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Livelihood Vulnerability Resilience Capacity of the Rural Economy in Nigeria's Bauchi State

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ABSTRACT

For poor households, a pattern of susceptibility is often revealed by the interaction of internal livelihood elements and external forces. Over the past ten years, there has been a lot of discussion around the idea of vulnerability in rural Africa. The literature on livelihoods has paid far less attention to the resilience idea, which was adopted from the ecological literature. It is against this background that this research, themed "Livelihood vulnerability resilience capacity of the rural economy of Nigeria's Bauchi state", was conceptualized for the purpose of charting a realistic sustainable livelihood policy course in the study area. Using a well-structured questionnaire coupled with an interview schedule to elicit information from a total of 322 households selected through a multi-stage random sampling technique, the specified objectives of the research were achieved using both descriptive and inferential statistics. Empirically, good possession of livelihoods assets *viz.* natural, human and financial capitals makes majority of households adopt adaptive strategies *viz.* diversification and intensification, so as to spread their consumption failure risks. Besides, the effect of adaptive capacity lessens the proportion of households with vulnerable livelihoods. However, the masking effect of food insecurity on adaptive capacity worsens the resilience capacity of households to livelihood vulnerability, consequently, the resultant heightened poor livelihood sustainability security that marred the rural economy. Therefore, the study advises policymakers to enhance the pillars that buffer livelihood vulnerability resilience capacity, given the empirical justification that resilience capacity has a significant direct influence on short-term, mid-term, long-term food securities and sustainable livelihoods in the study area.

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INTRODUCTION

One of the biggest issues facing human society today is climate change, coupled with its effects on people's livelihoods (Yang *et al.*, 2023). Relating to the initial state of existence, resilience is envisioned as a crucial element of sustainable livelihood, mainly reflecting the capacity to deal with external tensions alongside shocks or absorb fluctuations in order to keep its original structure and function (Nasrnia and Ashktorab, 2021; Zhao *et al.*, 2023). Over the past few decades, the resilience notion has gained popularity across a variety of fields (Tebboth *et al.*, 2019; Dang *et al.*, 2022). Resilience theory has, however, primarily been studied in the physical sciences, and its proponents have frequently come under fire for overlooking the societal or political facets of ecological and social networks (Ha-Mim *et al.*, 2020; Zhou *et al.*, 2021).

In order to address these issues, resilience thinking is advocated from the viewpoint of livelihood (Keshavarz and Moqadas, 2021). According to Wang *et al.* (2021), the notion of resilience is utilized to manage resources sustainably for ecological performance, human growth, and well-being. As reported by Liu *et al.*

(2022), livelihood resilience is the ability of all individuals from various generations to sustain and improve their living conditions, well-being, and circumstances in the face of crises in the environment, economy, social, and political spheres. The adaptive tactics used by people or households in stressful or shocking situations provide the basis for livelihood resilience (Shi *et al.*, 2022; Chen *et al.*, 2023). Building livelihood resilience suggests that a person's livelihood tactics make it far simpler for them to deal with the effects of pressures and shocks, overcome ambiguity, and accommodate changing circumstances (Tannor *et al.*, 2022; Fahad *et al.*, 2023).

Scholars have established the concepts of vulnerability and resilience in a variety of ways, from opposite ends of the spectrum to crossed relationships (Bauer *et al.*, 2022). Few researchers have claimed that resilience and vulnerability are related concepts that might not be distinguished (Mahmoodi and Hasani, 2021; Insani *et al.*, 2022). Li *et al.* (2022) contends that, depending on the circumstances, both resilience and vulnerability may coexist and even overlap. Although vulnerability and resilience are frequently thought of as being inversely related (Atara *et al.*, 2020), the complexity

arises when the situation varies depending on the place and geographical environment (Liu *et al.*, 2020a). Understanding how vulnerability and resilience discourses coexist within an integrated framework aids in exploring how isolated and disadvantaged populations can adapt to climate change and extreme weather events (Liu *et al.*, 2020b). Understanding what creates and enhances livelihood resilience against climatic changes, such as floods and droughts, is also essential since livelihood systems should be adaptable to both global and local changes (Liu *et al.*, 2020c). Therefore, the idea of livelihood resilience has become more popular recently since the livelihood of rural households is becoming more and more dependent on significant worldwide advances in the climatic, economical, and social spheres (Pagnani *et al.*, 2021). The most impacted individuals, such as rural dwellers, might continue their prior social and economic activities by improving their quality of life, which would support long-term development and rehabilitation (Yang *et al.*, 2023). It would be easier for them to develop effective tactics if they were aware of how impacted individuals react to potentially fatal disasters, particularly by detailing how they adapt to novel natural phenomena (Zhao *et al.*, 2023). Such comprehension would give a clearer picture of the essential components, such as resilience traits, that enable people to establish resilience to appropriate agencies in addressing the personal needs to deal with disasters, even before those events occur (Zhou *et al.*, 2021).

Enhancing capacity, advancing justice, and boosting social sustainability are ways to attain sustainability, as is adopting a holistic viewpoint on how rural communities survive and earn a living (Chitongo, 2019). Sustainable livelihood is a suitable strategy taking into account all these varied factors in order to empower and advance the economic and social well-being of households (Weldegebriel and Amphune, 2017). According to Yang *et al.* (2023), a sustainable style of life is one that can respond to different shocks in an effective manner while also recovering and enhancing one's skills and resources to create possibilities for future generations to live sustainably. A sustainable way of life can be utilized to help manage sustainable resources, integrate development programs, and eradicate poverty all at once (Alam *et al.*, 2018). One of the fundamental and crucial methods for achieving sustainable development is to offer a livelihood approach to the poor in rural regions in order to empower them and enhance their capacity (Pagnani *et al.*, 2021).

The economy of Bauchi State, which is in the northeastern part of Nigeria, is primarily rural and mainly dependent on agriculture. Having a reliance on rain-fed agriculture exposes farmers to the hazards of droughts as well as weather-related

difficulties, making livelihoods more vulnerable. In academics and international development, the idea of resilience—specifically, livelihood resilience—is gaining popularity. Some studies have shown that factors such as household income, livelihood variety, ownership, social cohesiveness, place connection, environmental attitudes, availability to water resources, and usage of various adaptation techniques affect resistance to weather-induced vagaries (Keshavarz and Moqadas, 2021; Pagnani *et al.*, 2021; Yang *et al.*, 2023). Despite being mostly variable, the factors that influence household livelihood vulnerability and resilience have not been extensively studied in the context of emerging nations. Additionally, there is an urgent need to gauge livelihood resilience and comprehend how weather shocks affect it. Focusing on the livelihood resilience of the economy in rural areas not only puts people at the center of the investigation and highlights their capacity to withstand shocks (Zhao *et al.*, 2023), but it also helps resolve the issues of resilience in how they react to what and for whom (Fahad *et al.*, 2023). It is against this background that this research attempts to assess the livelihood vulnerability resilience capacity of the rural households in Nigeria's Bauchi State. The specific objectives were to determine the households' multi-dimensional poverty status; determine the households' livelihood survival strategy; determine households' livelihood vulnerability status; determine households' livelihood vulnerability resilience capacity; determine the effect of households' livelihood vulnerability resilience capacity on food security and sustainable livelihood; and, determine households' livelihood sustainability security.

RESEARCH METHODOLOGY

The state is situated between longitudes 8°45' and 11°0' East of the Greenwich meridian and latitudes 9°30' and 12°30' North of the equator. According to the 2006 census, Bauchi State had a population of 4,655,073 and was projected to have 7,685,312 inhabitants by 2021 (NPC, 2021). Due to its size and geographical changes, Bauchi State, which is located in northeastern Nigeria, has a wide range of agro-climatic conditions and has a landmass of 49,259km square. The state's location in the Sahel area, which has a semi-arid to sub-humid climate, has a significant impact on the state's climate. Typically, the rainy season starts in May and lasts through September or October. The majority of the state's yearly precipitation falls during this time. The dry season often begins in November and lasts through April. The Harmattan wind from the Sahara desert can blow during this time, bringing dry and dusty conditions along with the hot, dry weather. The climate in Bauchi State is often warm to hot all year round. During the dry season, temperatures are higher, frequently topping

30°C (86°F) during the day and occasionally going over 40°C (104°F) during the night. The state's vegetation ranges from guinea savannah in the south to savannah grasslands in the north. While Bauchi State's southern regions see comparatively higher rainfall and more intensive agricultural operations, the state's northern regions are more desert. In Bauchi State, agriculture has a vital economic role. The state frequently cultivates crops like millet, sorghum, maize, rice, and groundnuts. Additionally, raising cattle, sheep, and goats are quite important for the economy.

Using a multi-stage random sampling technique, a total of 322 respondents were chosen in households' survey conducted in the year 2022. Firstly, all the stratified agricultural zones of Bauchi State Agricultural Development Project (BASADP) viz. Zone (A) Western, (B) Central and (C) Northern were selected as livelihood challenge is a general phenomenon. Subsequently, given the disproportionate distribution inherent with LGAs across the strata, the representative LGAs were proportionately selected. Thereafter, from each of the selected LGAs, two villages were randomly selected. Based on the sample frame generated by reconnaissance survey (Table 1), Krejcie and Morgan (1970) formula (Equation 1) was used to

determine the representative sample size. Thus, a total sample size of 322 households was randomly chosen for the study. A well-structured questionnaire coupled with interview schedule was used to collect the relevant information for the research. Objectives 1 was achieved using multi-dimensional poverty index (MPI) while objectives 2, 3, 4 and 6 were achieved using Livelihood's strategy index (LSI), Livelihood's vulnerability index (LVI), Livelihood's vulnerability resilience index (LVRI) and Livelihood's sustainability security index (LSSI) respectively. Nevertheless, objective 5 was achieved using confirmatory factor analysis (CFA).

$$X = \dots\dots\dots (1)$$

X =
 n = Sample size; N = Population size; e = Acceptable sampling error; X= Finite sample size; and, P = Proportion of the population

Empirical models

1. Multidimensional poverty index (MPI): The MPI is a composite indicator of poverty that accounts for both the distribution of deprived areas and their prevalence (Appendix 1) (Sadiq and Sani, 2022). The following are the indexes involved in the measurement:

Table 1: Sampling frame of rural households

Zones	LGAs	Villages	Sampling frame	Sample size
Western	Dass	Kagadama	3,230	9
		Wandi	9,210	26
	Kirfi	Badara	5,767	16
		Beni	5,322	15
	Tabawa-Baleawa	Burga	5,532	16
		Zango	4,127	12
	Toro	Polchi	4,241	12
		Zalau	5,300	15
	Central	Ningi	Zidinga	3,403
Tsangayan Dirya			5,350	15
Darazo		Lanzai	9,120	26
		Yautare	8,423	24
Northern	Katagum	Chinede	5,437	15
		Ragwam	4,216	12
	Gamawa	Wabu	9,326	26
		Lariski	2,671	8
	Giade	Jugudu	3,310	9
		Hardori	3,221	9
	Misau	Akuyam	5,324	15
		Zindi	3,350	10
	Shira	Kilbore	2,320	7
		Yana	5,230	15
Total	11	22	113,330	322

Source: Reconnaissance survey, 2022

2. Multidimensional headcount ratio (H): Is the proportion of persons who have been classified as multidimensionally poor, i.e. those who fall below the poverty line, and is expressed as:

..... (2)
 The number (or headcount) of multidimensionally poor persons according to parameter k is $q(k)$.

.....(3)
 The average deprivation share across the poor is defined as the intensity of poverty A , often known as the breadth of poverty. This is presented as:

.....(4)
 The percentage of the d indicators in which the average multidimensionally poor person is deprived is the intensity of poverty.

The measure is the so-called adjusted headcount ratio when $= 0$.

..... (11)
 When, the measure, adjusted poverty gap, defined as the weighted average of indicator-specific poverty gaps is used. is poverty gap.

.....(5)
(6)

Finally, when , the adjusted squared poverty gap () is calculated as the weighted average of the indicator-specific squared poverty gaps. is poverty severity.

.....(6)
(7)

Seth and Alkire (2014) as reported by Sadiq and Sani (2022) suggested an additively decomposable inequality measure that is a positive multiple of "variance" and has within-group and between-group components. The inequality measure employs the vector of deprivation scores of the q impoverished people to quantify inequality among the poor at the national or sub-national level.

.....(8)

To calculate the measure of inequality, the difference between each poor person's deprivation score and average intensity is squared, then the squared distances are added together and multiplied by a constant. We set $=1/24$ since the poor's deprivation ratings vary from $1/8$ to 1 . This is the greatest permissible number for the inequality gauge, guaranteeing that the inequality gauge is constrained between zero and one, given the spectrum of deprivation scores. Nevertheless, a lower degree of poverty or a decline in poverty does not necessarily mean that every region or demographic categories have experienced an equal reduction in poverty (Sadiq and Sani, 2022).

2. Livelihood indexes: Before specifying the indexes, the preamble steps for generating the composite indexes viz. minimum normalization measure (Equation 9) and dimension index (Equation 10) are presented below:

..... (9)
 Where, T' is the indicator index, is the value of the indicator; is the minimum value of the indicator; and, is the maximum value of the indicator.

..... (10)
 Where, is the dimension index of households and w is the weight of Indicator index.

..... (11)
 Where, is the Livelihood strategy index of households; w is the weight of dimension.

The livelihood capital assets' classification (Sadiq and Sani, 2022): $< 20\%$ = very poor; 20% = poor; 40% = moderate; 60% = good; 80% = very good.

The livelihood strategy classification is: < 1 = survival strategy, 1 = coping strategy, 2 = adaptation strategy, 3 = accumulation strategy (four-scale) (Morris *et al.*, 2001); <1 = survival strategy, 1 = coping strategy, 2 = adaptation strategy, 3 = consolidation and 4 = accumulation strategy (five-scale).

Livelihood assets:

The household's livelihood may be constructed on a foundation that is represented by the assets accessible for generating income. The five categories listed below serve as representations of these assets in the DFID framework (Appendix 2a).

Natural capital (N): refers to the stocks of natural resources that provide resource flows necessary for subsistence (such as land, water, animals, biodiversity, and environmental resources);

Human capital (H): refers to the abilities to work, learn, and maintain good health, all of which are necessary for pursuing a variety of livelihood options;

Physical capital (P): is the production machinery and tools that allow individuals to pursue their livelihoods, as well as the essential infrastructure (transportation, housing, water, energy, and communications);

Social capital (S): the social assets (networks, group membership, trust-based relationships, and access to larger institutions of society) that people rely on in order to support themselves; and,

Financial capital (F): the available financial resources that enable people to choose from a variety of sources of income, such as savings, credit, regular remittances, or pensions.

These assets include both the intangible resources more commonly studied by sociological and anthropological research (such as social capital, health, and educational status) and the tangible productive resources more commonly linked with economic studies (such as land, labor, capital, and stocks).

Livelihood strategy

Among others, Devereaux (1993) and Davies (1996) have distinguished between survival, coping,

adaptive, and accumulative strategies (Appendix 2b). In response to an opportunity, accumulative techniques boost asset stocks and consumption results. Adaptive strategies aim to disperse consumption failure risk in response to foreseen negative trends. This could be achieved by expanding into new activities or by intensifying current livelihood methods. Coping mechanisms involve lowering consumption and depleting assets in order to lessen the effects of a negative shock. In the absence of respite, coping may result in survival tactics. In an effort to avoid poverty and death, survival methods not only dramatically cut back on consumption but also significantly, and most frequently irreparably, deplete household assets.

a. (12) (Appendix 2a)
 Livelihood vulnerability index (LVI) classification:
 <0= non-vulnerable, = very less vulnerable, = less

vulnerable, = moderately vulnerable, = highly vulnerable and = very highly vulnerable.

b. (13) (Appendix 3)
 Where, AC = Adaptive capacity, ABC = Absorptive capacity, TC = Transformative capacity
 Livelihood vulnerability resilience index (LVRI) classification: = very less resilience, = less resilience, = moderate resilience, = high resilience and = very high resilience.

c. (14) (Appendix 4)
 Where, ES = Ecological security, EE = Economic efficiency, SE = Social equity
 Livelihood sustainability security index (LSSI) classification: < 20= very poor sustainability security, = poor sustainability security, = moderate sustainability security, = good sustainability security and = very good sustainability security.

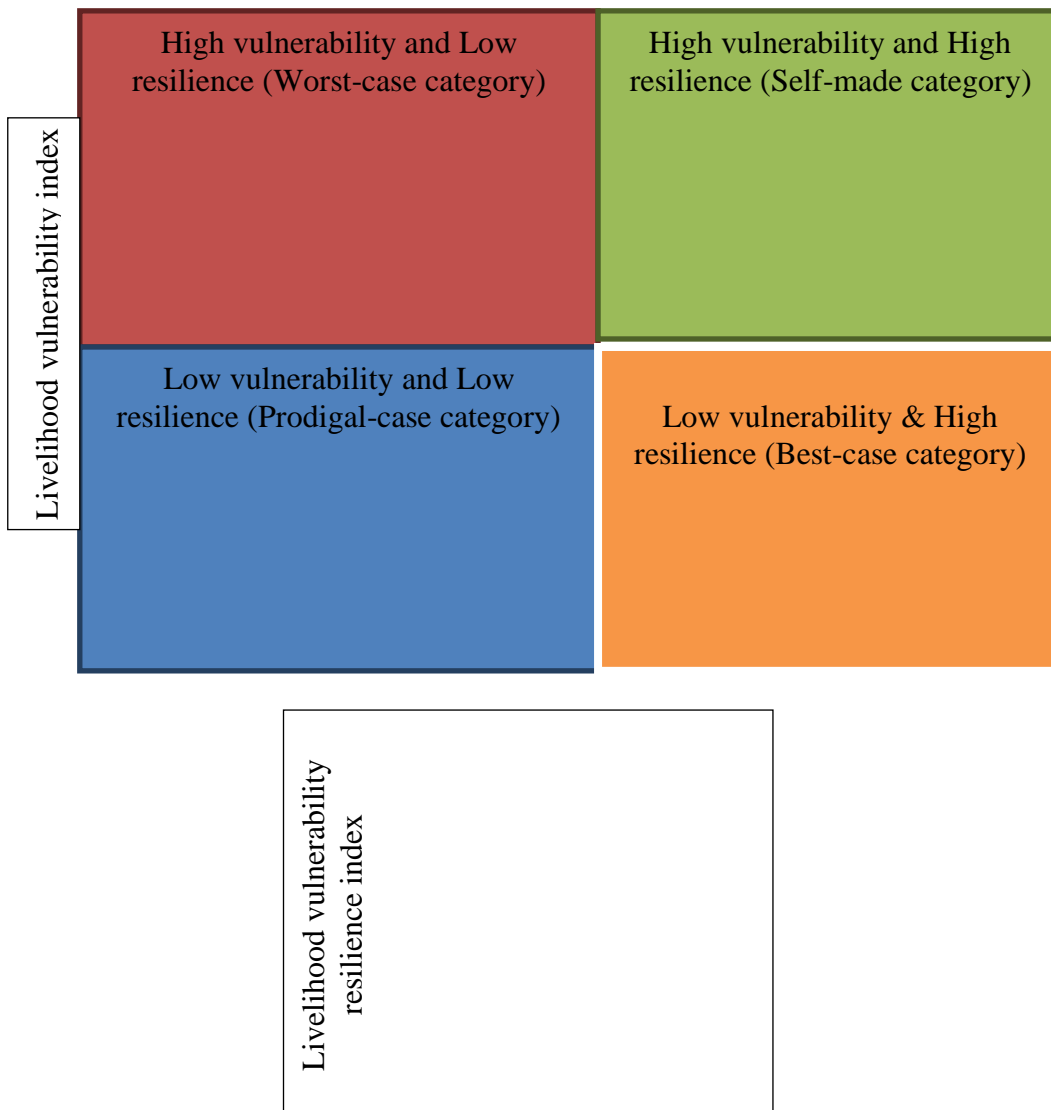


Figure 1: Nexus between livelihood vulnerability and Livelihood vulnerability resilience index

RESULTS AND DISCUSSION

Socio-economic Profiles of Rural Households

A cursory review of Table 2 showed the study area to be populated by early middle-aged adult (\bar{X} 48.03 years and $SD \pm 10.92$), had education beyond first school leaving certificate (\bar{X} 9.66 years and $SD \pm 6.94$), married (\bar{X} 0.96: 96% and $SD \pm 0.198$) and maintained a large household size (\bar{X} 12 persons and $SD \pm 7.19$) so as to have access to cheap farm labour and external income remittance. Besides, majority of the household heads were male (\bar{X} 0.87: 87% and $SD \pm 0.332$) which is expected as culture and religious discourage women from being a primary head in as much there is a living male adult in a household; majority of the respondents owned a land (\bar{X} 0.96: 96% and $SD \pm 0.205$) which mostly they acquired through inheritance, thus the possible reason why most of them cultivate crops on a medium-scale (\bar{X} 4.24 and $SD \pm 3.57$). In spite of being middle-income earners, as a measure of augmenting income, majority of the respondents engaged in off-farm activities (91%) and keeps livestock (83%). Despite weak harnessing of social capital pooling (47%), the study area is challenged with poor institutional support viz. extension (48%) and credit (34%) facilities, thus a portend threat to growth and development of the rural economy if not addressed immediately. Nevertheless, with effective institutional facilities, the study area has the capacity of sustaining the rural economy given that majority of the populace had adequate years of experience in managing agricultural activities, the pivot/ major driver of rural economy.

Multi-dimensional Poverty Status of Rural Households

Generally, at the poverty threshold and severity points respectively, the poverty incidence index showed proportions of multidimensional deprived rural households to be 74.99 and 24.26% (Table 3 and Figure 2a-b). Besides, the poverty intensity index showed the average deprivation suffered by the rural households to be 47.1 and 60.67% respectively, at the threshold and severity poverty levels. Succinctly, it translates into households' facing deprivation in not less than three and four poverty dimensions with respect to the aforementioned levels. Furthermore, by adjusting the poverty incidence by intensity, the index showed that across all deprivation indicators, the potential share proportions of deprivation suffered by the rural households at the threshold and acute poverty levels respectively were 35.78 and 14.26%. In addition, at the lower and higher poverty points

respectively, deprivation faced by the poorest among the poor even if they remained multidimensional poor will reduced by 35.78 and 14.72%. Zone-wise, poverty incidence was higher in Zone II and it faced the highest share deprivation from the total potential deprivations in the study area. Moreover, the adjusted poverty gap index showed that in each indicator, the depth of deprivation suffered by each of the rural households at the poverty ebb and peak points respectively were 39.21 and 9.54% respectively. In addition, the proportion of the indicators that constituted the larger shortfalls at the poverty trough and peak points were 21.51 and 4.05% respectively as evident by the adjusted poverty severity index. Therefore, it can be inferred that a large proportion of the population were vulnerable to poverty at the poverty ebb point while at the peak point, the population proportion faced with acute poverty were few.

Dimension-wise, generally, at the vulnerability level, deprivations in wealth contributed most to MPI; while at the severity level, though at par with slight marginal differences, deprivations in environment, standard of living and empowerment contributed highest to the MPI (Table 3 and Figure 2c-d). Across the zones, at the vulnerability level, in Zones I and III respectively, wealth and environment had the highest contributions to MPI while in Zone II, the duo of standard of living and wealth contributed highest to the MPI as evident by their percent contributions that are at par. Besides, at the severity point, standard of living and environment respectively contributed highest to the MPI at Zones II and III while the trio of wealth, empowerment and social connection contributed highest to MPI in Zone I as evident by their percent contributions that are at par. Nevertheless, generally and across the zones, poverty incidence was higher in wealth dimension across both poverty levels. Further, at both poverty levels, it was established that there is a serious unequal distribution of poverty in the rural economy of the state with some zones bearing a disproportionate share of poverty as evident by the poverty share contribution of Zone II that widely supersedes its population share (Figure 3). Thus, this calls for urgent intervention to arrest destitution in the rural area of the state before it cascade into its urban area in particular and the country at large viz. exodus rural-urban migration, strangulation of the food security of the state in particular given that the rural economy is the hub of food supply, and threats to social well-being and security of the state in particular.

Table 2: Socio-economic profiles of rural households.

Variables	Mean diff.	SD	Min	Max	t-stat	95% confidence interval of diff.	
						Lower	Upper
Gender (male=1, female =0)	.875	.332	0	1	47.096***	.84	.91
Age (years)	48.028	10.922	20	75	78.541***	46.83	49.23
Education (years)	9.660	6.936	0	29	24.836***	8.90	10.43
Marital status (binary)	.959	.198	0	1	86.517***	.94	.98
Household size (number)	12.433	7.192	1	40	30.873***	11.64	13.22
Income (₦)	1020467.65	1799461.44	10000	15204000	10.129***	822245.88	1218689.41
Experience (years)	23.755	11.902	1	50	35.648***	22.44	25.07
Extension contact	.480	.500	0	1	17.120***	.42	.53
Co-operative membership	.470	.500	0	1	16.800**	.42	.53
Land ownership	.956	.205	0	1	83.234***	.93	.98
AGH(hectare)	4.887	4.631	1	35	18.848***	4.38	5.40
OPH(hectare)	4.241	3.568	1	27	21.231***	3.85	4.63
Credit access	.335	.473	0	1	12.669***	.28	.39
Off-farm income	.906	.292	0	1	55.348***	.87	.94
Livestock's ownership	.828	.378	0	1	39.069***	.79	.87

Source: Field survey, 20222

Note: AGH = Agricultural holding; OPH = Operational holding; ₦ = Naira currency (1\$ = ₦370)

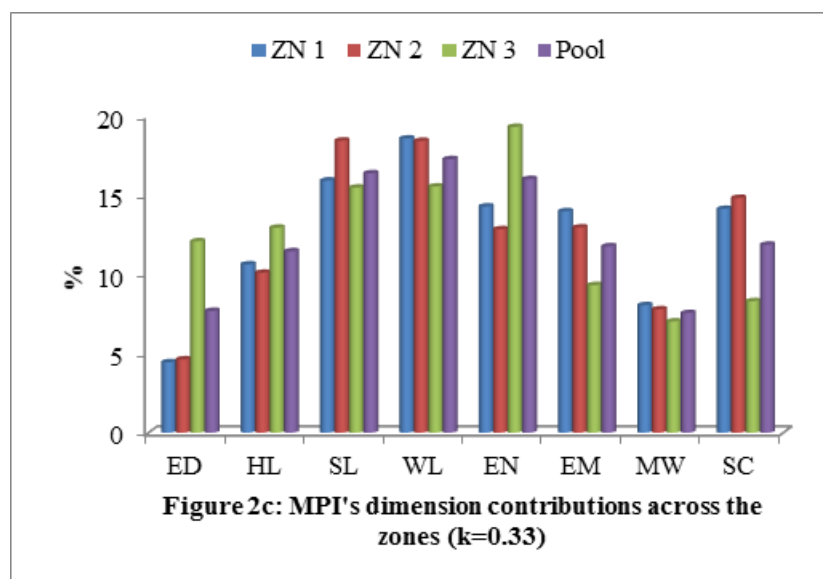
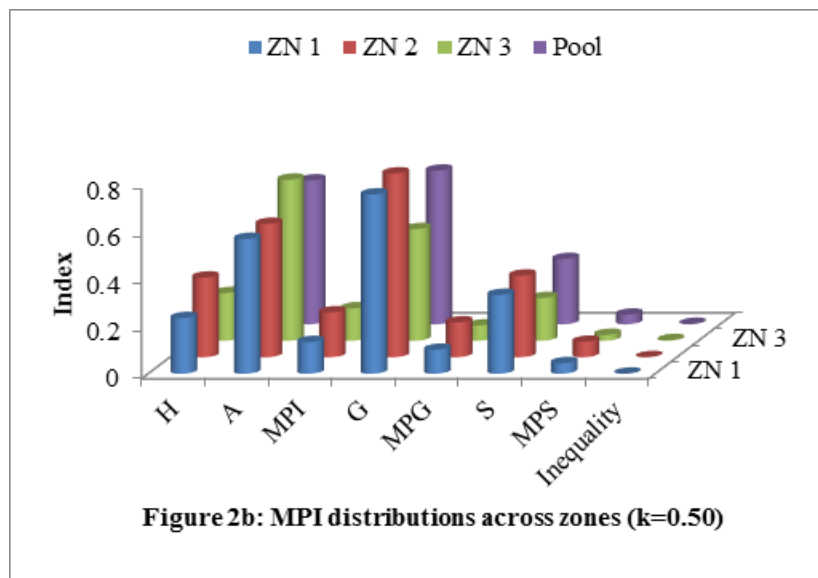
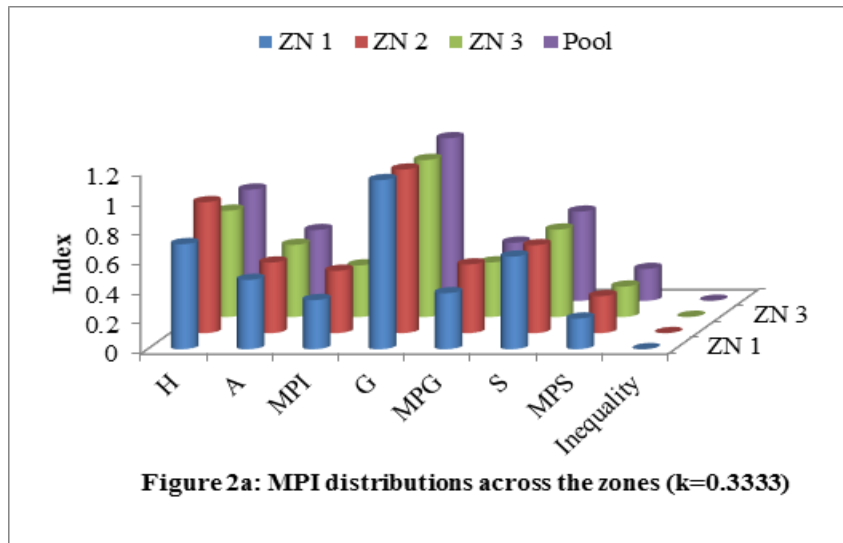
Measurements: Marital status (married =1, otherwise=0); Extension contact (yes =1, otherwise = 0); Co-operative membership (yes=1, otherwise=0); Land ownership (yes=1, otherwise=0); Credit access (yes=1, otherwise=0); Off-farm income (yes=1, otherwise=0); Livestock's ownership (yes=1, otherwise=0)

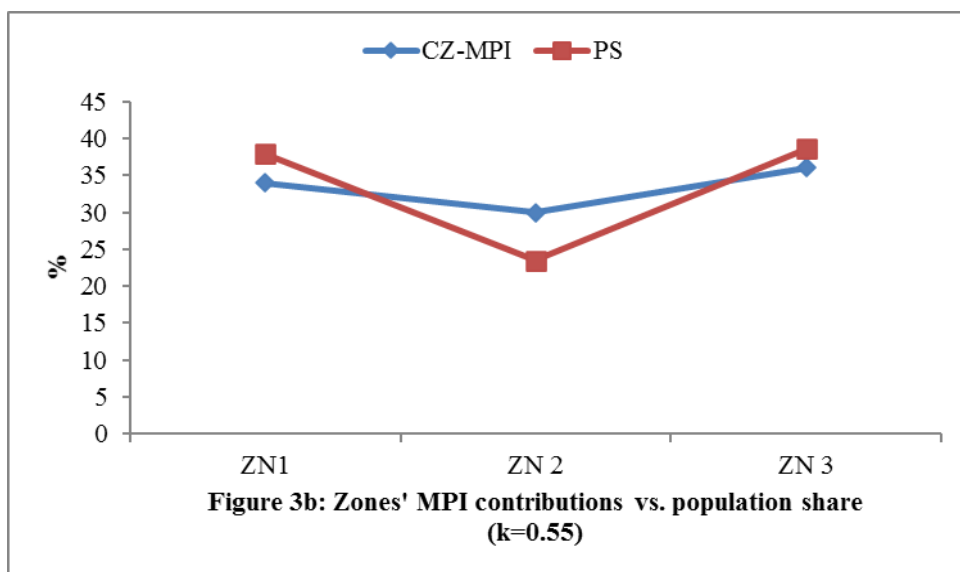
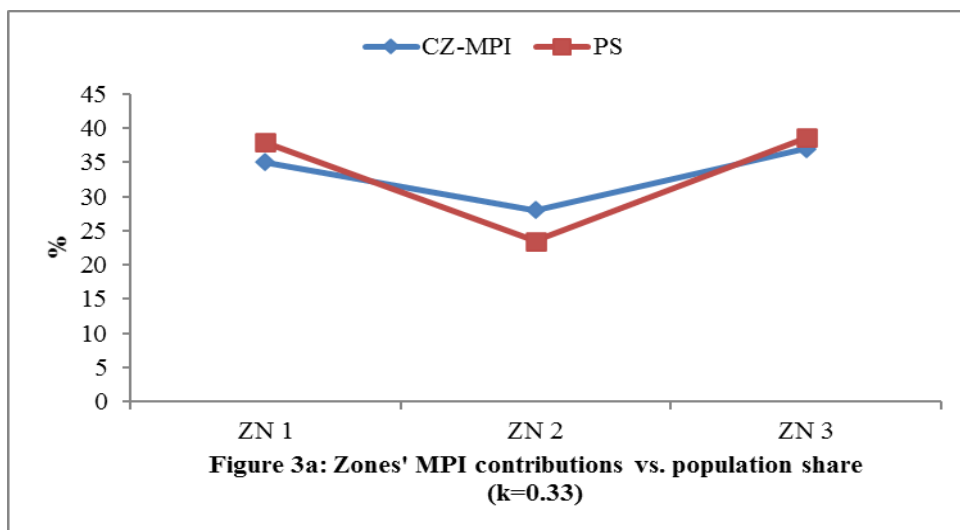
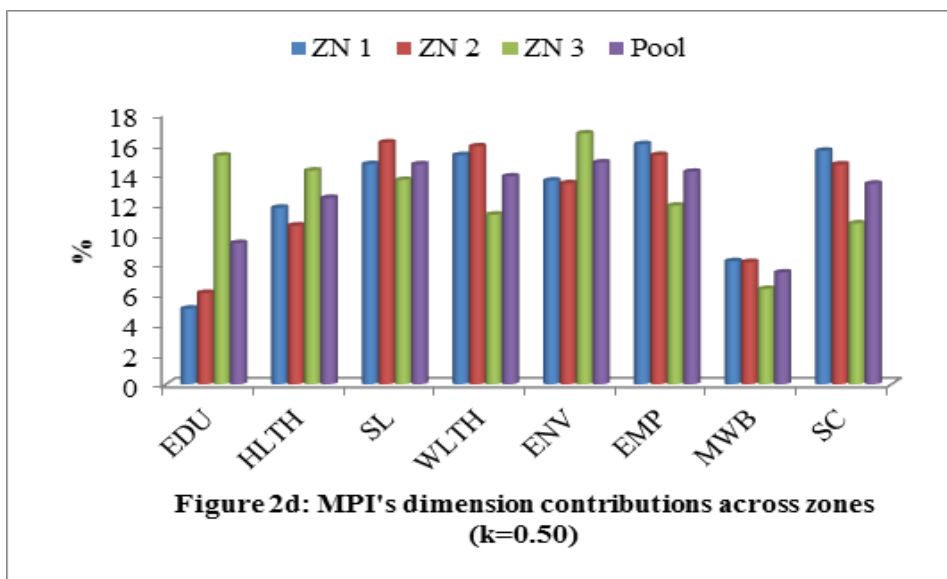
Table 3: Multidimensional poverty status of rural households

Items	K=0.3333				K=0.50				
	ZN 1	ZN 2	ZN 3	Pool	ZN1	ZN 2	ZN 3	Pool	
H	0.708333	0.882488	0.716295	0.749874	0.234914	0.336406	0.201055	0.242562	
A	0.467324	0.475699	0.485875	0.477104	0.569158	0.563071	0.679695	0.606722	
MPI (MPI ₀)	0.331021	0.419799	0.34803	0.357768	0.133703	0.18942	0.136656	0.147168	
G	1.139844	1.10217	1.058141	1.095981	0.756982	0.775976	0.471248	0.648201	
MPG (MPI ₁)	0.377312	0.46269	0.368265	0.392106	0.101211	0.146985	0.064399	0.095394	
S	0.624156	0.592272	0.589045	0.601276	0.332871	0.344295	0.18024	0.275123	
MPS (MPI ₂)	0.206609	0.248635	0.205005	0.215117	0.044506	0.065216	0.024631	0.040489	
Inequality	0.000335	0.000286	0.000915	0.00056	0.000513	0.000431	0.00254	0.001211	
CZ MPI	35	28	37	100	34	30	36	100	
PS	37.93	23.51	38.56	100	37.93	23.51	38.56	100	
				Dimension (Index)					
ED	0.014727	0.019441	0.042057	0.027515	0.006735	0.011521	0.020809	0.013836	
HL	0.035171	0.042387	0.045037	0.040994	0.015715	0.020017	0.019441	0.018259	
SL	0.052689	0.077405	0.053854	0.0586	0.019599	0.030494	0.018592	0.02155	
WL	0.061482	0.077333	0.054098	0.061775	0.020399	0.030002	0.015436	0.020366	
EN	0.047279	0.053931	0.067189	0.0573	0.018139	0.025346	0.022824	0.021732	
EM	0.046269	0.054399	0.032441	0.0421	0.021372	0.02891	0.016248	0.020818	
MW	0.02664	0.03269	0.024448	0.027021	0.010955	0.015409	0.00867	0.010947	
SC	0.046763	0.062212	0.028905	0.042462	0.020788	0.027722	0.014636	0.019659	
MPI	0.331021	0.419799	0.34803	0.357768	0.133703	0.18942	0.136656	0.147168	
				Dimension (%)					
ED	4.448966	4.631085	12.08442	7.690783	5.037219	6.082108	15.2272	9.40177	
HL	10.62507	10.09691	12.94058	11.45836	11.75351	10.56766	14.22635	12.4072	
SL	15.91726	18.43858	15.47396	16.37925	14.65831	16.09858	13.60529	14.64342	
WL	18.57353	18.42143	15.54413	17.26682	15.25718	15.83882	11.2953	13.83852	
EN	14.28281	12.84697	19.3056	16.01586	13.56691	13.38064	16.70167	14.76656	
EM	13.97762	12.95846	9.321216	11.76743	15.98478	15.26229	11.88955	14.14549	
MW	8.047926	7.787084	7.024685	7.552766	8.193877	8.13482	6.344667	7.438607	
SC	14.12682	14.81947	8.305409	11.86874	15.54822	14.63507	10.70998	13.35844	
Total	100	100	100	100	100	100	100	100	

Source: Field survey, 2022

Note: Z= Zone; CZ = Contribution of zone to MPI; PS= Population share





Livelihood Capacity of Rural Households Status of rural households' livelihood capital assets

On the average, the possessed livelihood capital asset that is most pertinently good for the rural households is natural capital (71.14%), followed by human (68.81%) and then financial (60.04%) capitals (Figure 4). The adequate possession of the natural capital can be attributed to agrarian activities as the major profession that characterized a rural economy in a typical Africa setting which the study area is inclusive. Besides, the good status of human capital asset is a testimony of adequate availability of physical and mental prepared labour force engaged in the rural economy of the study area. This trend is normal in a typical characterized African agrarian setting as there exists a mammoth economic labour force that undertake various economic activities along the supply chain of especially agricultural and allied activities in the study area. However, the status of financial capital being good revealed a paradigm shift in the financial sector of the rural economy in a typical agrarian setting in Africa that is mostly challenged by economic power owing to the fact that most of the rural inhabitants are resource poor. Besides, this dramatically change in the study area is tied to the multitude of governmental and non-governmental agricultural financial policies and programme, social intervention and corporate social responsibility that trickled down successfully to the rural economy of the state. Examples of these agricultural financial interventions are the national social investment programme- trader monie, farmers' monie, conditional cash transfer programme (CCFP), government enterprise empowerment programme

(GEEP), NPower scheme for unemployed graduates, Central Bank of Nigeria Anchor borrower farmers' programme etc; non-governmental in conjunction with governmental supports- FADAMA IIIAF+, IFAD programme, Rural Access and Agricultural Marketing Project (RAAMP), Alliance for a Green Revolution in Africa (AGRA), Community and Social Development Project (CSDP), Local Empowerment and Environmental Project (LEEMP), Women in Agriculture (WIA) etc. Succinctly, the Buhari Government at the inception of its second tenure created (19th August, 2019) the Federal Ministry of Humanitarian Affairs and Disaster Management solely responsible for national social intervention programme and billions of dollars was gulped by the agency for social safety measures. However, the empirically established good status of financial capital in the rural economy of the study area is a testimony of a giant developmental stride against rural economy of most contemporary states in the country where the stories are sad tales in the mouth. It is not far fetch if it is inferred that the financial capital is the catalyst responsible for the good capital status achieved for the natural and human capital assets in the study area. However, the capital statuses of social (59.38%) and physical (56.08%) capitals were moderate as evident by their respective average index. Thus, their indexes being at almost border line of a capital index to achieve good rating/status, it becomes very pertinent and urgent for policy makers to fast-track their efforts in improving the social networking and infrastructural development in order to arrest a pull-down effect as livelihood capitals play complementary roles to each other.

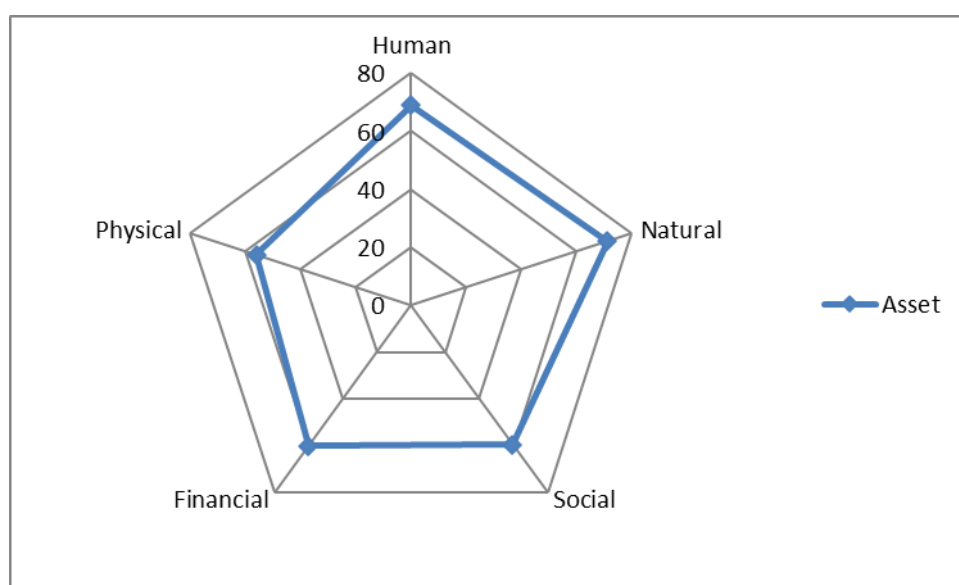


Figure 4: Status of capital assets

Livelihood vulnerability status of rural households

Empirically, it was established that majority (65.9%) of the rural households had their livelihoods to be in the sub-category of less vulnerability: very less and less vulnerable vis-à-vis 31.7 and 34.2% respectively (Figure 5a). Besides, at close range, 16.9% of the rural households had their livelihoods to be moderately vulnerable while the livelihoods of 8.01% of the rural households were subjected to both high and very high vulnerability. However, a handful of 9.1% of the rural households didn't have their livelihoods vulnerable to induced

climate change shocks. Nevertheless, among the vulnerability indicators, the average index contribution of sensitivity (71.14%) - a weak natural capital as classified by LVI-IPCC was the highest, thus masking the effect of adaptive capacity (59.72%)(Figure 5b). Nevertheless, the compounded effect of exposure (15.85%) induced the heightened vulnerability experienced in the study area. Therefore, it can be inferred that the exacerbation of the livelihood vulnerability owes to the mask effect of rural households sensitivity to climate-induced shocks in the study area, thus a chasm to sustainable livelihood in the rural economy.

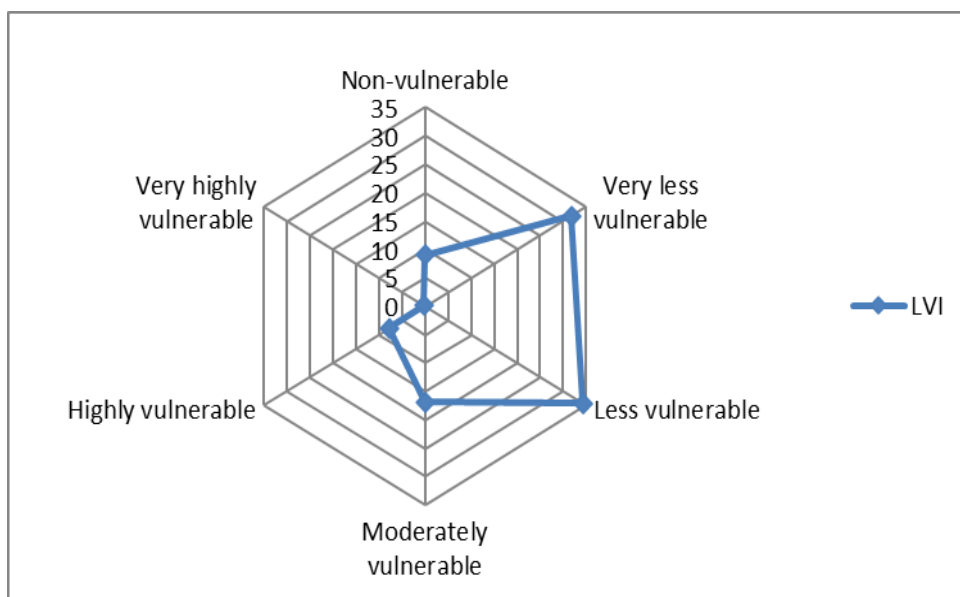


Figure 5a: Livelihood vulnerability distribution of rural households

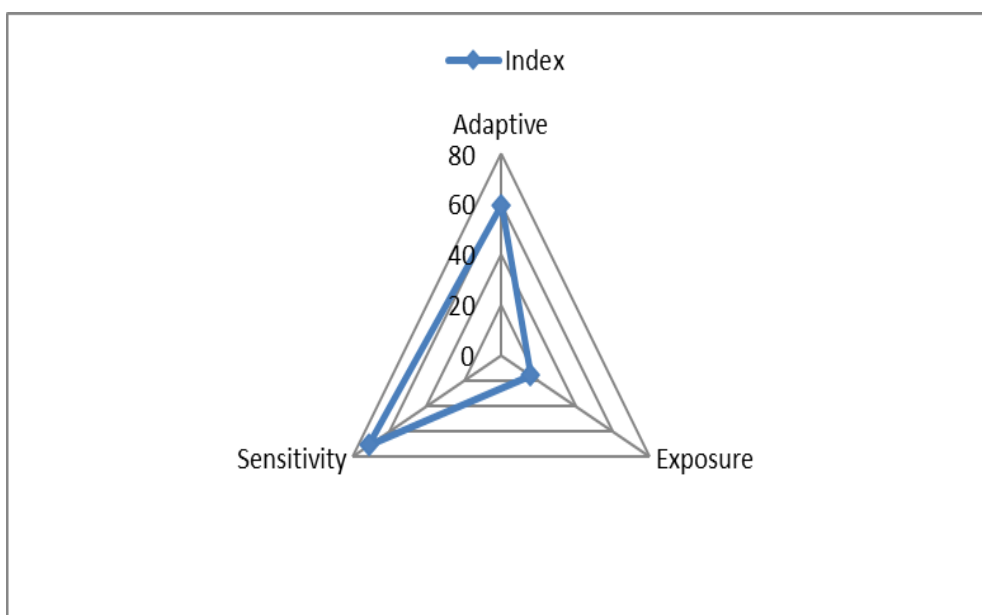


Figure 5b: Livelihood vulnerability indicators distribution

Livelihood vulnerability resilience capacity of rural households

In furtherance, empirically it was observed that majority (97.8%) of the rural households had poor resilience capacity to withstand livelihood vulnerability to climate-induced challenges as evident by their classification in the less resilient sub-category (Figure 6). In a nutshell, the majority (56.7%) had a very less livelihood vulnerability resilience capacity; 41.1% had a less resilience capacity to livelihood vulnerability while a handful of 2.2% had a moderate resilience capacity against livelihood vulnerability. Therefore, the height of the

poor resilience capacity to withstand livelihood vulnerability among majority of the rural households is the driving force behind the poor livelihood that ravaged the study area’s rural economy. Of the livelihood vulnerability resilience capacity indicators, on the average, the adaptive capacity contributed most (29.22%) while the duo of absorptive (15.85%) and transformation (15.26%) capacities- sensitivity to weather extremities and public goods respectively had almost equal contribution (Figure 6b).

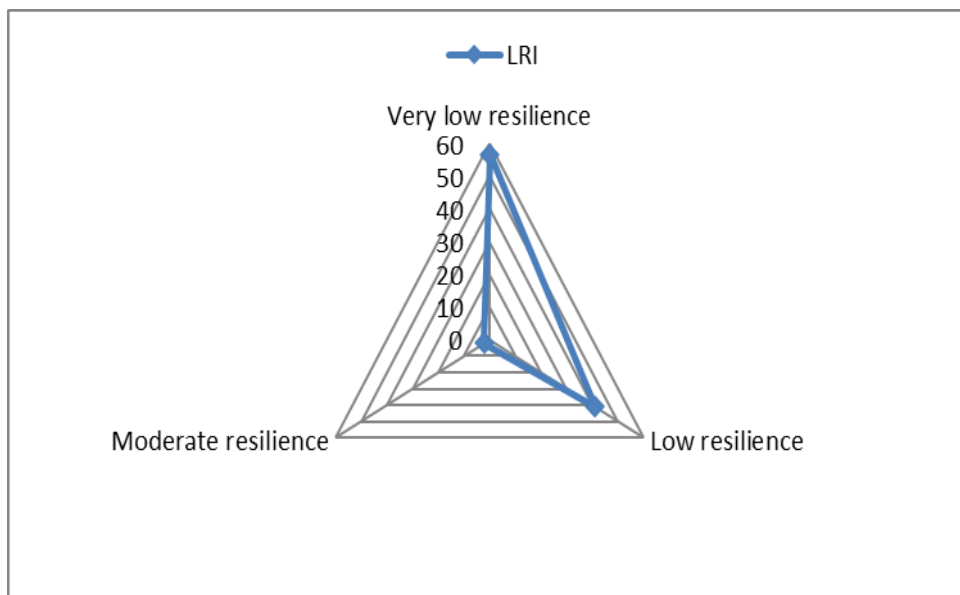


Figure 6a: Livelihood vulnerability resilience capacity distribution of households

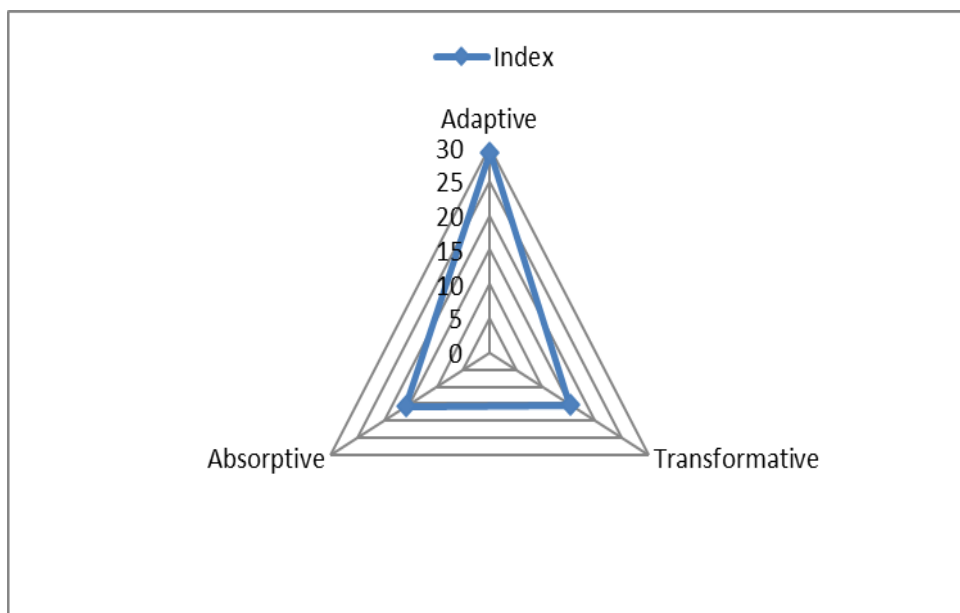


Figure 6b: Livelihood vulnerability resilience capacity indicators distribution

Mediating effect of livelihood vulnerability resilience capacity on food security and livelihood sustainability

Structurally, the effects of the resilience capacity indicators on livelihood vulnerability resilience capacity as a mediation vis-à-vis human growth and development showed that resilient capacity (LR) had a positive significant effect on hunger (DDS) (short-term food security), medium (food score consumption- FSC), long terms (food security- FS) food securities, and livelihood sustainability (LI) as evident by the plausibility of their respective parameter estimates at 10% error gap (Table 4a and Figure 7). The households' livelihood vulnerability resilient capacity is significantly being influenced by the adaptive and transformation capacities as shown by their respective estimated coefficients that are plausible within the acceptable margin of 10% degree of freedom. Evidently, a unit increase in the adaptive capacity of a rural household will increased its livelihood vulnerability resilience by 2.86% while a unit increase in the transformation capacity of a households will plummets its livelihood vulnerability resilience capacity by 1.47%. The positive significant influence of adaptive capacity on the livelihood vulnerability resilience of households in the study area didn't sprout a surprise as rural households are known to be good in devising and adopting advance contingency plans (liquidity holding for speculation, cash reserve in

form of livestock, e.t.c) against the unforeseen/uncertain future time that is risk and uncertainty characterized, thus as measures to expand income and enjoy continuum future expenditures. The negative significant influence of transformation capacity on livelihood's vulnerability resilience capacity may be attributed too weak public goods- poor infrastructural facilities and social safety nets that induced laxity in the study area. Though positive-signed, the non-significant influence of absorptive capacity of rural households on their livelihood's vulnerability resilience reflects ineffective adoption of traditional and conventional early warning signs of weather vagaries by the rural households in the study area. Furthermore, the households' livelihood vulnerability resilience capacity as a mediation, positively and significantly influenced households' dietary diversity (a strategy against hunger- short-term food security); households medium-term food security (food consumption score); households' long-term food security (access, affordability, utilization and stability); and enhanced sustainable livelihood (households' general wellbeing) as indicated by its parameter estimates that were different from zero at 10% probability level. Succinctly, for a unit increase in a household's livelihood vulnerability resilience capacity, its food dietary diversity (short-term food security), mid-term food security, long-term food security and the general wellbeing respectively will increased by 0.50, 3.52, 0.05 and 0.13%.

Table 4a: Effects of livelihood resilience capacity on food security and sustainable livelihood

Variable (→)	Estimate (US)	Estimate (S)	SE	CR	P-value	R ²
AC LR	2.863	0.768	0.315	9.083	***	0.672
TRANS LR	-1.474	-0.285	0.333	-4.427	***	
ABSP LR	0.036	0.008	0.284	0.127	0.899 ^{NS}	
LR LI	0.133	0.487	0.021	6.490	***	0.237
LR FS	0.052	0.492	0.008	6.539	***	0.242
LR Linc	1.000	0.561	-	-	-	0.315
LR DDS	0.495	0.218	0.151	3.278	0.001**	0.047
LR FSC	3.517	0.240	0.981	3.584	***	0.057
Variance						
AC -	0.026	-	0.002	12.610	***	-
TRANS -	0.014	-	0.001	12.610	***	-
ABSP -	0.017	-	0.001	12.610	***	-
e1 -	0.120	-	0.042	2.855	0.004**	-
e2 -	0.021	-	0.002	11.204	***	-
e3 -	0.003	-	0.000	11.159	***	-
e4 -	0.797	-	0.077	10.372	***	-
e5 -	1.806	-	0.146	12.411	***	-
e6 -	74.382	-	6.015	12.366	***	-

Source: Field survey, 2022

Note: ***, **, * & NS mean significant at 1, 5, 10% and non-significant respectively; US= Unstandardized; S= Standardized; SE= Standard error; CR= Critical ratio; P= Probability; R²= Squared multiple correlation; → = relationship; e= error term; and, Linc= Logarithm of income.

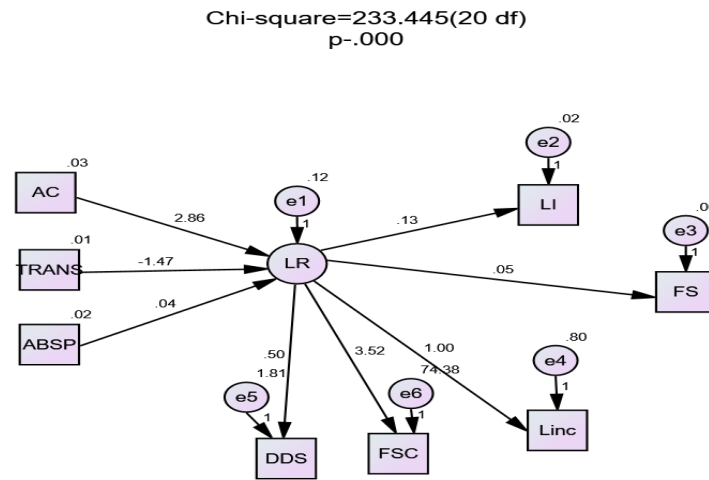


Figure 7: Structural modeling of the effect livelihood vulnerability resilience capacity on food security and sustainable livelihood

The respective total effects of absorptive (ABSP), adaptive (AC) and transformative (TRANS) capacities of a given household on its livelihood vulnerability resilience capacity, dietary diversity, food consumption score, long-term food

security and sustainable livelihood are 0.036, 2.86 and -1.47%; 0.018, 1.418 and -0.73%; 0.127, 10.07 and -5.185%; 0.002, 0.150 and -0.077%; and, 0.005, 0.382 and -0.197% respectively (Table 4b).

Table 4b: Direct, indirect and total effects of latent and mediating variables on food security and sustainable livelihood

Variable	ABSP	TRANS	AC	LR	ABSP	TRANS	AC	LR
	Unstandardized				Standardized			
Direct effect								
LR	.036	-1.474	2.863	.000	.008	-.285	.768	.000
FSC	.000	.000	.000	3.517	.000	.000	.000	.240
DDS	.000	.000	.000	.495	.000	.000	.000	.218
Linc	.000	.000	.000	1.000	.000	.000	.000	.561
FS	.000	.000	.000	.052	.000	.000	.000	.492
LI	.000	.000	.000	.133	.000	.000	.000	.487
Indirect effect								
LR	.000	.000	.000	.000	.000	.000	.000	.000
FSC	.127	-5.185	10.070	.000	.002	-.068	.184	.000
DDS	.018	-.730	1.418	.000	.002	-.062	.167	.000
Linc	.036	-1.474	2.863	.000	.004	-.160	.431	.000
FS	.002	-.077	.150	.000	.004	-.140	.378	.000
LI	.005	-.197	.382	.000	.004	-.139	.374	.000
Total effect								
LR	.036	-1.474	2.863	.000	.008	-.285	.768	.000
FSC	.127	-5.185	10.070	3.517	.002	-.068	.184	.240
DDS	.018	-.730	1.418	.495	.002	-.062	.167	.218
Linc	.036	-1.474	2.863	1.000	.004	-.160	.431	.561
FS	.002	-.077	.150	.052	.004	-.140	.378	.492
LI	.005	-.197	.382	.133	.004	-.139	.374	.487

Source: Field survey, 2022

Besides, the total effect of a household's livelihood vulnerability resilience capacity on dietary diversity, med-term food security, long-term food security and enhanced sustainable livelihood standard are 0.495, 3.517, 0.052 and 0.133% respectively. Generally, it can be concluded that adaptive capacity has greater influence across all the dimensions that enhance a better wellbeing in the study area. Therefore, it can be inferred that households' ability to withstand livelihood's vulnerability has positive bearing in achieving a healthy livelihood in the study area. As such, the study made a clarion call on the policymakers to adequately intervene in public commodities especially physical infrastructural facilities in order to enhance the livelihood's vulnerability resilience capacity of the rural populace, thus buffering both food and social securities of the state's rural economy in particular and by extension the state and the country in general. The validity of the diagnostic tests by being within their respective recommended thresholds implies that the structural equation model is fit for the specified structural equation (Table 4c). Thus, it can be concluded that the estimated parameter of the

confirmatory factor analysis are valid for future predictions with accuracy, certainty and consistency.

Livelihood sustainability security of rural households

Empirically, in assessing the livelihood sustainability security of the rural households, the livelihood's security sustainability of majority of the rural households was observed to be poor vis-à-vis 53.6 and 40.1% respectively (Figure 8a). In other words, majority of the households are been caught in the webs of very poor and poor sustainable livelihood security. Besides, 4.7 and 1.5% respectively of the rural households were classified to have moderate and good sustainable livelihood security. However, vis-à-vis good sustainable livelihood security, 0.6 and 0.9% of the rural households respectively had good and very good sustainable livelihood security. Furthermore, average-wise, the security status of sustainable livelihood indicators *viz.* ecological security and economic efficiency were very poor while social equity security had good rate (Figure 8b-c).

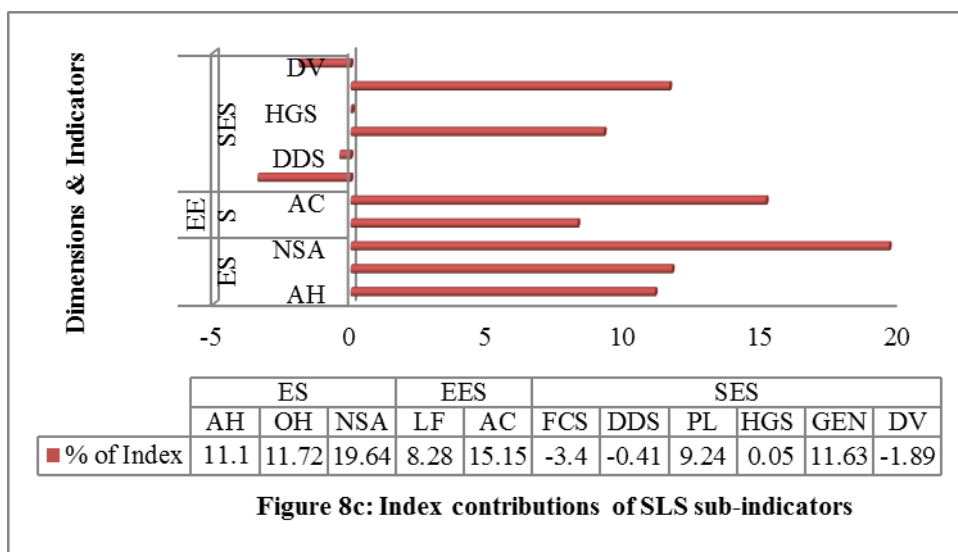
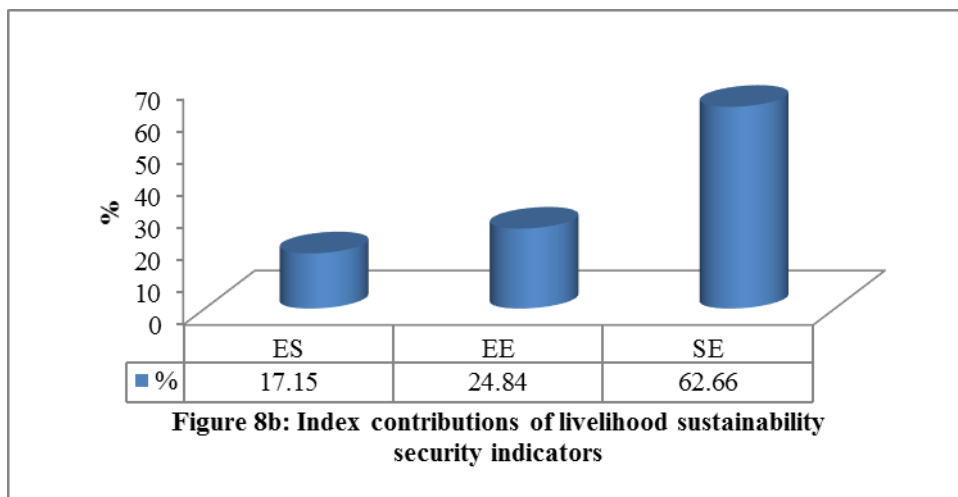
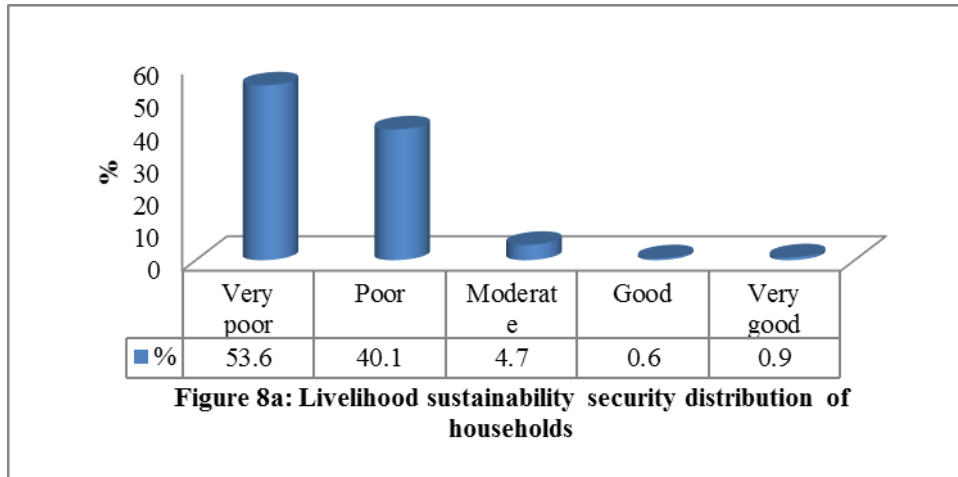
Table 4c: Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	233.445	-
	DF	20	-
	P	0	p<=0.05
	RMSEA	0.183	< 0.08
	RMR	1.121	<0.02
	GFI	0.962	> 0.90
	AGFI	0.952	> 0.90
Incremental fit	NFI	0.918	> 0.90
	RFI	0.925	> 0.90
	CFI	0.932	> 0.90
	TLI	0.945	> 0.90
	IFI	0.94	> 0.90
	PGFI	0.979	> 0.90
	FMIN	0.934	> 0.90
	CMIN/DF	4.672	< 5.0
Others	CAIC	341.688	-
	NCP	213.445	-
	PRATIO	0.714	-
	PNFI	0.37	-
	PCFI	0.38	-
	ECVI	0.835	-
	MECVI	0.838	-
	HOELTER 0.5	43	-
	HOELTER 0.1	52	-
	AIC	265.445	-
	BCC	266.377	-
	BIC	325.688	-

Source: Field survey, 2022

Thus, on this note, it can be inferred that poor sustainable livelihood security in the study area owed to climate-induced vagaries wreck devastating havoc on the environment, consequently

plummeting/ marring the ecological security and economic efficiency security indicators of livelihood's sustainability security of the rural populace in the study area.



Livelihood strategy of rural households

Furthermore, a thoughtful assessment of the livelihood survival strategy in a five-radar dimension (as modified by the researchers by contextualization of a strategy adopted by Illu *et al.*, 2021; Sadiq and Bashir, 2022) showed that most (43.6%) of the rural households adopted consolidation strategy, closely followed by 32.3% that opted for adaptive strategy, and a handful of 11.9 and 11.6% households respectively that were in the folds of coping and accumulation strategies (Figure 9a). However, it was observed that only insignificant share of the sampled rural population were caught/ got entangled in the category of survival strategy. Nevertheless, in a four-radar dimension, it was observed that majority (54.9%) of the rural households adopted adaptive strategy;

22.6% of the households adopted the accumulative strategy while an equivalent share of the foregoing are in near destitution- 20.4 and 2.2% are in the classes of coping and survival strategies respectively (Figure 9b). By implication, it means that majority of the households through intensification of existing livelihood or diversification into new income generating activities spread their risks of consumption failure in response to anticipated adverse trends. Consequently, the study advice policymakers to devise proactive measures that will earnestly arrest the vicious cycle of livelihood destitution affecting the rural households in the folds of survival and coping strategies so as not to become a societal nuisance in a near period in the study area.

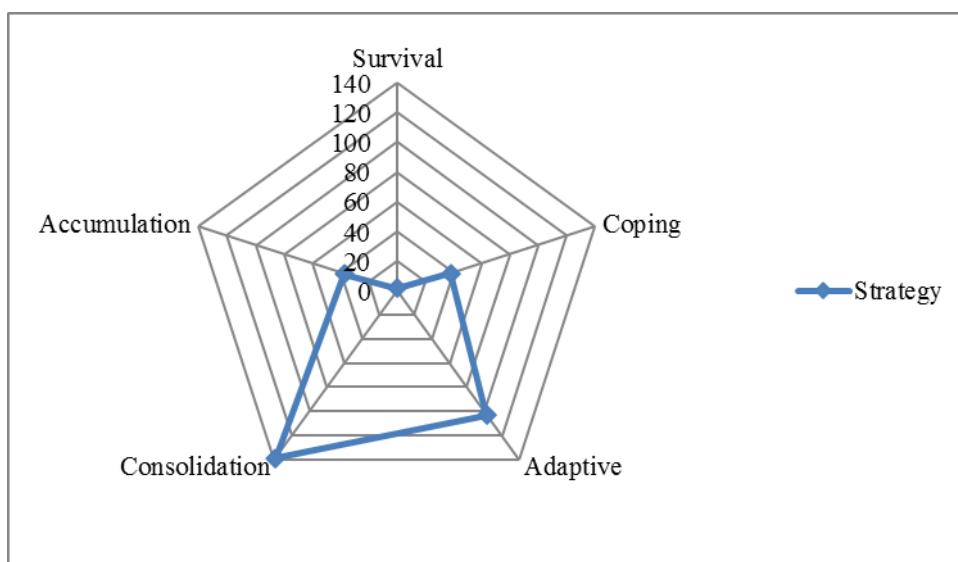


Figure 9a: Livelihood strategy distributions of households (5-dimensions)

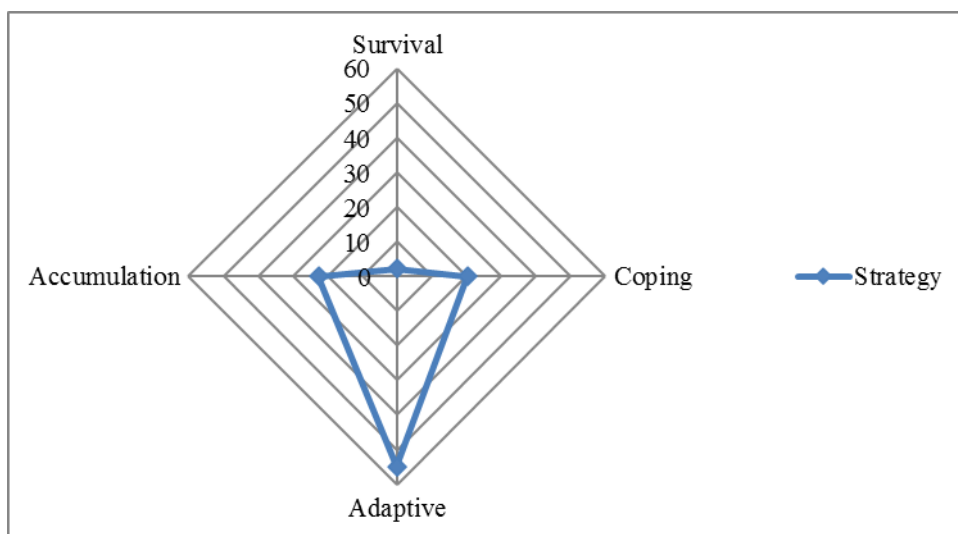


Figure 9b: Livelihood strategy distributions of households (4- dimensions)

Juxtaposing livelihood’s assets, vulnerability and resilience

The nexus of livelihood vulnerability to resilience capacity showed majority (74%) of the households to be in the prodigal-case category, an indication that they possessed poor economic, social and physical adaptation strategies to deal with shocks and stress (Figure 10). Households in this category are challenged with less vulnerability in terms of physical, social and political dimensions. Nevertheless, 23.8% of the study population fell in the worst-case category while few fell in the best-case (1.3%) and self-made (0.9%) categories. For identification of the appropriate vulnerable groups viz. integrative framework of the trio- livelihood

assets, vulnerability and resilience, based on livelihood’s assets, these four categories can further be characterized into eight groups. As presented in Table 5, each of these eight categories needs different treatment and policy measures for building adaptability. Therefore, households that fell in category three (3) should be accorded the highest priority in the events of any shocks and stress-crises, given their low livelihood statuses in assets, vulnerability and resilience. Besides, except households in category eight that needs little or no attention, the same treatment should be given to the other categories as they are challenged with sustainable livelihood dimensions.

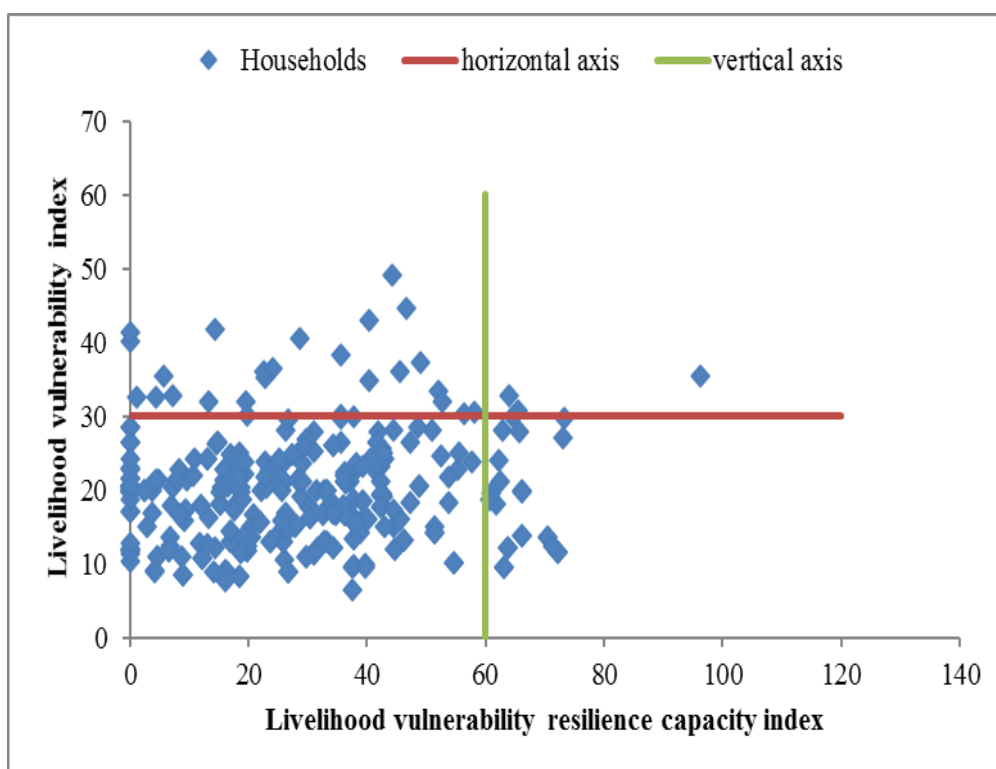


Figure 10: Nexus of livelihood vulnerability and resilience capacity

Table 5: Livelihood vulnerability and resilience differential in different livelihood asset profile

Category	LAP	LVP	LRP	Frequency	%
C-1	Low	Low	Low	46	14.4
C-2	Low	Low	High	1	0.3
C-3	Low	High	Low	23	7.2
C-4	Low	High	High	1	0.3
C-5	High	Low	Low	189	59.2
C-6	High	Low	High	3	0.9
C-7	High	High	Low	54	16.9
C-8	High	High	High	2	0.6
Total				319	100

Source: Field survey, 2022

Note: LAP= Livelihood asset profile; LVP=Livelihood vulnerability profile; LRP= Livelihood resilience profile

CONCLUSION AND RECOMMENDATIONS

Based on the findings, it was inferred that multi-dimensional poverty is rife among most of the rural households with them being deprived of at least three livelihood dimensions. Besides, deprivation in wealth rears its ugly head more in multi-dimensional deprivation faced by the rural households. However, Zone II of the study area is more challenged by multi-dimensional poverty. Furthermore, most of the households adopted adaptive strategy and this owes to good possession of livelihood capital assets *viz.* natural, human and financial capitals. Consequently, households spread their consumption failure risks by intensifying their existing livelihood strategies and diversifying into new economic activities. Besides, owing to adaptive capacity, livelihood vulnerability to anticipated adverse trends was less among majority of the households. However, the masked effect of food insecurity on adaptive capacity inhibited livelihood vulnerability resilience capacity of majority, consequently, makes livelihood sustainability security elusive in the study area. Therefore, onus lies on policy makers to enhance the pillars that buffer livelihood vulnerability resilience capacity given the empirical justification that resilience capacity has direct significant influence on short-term, mid-term, long-term food securities and sustainable livelihood in the study area.

REFERENCES

- Alam, G. M., Alam, K., Mushtaq, S., & Leal Filho, W. (2018). How do climate change and associated hazards impact on the resilience of riparian rural communities in Bangladesh? Policy implications for livelihood development. *Environmental Science & Policy*, **84**, 7-18.
- Atara, A., Tolossa, D., & Denu, B. (2020). Analysis of rural households' resilience to food insecurity: Does livelihood systems/choice/matter? The case of Boricha woreda of sidama zone in southern Ethiopia. *Environmental Development*, **35**, 100530.
- Bauer, T., de Jong, W., Ingram, V., Arts, B., & Pacheco, P. (2022). Thriving in turbulent times: Livelihood resilience and vulnerability assessment of Bolivian Indigenous forest households. *Land Use Policy*, **119**, 106146.
- Chen, S., Wu, J., Zhou, K., & Li, R. (2023). Livelihood resilience and livelihood construction path of China's rural reservoir resettled households in the energy transition. *Frontiers in Sustainable Food Systems*, **6**, 1046761.
- Chitongo, L. (2019). Rural livelihood resilience strategies in the face of harsh climatic conditions. The case of ward 11 Gwanda, South, Zimbabwe. *Cogent Social Sciences*, **5**(1), 1617090.
- Dang, P., Ren, L., & Li, J. (2022). Livelihood resilience or policy attraction? Factors determining households' willingness to participate in rural tourism in western China. *International Journal of Environmental Research and Public Health*, **19**, 7224.
- Davies, S. (1996). Adaptable livelihoods: coping with food insecurity in the Malian Sahel. *Sciences. Technology and Development*, **14**(1), 144-156.
- Devereux, S. (1993). Goats before ploughs: dilemmas of household response sequencing during food shortages. *Ids Bulletin*, **24**(4), 52-59.
- Fahad, S., Hossain, M. S., Huong, N. T. L., Nassani, A. A., Haffar, M., & Naeem, M. R. (2023). An assessment of rural household vulnerability and resilience in natural hazards: evidence from flood prone areas. *Environment, Development and Sustainability*, **25**(6), 5561-5577.
- Hahn, M. B., Riederer, A. M., & Foster, S. O. (2009). The Livelihood vulnerability index: A pragmatic approach to assessing risks from climate variability and change-A case study in Mozambique. *Global Environmental Change*, **19**(1), 74-88.
- Ha-Mim, N. M., Hossain, M. Z., Rahaman, K. R., & Mallick, B. (2020). Exploring vulnerability-resilience-livelihood nexus in the face of climate change: A multi-criteria analysis for Mongla, Bangladesh. *Sustainability*, **12**(17), 7054.
- Illu, A.R., Muhaimin, A.W. and Setiawan, B.(2021). Farmers' livelihoods strategy based on asset in Pandansari village post eruption of Mount Kelud. *Agricultural Socio-Economics Journal*, **21**(4), 277-284
- Insani, T. D., Rudiarto, I., Handayani, W., & Wijaya, H. B. (2022). Rural livelihood resilience on multiple dimensions: a case study from selected coastal areas in Central Java. *World Review of Science, Technology and Sustainable Development*, **18**(2), 176-193.
- Keshavarz, M., & Moqadas, R. S. (2021). Assessing rural households' resilience and adaptation strategies to climate variability and change. *Journal of Arid Environments*, **184**, 104323.

- Li, E., Deng, Q., & Zhou, Y. (2022). Livelihood resilience and the generative mechanism of rural households out of poverty: An empirical analysis from Lankao County, Henan Province, China. *Journal of Rural Studies*, **93**, 210-222.
- Liu, H., Pan, W., Su, F., Huang, J., Luo, J., Tong, L., ... & Fu, J. (2022). Livelihood resilience of rural residents under natural disasters in China. *Sustainability*, **14**(14), 8540.
- Liu, W., Li, J., Ren, L., Xu, J., Li, C., & Li, S. (2020a). Exploring livelihood resilience and its impact on livelihood strategy in rural China. *Social Indicators Research*, **150**, 977-998.
- Liu, W., Li, J., & Xu, J. (2020b). Effects of disaster-related resettlement on the livelihood resilience of rural households in China. *International Journal of Disaster Risk Reduction*, **49**, 101649.
- Mahmoodi, S., & Hasani Talesh, M. (2021). Livelihood resilience of rural households with emphasis on sustainable agriculture (Case study: Khotbe'sara district, Talesh county). *Geography and Development*, **19**(63): 119-146.
- Morris, M., Butterworth, J., Lamboll, R., Lazaro, E., Maganga, F., & Marsland, N. (2001). Household livelihood strategies in semi-arid Tanzania: synthesis of findings. Annex A of the final technical report of project R7805. DFID Project. *Natural Resource Institute, University of Greenwich, Chattam*, **94**.
- Nasrnia, F., & Ashktorab, N. (2021). Sustainable livelihood framework-based assessment of drought resilience patterns of rural households of Bakhtegan basin, Iran. *Ecological Indicators*, **128**, 107817.
- National Population Commission (NPC) (2021). 2006 Population and Housing Census: Population Distribution by Sex, State, LGA and Senatorial District (Priority Table Volume III). Abuja: National Population Commission, Abuja, Nigeria
- Pagnani, T., Gotor, E., & Caracciolo, F. (2021). Adaptive strategies enhance smallholders' livelihood resilience in Bihar, India. *Food Security*, **13**, 419-437.
- Sadiq, M.S., & Sani, B.S.(2022). Livelihood status of paddy rice agro-processors that benefitted from microfinance credit in Jigawa State of Nigeria, *Bozok Journal of Agriculture and Natural Sciences*, **1**(2), 71-94.
- Seth, S., & Alkire, S. (2014). Measuring and decomposing inequality among the multidimensionally poor using ordinal data: A counting approach.
- Shi, G., Zhao, Y., Mei, X., Yan, D., Zhang, H., Xu, Y., & Dong, Y. (2022). Livelihood resilience perception: Gender equalisation of resettlers from rural reservoirs-empirical evidence from China. *Sustainability*, **14**(17), 11053.
- Simane, B., Zaitchik, B. F., & Foltz, J. D. (2016). Agroecosystem specific climate vulnerability analysis: application of the livelihood vulnerability index to a tropical highland region. *Mitigation and Adaptation Strategies for Global Change*, **21**, 39-65.
- Tannor, S. J., Kelboro, G., Greve, K., Borgemeister, C., & Tischbein, B. (2022). Climate variability and extractivism exposures: Understanding household perspectives on livelihood resilience in rural Ghana. *The Extractive Industries and Society*, **12**, 101164.
- Tebboth, M. G. L., Conway, D., & Adger, W. N. (2019). Mobility endowment and entitlements mediate resilience in rural livelihood systems. *Global Environmental Change*, **54**, 172-183.
- Wang, Y., Zhang, Q., Li, Q., Wang, J., Sannigrahi, S., Bilsborrow, R., ... & Song, C. (2021). Role of social networks in building household livelihood resilience under payments for ecosystem services programs in a poor rural community in China. *Journal of Rural Studies*, **86**, 208-225.
- Weldegebriel, Z. B., & Amphune, B. E. (2017). Livelihood resilience in the face of recurring floods: an empirical evidence from Northwest Ethiopia. *Geoenvironmental Disasters*, **4**, 1-19.
- Yang, X., Li, X., Lu, K., & Peng, Z. R. (2023). Integrating rural livelihood resilience and sustainability for post-disaster community relocation: a theoretical framework and empirical study. *Natural Hazards*, **116**(2), 1775-1803.
- Zhao, X., Xiang, H., & Zhao, F. (2023). Measurement and spatial differentiation of farmers' livelihood resilience under the COVID-19 epidemic outbreak in rural China. *Social Indicators Research*, **166**(2), 239-267.
- Zhou, W., Guo, S., Deng, X., & Xu, D. (2021). Livelihood resilience and strategies of rural residents of earthquake-threatened areas in Sichuan Province, China. *Natural Hazards*, **106**, 255-275

Appendix 1: Dimensions, indicators, cut-off points and relative weight of MPI

Dimensions	Indicators	Deprivation cut-off	Relative weight
Education (ED)	School	No child (≥ 10 years) has completed five years of schooling	1/8
Health (HL)	Nutrition	Any family member that is underweight (slim) ($BMI < 18.5$)/overweight (≥ 23)/Obesity (≥ 25)	1/24
	Vaccination	Any family member not immunized/vaccinated to prevent any type of communicable diseases	1/24
	Health insurance	No family member is insured under any type of health insurance scheme	1/24
Standard of Living (SL)	Housing	Living in an inadequate housing condition	1/32
	Electricity	No access to electricity	1/32
	Water	No access to safe drinking water	1/32
	Mobility	Didn't owned any type of motor vehicle for transportation purpose	1/32
Wealth/Asset (WL)	Bank	Didn't possessed a savings bank account	1/48
	Land	Didn't owned any hectare of residential land other than where he/she is residing	1/48
	Credit	Didn't have access to credit facilities	1/48
	Dead stock (NAGA)	Didn't possessed non-agricultural dead stocks	1/48
	Dead stock (AGA)	Didn't possessed agricultural dead stocks	1/48
	Livestock	Livestock ownership (deprived if TLU is less than average)	1/48
Environment (EN)	Toilet	Household still practicing open defecation	1/16
	Energy	Using dirty fuel as primary energy for cooking (e.g firewood, dung & charcoal)	1/16
Empowerment (EM)	Health decision	Unable to take healthcare decision	1/32
	Domestic violence	Unable to prevent domestic violence	1/32
	Socio-political instability	Problem of social/political unrest	1/32
	Self-defense	Problem of personal security	1/32
Material well-being (MW)	Job	Unable to take any type of employment decisions for yourself other than	1/24
	Diversification	Off-farm activities	1/24
	Food security	Food insecure	1/24
Social connectedness (SC)	Community service	has not participated in any type of community-level activities	1/32
	corporate responsibility	has not been involved in organizing any type of community-level activities	1/32
	Social safety net	Didn't trust government social investment programme (e.g. farmers/traders monie etc)	1/32
	Social capital	Not member of any co-operative association	1/32

Note: NAGA= Non-agricultural asset; AGA=Agricultural asset

Appendix 2a: Livelihood vulnerability and capital assets dimensions-indicators

Vulnerability Factors	Livelihood Capitals	Profiles	Indicators
Exposure		Climate	Number of parasites attack on crop in the last 10 years
			Number of parasites attack on livestock in the last 10 years
			Number of livestock lost to pest and diseases in the last 10 years
			Number of household's member(s) sick in the last 1 year
			Number of flood/drought in the last 10 years
Sensitivity	Natural	Ecosystem	Number of fire outbreak either in the house or farm in the last 10 years
			Climate suitability (6 Likert scales (HF to HUF))
		Agriculture	Irrigation water sources
			Farm production
			Land fertility
Adaptive Capacity	Human	Human	Farm production
			Farming knowledge
			Farming skills
			Farming experience
			Health
			Household size
			Other business skills
	Social	Community	Other business experiences
			Community Organization
			Social Networking
			Mutual cooperation
	Financial	Wealth	Trust
			Income
			Savings
			Assistance / Subsidies
Individual Credit			
Credit from Credit Institutions			
Remittances			
Physical	Infrastructure	Access to transportation and ICT	
		Production facilities	
		Infrastructures	
		Working equipment	
		Accessibility to institutions	

Source: Modeled according to Sadiq and Sani, 2022; Simane *et al.*, 2014; Hahn *et al.*, 2009

Appendix 2b: Typology and examples of different livelihood strategies

Livelihood strategy	Internal livelihood system component		
	Change to assets	Strategies	Consumption outcomes
Accumulative	Increased asset stock. Increased flexibility across asset base.	As for adaptive	More income. Better nourishment. Increased security.
Adaptive	Altering the mix of assets. Prudently preserving money and other assets.	Extensification (cultivation of more land). On-farm & off-farm diversification (e.g. change in cropping mix, wage labour). Intensification of cash cropping. Investments in social capital. Migration.	Consumption and income smoothing Lowering of risk Spreading of risk. smoothing of labor
Coping	Increased livestock sales Calling down impromptu claims (for instance, via kin networks).	Farm labor, piecework Temporary migration Youngsters being taken out of school.	Reduced meal frequency, size, and quality. Use where available of relief food. Less social and ceremonial duties.
Survival	Selling of useful assets (like bicycles and land). Sale of furniture and other home items.	Illicit behavior. Begging.	Permanent out-migration Poverty and starvation.

Source: Morris *et al.*(2001); Davies (1996); Devereaux (1993)

Appendix 3: Livelihood resilience capacity dimensions and indicators

Dimensions	Indicators	Units
Adaptive capacity	Access to credit service	Yes/No
	Income sources possessed	Number
	Numbers of crops cultivated in the last season	Number
	Perception on food security adaptive capacity level	4-likert scale (Very high to Low)
	Number of food coping strategies adopted	Number
	Household's consumed balance diet in the last three days	3-likert scale (Yes to No)
	Extension services	Yes/No
	Membership of co-operative association	Yes/No
	Dependency ratio	%
	Education level	Years
	Number of household's members that have attended school	Number
	Dietary diversity score	Index
	Food consumption score	Index
	Income	Naira
Absorptive capacity	The same with exposure indicators in Appendix 2a	Number
Transformative capacity	Land ownership	Yes/No
	Livestock ownership	TLU
	Wealth	Index
	Agricultural Asset	Index
	Received food assistance from friends	Yes/No
	Perception on the importance food aid received	5-Likert scale (VI to NI)
	Remittance from family member	Yes/No
	Assistance from government	Yes/No
	Access to children scholarship	Yes/No
	Access to telecommunication services	Yes/No
	Cost of transportation to health centre	Naira
	Cost of transportation to pharmacy	Naira
	Cost of transportation to market centre	Naira
	Cost of transportation to agro-service centre	Naira
Cost of transportation to agro-processing centre	Naira	
Cost of transportation to primary school	Naira	
Cost of transportation to veterinary centre	Naira	

Source: Modeled according to Weldegebriel and Amphune, 2017; Note: VI =Very important, NI=Not important

Appendix 4: Livelihood sustainability security dimensions and indicators

Dimensions	Indicators	Units
Ecological security (ES)	Agri-holding (AH)	Hectare
	Operational holding (OH)	Hectare
	Net sown area (NSA)	Hectare
	Forest cover**	5-Likert scale (Very high to Undecided)
Economic efficiency (EE)	Land fertility (LF)	6-Likert scale
	Areas under cereals (AC)	Hectare
Social equity (SE)	Food consumption score (FCS)	Households above the FCS threshold
	Dietary diversity score (DDS)	Households above the DDS threshold
	Poverty line (PL)	Households above the poverty threshold
	Hunger scale (HGS)	Households above hunger threshold
	Gender (GEN)	Male/Female
	Women's literacy**	Year
	Domestic violence (DV)	Yes/No

Note: ** means recommended for inclusion in further study