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Food Insecurity Resilience Capacity of Rural Households in the Face of Induced-Weather Extremities in Bauchi State of Nigeria

Abstract. It is no longer a chasm that human existence is being threatened by induced-weather vagaries. Given the dynamic nature of the weather vagaries, if tacit actions are not taken on continuum basis, soonest, human race will go into extinction because of the steep devastating push effect of climate change. It is in lieu of the foregoing, that the researchers conceptualized a study that assessed rural households' food insecurity resilience capacity in Nigeria's Bauchi state using a resilience index measurement analysis (RIMA II), a novel methodological approach developed by FAO for studying such scenario, as literature review showed no evidence of its application in the study area. Adopting a multi-stage random sampling technique, a total of 322 households were randomly sampled from a sampling frame obtained by a reconnaissance survey. Using a well-structured questionnaire complemented with interview schedule, rural households' survey data were collected in the year 2022. Besides, the collected data were analyzed using both descriptive and inferential statistics. Empirically, it was established that the study area is challenged with food insecurity that owes majorly to poor food utilization and stability. Besides, poor food insecurity resilience capacity majorly due to vulnerable adaptive capacity was unmasked as the push effect behind food insecurity bane in the study area. However, evidence showed that food insecurity resilience capacity has a lasting effect on general well-being of rural households while households' hunger resilience capacity has a transitory effect as it can only contain food crises on the short-term basis. Nevertheless, income and consumption smoothening were the commonest short-term food coping strategies adopted in the study area. To achieve the sustainable development goals of zero hunger by 2030, it becomes imperative on policymakers to sensitize rural households on the need to adopt safe and eco-friendly improved indigenous food technologies so as to address the poor states of food utilization and stability affecting food security of the study area.

Keywords: food security, resilience, rural, sustainability, Nigeria

JEL Classification: I31, I32, Q12, Q18

Introduction

According to the Beyene et al. (2023), rural areas make up 59% of the population in developing nations and are crucial for the provision of food and other raw resources, the development of the national economy, the creation of jobs, and the preservation of natural

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areas (Mkupete et al., 2023). While rural areas are the backbone of the economy and make a sizable contribution to GDP (Sunday et al., 2023; Atara et al., 2020; Lascano Galarza, 2020), the sustainability of rural residents' livelihoods has been threatened by an increase in climatic stressors like droughts and anthropogenic forces, market volatility, and political unrest (Egamberdiev et al., 2023; Meyer, 2020). In many developing nations, this has resulted in unrelenting poverty and insufficient socioeconomic entitlements (d'Errico et al., 2023; Ado et al, 2022; Melketo et al., 2021; Dhraief et al., 2019).

Acute food insecurity has plagued millions of people in sub-Saharan Africa for the past 40 years due to harsh weather circumstances (Ouoba and Sawadogo, 2022; Sadiq et al., 2018a&b). The food system is currently subject to climate-related shocks every two years, which are nearly permanent in some regions (Bahta, 2022; Myeki and Bahta, 2021; Béné, 2020). These circumstances make it impossible for farmers in these nations or regions to recover from shocks (Merchant et al., 2022; Abebe, 2020; Ansah et al., 2019). This means that in order to more swiftly recover from food shocks, it's necessary to invest in the adaptability of communities and ecosystems. According to the UN, up to 65% of Africa's arable land has been degraded, and 45% of it has been damaged by desertification (Negesse et al., 2022). The World Food Programme (WFP), the United Nations Children's Fund (UNICEF), and the Food and Agriculture Organization of the United Nations (FAO), issued a joint statement at the Network for Food Crisis Prevention in West Africa (RPCA) annual meeting in Lomé in December 2022, sounding the alarm.

If urgent and long-term solutions are not discovered, these organizations warned that by the end of 2023, there will be more than 48 million hungry people in West and Central Africa, including 9 million children (Sadiq and Sani, 2022). African nations are also generally impacted by global economic fluctuations that threaten their food security, such as unstable commodity markets (Haile et al., 2022; Chamdimba et al., 2021), rising energy and fertilizer costs, snags in global trade (Ansah et al., 2023), as well as the ongoing situation in Ukraine. As a result of these shocks, food prices have sharply increased throughout the region, worsening food insecurity as persistent surge in the general price level (inflation) squeezes already-limited household finances and jeopardize social cohesion. All evidence points to the urgent need for sustainable solutions to be discovered in order to guarantee that future generations will have access to arable land that can support their demands.

The North-east of Nigeria consistently struggles with issues like poverty, resource depletion, climate change, and food and nutritional insecurity. Despite the mobilization and intervention of numerous actors to offer food help to the most vulnerable people, the region has experienced the biggest spike in starvation over the last ten years. The livelihoods of its inhabitants are under danger due to an increase in insecurity brought on by escalating conflict situations and millions of internally displaced persons (Agwu, 2023). Food security is a multifaceted notion that can be broadly classified into four basic categories: stability, availability, utilization, and access. Comprehending the application of these dimensions to Nigerian rural households offers a valuable understanding of the obstacles they have in guaranteeing a steady and dependable food supply.

The idea of resilience is increasingly being applied to development projects meant to increase rural households' and communities' ability to adapt, change, and cope with varieties of shocks and stressors (Calloway et al., 2022; Murendo et al., 2021; Nahid et al., 2021; Alhassan, 2020). However, there are still many obstacles to overcome before integrating the idea of resilience into food and nutrition security regulations and programming. This is mainly due to the fact that the concept can be best understood as being encased within constantly changing and highly specific processes that can be comprehended differently by different parties. Consequently, this has created a vacuum in research viz. knowledge, empirical, methodological and population gaps, thus the need for urgent information for policymakers and academic literature. It is in lieu of the foregoing that this research attempts to assess the food insecurity resilience capacity of rural households in the face of induced-weather extremities in Bauchi State of Nigeria. The specific objectives of the study were to determine the food insecurity status of the households; determine the food insecurity resilience capacity of the households; determine the effect of food insecurity resilience on food security and sustainable livelihood in the study area; and, to determine the food security coping strategies adopted by the households in the study area.

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 is 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 food insecurity is a general phenomenon. Subsequently, given the disproportionate distribution of the inherent LGAs across the strata, proportionate sampling technique was used to select the representative LGAs. Thereafter, from each of the selected LGAs, two villages were randomly selected. Based on the sample frame generated through 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. Hunger scale, dietary diversity score, food consumption score and food insecurity index were used to achieve objective I; resilience index measurement and analysis (RIMA II) and confirmatory factor were used to achieve objectives II and III; while IV was achieved using exploratory factor analysis. It is worth to mention that principal component analysis was used as a complimentary tool to generate food insecurity and RIMA II indexes.

$$n_p = \frac{N(X)}{X+(N-1)} \quad \text{.................................... (1)}$$

where:

$X = \frac{Z^2 \ x\, P(1-P)}{e^2}$

n = Sample size;

N = Population size;

e = Acceptable sampling error;

X= Finite sample size;

P = Proportion of the population

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	10
		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.

Empirical models

1. ***Dietary diversity score:***

$DDS = \frac{\sum_{n=1} foods\ consumed}{Total\ household\ size}$ …………………..…….. (2)

2. ***Minimum normalization index***

$I = \frac{I_i - I_{min}}{I_{max} - I_{min}}$ ……………………………….....……. (3)

Where: *'I'* is the indicator index, I_i is the value of the i^{th} indicator; $I_{min}$is the minimum value of the i^{th}indicator; and, I_{max} is the maximum value of the i^{th}indicator.

3. ***Dimension index***

$D_i = \sum_{i=1}^{n=0} \left(\frac{w_i * I_i + \ ......w_n * I_n}{w_i + \ ....w_n} \right)$ ………………………… (4)

Where: D_i is the dimension index of i^{th} households and w is the weight of i^{th} Indicator index.

4. ***Food insecurity index***

$FISI = \frac{(AV^3 + AC^3 + U^3 + S^3)^{1/3}}{4}$ ………………………. (5) (Anand and Sen, 1997)

Where: AV= Availability; AC= Access; U= Utilization; and, S= Stability (Table 2).

5. ***RIMA-II***

Resilience is complex and difficult to measure because it cannot be immediately witnessed or measured. The FAO RIMA-I and RIMA-II approaches use a set of pillars to measure resilience, which are then combined using latent variable models. After RIMA-I was initially implemented in more than ten countries; FAO refined the process and created a second version in 2015 (FAO, 2015). Both direct and indirect indicators of resilience are included in the updated RIMA-II, which eventually leads to a more thorough evaluation of resilience and more reliable policy recommendations. Within a dynamic framework, RIMA-II shows statistically sound causal links between food security drivers and outcomes, as well as predicts the factors that influence changes in the capacity for resilience and food security. The direct measure in RIMA-II now consists of four pillars instead of the previous six pillars. Rather than being part of the estimate model, shocks and food security indicators are used as predictors (shocks) & resilience outcomes (food security) (FAO, 2016). The Resilience Capacity Index (RCI) and the Resilience Structure Matrix (RSM) are two tools used by RIMA-II to measure resilience directly (FAO, 2015). The former assesses a household's ability to withstand shocks and stressors and prevent long-term harm, while the latter indicates the relative importance of each pillar in determining resilience.

$RIMA - II = \frac{ABS + AST + SSN + AC}{W_{ABS} + W_{AST} + W_{SSN} + W_{AC}}$ … (6) (FAO, 2015 & 2016; Alinovi et al., 2008)

ABS=Access to basic services; AST=Assets; SSN=Social safety net; and, AC=Adaptive capacity (Table 3).

6. ***Confirmatory factor analysis (CFA)*:** The multiple indicator multiple cause (MIMC) belongs to structural equation model (SEM) family, and it combines two models of SEM viz. formative and reflective models. The distinction between these two models lies on causal structure. A formative model sees the observed variables as the cause of the latent variable while the reverse is the case for reflective model. Given below is the MIMC model:

$$\begin{bmatrix} LI \\ FS \\ Linc \end{bmatrix} = [\beta_{1-4}] * [\eta] + [\varepsilon_2, \varepsilon_6] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

$$[\eta] = [\delta_{1-5}] * \begin{bmatrix} ABS \\ AC \\ SSN \\ AS \\ Shock \end{bmatrix} + [\varepsilon_1] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

$$\begin{bmatrix} LI \\ FS \\ INC \end{bmatrix} = [\alpha_{1-4}] * [\omega] + [\varepsilon_{14}, \varepsilon_{18}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(9)}$$

$$[\omega] = [\gamma_{1-3}] * \begin{bmatrix} MS \\ IM \\ CC \end{bmatrix} + [\varepsilon_{1-13}] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(10)}$$

Where, MIMC for food insecurity resilience and hunger resilience are (Equations 7-8) and (Equations 9-10) respectively. η is food insecurity resilience capacity (FIRC), β_{1-4} is parameter estimates of FIRC, δ_{1-5} is parameter estimates of food security indicators (ABS, AC, SSN, AS) and shocks; ω is hunger resilience capacity (HRC), α_{1-4} is parameter estimates of FIRC, γ_{1-3} is parameter estimates of hunger coping strategies (MS= meal skipping, IM= inferior meal, and CC= consumption credit); LI is livelihood index, FS is food security index (short- DDS, medium- FSC and long- FS terms), IN is income, Linc is log income; and, ε_{1-n} is error term.

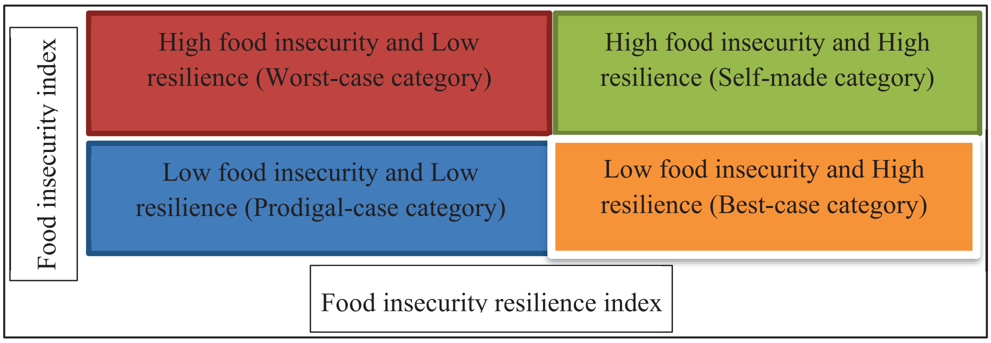


Fig. 1. Nexus between food insecurity and resilience index

Source: Ha-Mim *et al*. (2020).

Table 2. Dimensions and indicators of food insecurity

Dimensions	Indicators	Units
AV	Food expenditure per household	Naira per head
	Farm size	Hectare
	Number of farms	Number
	Land tenure ship	Type (rent, inheritance, etc)
	Food purchased capacity	Naira
	Food stock for over 2-6 months	Naira
	Quantity of food assistance	Naira
	Income from sales of crop	Naira
	Income from sales of Livestock	Naira
	Quantity of purchased food product from the market	Naira
	Quantity obtained from fishing/wild gathering	Naira
	Income diversification	Number
	Availability of wild food	Yes/No
	Monthly purchasing power/ monthly income	Naira
AC	Transport Cost for farm produce & livestock	Naira
	Availability of road market infrastructure	Yes/No
	Distance to market's road	Cost
	Availability of market	Yes/No
	Distance to market	Cost
	Labor exchange for Food	Naira
	Availability of storage facilities	Yes/No
	Capacity of storage facilities	Bag(s)
	Income from women and children	Naira
	Membership of trade association	Number
	Income from off-farm activities	Naira
	Income from farm activities	Naira
	Engagement in Non-Farm Employment	Number
	Engagement in dry season farming	Yes/No
ST	Household's production (output)	Naira
	Number of months of rainfall	Number
	Drought, Erosion, flood	Yes/No
	Political crises/ social unrest	Yes/No
	Price of a major commodity	Naira per month
UT	Disease affliction (diarrhoea, fever, cholera, etc)	Number
	Water supply source(s)	Number
	Number of meals per day	Number
	Number of meal variety per day	Number
	Number of food items consumed	Number
	Food habits	3-likert scale (H to P)
	Number of food preparation practices	Number
	Number of acceptable food preferences & substitutes	Number
	Availability of and access to milling facilities	Yes/No
	Adequate sanitation	4-Likert scale (H to VP)
	Access to health services	4-Likert scale (H to VP)

Note: H= High; P= Poor; and, VP= Very poor.

Source: Adopted and modified from Sadiq and Sani (2022).

Table 3. Dimensions and indicators of resilience

Dimension	Indicator	Unit
ABS	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
AC	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-likerst scale (VH to L)
	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
SSN	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
AST	Land ownership	Yes/No
	Livestock ownership	TLU
	Wealth	Index
	Agricultural Asset	Index

Note: VH= Very high; L= Low; TLU= Tropical livestock units; Naira = Nigerian currency.

Source: FAO (2015 & 2016).

Table 4. Weather-induced shocks’ indicators

Indicators
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
Number of fire outbreak either in the house or farm in the last 10 years

Source: FAO (2015 & 2016).

Results and discussion

A cursory review of hunger status, short-term food insecurity, revealed that majority (57.1%) of the rural households is at risk of hunger (Figure 2). Besides, slightly less than half (42.3%) of the sampled households were hungry while insignificant proportion (0.6%) of the rural populace escaped the voracious web of hunger in the study area. Therefore, it can be inferred that the rural populace are challenged with hunger, a short-term food insecurity challenge.

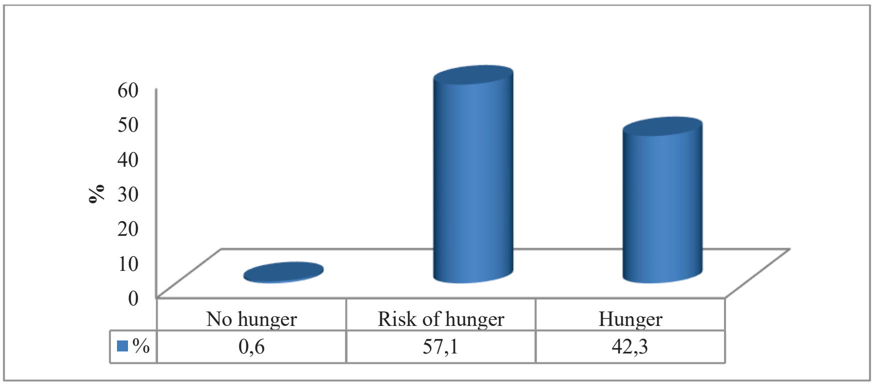


Fig. 2. Hunger scale of rural households

Source: Field survey, 2022.

As a rider, the average dietary diversity of households in the study area being 1.4 per head justified the height of hunger in the study area. Nevertheless, at a threshold of 4 meals per head as used by Mathye and Gericke (2019), almost all the rural households have poor dietary diversity vis-à-vis 84.3 and 11.9% respectively are faced with very poor and poor dietary diversities (Figure 3). Fortunately, 1.9% is at the threshold of vulnerability while a similar percent replica had a good dietary diversity per head in the study area. This state of heightened short-term food insecurity is a potential threat to the growth and development of the rural economy as it will not only heighten rural-urban migration that creates state of human nuisance in the state in particular and the country in general but will worsen the state of food security in general as rural economy still remains the pivot of food supply in a country whose economy is subsistence characterized.

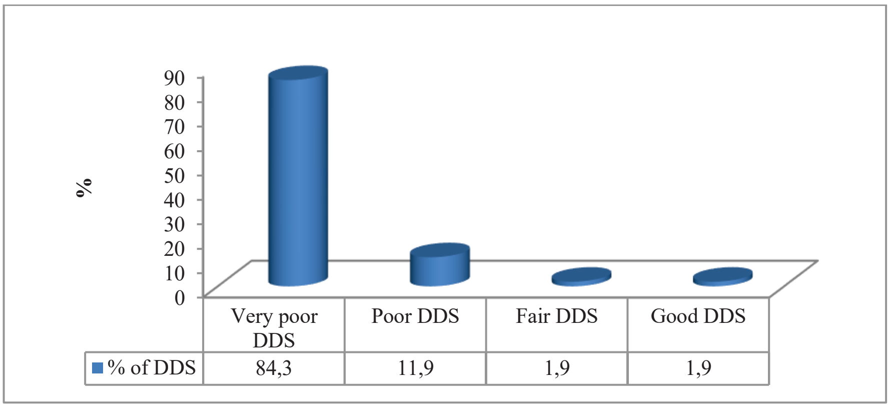


Fig. 3. Distribution of households' dietary diversity status

Source: Field survey, 2022.

Contrarily, in the med-term food security, majority of the rural households (55.2%) were off the threshold of food insecurity, i.e. were in acceptable fold of food consumption score (FCS), meaning they had good food consumption score status (Figure 4). However, slightly less than half (32.6%) of the rural households were vulnerable to food insecurity, i.e., were in the borderline fold of FCS classification while a handful of 12% were classified to have poor food consumption score status. Therefore, it can be inferred that in the mid-term, the rural economy is in the comfort zone of food security.

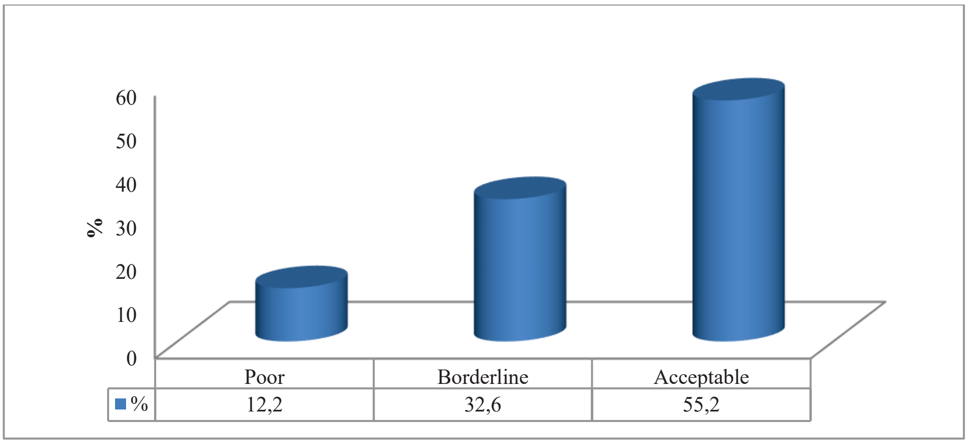


Fig. 4. Distribution of households' Food consumption score status

Source: Field survey, 2022.

Furthermore, on the average, the frame work of food insecurity in the long-term showed that food stability (60.54%) contributed most to food insecurity, followed by food utilization (50.88%), then food access (10.77%) and food availability (9.43%)(Figure 5). By implication, there is poor stability and utilization of food in the study area, thus the bane of food security. However, access and availability of food in the study area can be inferred to be fair but food being a precursor of life, more need to be done to make their status to be good. It is worth to mention, that the households should be enlightened on the need to explore the use of good indigenous technology of extend the shelf of food commodities especially the non-perishable ones, thereby ensuring stable and appropriate utilization of food. The poor stability and utilization of food owes to ineffective facilities- conventional and non-conventional value addition and storage technologies which makes rural households to treat most of the available and accessible food commodities as a flow resource rather than as a stock resource. Therefore, onus lies on households and policymakers to devise appropriate measures that will enhance households' food security in the rural economy before it cascade into a state of disaster in the state in particular and the country in general.

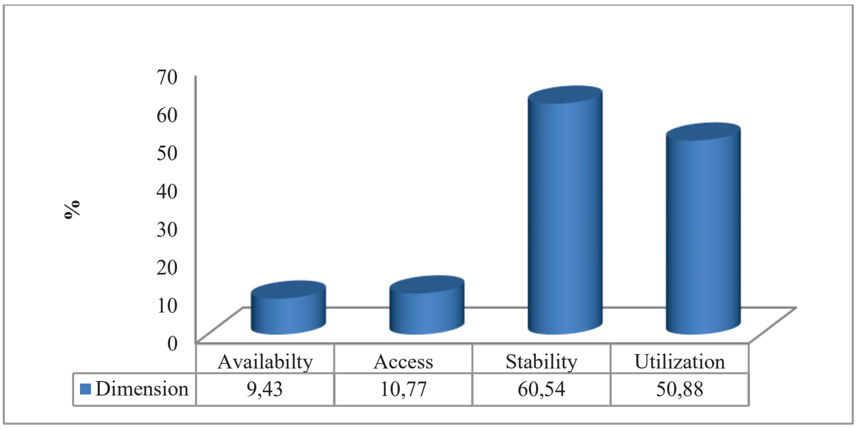
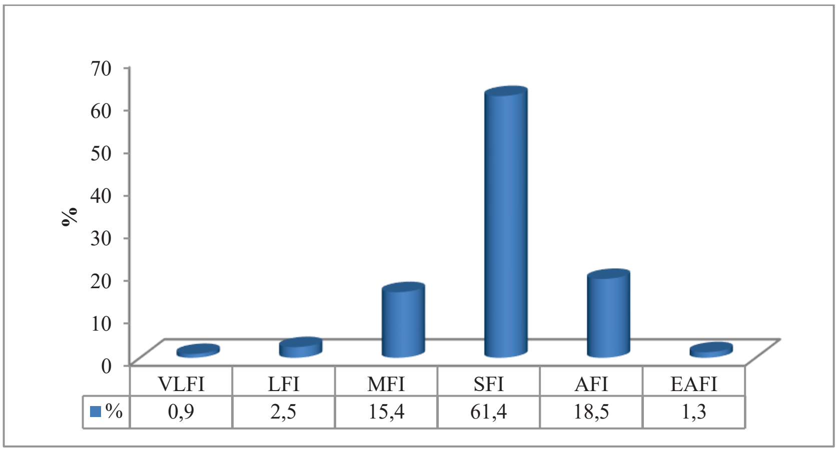


Fig. 5. Distribution of households' food security dimensions

Source: Field survey, 2022.

Moreover, it was established that majority (61.4%) of the households are in the state of serious food insecurity; 18.5% are in state of alarming food insecurity while 1.3% are challenged with extreme alarming food insecurity (Figure 6). Nevertheless, 15.4% are in the threshold of vulnerable-voracious state of food insecurity, i.e., moderate food insecurity while 2.5 and 0.9% households respectively are in the states of low and very low food insecurity. Generally, it can be inferred that the study area is in a peril condition owing to poor food stability and utilization, thus jeopardize what keeps the body and the soul together. Though the rural economy is not in a marathon race between life and death owing to its fair status in food availability and accessibility but it is obviously in a battle to keep the body and the soul together.



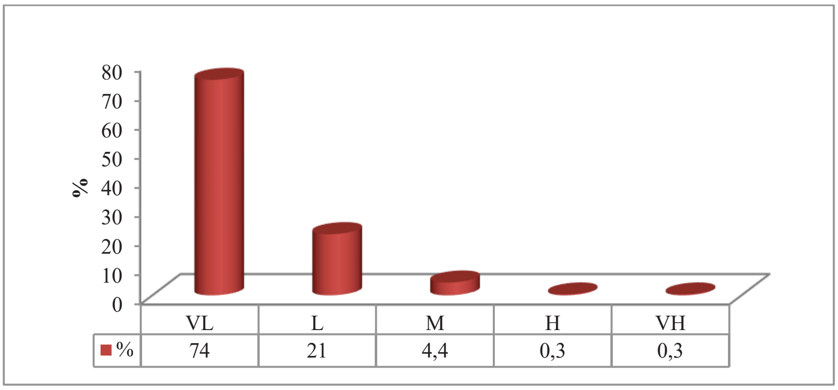
Note: VL=Very low; L=Low; M=Moderate; S=Severely; A=Alarming; EA=Extremely alarming; FI=Food insecurity.

Fig. 6. Distribution of households' food insecurity status

Source: Field survey, 2022.

Food Insecurity Resilience Capacity of Rural Households

A perusal of weather-induced shocks showed that majority (95%) of the households' had their food security to be affected by low weather-induced shocks vis-à-vis very low (74%) and low (21%)(Figure 7). However, it was observed that a handful of 4.4% had their food security to be affected by moderate weather-induced shocks while 0.6% encountered high weather-induced shocks that affected their food security.



Note: VL= Very low; L=Low; M=Moderate; H=High; and, VH=Very high

Fig. 7. Distributions of households' response to weather-induced shocks

Source: Field survey, 2022.

Empirically, using a direct approach, a cursory review of food insecurity resilience capacity index (RCI) showed that majority of the households had low food insecurity resilience capacity vis-à-vis 40.1% and 50.8% respectively with very low and low resilience capacity. However, 8.5% of the households had moderate food insecurity resilience capacity while the food insecurity resilience capacity of 0.6% was high (Figure 8). Nevertheless, a detailed view of the resilience structure matrix (RSM) showed adaptive capacity (AC) to be the pillar that contributed most to households' food insecurity resilience capacity in the study area, closely followed by social safety nets (SSN) and assets (AST) and then at distance, access to basic services (ABS) with least contribution (Figure 9a). In other words, on the average, the index contributions' status of all the food insecurity resilience indicators was poor and that of access to basic services being the worst as evident by their respective average index that was less than 13%. Besides, sub-pillar-wise, agricultural asset (AST4) contributed most to food insecurity resilience capacity, then followed by rural advisory services (extension services) (AC7) while the frequency of coping strategy (AC5) contributed least to food insecurity resilience capacity of the rural households in the study area (Figure 9b). Thus, the heightened poor food insecurity resilience capacity among majority of the households in the study area can be attributed to the worsen status of the pillars that determine resilience capacity against long lasting consequence of stresses and shocks on food security in the rural economy of the study area. Generally, it can be inferred that the households' resilience capacity to avoid shocks and stresses that have long lasting effects in the study area is poor, thus the need for a swift intervention before it cascade into a calamitous situation that will be pervaded with hunger, starvation and endangered health epidemics.

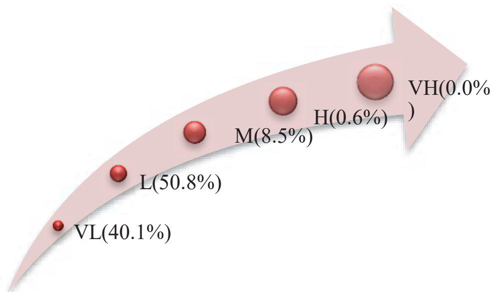


Fig. 8. Food insecurity distributions of households

Source: Field survey, 2022.

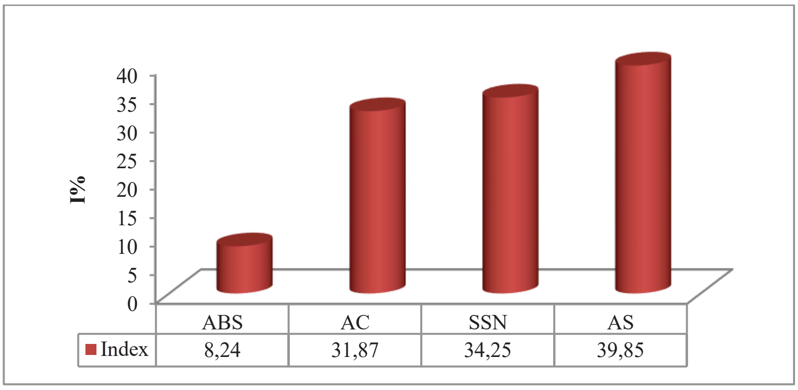


Fig. 9a Average index contribution of RC indicators

Source: Field survey, 2022.

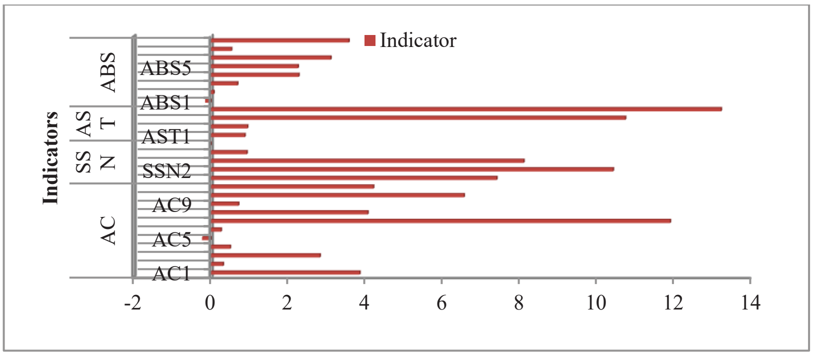


Fig. 9b. RSM contributions of sub-indicators (%)

Source: Field survey, 2022.

Using the indirect approach, structurally, except asset (AST), all the remain resilience pillars had significant influence on households' food insecurity resilience capacity (FIRC) as evident by their respective estimated coefficients that were different from zero at 10% probability level (Table 5a and Figure 10). Besides, except access to basic services (ABS), the duo of adaptive capacity (AC) and social safety nets (SSN) positively increased the households' resilience capacity towards food insecurity and this may be attributed to adoption of good contingency plan by the rural households with respect to the former and the support of effective implementation of national social intervention programme in the study area with respect to the latter. Nevertheless, the declining effect of ABS on households' resilience capacity may not be far from weak and ineffective infrastructural facilities in the study area. However, the insignificant influence of AST on households' resilience capacity may be attributed to the resource poor status of rural households given that in agrarian characterized rural settings of Nigeria, unlike social capital, the rural economy is challenged with serious limitation of economic capital. Empirically, any household stands the chance of having its food insecurity resilience capacity to increase by 2.04 and 0.34% respectively if it's AC and SSN increased by 1%. However, their resilience capacity stands to plummet by 1.47% if the state of infrastructural decay increased by 1%. In addition, the influence of weather-induced shocks was insignificant and the possible reasons are because weather vagaries exert mild effect on their food security as evidently established in the previous report on the influence of weather-induced shocks on food security; and, the buffer effects of AC and SSN that absolve the consequence of weather-induced shocks. Noteworthy, contrary to the a prior expectation, the positive sign associated with weather-induced shocks exhibit the active readiness of the rural households against any anticipated stress that will have a long term effect on their households' food security in the study area.

Furthermore, it was established that FIRC as a mediation factor significantly influenced short-term, mid-term, long-term food securities and sustainable livelihood (general wellbeing) of the rural households in the study area as evident by their respective estimated coefficients that were different from zero at 10% degree of freedom. Empirically, any given households have the chance of its short, mid, long-term food securities and sustainable livelihood to increase by 0.49, 3.70, 0.06 and 0.15% respectively for any given increase in its FIRC by 1%.

Table 5a: Effects of food insecurity resilience capacity on food security and sustainable livelihood

Variable (→)		Estimate (US)	Estimate (S)	SE	CR	P-value	R^2
ABS	FIRC	-1.472	-0.373	0.292	-5.044	***	
AC	FIRC	2.043	0.664	0.281	7.268	***	
SSN	FIRC	0.339	0.198	0.115	2.949	0.003**	0.626
AS	FIRC	0.343	0.065	0.342	1.002	0.316^{NS}	
SHOCK	FIRC	0.194	0.047	0.268	0.722	0.470^{NS}	
FIRC	LI	0.153	0.500	0.026	5.980	***	0.250
FIRC	FS	0.057	0.478	0.010	5.816	***	0.228
FIRC	FSC	3.700	0.223	1.151	3.214	0.001**	0.050
FIRC	DDS	0.494	0.192	0.176	2.807	0.005**	0.037
FIRC	Linc	1.000	0.501	-	-	-	0.251
Variance							
ABS	-	0.018	-	0.001	12.610	***	-
AC	-	0.030	-	0.002	12.610	***	-
SSN	-	0.098	-	0.008	12.610	***	-
AS	-	0.010	-	0.001	12.610	***	-
SHOCK	-	0.017	-	0.001	12.610	***	-
e1	-	0.107	-	0.039	2.730	0.006	-
e2	-	0.020	-	0.002	10.784	***	-
e3	-	0.003	-	0.000	11.021	***	-
e4	-	74.639	-	6.038	12.361	***	-
e5		1.821	-	0.147	12.429	***	-
e6		0.855	-	0.079	10.780	***	-

Note: ***, **, * & NS mean significant at 1, 5, 10% and non-significant respectively; US=Unstandardized; S=Standardized; SE=Standard error: CR=Critical ratio; P=Probability; R^2=Squared multiple correlation; →=relationship; e=error term; Linc=Logarithm of income.

Source: Field survey, 2022.

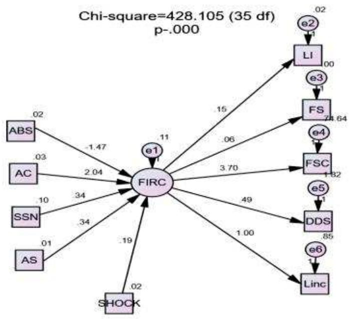


Fig. 10. Structural modeling of food insecurity resilience capacity

Source: Computer print-out, 2022.

Noteworthy, the respective total effects of AC, SSN, AST and ABS, the de facto pillars of resilience capacity, on short-term, mid-term, long-term food securities and sustainable livelihood are 1.010, 7.559, 0.116 and 0.313%; 0.168, 1.255, 0.019 and 0.052%; 0.170, 1.270, 0.020 and 0.030%; and, -0.728, -5.447, -0.084 and -0.225% respectively (Table 5b). Besides, weather-induced shocks' total effects on short-term mid-term, long-term securities and sustainable livelihood are 0.096, 0.717, 0.011 and 0.030% respectively. Nevertheless, the model fit results showed that the structural equation model best fit the specified equation as evident by its respective diagnostic statistics that are within the recommended thresholds (Table 5c).

Table 5b: Direct, indirect and total effects of latent and mediating variables on food security and sustainable livelihood

Variable	SHOCK	AS	SSN	AC	ABS	FIRC	SHOCK	AS	SSN	AC	ABS	FIRC
	Unstandardized						Standardized					
Direct effect												
FIRC	0.194	0.343	0.339	2.043	-1.472	0.000	0.047	0.065	0.198	0.664	-0.373	0.000
Linc	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.501
DDS	0.000	0.000	0.000	0.000	0.000	0.494	0.000	0.000	0.000	0.000	0.000	0.192
FSC	0.000	0.000	0.000	0.000	0.000	3.700	0.000	0.000	0.000	0.000	0.000	0.223
FS	0.000	0.000	0.000	0.000	0.000	0.057	0.000	0.000	0.000	0.000	0.000	0.478
LI	0.000	0.000	0.000	0.000	0.000	0.153	0.000	0.000	0.000	0.000	0.000	0.500
Indirect effect												
FIRC	0.000	0.000	0.000	0.000	.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Linc	0.194	0.343	0.339	2.043	-1.472	0.000	0.023	0.033	0.099	0.332	-0.187	0.000
DDS	0.096	0.170	0.168	1.010	-0.728	0.000	0.009	0.012	0.038	0.128	-0.072	0.000
FSC	0.717	1.270	1.255	7.559	-5.447	0.000	0.010	0.014	0.044	0.148	-0.083	0.000
FS	0.011	0.020	0.019	0.116	-0.084	0.000	0.022	0.031	0.095	0.317	-0.179	0.000
LI	0.030	0.053	0.052	0.313	-0.225	0.000	0.023	0.032	0.099	.332	-0.187	0.000
Total effect												
FIRC	0.194	0.343	0.339	2.043	-1.472	0.000	0.047	0.065	0.198	0.664	-0.373	0.000
Linc	0.194	0.343	0.339	2.043	-1.472	1.000	0.023	0.033	0.099	0.332	-0.187	0.501
DDS	0.096	0.170	0.168	1.010	-0.728	0.494	0.009	0.012	0.038	0.128	-0.072	0.192
FSC	0.717	1.270	1.255	7.559	-5.447	3.700	0.010	0.014	0.044	0.148	-0.083	0.223
FS	0.011	0.020	0.019	0.116	-0.084	0.057	0.022	0.031	0.095	0.317	-0.179	0.478
LI	0.030	0.053	0.052	0.313	-0.225	0.153	0.023	0.032	0.099	0.332	-0.187	0.500

Source: Field survey, 2022.

Table 5c. Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	428.105	-
	DF	35	-
	P	0	p<=0.05
	RMSEA	0.078	< 0.08
	RMR	0.012	<0.02
	GFI	0.905	> 0.90
Incremental fit	AGFI	0.994	> 0.90
	NFI	0.96	> 0.90
	RFI	0.977	> 0.90
	TLI	0.99	> 0.90
	CFI	0.97	> 0.90
	IFI	0.98	> 0.90
	PGFI	0.913	> 0.90
	FMIN	0.9346	> 0.90
Parsimonious fit	CMIN/DF	2.232	< 5.0
Others	NPAR	20	-
	PRATIO	0.778	-
	PNFI	0.28	-
	PCFI	0.288	-
	NCP	393.105	-
	AIC	468.105	-
	BCC	469.538	-
	BIC	543.409	-
	CAIC	563.409	-
	ECVI	1.472	-
	MECVI	1.477	-
	HOELTER (0.05)	37	-
	HOELTER (0.01)	43	-

Source: Field survey, 2022.

Nexus between food insecurity and resilience capacity

The integrative framework of households' food insecurity and resilience capacity showed that majority of the households fell in the best-case category as evident by the density of the dotted points in second bottom quadrant in Figure 11. Besides, self-made category is the next populated category, followed by prodigal-case category while worst-case category had very few households.

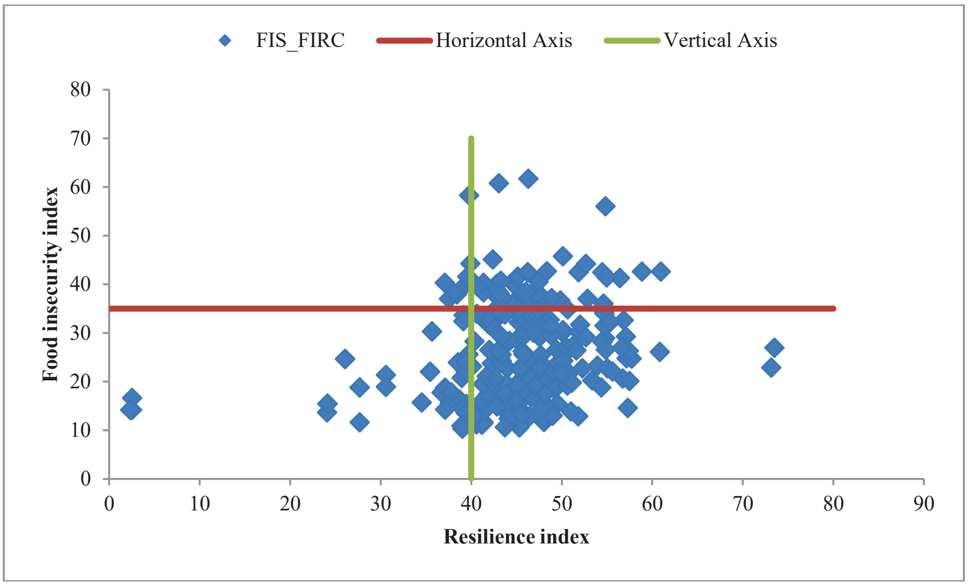


Fig. 11. Nexus of food insecurity and resilience capacity

Source: Field survey, 2022.

Food Coping Strategies Adopted by Households

To identify the common food coping strategies, of the twelve adopted food coping strategy components, the varimax rotation retained only three interpretable components as evident by their respective Eigen value that are greater than unity (Table 6). Besides, these retained factors account for 60.57% of the total variation of the adopted food coping strategies subjected to analysis. Noteworthy, the sampling was established to be adequate as evident by the KMO measure that possessed a good value of 0.870 that is above the satisfactory threshold value of 0.50 recommended by Keiser (1974); Field (2005); Sadiq et al.(2017); Sadiq et al.(2018c&d). In addition, the rotation matrix (R-matrix) has a common. The R-matrix is not an identity matrix as evident by the plausibility of its Bartlett's sphericity test at less than 1% probability level. Nevertheless, each of these factors had internal consistency in its loadings as indicated by their respective Cronbach's Alpha tests that are above the threshold of 0.70 reported to be satisfactory for social science studies by Nunnally (1978); Nunnally and Bernstein (1994); Prunomo and Lee (2010); Sadiq et al.(2017); Sadiq et al.(2018c&d).

As rightly done by Bagheri and Fami (2016); Sadiq et al.(2017) and Sadiq et al.(2018c&d), factor loadings with values less than 0.40 in each of the extracted components were dropped and in labeling a component loaded with only two loadings, only the factor with the highest score is considered. Component 1, labeled "meal skipping (MS)", with 40.07% of total variance and loaded with seven factors showed households concern on income smoothening as a food coping measure. Component 2, labeled "eaten of inferior meals (IM)", with 11.67% of total variance proportion and loaded with three factors showed households concern on meal substitutions, thus smoothening their income. The duo of these components is aimed towards enjoying expanded expenditure on food commodities on continuum basis by the rural households. Component 3, labeled "consumption credit (CC)", loaded with two factors and accounted for 8.83% of the total variance showed households concern on the use of consumption credit as a measure to smoothen their consumption

Table 6. Coping strategies adopted by the rural households

Strategies	F1	F2	F3
Rely on less preferred and less expensive food (C1)		0.690	
Borrow food from a relative or friend (C2)	0.468	0.500	
Purchase food on credit (C3)			0.809
Consume seed stock for next season (C4)			0.638
Gather wild food, hunt, or harvest immature crops (C5)	0.798		
Send children to eat with neighbor/relative (C6)	0.776		
Send members of the household to beg (C7)	0.772		
Reduce the portion size at mealtimes (C8)	0.458	0.527	
Restrict consumption of adult for children to eat (C9)	0.745	0.447	
Reduced the number of meals eaten in a day (C10)	0.601	0.570	
Skip a complete day without eaten (C11)	0.827		
Sell of agricultural equipment/assets (C12)	0.559		
Eigen value	**4.808**	**1.400**	**1.059**
Variance %	**40.071**	**11.667**	**8.828**
Cronbach's Alpha	**0.872**	**0.423**	**0.388**
KMO		**0.870**	
Bartlett's Test		**1481.321 (0.00***)**	

Note: Measured on four scale continuum basis (frequently; occasionally; rarely & not used)

*** means significant at 1%

Source: Field survey, 2022.

Furthermore, structurally, it was established that IM and CC significantly influenced households' hunger resilience capacity (HRC) as evident by their respective parameter estimates that are plausible within 10% probability level (Table 7a and Figure 12). While CC increases the HRC, IM tends to decrease it and the possible reason may be that the substituted inferior foods are of poor diet quality, thus affecting their labour productivity. However, SM, an income smoothening measure, being insignificant on HRC may be associated to less dependency ratio in the households' composition. Therefore, a unit increase in IM and CC coping strategies will increase and decrease households' HRC by 0.151 and -0.104% respectively. The total effects of CC, IM and SM on HRC were 0.151, -0.104 and 0.062% respectively. Furthermore, HRC, a mediation factor, positively and significantly influenced short-term (dietary diversity-DDS) and mid-term (food consumption score- FSC) food securities but failed to have significant influence on long-term food security (FSS) and sustainable livelihood (LI). Nevertheless, HRC being a transitory situation might be the possible reason why its influence on the duo of long-term food security and sustainable livelihood were insignificant. The total effects of HRC on DDS, FCS, FSS and LI were 5.872, 47.524, 0.055 and 0.118% respectively (Table 7b). The model fit statistics confirmed that the structural model is best fit for the specified equation as indicated by its respective test statistics that are within the acceptable recommended thresholds (Table 7c). Generally, it can be inferred that hunger coping strategy has a transitory effect on the food security of the rural households in the study area.

Table 7a: Effects of coping strategy on food security and sustainable livelihood

Variable (→)		Estimate (US)	Estimate (S)	SE	CR	P-value	R^2
HRC	MS	0.062	0.113	0.044	1.415	0.157^{NS}	0.043
HRC	IM	-0.104	-0.145	0.056	-1.847	0.065*	
HRC	CC	0.151	0.098	0.083	1.814	0.070*	
C12	MS	1.000	0.438	-	-	-	0.192
C11	MS	1.773	0.818	0.229	7.734	***	0.670
C10	MS	2.084	0.678	0.288	7.243	***	0.460
C9	MS	2.804	0.819	0.363	7.736	***	0.671
C7	MS	1.471	0.723	0.198	7.422	***	0.523
C6	MS	1.668	0.757	0.221	7.545	***	0.574
C5	MS	1.738	0.745	0.232	7.500	***	0.554
C8	IM	1.000	0.278	-	-	-	0.077
C2	IM	4.622	1.312	4.379	1.055	0.291^{NS}	1.720
C1	IM	0.467	0.138	0.158	2.952	0.003**	0.019
C4	CC	1.000	0.115	-	-	-	0.013
C3	CC	17.594	2.172	94.815	0.186	0.853^{NS}	4.718
LI	HRC	0.118	0.117	0.079	1.499	0.134^{NS}	0.014
FSS	HRC	0.055	0.117	0.037	1.497	0.135^{NS}	0.014
FSC	HRC	47.524	0.871	20.262	2.345	0.019**	0.758
DDS	HRC	5.872	0.699	2.426	2.421	0.015**	0.489
INC	HRC	1.000	0.152	-	-	-	0.023
Variance							
MS	-	0.092	-	0.023	3.903	***	-
IM	-	0.054	-	0.054	1.000	0.317^{NS}	-
CC	-	0.012	-	0.063	0.184	0.854^{NS}	-
e13	-	0.027	-	0.022	1.217	0.224^{NS}	-
e1	-	0.386	-	0.031	12.271	***	-
e2	-	0.142	-	0.015	9.652	***	-
e3	-	0.467	-	0.041	11.382	***	-
e4	-	0.353	-	0.037	9.636	***	-
e5	-	0.181	-	0.016	11.025	***	-
e6	-	0.189	-	0.018	10.658	***	-
e7	-	0.222	-	0.021	10.806	***	-
e8	-	0.641	-	0.071	9.062	***	-
e9	-	-0.479	-	1.055	-0.454	0.650^{NS}	-
e10	-	0.603	-	0.049	12.344	***	-
e11	-	0.863	-	0.092	9.358	***	-
e12	-	-2.819	-	19.142	-0.147	0.883^{NS}	-
e14	-	0.028	-	0.002	12.567	***	-
e15	-	0.006	-	0.000	12.567	***	-
e16	-	19.932	-	10.569	1.886	0.059*	-
e17	-	0.998	-	0.178	5.593	***	-
e18	-	1.174	-	0.094	12.536	***	-

Note: ***, **, * & NS mean significant at 1, 5, 10% and non-significant respectively; US=Unstandardized; S=Standardized; SE=Standard error: CR=Critical ratio; P=Probability; R^2=Squared multiple correlation; →=relationship; e= error term; and, INC= Income.

Source: Field survey, 2022.

Table 7b: Direct, indirect and total effects of latent and mediating variables on food security and sustainable livelihood

Variable	CC	IM	MS	HRC	CC	IM	MS	HRC
	Unstandardized				Standardized			
Direct effect								
HRC	.151	-.104	.062	.000	.098	-.145	.113	.000
INC	.000	.000	.000	1.000	.000	.000	.000	.152
DDS	.000	.000	.000	5.872	.000	.000	.000	.699
FSC	.000	.000	.000	47.524	.000	.000	.000	.871
FSS	.000	.000	.000	.055	.000	.000	.000	.117
LI	.000	.000	.000	.118	.000	.000	.000	.117
C3	17.594	.000	.000	.000	2.172	.000	.000	.000
C4	1.000	.000	.000	.000	.115	.000	.000	.000
C1	.000	.467	.000	.000	.000	.138	.000	.000
C2	.000	4.622	.000	.000	.000	1.312	.000	.000
C8	.000	1.000	.000	.000	.000	.278	.000	.000
C5	.000	.000	1.738	.000	.000	.000	.745	.000
C6	.000	.000	1.668	.000	.000	.000	.757	.000
C7	.000	.000	1.471	.000	.000	.000	.723	.000
C9	.000	.000	2.804	.000	.000	.000	.819	.000
C10	.000	.000	2.084	.000	.000	.000	.678	.000
C11	.000	.000	1.773	.000	.000	.000	.818	.000
C12	.000	.000	1.000	.000	.000	.000	.438	.000
Indirect effect								
HRC	.000	.000	.000	.000	.000	.000	.000	.000
INC	.151	-.104	.062	.000	.015	-.022	.017	.000
DDS	.888	-.611	.365	.000	.068	-.101	.079	.000
FSC	7.187	-4.945	2.957	.000	.085	-.126	.098	.000
FSS	.008	-.006	.003	.000	.011	-.017	.013	.000
LI	.018	-.012	.007	.000	.011	-.017	.013	.000
C3	.000	.000	.000	.000	.000	.000	.000	.000
C4	.000	.000	.000	.000	.000	.000	.000	.000
C1	.000	.000	.000	.000	.000	.000	.000	.000
C2	.000	.000	.000	.000	.000	.000	.000	.000
C8	.000	.000	.000	.000	.000	.000	.000	.000
C5	.000	.000	.000	.000	.000	.000	.000	.000
C6	.000	.000	.000	.000	.000	.000	.000	.000
C7	.000	.000	.000	.000	.000	.000	.000	.000
C9	.000	.000	.000	.000	.000	.000	.000	.000
C10	.000	.000	.000	.000	.000	.000	.000	.000
C11	.000	.000	.000	.000	.000	.000	.000	.000
C12	.000	.000	.000	.000	.000	.000	.000	.000
Total effect								
HRC	.151	-.104	.062	.000	.098	-.145	.113	.000
INC	.151	-.104	.062	1.000	.015	-.022	.017	.152
DDS	.888	-.611	.365	5.872	.068	-.101	.079	.699
FSC	7.187	-4.945	2.957	47.524	.085	-.126	.098	.871
FSS	.008	-.006	.003	.055	.011	-.017	.013	.117
LI	.018	-.012	.007	.118	.011	-.017	.013	.117
C3	17.594	.000	.000	.000	2.172	.000	.000	.000
C4	1.000	.000	.000	.000	.115	.000	.000	.000
C1	.000	.467	.000	.000	.000	.138	.000	.000
C2	.000	4.622	.000	.000	.000	1.312	.000	.000
C8	.000	1.000	.000	.000	.000	.278	.000	.000
C5	.000	.000	1.738	.000	.000	.000	.745	.000
C6	.000	.000	1.668	.000	.000	.000	.757	.000
C7	.000	.000	1.471	.000	.000	.000	.723	.000
C9	.000	.000	2.804	.000	.000	.000	.819	.000
C10	.000	.000	2.084	.000	.000	.000	.678	.000
C11	.000	.000	1.773	.000	.000	.000	.818	.000
C12	.000	.000	1.000	.000	.000	.000	.438	.000

Source: Field survey, 2022.

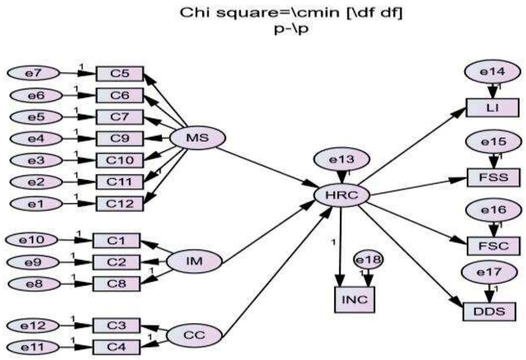


Fig. 12. Structural modeling of hunger resilience capacity (HRC)
Source: Computer print-out, 2022

Table 7c. Model fit summary

Category name	Index name	Obtained	Recommended
Absolute fit	CMIN	603.885	-
	DF	116	-
	P	0.00	p<=0.05
	RMSEA	0.015	< 0.08
	RMR	0.014	<0.02
	GFI	0.924	> 0.90
Incremental fit	AGFI	0.968	> 0.90
	NFI	0.973	> 0.90
	RFI	0.917	> 0.90
	TLI	0.966	> 0.90
	CFI	0.915	> 0.90
	IFI	0.919	> 0.90
	PGFI	0.925	> 0.90
	FMIN	1.899	> 0.90
Parsimonious fit	CMIN/DF	4.206	< 5.0
Others	NPAR	37	-
	PRATIO	0.853	-
	PNFI	0.574	-
	PCFI	0.61	-
	NCP	487.885	-
	AIC	677.885	-
	BCC	682.325	-
	BIC	817.197	-
	CAIC	854.197	-
	ECVI	2.132	-
	MECVI	2.146	-
	HOELTER (0.05)	75	-
	HOELTER (0.01)	82	-

Source: Field survey, 2022.

Conclusions and recommendations

Empirically, the findings established that the study area is challenged with food insecurity in the short and long terms while it was in the comfort zone of food security in the mid-term. However, poor food utilization and stability were the bane of food insecurity in the long-run. Generally, it was inferred that the rural economy of the study area is obviously in a battle to keep the body and soul together. Furthermore, poor food insecurity resilience capacity of majority of the households due to poor adaptive capacity was unmasked as the prime factor behind the exacerbated state of food insecurity. More so, food insecurity resilience capacity significantly influenced food security across the term periods and sustainable livelihood while households' hunger resilience capacity is only sustainable on short-term food security. Nevertheless, the empirical evidence showed that the rural households adopted income and consumption smoothening as coping strategies for short-term food insecurity. Therefore, to adjust the state of poor food stability and utilization, the study advises the rural households to adopt safe and eco-friendly improved indigenous food technologies that will minimize waste, thereby enhancing food shelf-life and value addition. By so doing, it will go a long way to address the alarming state of food insecurity which is a portend threat to the achievement of sustainable development goals of zero hunger by 2030.

References

Abebe, G. (2020). Cash-for-work and food-for-work programmes' role in household resilience to food insecurity in southern Ethiopia. *Development in Practice*, 30(8), 1068-1081.

Ado, A.M., Savadogo, P., Abdoul-Azize, H.T. (2022). Livelihood strategies and household resilience to food insecurity: Insight from a farming community in Aguie district of Niger. In: Rethinking Food System Transformation (pp. 97-111). Cham: Springer Nature Switzerland.

Agwu, G.A. (2023). The Boko Haram conflict and food insecurity: Does resilience capacity matter? *Journal of African Economies*, 32(4), 352-382.

Alhassan, H. (2020). Farm households' flood adaptation practices, resilience and food security in the Upper East region, Ghana. Heliyon, 6(6).

Alinovi, L., Mane, E., Romano, D. (2008). Towards the measurement of household resilience to food insecurity: applying a model to Palestinian household data. In: Deriving Food Security Information from National Household Budget Surveys. Experiences, Achievement, Challenges (pp. 137-152). Food and Agricultural Organization of the United Nations.

Anand, S., Sen, A. (1997). Concepts of human development and poverty: A Multidimensional perspective. In: Poverty and Human Development. Human Development Papers. Human Development Report Office. The United Nations Development Programme, NY, USA.

Ansah, I.G.K., Gardebroek, C., Ihle, R. (2019). Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. *Food Security*, 11(6), 1187-1203.

Ansah, I.G.K., Kotu, B.H., Manda, J., Muthoni, F., Azzarri, C. (2023). Mediation and moderation roles of resilience capacity in the shock–food-security nexus in northern Ghana. *Ecological Economics*, 211, 107894.

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.

Bagheri, A., Fami, H.S.(2016). Potato growers' risk perception: A case study in Ardabil Province of Iran. *Journal of Agricultural Science and Technology*, 18, 55-65

Bahta, Y.T. (2022). Nexus between coping strategies and households' agricultural drought resilience to food insecurity in South Africa. *Land*, 11(6), 893.

Béné, C. (2020). Resilience of local food systems and links to food security-A review of some important concepts in the context of COVID-19 and other shocks. *Food Security*, 12(4), 805-822.

Beyene, F., Senapathy, M., Bojago, E., Tadiwos, T. (2023). Rural household resilience to food insecurity and its determinants: Damot Pulasa district, Southern Ethiopia. *Journal of Agriculture and Food Research*, 11, 100500.

Calloway, E.E., Carpenter, L.R., Gargano, T., Sharp, J.L., Yaroch, A.L. (2022). Development of three new multidimensional measures to assess household food insecurity resilience in the United States. *Frontiers in Public Health,* 10, 1048501.

Chamdimba, O.Y., Ortmann, G.F., Wale, E. (2021). Resilience to shocks and food insecurity: Determinants, and the impact of smallholder jatropha curcas cultivation in Southern Malawi. *African Journal of Science, Technology, Innovation and Development*, 13(5), 619-633.

d'Errico, M., Pinay, J., Jumbe, E., Luu, A.H. (2023). Drivers and stressors of resilience to food insecurity: evidence from 35 countries. *Food Security*, 1-23.

Dhraief, M. Z., Dhehibi, B., Daly Hassen, H., Zlaoui, M., Khatoui, C., Jemni, S., ... & Rekik, M. (2019). Livelihoods strategies and household resilience to food insecurity: A case study from rural Tunisia. Sustainability, 11(3), 907.

Egamberdiev, B., Bobojonov, I., Kuhn, L., & Glauben, T. (2023). Household resilience capacity and food security: evidence from Kyrgyzstan. Food Security, 15(4), 1161-1183.

FAO (2016). Resilience Measurement and Analysis-II (RIMA-II). Retrieved from www.fao.org/publication.

FAO(2015). RIMA-II: Moving Forward the Development of the Resilience Index Measurement and Analysis Model. Retrieved from www.fao.org/resilience

Field, A.P. (2005). Is the meta-analysis of correlation coefficients accurate when population correlations vary? *Psychological Methods*, 10(4), 444.

Haile, D., Seyoum, A., Azmeraw, A. (2022). Food and nutrition security impacts of resilience capacity: Evidence from rural Ethiopia. *Journal of Agriculture and Food Research*, 8, 100305.

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.

Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31-36.

Lascano Galarza, M.X. (2020). Resilience to food insecurity: Theory and empirical evidence from international food assistance in Malawi. *Journal of Agricultural Economics*, 71(3), 936-961.

Mathye, R., Gerickle, G. (2019). Caregivers' perceptions of household hunger and adequacy of dietary intake in a resource limited community in the Bronkhorstspruit district (Gauteng). *African Journal of Food, Agriculture, Nutrition and Development*, 19(3), 14541-14554.

Melketo, T., Schmidt, M., Bonatti, M., Sieber, S., Müller, K., Lana, M. (2021). Determinants of pastoral household resilience to food insecurity in Afar region, northeast Ethiopia. *Journal of Arid Environments*, 188, 104454.

Merchant, E.V., Fatima, T., Fatima, A., Maiyo, N., Mutuku, V., Keino, S., ... & Downs, S. M. (2022). The influence of food environments on food Security resilience during the COVID-19 pandemic: an examination of urban and rural difference in Kenya. *Nutrients*, 14(14), 2939.

Meyer, M.A. (2020). The role of resilience in food system studies in low-and middle-income countries. *Global Food Security*, 24, 100356.

Mkupete, M.J., Donath, L.T., Mugizi, F.M. (2023). Household resilience to food and nutrition insecurity during COVID-19 in Tanzania. *Geojournal*, 88(2), 1721-1735.

Murendo, C., Aziz, T., Tirivanhu, D., Mapfungautsi, R., Stack, J., Mutambara, S., ... & Mafuratidze, C. (2021). Dietary diversity and food coping strategies in Zimbabwe: do resilience and food insecurity status matter? *Ecology of Food and Nutrition*, 60(1), 116-136.

Myeki, V.A., Bahta, Y.T. (2021). Determinants of smallholder livestock farmers' household resilience to food insecurity in South Africa. *Climate*, 9(7), 117.

Nahid, N., Lashgarara, F., Farajolah Hosseini, S.J., Mirdamadi, S.M., Rezaei-Moghaddam, K. (2021). Determining the resilience of rural households to food insecurity during drought conditions in Fars province, Iran. *Sustainability*, 13(15), 8384.

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.

Negesse, A., Woyraw, W., Temesgen, H., Teka, Y., Yismaw, L., Akalu, T.Y., ... & Desalegn, B.B. (2022). Spatial exploration of non-resilience to food insecurity, its association with COVID-19 and household coping strategies in East Gojjam districts, Northwest Ethiopia, 2020. Scientific Reports, 12(1), 15511.

Nunnally, J., Bernstein, I. (1994). Psychometric Theory 3rd Edition (MacGraw-Hill, New York).

Nunnaly, J.C. (1978). Psychometric Theory, 2nd Edition, McGraw Hill, New York.

Ouoba, Y., Sawadogo, N. (2022). Food security, poverty and household resilience to COVID-19 in Burkina Faso: Evidence from urban small traders' households. *World Development Perspectives*, 25, 100387.

Sadiq, M.S., Sani, B.S. (2022). Lıvelıhood status of paddy rıce agro-processors that benefitted from mıcrofınance credıt in Jıgawa State of Nıgerıa. *Bozok Journal of Agriculture and Natural Sciences*, 1(2), 71-94.

Sadiq, M.S., Singh, I.P., Ahmad, M.M., Lawal, M. (2018a). Drivers of poverty status among sugarcane farmers in Kwara State of Nigeria. *Academic Studies-National Journal of Jyoti Research Academy*, 12(2), 96-103.

Sadiq, M.S., Singh, I.P., Ahmad, M.M., Lawal, M., Sadiq, U.N., Kabeer, Y.M. (2018b). X-raying poverty dynamics of homestead broiler entrepreneurs in Niger State of Nigeria. *Journal of Animal Production Research*, 30(2), 204-214.

Sadiq, M.S., Singh, I.P., Ahmad, M.M., Lawal, M., Kamaldeen, N., Sani, T.P. (2018c).Determining the perceived constraints affecting cassava farmers in Kwara State of Nigeria. *FUDMA Journal of Agriculture and Agricultural Technology*, 4(2), 235-247

Sadiq, M.S., Singh, I.P., Ahmad, M.M., Lawal, M., Shehu, H.O., Sani, T.P., Yusuf, T.L. (2018d). Perceived constraints affecting homestead fish farming in Kogi State, Nigeria. *FUDMA Journal of Agriculture and Agricultural Technology*, 4(2), 255-266

Sadiq, M.S., Singh, I.P., Isah, M.A., Greima, I.J., Umar, S.M. (2017). Strategy of minimizing the cost of cultivation vis-à-vis boosting farm income of small-holder maize farmers in Niger State of Nigeria using Efficiency Measurement System (EMS). *Indian Journal of Economics and Development*, 17(2a), 722-728

Sunday, N., Kahunde, R., Atwine, B., Adelaja, A., George, J. (2023). How specific resilience pillars mitigate the impact of drought on food security: Evidence from Uganda. *Food Security*, 15(1), 111-131.

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