

**Resilience Capacity of Farmers in Sub-Saharan Africa: A Case Study of Rice Farmers in
Ogun and Niger States, Nigeria**

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1. Introduction: The Vulnerability of Food Production Systems in Africa.

Food production in Sub Saharan Africa faces challenges of which climate change is major. Being a global environmental threat of this century, the Inter-Government Panel on Climate Change estimated that if the current emissions rate of greenhouse gasses (GHGs) continues, the present warming levels are likely to reach 1.5°C between 2030 and 2052 –additional warming of 0.5°C (IPCC., 2018). This particularly is a point of concern as extreme weather events can negatively impact crop production (IPCC., 2018) . Some critical challenges that agriculture has been forecast to face under climate changes are already obvious. They comprise drought, deforestation, flooding, desertification, sea-level rise, erosion, heat stress, pests and diseases, erratic rainfall patterns, and land degradation (Ayinde *et al.*, 2013). This phenomenon is severely felt in Sub Saharan Africa, where people rely directly on the rain for their foods and livelihoods in agriculture and related vocations (Olayide *et al.*, 2018). The role of agriculture in Africa cannot be overemphasized. It plays a prominent role in transforming rural livelihood and helps in boosting economic growth. The level of dependence on agriculture will continue to soar, because the sector has massive impact on the economic growth and development as well as livelihoods. However, increasingly exposing these developing economies to climate change without mitigating actions can be detrimental to development. In return, these countries, mostly African countries South of the Sahara (SSA) will lose substantial amounts of their GDP to recurring shocks such as landslides, droughts, disease outbreak, epidemics, flood and other shocks (Boka, 2017). In response to these risks and shocks induced by climate, there is growing interest in assessing and building resilience in vulnerable households, communities and economies. Many development and humanitarian actors, resilient households and communities have been identified as those that are work efficiently to get themselves out of poverty, despite the various challenges they may face (Oxfam, 2013). This review considers resilience in the context of farming systems with a focus on small holder farmers with a case study of rural rice farmers in Nigeria.

1.2 The Theory of Resilience

The term “resilience” is defined by the Resilience Measurement Technical Working Group (RM-TWG) as “a capacity that ensures stressors and shocks do not have long-lasting adverse development consequences” (RM-TWG, 2014). Natural and social systems can cope, absorb stresses or shocks, and recover or “bounce back” from climate-related variations. This is termed

climate resilience (FMARD., 2015). The Resilience Alliance explains that resilience applies to the interaction between nature and man, in three manners: (1) the level of disruption a system can allow and still maintain its original state or sphere of attraction; (2) the level to which a system is able to organize itself against the lack of self-organization or those enforced by external forces and (3) the level to which the system can develop and rise their adaptation capacity. In the light of this, resilience is a state that a system can attain within set restrictions. Therefore, once a certain level or threshold is attained, alteration would be required to get a new level of resilience. The concept of going out of a threshold is therefore critical in working towards the improved livelihood and socio-ecological well-being. (Walker *et al.*, 2006).

Subsequently, according to the United Nations Office for Disaster Risk Reduction (UNISDR 2009), resilience is defined as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner by resisting or changing to reach and maintain an acceptable level of functioning and structure”. Also, the Intergovernmental Panel on Climate Change (IPCC) defined resilience as “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change” (Field *et al.*, 2012).

The United States Agency for International Development (USAID) in its framework viewed resilience in the face of recurrent crisis as the ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth (USAID 2012). Similarly, the UK’s Department for International Development (DFID) had the working definition of Disaster Resilience “as the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses—such as earthquakes, drought or violent conflict—without compromising their long-term prospects” (DFID., 2011).

2. Resilience Measurement Approaches

2.1 The United States Agency for International Development (USAID) Resilience Framework

The United States Agency for International Development (USAID) applies the concept of resilience to different of the system in which USAID operates such as areas where lingering poverty matches with shocks and stresses that affects development. USAID recommends developing more adaptive capacity and increasing the ability to effectively and swiftly respond to the new situation and improving the ability to reduce and manage risks. This framework is also applicable to the formulation of policy and programme that are intended to increase adaptive capacity, improved ability to address and reduce risk and ultimately improve the socioeconomic situations of vulnerable populations. This framework clarifies some major constituents, which are planned to deliver for an extensive frame of reference to consider in the development of needs-specific strategies. Its efforts are focused on building resilience in areas, with low capacity to manage shocks. It also prioritizes four main areas: preparedness, mitigation, prevention, and protection (USAID, 2011). The USAID framework employs a multidimensional consideration of the various resilience components and therefore makes it espoused to policymakers; however, from the standpoint of improved livelihood and reduced poverty of households and sustainable development in communities, there is a weak capacity to transform and safeguard the bouncing back better property of a resilience framework (Boka, 2017).

2.2 The Department for International Development (DFID) Resilience Framework.

The framework highlights the dimension of adaptive capacity in resilience programming. It considers capacity as the ability of the system or process to manage stress and shocks based on exposure, sensitivity and adaptive capacity levels. In this case, adaptive capacity and sensitivity are measured by the pool of assets and resources that can be amassed in the face of shocks and stresses. Such assets and resources can be social, human, technological, physical, economic, financial, environmental, natural, and political (DFID., 2012). Generally, the framework is based on a sustainable livelihood framework that targets vulnerability directly. It is, however, clear that the framework limits resilience to the definitional opposition of vulnerability, as it does not include all the major resilience dimensions.

2.3 The European Union (EU) Resilience Framework

The European Union's has a resilience development programme based in Ethiopia, East Africa. The programme, named (RESET) establish its resilience framework on the evidence that societal crisis such as food insecurity, are largely, howbeit not only triggered by environmental challenges like drought are best approached using a long-term resilience plan that connects development actions with human needs and not through a short-term plan that is mostly reactive and are not connected to development actions (Boka, 2017). This framework is hinged on four major pillars developing resilience: these include increasing the delivery of fundamental c services such as clean water, sanitation, quality healthcare and nutrition, etc.); It is designed to address chronic food insecurity by intervening through many sectors. It is also more relevant to the African content because it encompasses many sectors that are of paramount concerns such as health - water, sanitation and hygiene (WASH); nutrition; livelihoods; and NRM and more—make it relevant to building resilience. There should also be strong support for the livelihood and necessary safety net and ,reducing the incidence of disaster. Each pillar is complement the other as guard against the indiscriminate use of resources through effective natural resource management, climate change adaptation, sustainable land management, and social protection through an integrated approach strategy that allows different stakeholders come up with an integrated approach for a resilience that cuts across different sectors. In this framework, areas are grouped localities and are selected based on the evidence of their vulnerability (Boka, 2017). The limitation of this framework, however, is that it does not focus on helping households build back better livelihood after climate change-induced shocks and stress.

2.4 The Food and Agricultural Organization of the United Nations (FAO) Resilience Framework

The Food and Agricultural Organization of the United Nations (FAO) has identified these principles as pillars to be constructed in the instrument to compute the resilience capacity index (RCI) of the Resilience Index Measurement Analysis (RIMA). They are Assets (AST), Access to Basic Services (ABS), Adaptive Capacity (AC) and Social Safety Nets (SSN). ABS show the ability of a household to meet basic needs, by accessing and effectively using basic services, such as sending children to school; accessing water, electricity and sanitation; selling products at the market (FAO, 2017). AST are the essential livelihood elements that supports households to

produce and consume goods, they can be both productive and non-productive assets. Example of productive assets are land and the agricultural equipment while non-agricultural assets include monetary value of things like houses and the available appliances. (FAO, 2017). SSN is a substitute of the ability of the household to get assistance either formal or informal from institutions, friends, family etc. (FAO, 2017). AC explains the ability to acclimate to a new conditions and build new livelihood methods. . For instance, proxies of the AC are the average years of education of household members and the household perception of the decision-making process of their community (FAO, 2017).

Literature suggests that the impacts of climate change are likely to be more severe in sub-Saharan Africa and other developing countries that depend on climate-dependent sectors like agriculture and fisheries. These economies are characterized with low gross domestic products (GDP); high poverty levels, high illiteracy, and low human, economic, financial and institutional capacities (Madu, 2012). The characteristics of these developing countries and societies make them vulnerable to shocks attributed to climate change and also difficult to get back out of the shocks. This suggests that developing countries' vulnerability to the impacts of climate change which does not only rely on the scale of climatic shocks and stress but also on the ability of affected societies to adapt to or cope with such disruptions (Boka, 2017).

3. Case Study of Rice Farmers in Nigeria

The case of the resilience of rice smallholder farming households in Nigeria is considered in this paper by considering an effort at measuring the resilience capacity index (RCI) of the farmers in two Nigerian states. Using the Resilience Index Measurement Analysis (RIMA) of the Food and Agriculture Organization of the United Nations (FAO., 2016) and an analytical framework, datasets from the General Household Survey (World Bank., 2015), this study quantifies through factorial analysis, the pillars that are computed from variables derived from the GHS data. These pillars, called resilience pillars are thereafter fed into the model that is used to determine the Resilience Capacity Index (RCI) through a structural equation model (SEM). It also highlights factors affecting the RCI of farming households in Niger and Ogun States, Nigeria.

3.1 Study area

Niger State is one of the six states in North Central Nigeria, with a population estimate of 5.6 million (NBS., 2017) Created in 1976 with its capital in Minna, it is located between latitudes 8°20'N and 11°30'N and longitudes 3°30'E and 7°20'E, and currently covers a total land area of 76,000 square kilometers (about 9 per cent of Nigeria's total land area). It the largest state in the country and agriculture is the backbone of the economy. In 2017, Niger state is the largest rice-producing state (closely followed by Kaduna with 241,300 metric tonnes) in North-Central Nigeria produced 306,100 metric tonnes of rice (KPMG., 2019).

Ogun State is in South Western Nigeria with its capital in Abeokuta, its largest city. It was created in February 1976 from the former Western State with borders with Lagos State to the south, Oyo and Osun state to the north, Ondo to the east and the Republic of Benin to the west. The state has a population of 5.2 million [16] and is located between latitudes 6°11'N and 8°30'N and longitudes 2°00'E and 5°20'E. It has 16,432 square kilometres of land, 80% of which is arable and is popularly known for growing crops such as rice which is grown mostly exclusively in the state producing 7,700 metric tonnes of it in 2018 making it the second-largest rice producing state in South West Nigeria (after Ekiti with 11, 100 metric tonnes) in the same year (KPMG., 2019).

3.2 Data

From the General Household Survey dataset, the following variables were extracted for analysis: level of education of the households and household heads; labour variables: like dependency ratio and independency ratio; land owned, tropical livestock unit, agricultural asset index, household asset index, electricity, housing index, sex of household head, age of household head, scholarships, remittances, household dietary diversity score, and monthly food expenditure.

For this study, data were extracted from the General Household Survey (GHS) Data Waves 1 (2010), 2 (2012) and 3 (2015) (World Bank, 2015). The GHS sample is comprised of 60 Primary Sampling Units (PSUs) or Enumeration Areas (EAs) chosen from the Federal Capital Territory and each of the 36 states in Nigeria. This results in a total of 2,220 EAs nationally. Each EA contributes 10 households to the GHS sample, resulting in a sample size of 22,200 households that is representative at the state level and for rural and urban households. Out of this, in the GHS, 5000 households were selected for the General Household Survey using a two-stage probability sampling technique:

1. Stage 1: A total of 500 EAs were selected using this method. The selection of EAs was conducted, using probability proportional to size (PPS) of the total EAs in the thirty-six state and the Federal Capital Territory. (FCT), Abuja, and the total households listed in those EAs.
1. Stage 2: Selection of household was carried out during the second stage using a random selection technique to select ten (10) households per EA. This involved using some mathematical calculations to get the total number of households listed in a particular EA and then calculating a Sampling Interval (S.I) by dividing the total households listed by ten (10). The next step was to generate a random start 'r' from the table of random numbers which stands as the 1st selection. Consecutive selection of households was obtained by adding the sampling interval to the random start (NBS., 2017).

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3.3 Analytical Procedure

The RIMA approach used for this study is based on a two-step procedure. First, factor analysis is performed to estimate the four resilience pillars: ABS, AST, SSN and AC using observed variables from the GHS data. To achieve this, the following points were noted:

1. Variables under each pillar should go in the same direction. As such, we consider going up as good and going down, as bad.
2. Before the factor analysis was performed, the correlation between the variables for each pillar was analyzed to detect the nature of the relationship possible; positive or negative. We used variables with a positive correlation relationship of less than 0.85 to construct the pillars.
3. After running the factor analysis, we kept the factors up to 96% uniqueness. We kept the factors to explain almost all of the variance in the model using Bartlett's method.

After this, the RCI is estimated from the pillars, while taking into account food security indicators using the Multiple Indicators Multiple Causes (MIMIC) model (FAO., 2016). Following Buehn and Schneider (Buehn *et al.*, 2008), the mathematical representation for the structural equation model is:

$$y = \lambda\eta + \epsilon \dots\dots\dots (1)$$

where λ represents the magnitude of the expected change of indicator for a unit change in the latent variable η and ϵ is the shared variance unaccounted for by the indicators. y refers to indicators (food security indicators) of the latent variable η (resilience capacity index RCI), γ is the coefficient of η .

The latent variable η was calculated as:

$$\eta = \gamma x_k + \zeta \dots\dots\dots (2)$$

where γ is the vector of coefficients in the structural model describing the relationships between resilience and the predictor variables, (x_1, x_2, \dots, x_k) are the predictor variables of η , and ζ represents error; the shared variance between the outcomes not accounted for by the formative indicators.

Equation (1) states that y values are congeneric measures of η (*i.e., they* measure the same construct). The basic predictor variables within this study's structural model were Access to Basic Services (ABS), Asset (AST), Social Safety Nets (SSN), and Adaptive Capacity (AC).

$$[\eta] = [\beta_1, \beta_2] \times ABS\ AST\ SSN\ AC + [\varepsilon_1, \varepsilon_2] \dots \dots \dots (3)$$

In explaining the above, in the formative model, the hypothesis is that resilience (η) is influenced by the pillars ABS, AST, SSN and AC (FAO., 2016; 2017) The beta values are the coefficients in the structural model. Each variable has a potential effect on the latent variable, and the coefficient describes the influence of the variables on the latent one. Correlation and measurement of formative index are assumed. In the reflective part, the model's reflective indicator errors (ε) are correlated and assumed to contain measurement errors. The model permits simultaneous estimation of the measurement model and the incorporation of causal variables in the structural model for the latent variable, which is linearly determined (apart from random errors, ε_1) by formative indicators or pillars, and resilience determines the observed reflective indicators (apart from random errors, $\varepsilon_2, \varepsilon_3$) (FAO., 2017).

A minimum-maximum scaling was used to transform the pillars (ABS, SSN, AST, and AC) and RCI value into a standardized index, ranging between 0 and 100. The analysis was done using Stata statistical software.

3.4 Descriptions of Resilience Pillars

3.4.1 Access to Basic Services

In the study area, Access to Basic Services (ABS) was observed in the study area to be generally low showing 18.952 and 25.703 for Niger and Ogun states respectively in 2010; 7.121 and 21.954 for Niger and Ogun states respectively in 2012 and 8.438 and 27.465 for Niger and Ogun states respectively in 2015. In 2012, the average value was much lower (12.810) than the others at 28.086 in 2015 and 21.513 in 2010. The values observed for Niger state were lower than Ogun's in all three years.

3.4.2 Social Safety Nets

Social Safety Nets (SSN) in the study area showed an interesting trend in the study area. The analysis showed a 46.499 average for the study area in 2010 with 46.471 and 46.503 for Niger and Ogun States respectively. In 2012, the value dropped to 7.471 at 6.045 and 6.723 for Niger and Ogun states respectively. Interestingly, no result is recorded in Niger state for the 2015 data and Ogun showed a record of 0.677. SSN represents the ability of the household to access formal and informal assistance in form of transfers from institutions, as well as from relatives and friends

(Abdulai *et al.*, 2001). To compute this for this study, remittances and scholarships values are used. The large decline in values observed in 2012 and 2015 in relation to the 2010 figures could be attributed to the large decline in the remittances and scholarship recorded for these states in the dataset used during the affected years.

3.4.3 Assets

In 2010, the mean Asset (AST) index in the study area was 1.881 at 2.924 and 0.175 for Niger and Ogun states respectively; 0.789 in 2012 at 1.090 and 0.307 for Niger and Ogun states respectively and 1.314 in 2015 at 1.897 and 0.286 for Niger and Ogun states respectively. These low figures are a reflection of the low number of household and industrial (in this case, agricultural) assets of the households in the study area. For instance, the average land owned by farmers in Niger state in the three waves is 0.602 hectares. The average value for Ogun state is even much lower at 0.211 hectares.

3.4.4 Adaptive Capacity

Results show that there were higher Adaptive Capacities (AC) exhibited in the final (2015) wave than the other waves at 31.939 and 34.623 for Niger and Ogun states respectively with a mean of 32.909. In 2012, the adaptive capacity of Niger was 17.004 and Ogun was 17.514, and the values observed in 2010 was a mean of 24.573 at 22.548 and 27.886 for Niger and Ogun states respectively. Literacy levels in Nigeria have increased from 61.25 in 2008 to 71.26 in 2018 (UNESCO., 2020), and this is reflected in the changing capacities of farmers to adapt to shocks. The higher the literacy rate, the higher the adaptive capacity. The least educated and lower-skilled members of a society are likely to be the most vulnerable to climate hazards in terms of livelihoods and geographical location. The number of years of education has often been used to indicate acquired knowledge. It is used as an important indicator in the United Nations Human Development Index (UNESCO., 2020).

Table 1 shows the resilience pillars (ABS, SSN, AST, and AC) for the three waves (2010, 2012, and 2015).

Table 1: Results of Pillars for the Three Waves (Scale: 1 – 100)

	2010		2012		2015	
	Niger	Ogun	Niger	Ogun	Niger	Ogun
ABS	18.953 (10.886)	25.704 (9.870)	7.121 (4.314)	21.955 (10.568)	28.438 (15.280)	27.465 (10.141)
SSN	46.471 (0.512)	46.503 (0.778)	7.471 (2.757)	6.045 (1.433)	...	0.6767 (6.645)
AST	2.924 (4.578)	0.175 (1.351)	1.090 (2.334)	0.307 (1.227)	1.897 (3.025)	0.286 (1.050)
AC	22.548 (23.542)	27.886 (24.894)	0.203 (15.719)	0.278 (15.960)	31.939 (28.371)	34.623 (28.019)

Standard Deviation in parenthesis

3.5 Descriptions of the variables

Table 2 shows the mean values of the variables computed into the resilience pillars for the resilience capacity index for the three waves.

Table 2: Description of variables from the three waves.

Variables	2010		2012		2015	
	Niger (N=180)	Ogun (N=110)	Niger (N=183)	Ogun (N=114)	Niger (N=182)	Ogun (N=103)
Electricity (Kw/hr)	0.517 (0.501)	0.655 (0.477)	0.596 (0.492)	0.728 (0.447)	0.588 (0.493)	0.709 (0.456)
Housing Index	-0.076 (1.064)	0.538 (0.810)	-0.095 (1.235)	0.280 (0.451)	0.345 (1.202)	0.125 (0.875)
Land owned (Ha)	0.578 (0.495)	0.236 (0.426)	0.634 (0.483)	0.281 (0.451)	0.593 (0.493)	0.117 (0.322)
Scholarships (USD)	50.000 (670.820)	0.000 (0.000)	3.350 (3.950)	1.228 (2.087)	0.000 (0.000)	0.000 (0.000)

Independence ratio	1.103 (1.091)	17715.660 (10560.310)	1.353 (1.588)	1.046 (1.346)	1.592 (1.417)	1.079 (1.440)
Female Household Heads	0.017 (0.128)	0.245 (0.432)	0.0219 (0.147)	0.211 (0.409)	0.071 (0.258)	0.281 (0.452)
Monthly food expenditure (Naira)	21100.28 0 (14626.170)	0.245 (0.432)	26264.660 (16772.290)	18978.800 (13674.900)	23286.760 (16502.650)	23348.540 (12042.500)

Standard deviations are shown in parentheses.

3.6 Resilience Capacity Index of Rice Farmers

For the first two waves, Niger state showed higher RCI values of (14.963 and 9.094 respectively) while Ogun state values were 12.804 and 8.341 for Wave 1 and 2. However, Ogun state had a higher value of 17.750 than 14.717 in Niger state in the third wave. The result shows rice farmers in Niger state have higher RCI than the Ogun state counterparts in the first two waves. The results of the Resilience Capacity Index (RCI) on a scale of 1 to 100 (Table 3) show a drop during the second wave (2012) in both states in the study area. During the third wave, the index (16.234) showed a higher value than the values of the second and first waves (8.717 and 13.882 respectively).

Table 3: Resilience Capacity Index for the Three Waves Rescaled (1 to 100)

2010		2012		2015	
Niger	Ogun	Niger	Ogun	Niger	Ogun
14.963	12.804	9.094	8.341	14.717	17.750
(8.513)	(6.229)	(5.634)	(4.569)	(8.581)	(7.288)

3.6.1. Factors influencing the Resilience Capacity Index of Farmers in Niger and Ogun States, Nigeria

The results for the three waves show factors influencing resilience to be having electricity, independent household members, good housing, scholarships, as well as owning land. Many of these household heads were females.

Table 4 shows the regression results for factors influencing RCI for Wave1, 2 and 3. In 2010, the overall model was significant, $F(7, 282) = 803.18, p < 0.001$, Adjusted $R^2=0.95$. The model explains 95% of variance accounted for by the predictor variables. Factors that influence resilience include electricity ($\beta = 0.05, p < 0.001$), independency ratio ($\beta= 0.03, p < 0.05$), monthly food expenditure ($\beta = 0.93, p < 0.001$) and female-headed households ($\beta = -0.03, p < 0.001$). Specifically, this means that when farmers have modern energy and a larger number of working household members, they will have a greater ability to bounce back from shocks and stressors For this year, these heads of households were mostly female.

Table 4: Regression results for factors influencing Resilience Capacity Index for Wave 1 (2010), Wave 2 (2012) and Wave 3 (2015).

Factors	2010			2012			2015		
	β	SE	P> t	β	SE	P> t	β	SE	P> t
Electricity	0.920	0.2605	0.000	0.3800*	0.22	0.09	1.4324	0.642	0.02
	8*			**	35	0	**	5	7
Housing Index	0.000	0.1213	1.000	0.3059*	0.08	0.00	0.2456	0.257	0.34
	1				94	1		4	1
Land Owned	-	0.2222	0.354	-0.2448	0.20	0.23	-	0.605	0.00
	0.206				61	6	4.1024	0	0
	2						*		
Scholarships	1.477	1.7392	0.396	0.6774*	0.00	0.00			
	3				1	1			

Independence Ratio	0.228	0.0836	0.007	0.5297*	0.00	0.00	0.5943	0.181	0.00
	4*				00	7	*	1	1
Monthly Food Expenditure	0.000	0.0000	0.000	0.0003*	0.00	0.00	0.0004	0.000	0.00
	5*				00	0	*	01	0
Female Household Head	-	0.3480	0.008	-0.4774	0.13	0.13			
	0.924				7	7			
	9*								
Adjusted R²	0.951			0.9172			0.7329		
F	803.1			496.12			130.85		
	8								

In 2012, the overall model was significant, $F(7, 289) = 496.12$, $p < 0.001$, Adjusted $R^2 = 0.91$. The model explains 91% of variance accounted for by the predictor variables. Factors that influence resilience include housing index ($\beta = 0.06$, $p = 0.001$) scholarship ($\beta = 0.06$, $p = 0.001$), independency ratio ($\beta = 0.15$, $p < 0.001$), and monthly food expenditure ($\beta = 0.84$, $p < 0.001$). The results suggest that having good housing, scholarships, and independent household members significantly influence the resilience of rice farmers in the study area. These households, resultantly, spent more on food in that year for the study area.

In 2015, the overall model was significant, $F(6, 278) = 130.85$, $p < 0.001$, Adjusted $R^2 = 0.74$. The model explains 73% of variance accounted for by the predictor variables. Factors that influence resilience include independency ratio ($\beta = 0.01$, $p = 0.001$) monthly food expenditure ($\beta = 0.67$, $p < 0.001$), and female household heads ($\beta = 0.08$, $p < 0.01$). Specifically, the results suggest that independent household members influenced resilience. These households, for this year, were headed by females and they had more to spend on monthly food expenditure in the study area.

The Value Chain Development Programme (VCDP), an initiative of the Federal Government of Nigeria and the International Fund for Agricultural Development (IFAD) has been working “to enhance productivity and access to market for rice and cassava smallholder farmers through a commodity value chain approach” (VCDP. 2019). The 6-year long program started in 2013 in six

Nigerian states that include Niger and Ogun. The program reported an average, rice yield of 4.5 metric tonnes per hectare against the baseline figure of 2 metric tonnes per hectare (IFAD., 2019). At the state level, the Ogun State Government has initiated a policy towards achieving economies of scale by consolidating the numerous smallholder rice processing centres.

To bolster the resilience of farmers to climatic shocks, livelihoods should be diversified to accommodate other forms of farming and trade. Pastoral farming as well as investments along the rice production value chain will improve the adaptive capacities of these households to climate shocks. Also, improved seed varieties, as well as training and investments in irrigated farming, will improve the adaptability of farmers to shocks of heatwaves, drought, pests and diseases.

3.7 Limitations and Future Work

The research presented here could not be done on a larger scale with all the states and agro-ecological zones amply assessed but only two, out of the 36 states of the country could be assessed. These two states are the major rice-producing states in the North and South of Nigeria and that was why they were chosen for this study. Also, the secondary data collected, the General Household Survey (World Bank, 2015) were not collected specifically for the Resilience Index Measuring Analysis (RIMA). They were however cleaned and adapted to suit the requirements of RIMA. Looking ahead, data should be collected with an appropriate questionnaire designed for this purpose taking into consideration the relevant shocks and stressors that apply to the community, system or economy being studied.

3.8 Conclusion

Results show that rice farmers generally have low assets in the study area. Land owned by farmers is small (averagely less than a hectare). The distance covered to gain access to basic services in the study area did not improve the resilience of farming households in the study area. Remittances and scholarships, likewise, did not improve the resilience of the households. This was also found in a Bornu state (FAO., 2019) where despite the number of transfers received, households living in Monguno, Kukawa and Ngala are poor in terms of AST, notably land and the housing wealth index.

Access to basic services (ABS) such as modern energy; adaptive capacities (AC) like a larger number of independent household members as well as higher literacy rates made farming

households in the study area more resilient. This agrees with the earlier discussed report of the FAO assessing the resilience of households in Bornu state, Nigeria. In the report, AC is the most important pillar for household resilience in Kala Balge and Kwaya Kusar parts of the state (FAO., 2019).

4. Achieving a Resilient Food System in Sub-Saharan Africa

Development interventions promoting the use of efficient technologies to increase agricultural production, particularly with improved crop varieties and drought-resistant inputs for crops and livestock should be encouraged. Enhanced practices and technologies for animal production and health, including vaccination and animal health services will also encourage rice farmers to have more sources of income apart from rice farming. Indigenous knowledge and experience of the environment are, in many cases, as useful as having a high level of literacy (FAO., 2016) and this approach through formal education as well as informal trainings and capacity development interventions should be explored to build the capacity of farmers and improve resilience. Improving access to basic services such as health, financial and market facilities; water and sanitation (WASH) infrastructure with farmer-centered programmes and interventions that focus on rural livelihoods will improve farmers' resilience in the study area and should be looked upon by stakeholders. Interventions to increase the agricultural productivity of households headed by both male and females and the asset base of the population should be given attention according to the relevant livelihood. Also, programmes should focus on enhancing environmental conservation and sustainability, improving the management of natural resources of land and water and promoting equitable access to these resources by every member of the community. Income-generating activities to enhance the diversification of income sources and livelihoods should be encouraged and promoted with activities carried out both on and off the farm.

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