (3) Moderate, and (4) High. We converted the composite adaptive capacity index into ordinal value between 0 and 1 using the stata egen cut function. Based on this, farm households were ranked into four categories of adaptive capacity. From Figure 1, 96.8% of households in the rural sub-population have low adaptive capacity. Compared to the rural subpopulation, 72.06% of households located in the urban subpopulation, which are farmers, have moderate adaptive capacity. Farm households with high adaptive capacity, whether located in rural or urban areas, are insignificant.

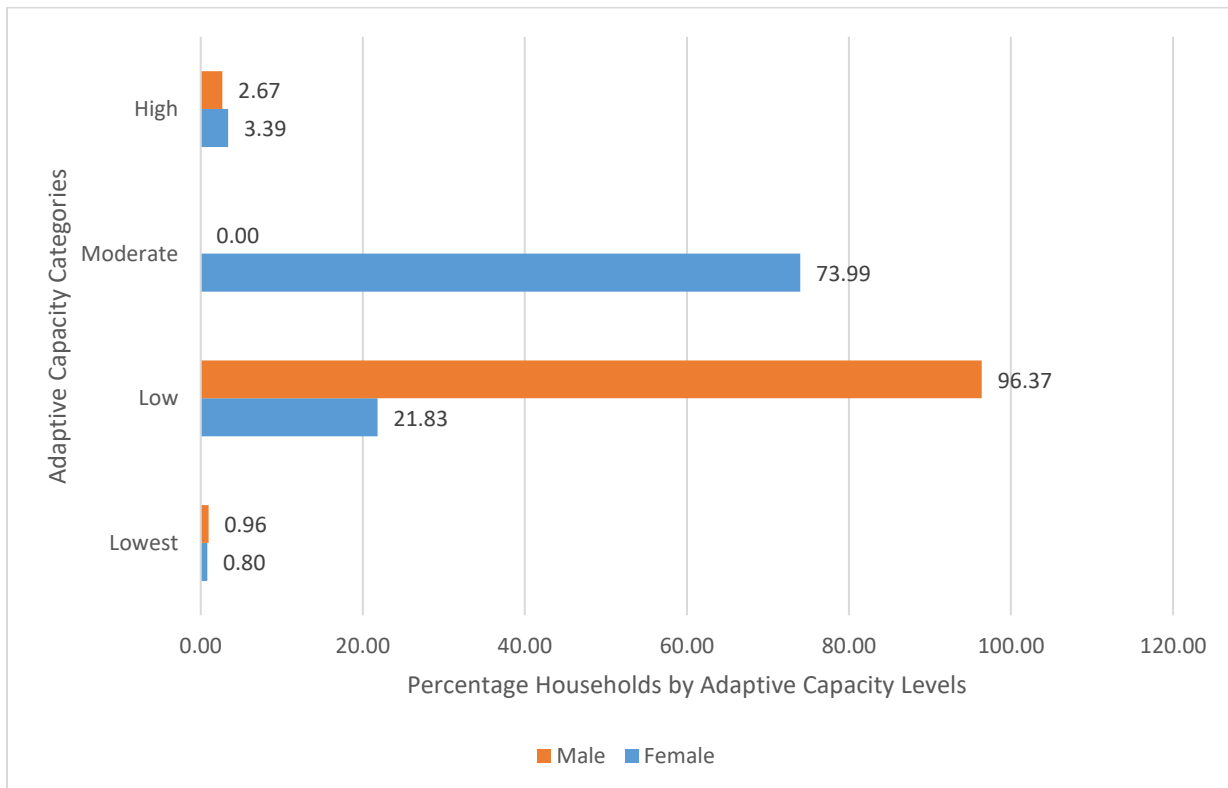
Figure 2 shows the percentage distribution of households by gender and across the four

adaptive capacity categories. From the figure, 96.7% of the male-headed sub-population have low adaptive capacity compared to the female-headed subpopulation, with a lower percentage of households, but with a higher percentage estimated at 74% having moderate adaptive capacity.

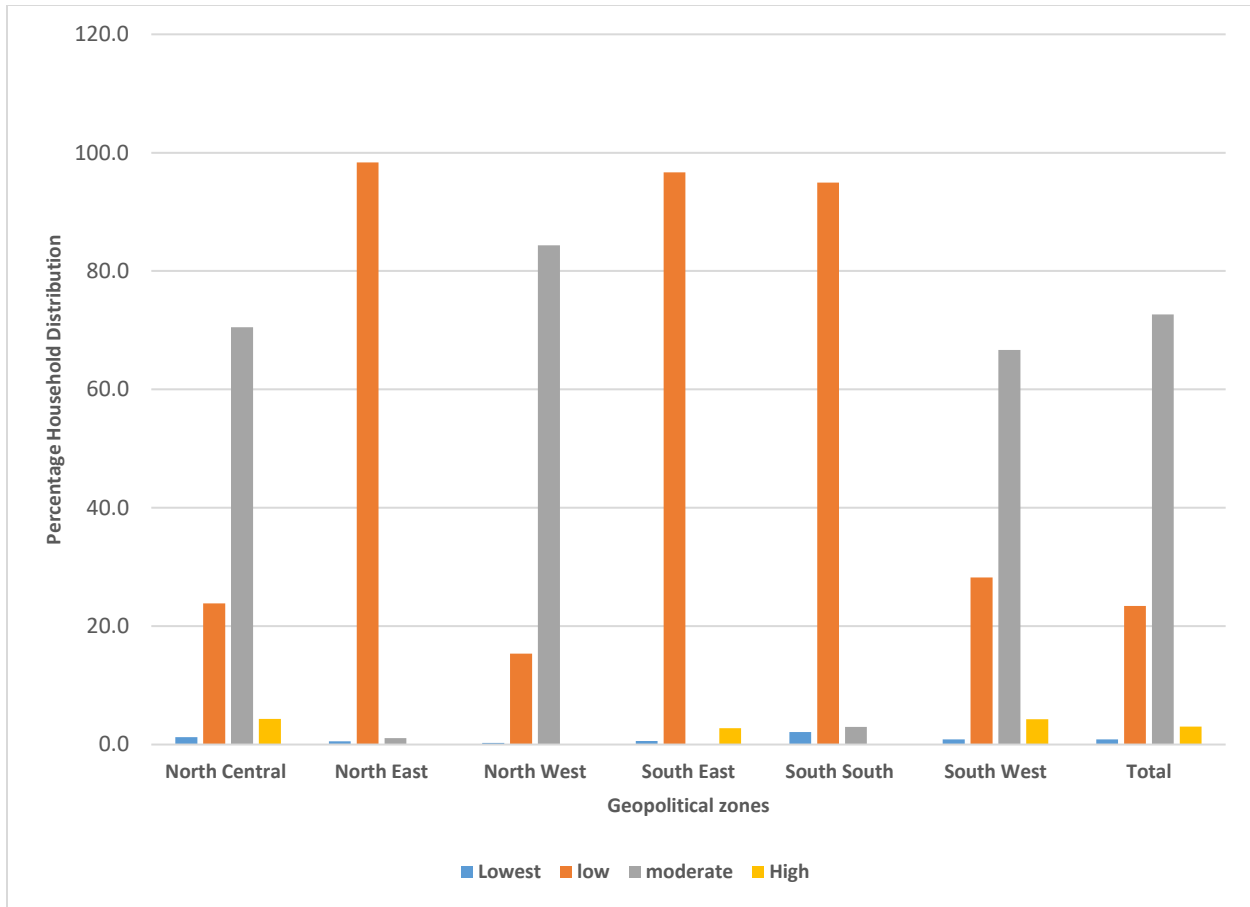
Figure 3 shows the percentage distribution of households by their adaptive capacity levels and across the six geopolitical zones. From the figure, households in the Northeast, Southeast, and South South geopolitical zones have a larger percentage of households with low adaptive capacity compared to the percentage of households in the Northwest, Northcentral, and Southwest. The importance of index analysis and the ranking of households based on the index is well recognized in the literature (Eakin, 2008). Such estimates are essential policy input for vulnerability programming for different groups based on their adaptive capacity levels



**Fig 1: Percentage Distribution of Households across Adaptive capacity groups**



**Figure 2: Distribution of households by gender and sector across Adaptive capacity groups**



**Figure 3: Percentage Distribution of households by Adaptive capacity groups and across geopolitical zones**

***Tobit Regression Analysis of Adaptive Capacity Determinants.***

Table 6 presents the Tobit regression analysis of the factors likely to influence the constructed farm household adaptive capacity. Employment was significant for farm households located in urban areas( $p < 0.01$ ) and male-headed households( $p < 0.1$ ) and was found to increase adaptive capacity. Remittances from abroad were significant for rural households ( $p < 0.05$ ) and female-headed households ( $p < 0.1$ ). Access to loans was significant for households located in urban areas ( $p < 0.1$ ). The loss of a household job reduced adaptive

capacity for both rural( $p < 0.5$ ) and urban( $p < 0.01$ ) households. Government economic support programmes (N-power, school feeding programme, Growth Enhancement Scheme, and E-wallet input subsidy) contributed to increasing farmers' adaptive capacity. Years of schooling, particularly for rural( $p < 0.01$ ) and female-headed( $p < 0.01$ ) households, were significant. Years lived in the community for urban households was significant( $p < 0.01$ ) and for a female-headed household( $p < 0.01$ ). Other variables found to be significant were age and belonging to farmers' and saving cooperatives

**Table 6: Regression analysis**

	<b>Urban</b>	<b>Rural</b>	<b>FEMALE</b>	<b>MALE</b>	<b>Pooled</b>
<b>Household Characteristics</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>
<b>Gender (male=1, female=0)</b>		-0.00770***			- 0.00873** *
		(0.00292)			(0.00283)
<b>employment</b>	0.0327*** (0.0110)			0.0114* (0.00588)	
<b>Remittances (Abroad)</b>		0.0362** (0.0171)	0.0467* (0.0246)		0.0350** (0.0163)
<b>Access to a loan</b>	0.0138* (0.00821)				
<b>Use of Tractor</b>		0.0404*** (0.00601)	0.0327*** (0.00746)	0.0305** * (0.00807)	0.0322*** (0.00548)
<b>Use of the plough</b>	0.0521*** (0.00999)	-0.0276*** (0.00325)	- (0.00433)	- (0.00473)	-0.0175*** (0.00318)
<b>Ownership of livestock</b>		0.0403*** (0.00331)	0.0298*** (0.00426)	0.0391** * (0.00462)	0.0341*** (0.00314)
<b>Loss of job</b>	- 0.0671*** (0.0140)	-0.0134** (0.00583)			
<b>N-POWER support</b>		0.0762*** (0.0193)	0.0589** (0.0252)	0.0565** (0.0236)	0.0568*** (0.0172)
<b>School feeding support</b>		0.0144*** (0.00336)	0.0131*** (0.00432)	0.0139** * (0.00477)	0.0135*** (0.00320)
<b>Growth enhancement s</b>		0.0440*** (0.0159)	0.0405* (0.0237)		0.0331** (0.0151)
<b>E-wallet input subsidy</b>		0.0418*** (0.0156)	0.0341* (0.0192)		0.0297** (0.0132)
<b>Savings/credit cooperative</b>	0.0365*** (0.00880)	0.00919** (0.00378)			
<b>farmer cooperative</b>	0.0638*** (0.00886)	0.0194*** (0.00304)	0.0232*** (0.00398)	0.0276** * (0.00440)	0.0251*** (0.00295)
<b>age</b>			0.000278* * (0.000115)		

<b>Years lived in the community</b>	0.000325* ** (0.000117)		0.000108* * (5.17e-05)		
<b>years of schooling</b>		0.000852** * (0.000286)	0.00130** * (0.000400)		0.000705* * (0.000277)
<b>Constant</b>	0.563*** (0.0221)	0.528*** (0.00760)	0.605*** (0.0135)	0.636*** (0.0153)	0.622*** (0.00990)
<b>Observations</b>	628	3,410	2,236	1,802	4,038

Standard errors in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**CONCLUSION**

The need to enhance human capability in addressing climate change within agricultural systems is at the forefront of rural vulnerability programming. Three objectives were addressed: (1) to determine the relative importance of adaptive capacity indicators; (2) to classify households’ adaptive capacity using a composite index; and (3) to examine the determinants. From the analysis, we found that access to community infrastructure, asset ownership, social capital, and assistance received by households were highly weighted by farm households as key indicators of adaptive capacity. We found disproportionately low adaptive capacity for rural Nigeria when compared to the other distribution types. Farm households linked to urban areas had moderate adaptive capacity, but households headed by males had low adaptive capacity. However, there are fewer households with moderate adaptive capacity than those with low adaptive capacity. From the Tobit regression analysis, several factors were found to influence a farmer's adaptive capacity. Factors such as employment and being a male-headed household increased adaptive capacity. Other factors include government support programmes and years of schooling. Factors that reduced adaptive capacity include loss of a job.

This paper raises the importance of increasing farmers’ educational years,

supportive government through farmers' support, farmers' cooperative society, and the availability of credit as important policy instruments for increasing farmers' adaptive capacity in rural Nigeria. It is argued that institutions exert a significant effect on the choices individuals, households, and smallholder farmers make. Institutional deficiencies, such as a lack of support mechanisms, poor functioning markets, and poor or inadequate infrastructure, frustrate farmers’ efforts to access appropriate resources and may significantly limit the ability of a system to cope with the effects of climate change and wider development pressures.

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