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I dedicate this work to God Almighty, the Most High; for His endless mercy, grace and favour that preserved me and saw me through this programme successfully. I also dedicate this work to my late Father Mr. Jacob O. Dada, and to my Mother Mrs. Mercy M. Dada for her unflinching support throughout the period of this study.

Food Insecurity (FI) has been on the increase in Nigeria particularly among rural households. Resilience helps households to withstand FI. Shocks such as drought, floods, illness and death of household head reduce resilience among the households thereby increasing FI. Available studies on FI in Nigeria have focused on determinants of FI with little research efforts on resilience. Therefore, resilience to food insecurity among rural household in Nigeria was investigated.

Data from general household survey panel (2010/2011, 2012/2013 and 2015/2016) were used for the study. Information on socio-economic characteristics (age, sex, educational level, household size, marital status, monthly income, membership of cooperatives, and access to extension services), food security indicators (expenditure on food and quantity of food consumed), and resilience indicators (access to basic services, adaptive capacity, assets and social safety nets) were utilised. Households were categorised into food insecure (1) and food secure (0). Resilience among households was also grouped into low resilience (0.0000-0.4100) and high resilience (0.4101-1.0000). Food security transition among the households was grouped into always food secure, moved from food secure into food insecure, moved from food insecure to food secure and always food insecure. Data were analysed using descriptive statistics, food calories benchmark (2,260 kcal/day), Forster Greer and Thorbecke, principal components analysis, multiple-indicator-multiple-causes model, Markov chain and fixed effect logit regression at $\alpha_{0.05}$.

Majority of the household heads (81.0%) were males with mean age of 53.0±14.86 years, 75.0% were married with a household size of 7.3±3.70 persons. Monthly income was ₦31,363.79±30,374.42 and 33.4% of the household had no formal education. Households that were food insecure and food secure were 36.6% and 63.4%, respectively. Incidence, depth and severity of food insecurity were 0.39, -0.19 and 0.68, respectively. Food Insecurity among male (68.9%) was higher than the female headed household (29.8%), while FI among married households (38.0%) was lower than that of unmarried households (41.0%). Out of the total households, 68.2% of those that were food secure, in 2010 were food secure in 2015, while 31.8% of households that were food secure in 2010 were food insecure in 2015. Also, 68.5% of households that were food insecure in 2010 were food secure in 2015, while 31.6% of households that were food insecure in 2010 were food insecure in 2015. At equilibrium, the probability that a household would be food secure was 68.3% and 31.7% for food insecure. Resilience among the households was 0.4±0.06, while among food secure and food insecure households was 0.42±0.07 and 0.39±0.06, respectively. Asset (β=0.6662) safety net (β=3.0575), no experience of flooding (β=0.7769) and no experience of drought (β=0.2257) increased the probability of being resilient to food insecurity, while access to basic services (β=-0.4749), adaptive capacity (β=-0.3674) and death shock (β=-0.0567) decreased it. Being a female headed household (β=0.7368), household size (β=0.0664) and access to extension services (β=0.8458) increased the probability of being food insecure, while resilience (β=-0.1072) and years of formal education (β=-0.0392) decreased it.

Resilience reduced food insecurity of rural households. Assets and safety net improved resilience among rural households in Nigeria.

**Keywords:** Resilience indicators, Food insecurity transitions, Safety nets, Adaptive capacity, Assets

I am grateful to Almighty God, the Most High, for the seeing me through the programme. I am infinitely grateful to Him for His unfailing support, endless provision and protection throughout my study.

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This is to certify that this project work was carried out by GBENGA EMMANUEL DADA Matriculation Number 159485 of the Department of Agricultural Economics, University of Ibadan, Oyo State, Nigeria.

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Supervisor Date

Dr Kabir Kayode Salman

**B.Tech LAUTECH, M.Sc, Ph.D IBADAN**

CHAPTER FOUR: RESULT AND DISCUSSIONS

## 1.1 Background

Food is very important, it is crucial for the good functioning and growth of the body (Omonona and Agoi, 2007). Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for active healthy life (Food and Agricultural organization, 1996). Food security involves current and future availability and access to food, issues of nutritional inadequacy, social acceptability of food, and the means used to access it (FAO, 1996). Food insecurity is defined by Bickel *et al.* (2000), as the limited or inability to obtain food in socially acceptable ways. Currently, Nigeria relies a lot on food imports (Mary, 2019), and this underlines the inability of the local food production to meet the food demands of the growing population.

The gap in food production and food demand could lead to food insecurity among households in Nigeria. Olawale (2018) reports that about 70% of the Nigerian population lives below the poverty line this could affect the ability of the households to acquire food for the members of their households which will increase food insecurity among the rural households in Nigeria. Global Food Security Index (GFSI), (2020) states that food insecurity in Nigeria has increased since 2013(when Nigeria was ranked 86 out of 107 countries) and reached a rank of 98 out of 107countries behind Ethiopia, Niger, and Cameroon.

Most households in Nigeria live in rural areas. The bulk of the households in rural areas carry out subsistent farming, this makes them vulnerable to climatic variability, reduction in the amount of rainfall, and general crop failure. These results in lower food production and it could lead to acute food shortages among rural households. FAO (2017) posits that about 1billion people across the world are food insecure. World Food Programme (WFP) (2020), states that about a 135million people are suffering from acute food insecurity in the world.

Resilience is defined as the "ability of people, households, communities, countries, and systems to mitigate, adapt to and recover from shocks in such a way that reduces chronic vulnerability and facilitates inclusive growth (USAID, 2012). Resilience thus represents the ability of a person over some time to be food secure in the face of various shocks, therefore if the individual or

household remains food secure by withstanding the shocks, then the individual or household is resilient (Constas and Barret, 2013).

Shocks are major drivers of food insecurity among rural households. Shocks could be covariate or idiosyncratic, covariate shocks are the shocks that affect people across different levels and it usually occurs on a large scale (it cuts across Communities, Regions, and Nations). Shocks include conflict, natural disasters such as earthquakes hurricanes, and Famine among rural households. Covariate shocks include conflicts, pest invasion, flooding, and drought, and crop failure. Idiosyncratic shocks are shocks that affect people at the individual household level and on a much smaller scale. Idiosyncratic shocks include the death of the household head or spouse, loss of property, theft of property, illness, injury, and loss of jobs. These shocks combine to threaten the level of food insecurity among rural households.

Shocks lead to depletion of resources and loss of income among the rural households. While experiencing shocks, households usually employ resilience to absorb, mitigate and recover from these shocks. However the recurrence of these shocks weakens resilience among the rural households, it reduced the ability of the households to plan for the shocks and manage the effect of the shocks on their food security. Hence the household will not be able to keep within a certain level of food security due to reduced resilience brought about by increase in occurrence of shocks among the rural households.

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It is no gainsaying that food insecurity is a challenge to the governments of nations all over the world. The economic development of a nation depends on its factor endowments, this includes both human and non-human resources; the productive capacity of human resources is a function of how well-fed they are (Omonona and Agoi, 2007). However, food production is tied to Agricultural production among rural households. Agriculture is the main occupation among rural households in Nigeria (IFAD, 2012). Most of the households in rural areas are smallholder farmers who are characterized by low output, low income, and high rate of poverty (FAO, 2016). World Bank report, (2018) posits that Nigeria has the highest extreme poverty in the World. NBS, (2019) also reports that about 40% of the Nigerian population lives below the poverty line. This could make it difficult for rural households to meet their consumption needs. This could lead to an increase in food insecurity among rural households.

The prevalence of food insecurity is made worse by the occurrence of shocks to rural households. These shocks include floods, drought, shorter rainfall cycle, pest invasion, and crop failure. Shocks often lead to wide variability in income, in absence of sufficient assets or means to assure smooth food consumption; it could lead to irreversible losses such as distress sales of assets, reduced nutrient intake, and prolonged food insecurity (Alayande and Alayande, 2004). Shocks also lead to a reduction in food production, thus leading to increased food insecurity among rural households (UNDESSA, 2019; UNCTAD 2019; and Food Security Information Network, 2019). Similarly, internal factors in the household such as loss of waged job, illness, and death of household head also inspire food insecurity among households in Nigeria. Finding the most effective method to minimize both the short and long-term impact of shocks and stressors is crucial because such methods can weaken and/or reverse the effects of shocks and help affected households recover from degraded conditions (Constas and Barret, 2013).

Resilience is the means by which households plan for and manage the effect of shocks. A sustained increase in the frequency of shocks will lead to a lower level of resilience among rural households. This will make the effect of shocks more severe among the rural households it will also make food insecurity more pronounced among the rural households. While shocks are largely unpredictable, the inability of the households to mitigate these shocks signifies a vividly low level of resilience among the households. Higher or lower resilience indicates how far the households will respond to shocks that they experience.

According to Global Report on Food Crisis (GRFC), the 2020 conflict was considered a major driver of food crises across the world in 2019. Shocks like conflict have become more violent and persistent among rural households in Nigeria. The shocks have precipitated conflict between cattle herders and Crop Farmers (World Food Programme, 2019). It has led to the loss of lives and properties, it has displaced people from their homes and primary source of livelihood income and it has led to increased food insecurity among the rural households (GRFC, 2020). These shocks could undermine government economic and development goals; more importantly, they could forestall the achievement of Sustainable Development Goals (SDG2) of food security for all by 2030(UN, 2017).

The Covid-19 pandemic has also had a direct effect on the food security of all nations across the world (Barret, 2020, Devereux *et al.,* 2020), it is expected to push 49million people into extreme poverty; 45% of whom are in Sub Saharan Africa(World Bank, 2020). The World Food Programme (2020) posits that the number of people currently experiencing acute food insecurity (135 million) will be doubled as a result of the pandemic due to income loss and disruption of food systems.

Furthermore, against the backdrop of prolonged Covid-19 shocks experienced by all households in Nigeria, there was a restriction in movement across communities and states; this could push about 5million Nigerians into poverty (World Bank, 2020; IMF, 2020). Similarly, Covid-19 related lockdown and social distancing measures have adversely affected income through the reduction in economic and livelihood activities (Barret, 2020; Devereux *et al.,* 2020; and Reardon *et al.,* 2020). According to World Bank (2020) Nigeria's high reliance on the import of staple foods has imposed an additional financial burden on food security within the households through the increase in prices of the staple foods.

The inflation rate in Nigeria currently stands at 18.17%, increase in food prices is the highest contributor to the high inflation rate (Central Bank of Nigeria report, March 2021) this could take food prices beyond the reach of most rural households and it could expose them to food insecurity. The above shocks of different forms have become recurrent both in frequency and intensity; It has further heightened the level of food insecurity among rural households. Thus it emphasizes that resilience to all the shocks that threaten food security among rural households is most needed now more than ever. This leads to the following questions:

- What is the level of food insecurity among rural households in Nigeria?
- What is the level of resilience to food insecurity among the rural households in Nigeria?
- What is the effect of resilience on rural household food insecurity in Nigeria?
- What is the effect of food insecurity shocks on resilience among rural households in Nigeria?

## 1.3 Objectives

Broadly, this study seeks to examine resilience to food insecurity among rural households in Nigeria. The specific objectives are to:

- Investigate the food insecurity status of rural households in Nigeria
- Determine the level of resilience to food insecurity among rural households in Nigeria
- Examine the influence of resilience on food insecurity among rural households in Nigeria
- Determine the effect of shocks on resilience among the rural households in Nigeria.

## 1.4 Significance

Foods play a vital role in the life of man, without it one would be weak, feeble, and unable to carry out any meaningful economic activity. Food provides nutrients for the body. It makes the body strong and helps it to fight against diseases. The bedrock of agricultural development in Nigeria is to ensure enough food reserve at all levels to help forestall the problem of food insecurity among the populace. It has led to the development of various programmes and policy initiatives and this includes; the National Accelerated Food Production Project (NAFPP), Operation Feed the Nation (OFN), Agricultural Development Program (ADP), Structural Adjustment Program (SAP), National Poverty Eradication Program (NAPEP), National Economic Empowerment and Development Strategy (NEEDS), Millennium Development Goals (MDG), Agricultural Transformation Agenda (ATA) and Agricultural Promotion Policy (APP) (Aboaba *et al.,* 2020). However, in spite of these programmes and policies, recent indices point to rising food insecurity in Nigeria (GFSI, 2020).

Shocks have been identified as a major driver of food insecurity among households (FAO, 2015, d'Erico, 2016). Prolonged shocks tend to stretch households beyond the limit of their resources, it weakens all the strategies and plans put in place to manage the effect of such shocks thereby exposing the households to food insecurity (GRFC, 2020). Covid-19 is a covariate shock that cut across most nations around the world, it stopped all economic activities in the affected countries; It increased food insecurity by preventing people from going to their workplaces to fetch income to meet their consumption needs(World Bank, 2020). An increase in the frequency of these kinds of shocks which cut across borders, with widespread destructive effects could successfully undermine government policies and programmes to achieve food security for its people.

Resilience is the means for households to withstand shocks, while still maintaining their basic functions; it explains how different households respond to different shocks that threaten their food security (FAO, 2015). Furthermore, resilience is important because it helps to know the factors that make the households vulnerable (d'Erico *et al.*, 2016). In literature, a lot of works has been done on food insecurity in Nigeria (Ayantoye *et al.,* 2011, Nwozor *et al.,* 2019, Akwukwe, 2020) and resilience (d'Erico *et al.,* 2016, Kiel *et al.,* 2008, Alinovi *et al.,* 2010). But not much is known about how resilience influences food insecurity among rural households in Nigeria. Therefore, this study will add to knowledge by investigating the effect of resilience on food insecurity among rural households in Nigeria.

This research spreads through chapters one to five. The chapter covers the introduction background of the study, statement of the problem, research questions, objectives of the study, justification of the study. Theoretical framework and literature review are presented in chapter two, while the source and type of data, sampling technique, measurement of variables, and analytical technique are discussed in chapter three. Chapter four dealt with results and discussions from the study. Finally, the summary, conclusions, and recommendations are covered in chapter five.

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This section discusses the various theories of resilience. These include Holling's Multiple Equilibrium Resilience Theory, Engineering Theory of resilience, and the Socio-Ecological Theory of resilience.

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The theory builds on Holling's work in 1973 which talks about how populations function within the Ecosystem after experiencing ecological stress. Previous ecological studies before Holling had focused on system equilibrium. Holling however posits that a system should move from one equilibrium state to another after experiencing shocks. A study of predator and prey relationship by Holling has shifted interest in Ecological studies from single state to multiple state equilibria that are unpredictable with more variable behavior (Folke, 2006). As such, resilience is defined from Holling's work as the ability to cope with a shock or Stress, while preserving its basic function and structure, without changing to a new equilibrium (Bahadur *et al.,* 2013).

This definition shifts focus from trying to prevent a system from change to attempting to build the capacity of the system to tolerate change. Hence, in Holling's words, the emphasis is not on constancy but on the ability to change from time to time (Folke, 2006). Holling's work on multiple stable states has two concepts of adaptive cycles and panarchy. The adaptive cycle is a cycle of disturbance and recovery that systems go through as they respond to stress, while Panarchy states that these systems are nested and not linearly arranged (Gunderson and Holling, 2002). Panarchy states that systems are complexly connected in such a way that failure at one level affects all other levels (Van Apeldoorn *et al.,* 2011).

According to Holling and Gunderson (2002) adaptive cycle has four stages. These are exploitation conservation, release, and reorganization, the first two stages are in front of the loop while the last two stages are back of the loop. The exploitation stage is a stage of increased growth and high resiliency, the conservation stage features high efficiency and builds up of

system resources, this gives room for inflexibility and vulnerability to change. The release stage features a rapid change that comes from system shocks.

The reorganization stage features rebuilding and accumulating some basic resources after the rapid change in stage three. If the system is unable to reorganize to its previous state, the system may become something new. This is a shift from one equilibrium state to another. The adaptive cycle explains the degree to which change is part of socio-ecological systems. Thus instead of describing resilience on the basis of the ability to maintain stable states, the natural cycle of change needs to be accounted for. The ultimate importance of change to a system means flexibility and adaptability are very crucial to a resilient system. This explains why resilience has been defined to capture cycles of changes, as well as changes from one state of equilibrium to another.

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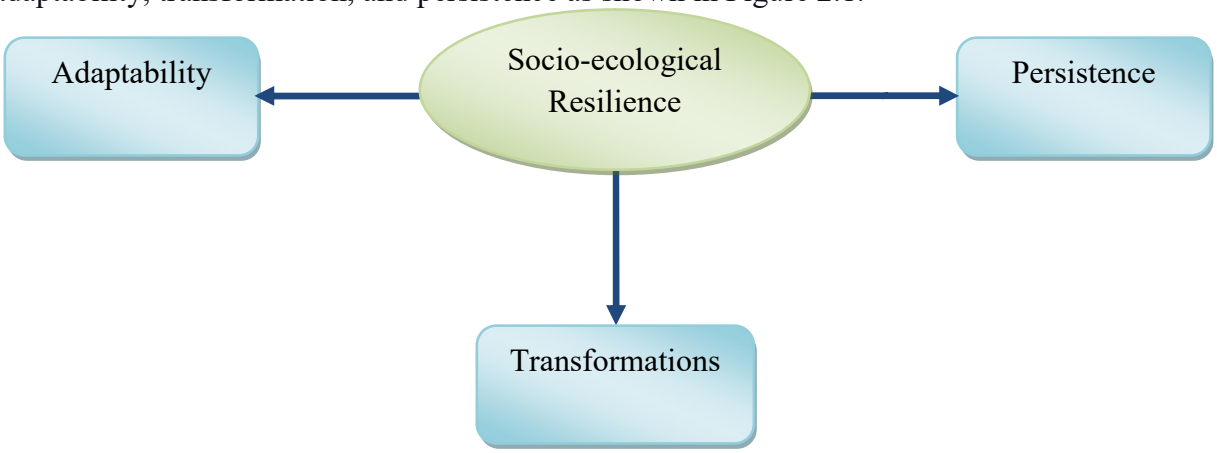
Engineering resilience is defined as the amount of time it takes for the system to return to its previous state after a disturbance (Folke, 2006). Resilience has been technically used in a narrow sense to refer to the return rate to equilibrium upon a perturbation called engineering resilience by Holling (1996). These definitions are only applicable to smaller disturbances where the system does not end up far from the initial equilibrium. However, a major criticism of these definitions is that it does not apply to the ecosystem in an unstable state. An important feature of resilience captured in this definition is the temporal dimension: the ability to recover and retain critical system functionality in response to a wide range of threats, both known and unknown. This definition of resilience implies that the assessment of resilience should, therefore, identify the critical functionality of a system and evaluate the temporal profile of system recovery in response to adverse events; it should comparatively evaluate cross-domain alternatives designed to enhance the system's ability to plan for adverse events, absorb stress, recover and predict and prepare for future stressors to adapt to their potential threats (Ganin *et al.,* 2016).

### [redacted]

The socio-ecological system theory of resilience combines social and ecological resilience into an interrelated system. It gives the two the same weight in their measurement (Folke, 2006). It goes beyond the ability to absorb shocks. It entails the potential for renewal, reorganization, and

development (Folke, 2006) It emphasizes that man must be seen as part of nature and not apart from nature. It posits that the separation between the two is artificial and arbitrary. It involves adaptability, transformation, and persistence as shown in Figure 2.1.



Adaptability is defined as the ability of a system to combine experience and adjust its responses to changing external circumstances (Folkes, 2006). Danhofer, (2014) further defined adaptive capacity as the ability of a system to adjust by learning and developing without involving radical changes to the system's function or structure. It is also described as reflected and shared learning in which actors within the system are able to learn and adjust based on past experiences and information from each other. It talks about the ability of a system to continue to develop within a stable domain (Folke, 2006). It helps to maintain a certain process in spite of changing internal and external demands on a system (Carpenter and Brock, 2008). Transformative Capacity is the ability of a system to create new systems when external forces make existing systems untenable. Transformative capacity is the ability of a system to respond to shock by radically altering its structures and functions (Danhofer, 2014). Here a shift from one equilibrium state to another is seen as resilient as long as the shift is beneficial in the long run. It draws on multiple scales in resilience (i.e. the ability of a system to move from one state to another). It posits that transformational change at smaller scales leads enable resilience at larger scales.

Persistence entails remaining within the same regime thereby retaining the same function and identity (Walker *et al.,* 2004, 2006). It emphasizes the ability of a system to self-reorganize in the face of shocks. The ability to self-reorganize is important in deciding how a system will emerge after a shock (Altieri *et al.,* 2015, Quinlan *et al.,* 2016). A self-organized system will be more resilient than one that is not organized or has a forced system of organization (Folke, 2006).

In relation to food security, households experience shocks, they adapt by employing various strategies such as the sale of assets to acquire food thus they are able to manage the effect of shocks without altering their structure and functions to remain food secure. However, the households may reorganize their food systems by reducing consumption hence they remain food secure in the face of shocks, and in this case, they are able to persist within the regime of food security. In other cases where shocks become prolonged such as drought or the Covid-19 shock in 2020 which lasted for a whole year, a household may deplete all available asset and may no longer be able to meet daily households food consumption and this could lead to transformation to a new equilibrium in food security (i.e. they may transform to new food security status such as being food insecure)

The Socio-Ecological Theory of resilience states that households have food systems that make them food secure. It posits that the food systems consist of both social and ecological components. It states that the occurrence of shocks leads to disruptions in the food system which could lead to a shift in one state of equilibrium in the food system to the other (i.e. being food secure or insecure). It states those households employ the various components of socio-ecological theories such as adaptive capacity, persistence, and Transformation in their response to shocks to adjust, learn, remain or transform to new states of equilibrium (food secure or insecure).

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This section discussed the various analytical tools used in measurement of resilience. This includes the Resilience Index Measurement Approach RIMA II, Fixed effect and random effect models the Generalized Method of Moments, and the Principal Components Analysis.

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The resilience index measure approach is a latent variable model in which an unobserved variable is estimated from a set of observable variables. It involves a set of indicators that are used to construct an index for the dimensions (pillars) of resilience and food security indicators.

The RIMA II approach is carried out in two steps. In the first stage principal component analysis was used to construct indices for the four major pillars of resilience namely Access to Basic Services (ABSi), Asset (ASTi), Adaptive Capacity (ADCi), and Safety Nets (SSNi). In the second stage the resilience index was jointly estimated from the pillars of resilience and food security indicators(dietary diversity and food expenditure) through a multiple indicators multiple causes (MIMIC) model following d'Erico *et al.* (2016), it is specified as:

(MIMIC) model following d'Erico *et al.* (2016), it is specified as:

$$\begin{bmatrix} foodexpenditure \\ dietarydiversity \end{bmatrix} = \Lambda_1 \Lambda_2 \times [RCI] + [\varepsilon_{2,} \varepsilon_3] \qquad 2.1$$

Food expenditure and dietary diversity are food security indicators

RCI = resilience capacity index

$$[RCI] = [\beta_2, \beta_3] \times \begin{bmatrix} ABS \\ AST \\ SSN \\ AC \end{bmatrix} + [\varepsilon_1] \quad 2.2$$

$ABS_i$ = Access to Basic Services index

$AST_i$ = Assets index

$SSN_i$ = Social Safety Nets index

$AC_i$ = Adaptive Capacity index

$\beta_2, \beta_3$= coefficients of the food security indicators

$$foodexpenditure = \Lambda_1 RCI + \varepsilon_2 \quad 2.3$$

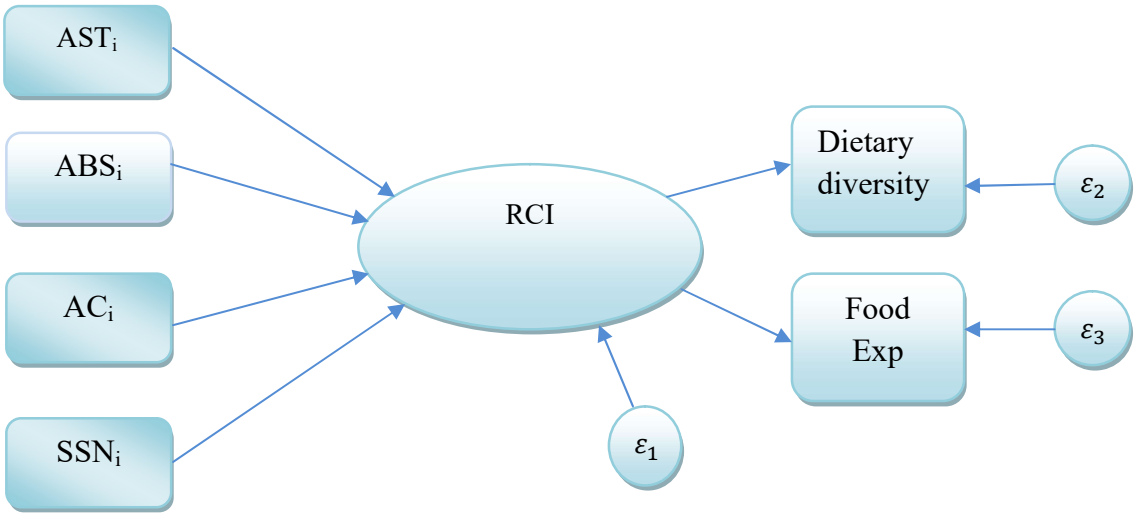
$$dietarydiversity = \Lambda_2 RCI + \varepsilon_3 \quad 2.4$$

The resilience capacity index helps to compare the level of resilience across the households. It makes it possible to identify which households have a lower or higher capacity to cope with shocks. The resilience structure matrix helps to identify the determinants or correlates of resilience. It makes it possible to identify the key drivers of resilience among households.

The resilience index measurement approach provides two results namely the Resilience Capacity Index (RCI) and Resilience Structure Matrix (RSM) otherwise known as determinants of resilience

The process of estimation of RIMA II is displayed in a diagram in figure 2.2; $AS_i$, $ABS_i$, $AC_i$ and $SSN_i$ are the pillars of resilience (access to basic services, assets, adaptive capacity, and social safety nets). Dietary diversity and food expenditure are food security indicators. The RCI is the resilience index is the unobservable variable that is jointly estimated from both the pillars and food security indicators.

As shown in Figure 2.2 that there are two sides of equations in the estimation of resilience capacity index, the left side represents the pillars of resilience (structural equation with error term), the right side represents the food security indicators(measurement model with error terms). It states the Resilience Capacity Index (RCI) in the middle is a joint estimate from both sides of the equation.

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$AST_i$ = Asset Index

$ABS_i$ = Access to Basic Service Index

$AC_i$ = Adaptive Capacity Index

$SSN_i$ = Social Safety Net Index

### 2.4.1 Linear probability model

The linear probability model is similar to the simple linear regression equation; however, it is different because the dependent variable is classified into two categories (1 and 0).

It is written as:

$$E(Y_i/X_i) = \beta_0 + \beta_i X_i + u_i \qquad 2.5$$

The Linear probability model's main weakness is the problem of heteroscedasticity, in addition, unless there is some tinkering with disturbances it is impossible to make the results look like true probabilities. Lastly because x'β cannot be constrained between 0 and 1, hence the model produces a probability that is unreliable with negative variance, the R square are generally low.

### 2.4.2 Logit model

The logit regression model is a binary choice model with a binary response variable. The dependent variables can take the values 0 and 1 (food secure and food insecure). The Logit model according to Greene, (2003) is given as:

$$P = \frac{e^{x_i\beta}}{1 + e^{x_i\beta}} \qquad 2.6$$

$$Z = \beta_0 + \beta_i X_i + \varepsilon \qquad 2.7$$

Where $X_1,\ldots,X_n$ are the regressors.

The logit regression model are suitable for finding the effect of resilience on food insecurity among the households  This is because the dependent variable food security is classified into two

categories(1=food secure and 0= food secure). It however may not be suitable for models that involve a panel dataset. Instead the fixed and random effect logit regression would be more appropriate.

### 2.[redacted]

The probit regression model is a binary choice model like the logit model and it also estimated the method of maximum likelihood. It is specified as follows:

$$Prob(Y = 1/x) = \int_{-\infty}^{x'\beta} \phi(t)dt = \phi(x'\beta) \qquad 2.8$$

The probit regression model shares similarity with the logit regression model. Both of them are binary response models. The result from both the logit and probit regression model are similar hence either models are suitable when the dependent variable are categorized into two categories (1=food secure and 0=food insecure).

### 2.[redacted]

The tobit regression model help to suppress some observations from being included in a regression through a system of cut-offs. It works like the ordinary least square (OLS) regression model however, it differs from the OLS in that it can exclude some observations that are below or above the cut off in the dependent variable from the estimation process. According to Greene (2003) the Tobit model is specified as:

$$y_i^* = x_i'\beta + \varepsilon_i \qquad 2.9$$

$$y_i = \begin{cases} 0 & if \quad y_i^* \leq 0 \\ y_i^* & if \quad y_i^* > 0 \end{cases} \qquad 2.10$$

Where $y_i^*$the censored is variable

### 2.[redacted]

The fixed-effects (FE) is used when analyzing the impact of variables that vary over time. FE explores the relationship between predictor and outcome variables within an entity (household). Each entity has its own individual characteristics that may or may not influence the predictor variables. When using FE it is assumed that something within the individual may impact or bias the predictor or outcome variables and there is the need to control for this. This is the rationale behind the assumption of the correlation between entity's error term and predictor variables. FE removes the effect of those time-invariant characteristics thus making it possible to assess the net effect of the predictors on the outcome variable. Following Gujarati (2004) it is specified as:

$$Y_{it} = \beta_{1t} + \beta_2 X_{2it} + \mu_{it} \quad 2.11$$

$$Y_{it} = \alpha_1 + \beta_{it} X_{it} + \gamma_{it} d_{it} + \delta_3 d_3 + \varepsilon_{it} \quad 2.12$$

Where $Y_{it}$ is a dependent variable, food security outcomes in year t, characteristics the time-invariant variables (e.g sex, religion, educational attainment) that influence household food security and it is the dummy variables. The fixed-effect model can also be used to estimate the relationship between resilience and household food security (d'Erico, 2016). It is specified as:

$$FS_{h,t} = \alpha_h + \beta R_i + \gamma P_i + \varepsilon_{h,t} \quad 2.13$$

Where Ri is the resilience capacity index for household h in time t, P represents household characteristics, ε is the error term, and αh is the household fixed effect.

**2.[redacted]**

Random effects (RE) assume that the entity's error term is not correlated with the predictors which allows for time-invariant variables to play a role as explanatory variables. In random-effects there is need to specify those individual characteristics that may or may not influence the predictor variables. The problem with this is that some variables may not be available therefore leading to omitted variable bias in the model. RE allows generalizing the inferences beyond the sample used in the model.

The rationale behind random effects model is that, unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model. The difference between the fixed effect model and the random effect model is that in the fixed effect model the intercept is fixed, while in the random effect

model the intercept is not fixed it varies overtime. According to Gujarati (2004), it is specified as:

$$Y_{it} = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon_i + \mu_{it} \quad 2.14$$

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + w_{it} \quad 2.15$$

Where

$$w_{it} = \varepsilon_i + \mu_{it} \quad 2.16$$

[redacted]

Principal Component Analysis (PCA) is a technique which uses mathematical principles to transforms several possibly correlated variables into a smaller number of variables called principal components. It is a dimension-reduction tool that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

[redacted]

Generalised method of moments(GMM) estimators choose the estimates that minimize a quadratic form of the moment conditions(restrictions imposed by economic theory in the process of estimation of parameter). GMM reduces to MM when the number of parameters equals the number of moment conditions. The GMM is specified following Gujarati (2004) as

$$h(\theta_0, w_t) \quad 2.17$$

with θ parameter to estimate

$$E[h(\theta_0, w_t)] = 0 \quad 2.18$$

under true parameter $\theta = \theta_0$

$$y_t = \{w_t, w_t, \dots, w_T\} \quad 2.19$$

$$g(\theta, y_T) = \frac{1}{T}\sum_{t=1}^{T} h(\theta, w_t) \quad 2.20$$

$\hat{\theta}$ Is found directly as:

$$\hat{\theta} = \arg min_\theta J(\theta, w_T) = \arg min_\theta g(\theta, w_T)' W_T g(\theta, y_T) \quad 2.21$$

Where $w_T$ is a positive weighing matrix.

The GMM is important because it can be used to measure the correlates of resilience. It used to eliminate the presence of endogeniety in while finding the determinants of resilience.

[redacted]

A way of assessing the future state of people in terms of the observed situation is the use of a technique known as the Markov chains. The Markov chain is a direct generalization of the scheme of independent trials. The Markov process exhibits no carry-over effect. That is the conditional distribution of the random variables in a future given their values now, is the same as their conditional distribution now and at all times. According to Ayantoye *et al.* (2011), the items in the transition matrix shown in simple first order Markov model in table 2.1 are converted into probability values of entering and exiting food insecurity by dividing each item by the corresponding row total to give the transition matrix in equation 2.22.

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \quad 2.22$$

In Table 2.1 $a_{11}$ and $a_{22}$ represent the stationary states of food security and food insecurity respectively. These households remained in their status in years 1 and 2. While $a_{12}$ represents the transitional states of those households that have moved from being food secure to being food insecure during the two years, $a_{21}$ represents the transitional states of food security, that is, those households that have exited food insecurity during the two years. Also the vector of initial probability P(o) was obtained by dividing each column total by the grand total. This gives the proportion of households that will be in each category in the subsequent periods as shown in equation 2.23

$$P(k) = P(o)*Pk \quad 2.23$$

Where k is the time period in years

The long term equilibrium when the proportion of households entering food security equals the proportion exiting it was obtained by equation 2.24.

$eP = e$ 2.24

Where e represent equilibrium and eP represent probability at equilibrium.

$$(b_1 b_2)\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} = (b_1, b_2)$$ 2.25

**[illegible]**

| | | [illegible] | [illegible] |
|---|---|---|---|
| [illegible] | FS | FIS | |
| [illegible] | $a_{11}$ | $a_{12}$ | $A_1$ |
| [illegible] | $a_{21}$ | $a_{22}$ | $A_2$ |
| [illegible] | $A_1$ | $A_2$ | |

[illegible] *et al.* ([illegible])

FS= Food Secure

FIS = Food Insecure

The solution to the matrix in equation 2.25 produced $b_1$ and $b_2$ which are the proportion of the households that will be food secure, and food insecure at equilibrium in the long run

Where

$b_1$ = probability that the households will be food secure at equilibrium.

$b_2$ = probability that the households will be food secure at equilibrium.

This section discussed the approaches employed by various works of literature in the measurement of resilience to food security. It also covers the type of data employed and relevant findings from the works of literature. It also discussed the relevance of the works of literature to this study. In addition, it also discussed the merits of the various method used in literature to measure resilience among the households.

d'Erico *et al.* (2016) used the RIMA II approach to find out what makes households resilient to food insecurity; their result indicates households are resilient as their adaptive capacities increase. In addition, their result reveals that food security is lowered by the occurrence of shocks. Hence the frequent occurrence of shocks tends to make the household's food insecure.

Alinovi *et al.* (2008) used decision matrices and multivariate methods to develop an index to measure resilience to food insecurity among households in Palestine, the decision rules for building the indices were validated through classification and regression tree (CART). Their study showed that resilience varies across regions and resilience was strongly influenced by income and services access and stability. Gambo *et al.* (2016) carried out a study to find out what makes rural households in Niger resilient to food insecurity. They used a Principal Components

Analysis to create a resilience index and later apply Structural Equation Modelling to identify determinants of rural households' resilience to food insecurity. They found that having asset and safety nets makes households more resilient.

Keil *et al.* (2008) examined resilience among households in times of drought and its impact on their food expenditures. They found that expenditure on foodstuff is lower than expenditure on other vital needs in the homes. Their study further revealed that Households' drought resilience is strengthened by the possession of liquid assets, access to credit, and the level of technical efficiency in agricultural production. FAO (2015) in a study on resilience food insecurity employed the resilience index measurement approach (RIMA) to measure household resilience to food insecurity the RIMA model involves two stages the first stage involve factor analysis to find the indicators of resilience the second stage involves multiple causes, multiple indicators approach to determine what influences resilience among the households. They found that having access to basic services; higher assets and increased adaptive capacity are crucial to being resilient among the households.

In Alinovi *et al*. (2008) when decision matrices and multivariate methods were used to develop an index to measure household resilience to food insecurity among households, the decision rules for building the indices were validated through classification and regression tree (CART). They found that the differences among regional resilience levels are significant. A similar study by Alinovi *et al.* (2010) carried out to measure the effect of livelihood strategies on resilience using Ward's cluster analysis technique among households in Kenya according to their livelihood strategies. They employed and updated the CART to measure household resilience to food insecurity. They found that there are significant differences across the different provinces and among clusters. In terms, of access to basic services, the social safety net contributes significantly to resilience among the households.

From the works of literature discussed above, the estimation of resilience follows two major approaches namely; the resilience index measurement approach (RIMA) I and II. The two approaches and their outcomes are shown in figure 2.3. The Resilience Index Measurement Approach (RIMA I) is employed by Kiel *et al.* (2008), Alinovi *et al*. (2008, and 2010), and it is carried out by two-stage factor analysis. In the first stage, factor analysis is used to construct an index for each of the pillars of resilience and in the second stage, factor analysis is used to generate a resilience index from the indices of all the pillars of resilience. The main advantage of

this method is that it allows flexibility in the measurement of resilience and it made it possible to relate resilience to other variables. A major disadvantage of this method is that it does eliminate the danger of endogeneity in the measurement of the resilience index. Another disadvantage is that resilience estimated from this procedure is used only for descriptive statistics.

The second approach discussed above, the Resilience Index Measurement Approach (RIMA II) was followed by FAO (2015), d'Erico *et al.* (2016), and Gambo *et al.* (2016). It is an improvement over RIMA I in that the problem of endogeneity is eliminated from the resilience index estimation procedure. RIMA II approach is divided into two steps direct method and indirect method.

The direct method is carried out in two stages in the first stage indices of the pillars of resilience are constructed using principal component analysis, in the second stage multiple indicators multiple causes (MIMIC) model is used to estimate the resilience index jointly from pillars of resilience and food security indicators. The major advantage of RIMA II (direct method) is that it allows inferences to be made on the correlates of resilience among the households; it also allows the measurement of resilience capacity index among the households.

The indirect method looks at the loss of food security and speed of recovery from shocks among the households. It classified households into resilient and non-resilient. Its major constraint is that it does not allow for comparison of resilience capacity among the household. It is also of limited use because of the lack of robust data on shocks which is crucial in determining loss of food security as a result of exposure to shocks and speed of recovery from shocks.

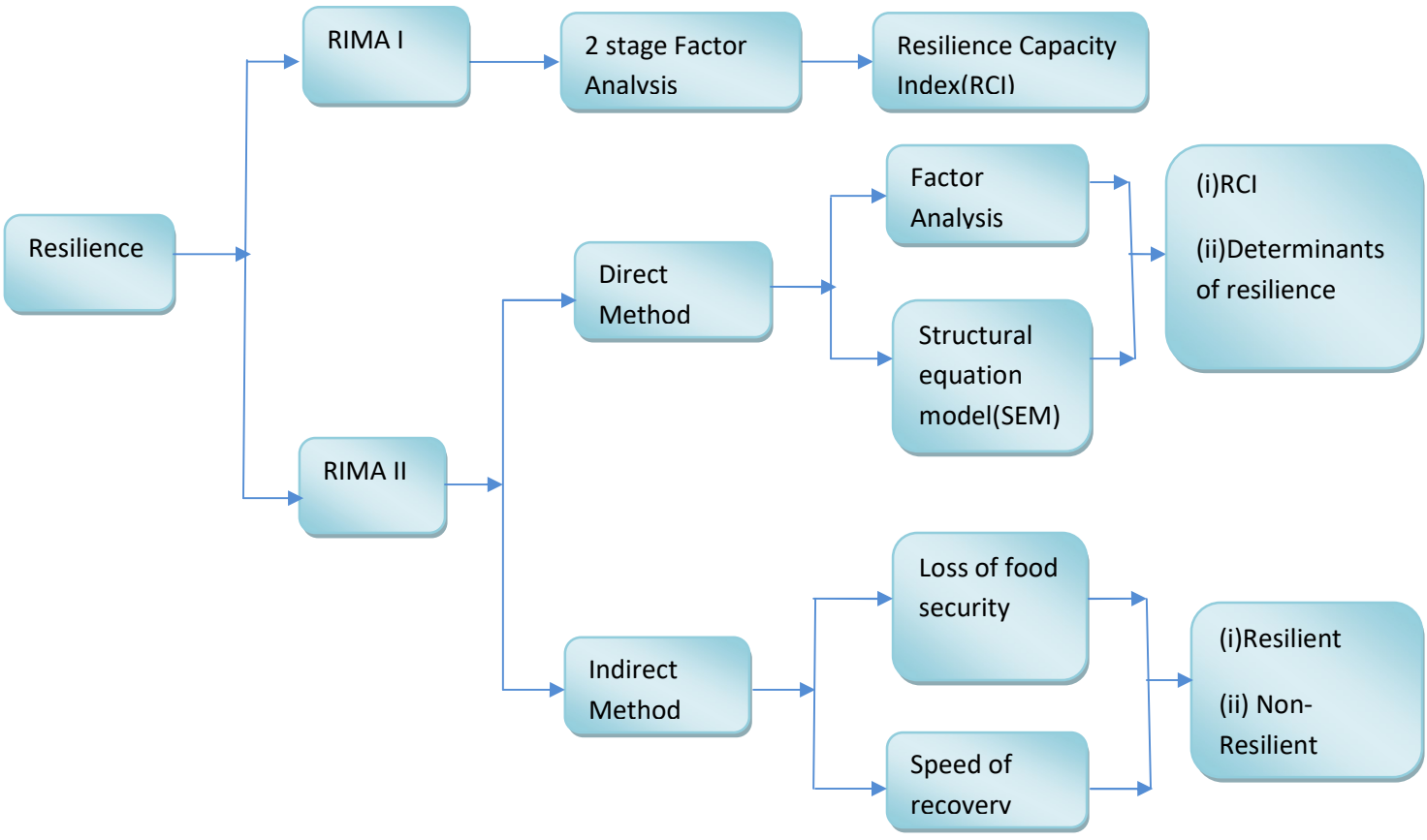
This study employed RIMA II (direct method) in measuring resilience to food insecurity among rural households in Nigeria because of its advantages over all other means of measuring resilience among the household.

**2[illegible]**

This section discussed the conceptual framework on resilience to food insecurity. Following FAO (2016), d'Erico *et al.* (2016), Alinovi *et al.* (2008, 2010); resilience is made up of four pillars or dimensions these are access to basic service, assets, safety nets, and adaptive capacity.

**2[illegible]**

Basics services among rural households include schools, health centers, water, electricity, and nearby markets. When rural households have access to these services it will make them more resilient for the following reasons: first income generation is influenced by access to market facilities. The nearness of the market can influence the amount of income generated among rural households (Dercon *et al.,* 2004). For an instant, crop sales at the farm-gate or district market can result in very different revenues for farmer households. In addition, the density of the road network influences not only access to markets but also the efficacy of aid distribution in response to disasters (Adger *et al.,* 2004).



Furthermore, Khan, (2014) posits that there is a strong connection between access to basic services before a disaster and the rate of recovery after a disaster. Second, ABS plays a key role in determining the risk exposure of households and communities. For example, "risk of illness is often closely related to particular environmental risks, linked to inadequate waste disposal, water supplies, and sanitation" (Dercon *et al.,* 2004).As stated earlier, nearness to market and access to roads could affect income-generating ability among the rural households and this could in turn affect food security among the rural households. Aside from having access to markets and roads, access to good health facilities could improve health status among the rural household. This will reduce the number of inactive days due to illness, it will increase productivity among the rural households, and it will make the household more resilient to food insecurity.

**2.4.5**

Productive Assets are the key elements of a livelihood, enabling households to produce consumable or tradable goods (FAO, 2016). The indicator includes agricultural wealth index (e.g. agricultural equipment and agricultural tools), wealth index (e.g. non-agricultural equipment), land owned, and tropical livestock unit (FAO, 2016).

Assets contribute directly to the income generation process (productive assets), shocks can have different consequences and lead to different behaviours, i.e. selling assets or slowing down asset accumulation could have important implications for future income generation (FAO, 2016) transitory shocks can have long-term consequences when income loss leads to changes in the asset investment decision. Households might reduce their consumption to preserve their assets (this is the case of asset smoothing) (Carter and Barrett, 2005; Zimmerman and Carter, 2003), or they can sell assets to protect consumption (consumption smoothing). According to Hoddinott

(2006), the probability of selling assets (e.g. animals) in the face of a negative-income shock depends on the prior level of assets. An increase in assets owned by households will help the households to withstand shocks that threaten their food security. This is because households can sell assets in times of need to acquire food for the members of their households. Thus ownership of assets increases resilience to shocks that threaten food security among rural households.

[redacted]

The social safety nets include both formal and informal transfers (FAO, 2016). While the former category is easily observed, informal social networks flowing through unrecorded channels are not easy to capture as they are not easily detected and quantified because they involve various forms of exchange that by definition take place outside formally institutionalized channels (Ligon, 2002; Mordoch, 1999). Formal transfers are one of the principal areas of intervention intended to provide social protection and poverty alleviation for the poor through improved access to credit and subsidization of credit (FAO, 2016). The extent to which households can refer to formal or informal channels depends mainly on the existence of healthy credit institutions, from the degree of a single individual's social connections and networks inside a community to the existence of public social protection intervention (Fafchamps *et al.,* 2007). Informal transfers are important for households and individuals and act as an insurance mechanism.

Households can borrow from friends and relatives in cash or kind, but private remittances sometimes are not able to protect households from shocks. Public social safety nets, social protection, and insurance programmes, even if of limited coverage in some developing countries, can help the poor to build up and protect their assets with the minimum of debt ( FAO, 2016). According to Mane *et al.* (2015), social protection offers an efficient answer to poverty and food insecurity in developing countries (Mane *et al.,* 2015). SSN indicators, for example, in the case of in-kind or food received, could be complementary in the calculation of food security levels as well as in total consumption (Skoufias and Quisumbing, 2004). Safety net helps households to withstand shocks that threaten their food security by providing emergency funds and credit to the

households. The size of the credit depends on the level of trust and networks built by the households over time hence safety net makes the household more resilient to food insecurity.

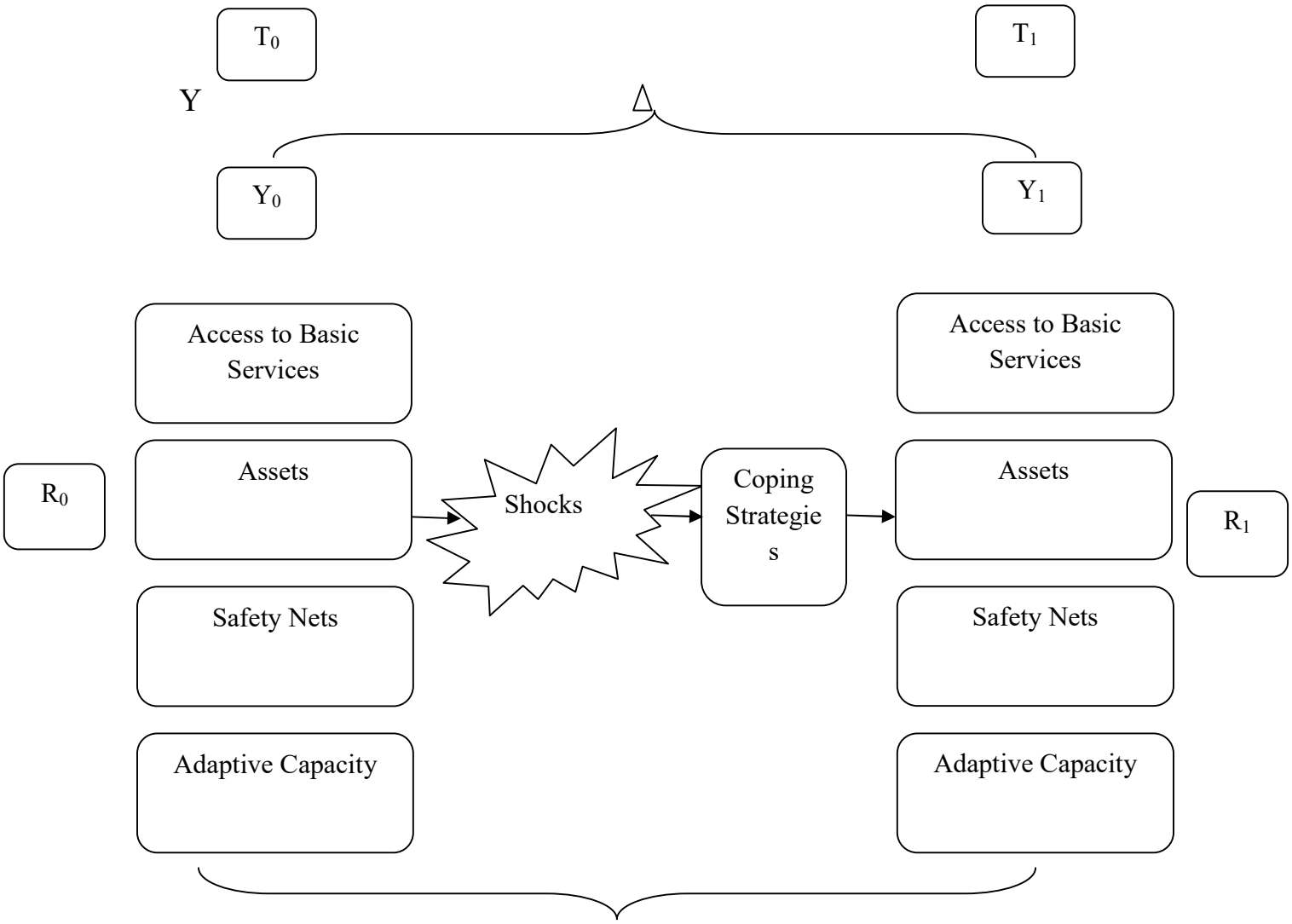
Adaptive Capacity is the ability of a household to adapt to a new situation and develop new sources of livelihood. For instance, having multiple sources of income may decrease the negative effects of a shock on a household. The observable variables included in this dimension are education, participation in income-generating activities, crop diversification index, and dependency ratio. Ecological and economic systems are non-linear and adaptive (Levin *et al.* 1998) and therefore the adaptive capacity of a household has to be taken into account.

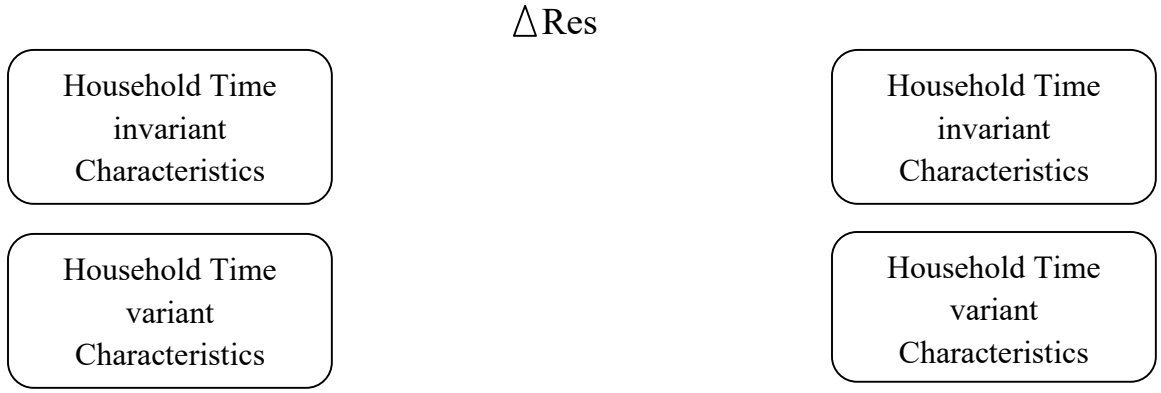
A household can become more adapted by improving its conditions in its environment (Gallopin, 2006). Adaptive capacity could help the household to adjust to a new environment in the face of shocks that threaten their food security. Shocks could have long-term and short-term effects. In face of shocks that have a short time effect households can quickly learn and adjust to the new environment and maintain their food security status. However, in the face of shocks with long term effect such as Covid-19 in 2020(World Bank, 2020) strategies and plans put in place by the households to help withstand the shocks might become exhausted overtime making the households vulnerable to food insecurity hence the households require an adaptive capacity to help them learn and adjust to the new environment and maintain their food security status while the shock lasts.

The conceptual framework on resilience to food insecurity (Figure 2.4) follows FAO (2016) RIMA II, which indicates the change in resilience from overtime. Resilience is captured by the four pillars assets access to basic service social safety nets and adaptive capacity. Its underlying theory is that shocks occur to household food security (Y0). The household responds with resilience and the food security status changes over time to (Y1) likewise it resilience changes from $R_0$ to $R_1$. The framework tries to underline the idea that resilience is a time concept of food security. It represents the approach used to determine the effect of resilience to food insecurity among rural households. It also indicates that the key variables used to estimate resilience to food insecurity among rural households.

## [redacted]

This section discussed the relationship between resilience and food security among households. According to Spedding (2012), if the household can act together, reorganize it systems and structures while experiencing shocks and stresses then they are resilient. In a resilient household, change has the potential to create opportunities for development, novelty, and innovation. As resilience declines, it takes a progressively smaller external event to cause a catastrophe.

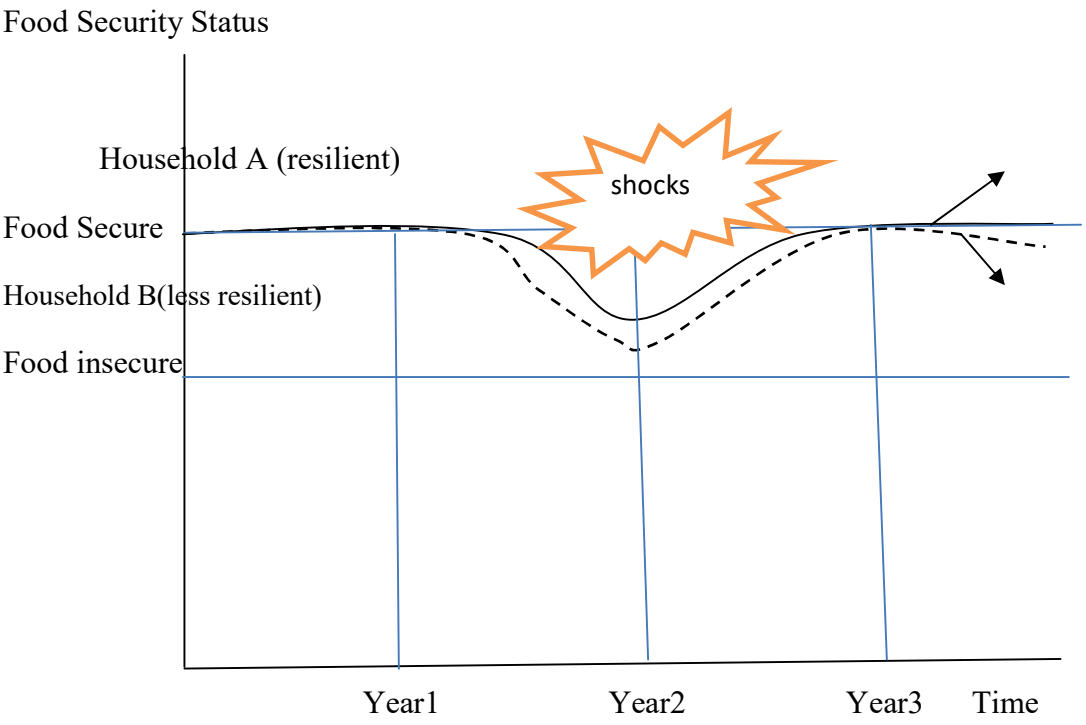





A household with low resilience may still maintain its functions and generate resources and services – i.e., may seem to be in good shape – but when subject to disturbances and stochastic events, it may exceed a critical threshold and change to a less desirable state (Alinovi *et al.* 2010).

The relationship between resilience and food security among two households (A and B) are shown in Figure 2.5 After experiencing shock the household A overcame the shock and was restored to a former level of food security while household B could not return to its previous level of food security again.

This is because most households have different means of coping with shocks that threaten their food security status. Households that have assets could sell some of it to meet their consumption needs in the face of shocks and this will help the household to withstand the shocks and return to previous food security levels these households as being resilient to shocks. While households whose response to shocks are weak and have poor coping strategies will be severely affected by the shocks and like household B they may never recover from the effect of the shocks, they may never return to their previous level of food security again thus household B is described as being less resilient to shocks.


Food Security Status
Household A (resilient)
shocks
Food Secure
Household B(less resilient)
Food insecure
Year1
Year2
Year3
Time

[redacted]

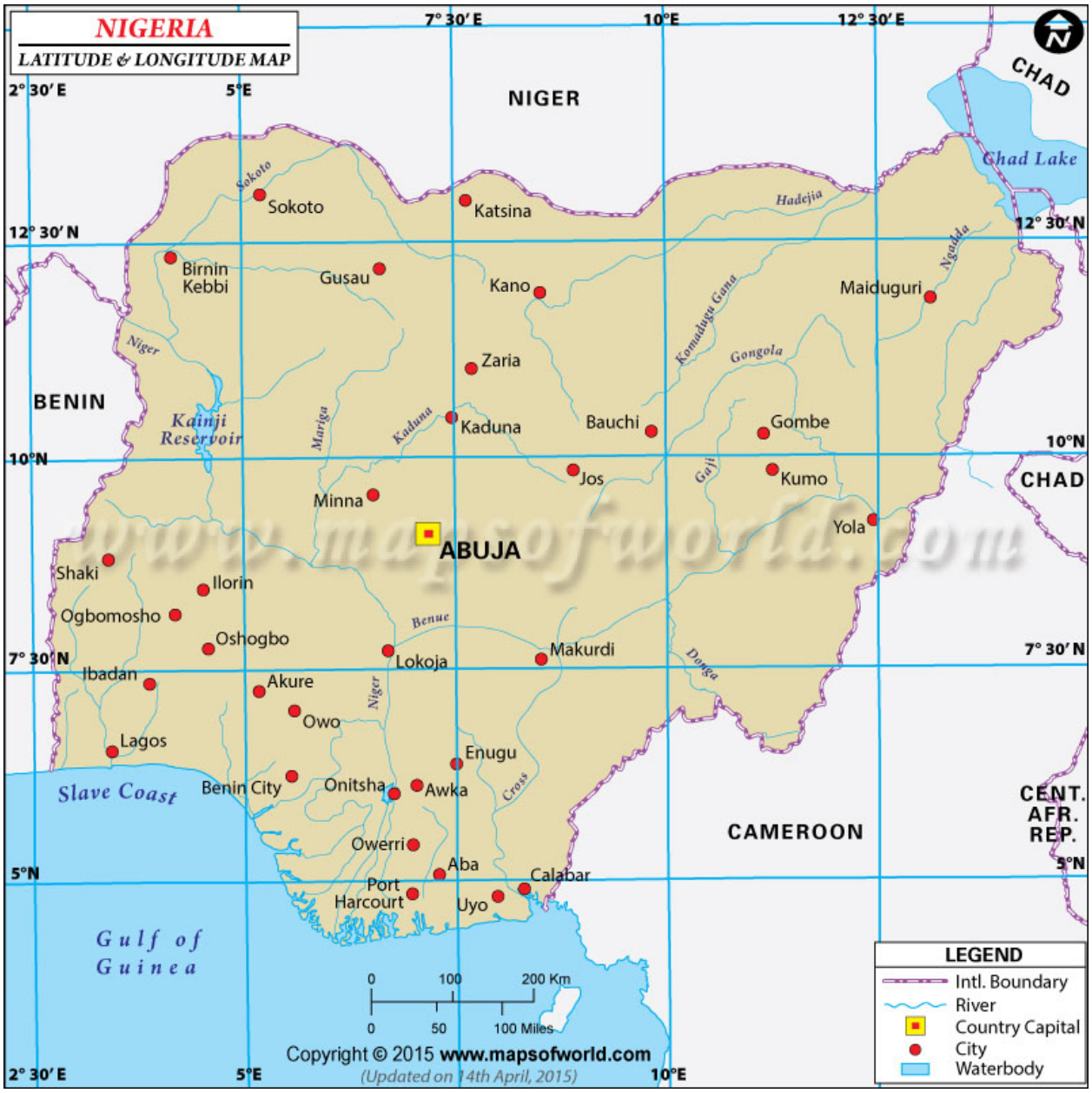
[redacted]

The study used a three-panel data set of the Nigerian General Household Survey (GHS) wave one, two, and three (2010/2011, 2012/2013, and 2015/2016). The GHS panel consists of 5,000 households across 500 enumeration areas (EAs). The data was representative across all the six zones in Nigeria, the information contained in the GHS includes household characteristics, welfare, and agricultural activity. The data were jointly obtained by the World Bank and the Nigerian National Bureau of Statistics, Nigeria. The information used for this study covers socio-economic characteristics such as age, sex, educational level, household size, occupation, farming experience (years), marital status, monthly income, access to credits, the quantity of food consumed(kg), food expenditure, assets owned, access to basic services, adaptive capacity and social safety nets.

[redacted]

The research focused on rural households in Nigeria (Figure 3.1). Information taken from the general household survey was used for this research. The information taken covered socioeconomic characteristics such as age, sex, marital status of household head, household size

and credit access, food security indicators such as food expenditure and food consumed(kg), resilience indicators such as access to basic services, assets, adaptive capacity, and social safety nets.


NIGERIA
LATITUDE & LONGITUDE MAP
7° 30′ E
10°E
12° 30′ E
2° 30′ E
5°E
NIGER
CHAD
Chad Lake
Sokoto
Sokoto
Katsina
Hadejia
12° 30′ N
Birnin Kebbi
Gusau
Kano
Maiduguri
Ngadda
Komadugu Gana
Gongola
Niger
Zaria
BENIN
Kainji Reservoir
Mariga
Kaduna
Kaduna
Bauchi
Gombe
10°N
Jos
Gaji
Kumo
CHAD
Minna
Yola
ABUJA
Shaki
Ilorin
Ogbomosho
Benue
Oshogbo
Lokoja
Makurdi
7° 30′ N
Ibadan
Akure
Niger
Donga
Owo
Lagos
Enugu
Slave Coast
Benin City
Onitsha
Awka
Cross
CENT. AFR. REP.
CAMEROON
Owerri
Aba
5°N
Calabar
Port Harcourt
Uyo
Gulf of Guinea
0 100 200 Km
0 50 100 Miles
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(Updated on 14th April, 2015)
LEGEND
Intl. Boundary
River
Country Capital
City
Waterbody

### 3.[redacted]

This section discussed the various methods used to analyze all the objectives of this study, and this includes the aggregate calorie benchmark, Forster Greer and Thorbecke (FGT) approach, Resilience Index Measurement Approach(RIMA II), and Fixed effect logit regression model.

### 3.[redacted]

The aggregate calories benchmark was used in literatures (FAO 2016; d'Erico *et al.,* 2016; Adeniyi and Ojo, 2013) to measure food security status among households. The quantities of food consumed among households are converted into kilograms. They are then converted from kilograms into calories. The household that consumes above the threshold of 2260kcal are classified as food secure while households that consume below the threshold are classified as food insecure

### 3.[redacted]

Foster *et al.* (1984) devised a simpler form of weighting which depends on the poor person's income and the poverty line. More specifically, they weight the normalized shortfalls by the normalized shortfall itself, raised to a power. The FGT approach provides a clear measure of differentiating between two categories of people in the population it is non-ambiguous and can be easily handled and understood by any beginner. The Forster Greer and Thorbecke(FGT) approach were previously used to measure the incidence depth and severity of poverty among households However, studies like Omonana and Agoi (2007) have employed FGT in the measurement of incidence depth and severity of food insecurity among households in Nigeria. Inline Omonana and Agoi (2007) the FGT index was used to determine the incidence, depth, and severity of food insecurity. It is specified as:

$$P_{\infty} = \frac{1}{N}\sum_{1=n}^{q}\left[\frac{z-y}{z}\right]^{\propto} \qquad 3.1$$

Pα = the weighted poverty index for the ith sub-group

α = Foster-Greer-Thorbecke (FGT) index and takes on the values of 0, 1 and 2 for incidence, depth and severity of poverty measures respectively

z = the poverty line for ith sub-group

N = the total number of households

n = the total number of households in the reference population

$y_i$ = the per capita expenditure of household j in the sub-group i

$z - y_i$ = poverty gap of the ith household

$\frac{z-y_i}{z}$ = poverty gap ratio

[redacted]

The resilience Index Measurement Approach (RIMA II) was used by FAO (2016), d'Erico *et al.* (2016) and Boukary *et al.* (2016) to determine resilience to food insecurity among households. It is carried out in two stages. In the first stage principal component analysis was used to estimate the index of each of the pillars of resilience access to basic services ($ABS_i$), Assets($AST_i$), Adaptive Capacity($AC_i$), and Social Safety Nets($SSN_i$)

$ABS_i$(access to basic service):

I. Electricity(Yes=1, No=0)
II. Improved water facility(Yes=1, No=0)
III. Improved toilet facility(Yes=1, No=0)
IV. Distance to water(Km)
V. Health facilities(Yes=1, No=0)

$SSN_i$ (Social Safety Net)

I. Assistance from Non-governmental Organisations(Yes=1, No=0)
II. Assistance from government agencies(Yes=1, No=0)
III. Assistance from international agencies(Yes=1, No=0)
IV. Charities(Yes=1, No=0)
V. Transfer and remittances(Yes=1, No=0)

$AC_i$(adaptive capacity):

I. Education(Year of education)
II. Dependency ratio
III. Household head wage earner(Yes=1, No=0)
IV. Household head farmer(Yes=1, No=0)
V. Household head employer(Yes=1, No=0)
VI. Household head no job(Yes=1, No=0)

$AST_i$(Assets):

I. Wealth index
II. Tropical livestock unit
III. Land ownership(Yes=1, No=0)
IV. House condition index

In the second stage a structural equation model was used to jointly estimate resilience capacity index from the index of pillars of resilience ($ABS_i$, $AST_i$, $AC_i$ and $SSN_i$)and food insecurity indicators(food expenditure and dietary diversity). This model is known as multiple indicators multiple causes (MIMIC) model. The mimic model is made up of two equations the structural equation (pillars of resilience) and the measurement model (food security indicators). It is specified as follows:

$$\begin{bmatrix} foodexpenditure \\ dietarydiversity \end{bmatrix} = \Lambda_1\Lambda_2 \times [RCI] + \begin{bmatrix} \varepsilon_2, \varepsilon_3 \end{bmatrix} \quad 3.2$$

Food expenditure and dietary diversity are food security indicators

RCI = resilience capacity index

$\varepsilon_2, \varepsilon_3$ = error term of the measurement model (food security indicators)

$$[RCI] = \begin{bmatrix} \beta_2, \beta_3 \end{bmatrix} \times \begin{bmatrix} ABS \\ AST \\ SSN \\ AC \end{bmatrix} + [\varepsilon_1] \quad 3.3$$

$ABS_i$ = Access to Basic Services index

$AST_i$ = Assets index

$SSN_i$ = Social Safety Nets index

$AC_i$ = Adaptive Capacity index

$\varepsilon_1$= error term of the structural equation(pillars of resilience)

$\beta_2, \beta_3$= coefficients of the food security indicators

$$foodexpenditure = \Lambda_1 RCI + \varepsilon_2 \quad 3.4$$

$$dietarydiversity = \Lambda_2 RCI + \varepsilon_3 \quad 3.5$$

$\Lambda_1, \Lambda_2$= loadings on resilience capacity index from food expenditure and dietary diversity

[redacted]

The fixed-effects (FE) regression model is used when analyzing the impact of variables that vary over time. FE explores the relationship between predictor and outcome variables within a household. Each household has its own individual characteristics that may or may not influence the predictor variables. When using FE it is assumed that something within the individual may impact or bias the predictor or outcome variables and there is the need to control for this. This is the rationale behind the assumption of the correlation between each household's error term and predictor variables. FE removes the effect of those time-invariant characteristics thus making it possible to assess the net effect of the predictors on the outcome variable. The Fixed-effects models are designed to study the causes of changes within a household.The influence of resilience on food insecurity in the household was determined with the aid of Fixed Effects model in line with d'Erico *et al.* (2016). Following Gujarati (2004) it is specified as:

$$Y_{it} = \alpha_1 + \delta_{it} RCI_i + \beta_{it} X_{it} + \gamma_{it} N_{it} + \varepsilon_{it} \quad 3.6$$

Where, $Y_{it}$ = Food security status (1 or 0)

$RCI_i$ = Resilience capacity index

$N_{it}$ = dummy variables

$X_{it} = X_1$-$X_6$

$X_1$=Age of household Head (years)

$X_2$ =Marital Status of Household Head(Married = 1, Unmarried = 0)

$X_3$ = Years of formal education (years)

$X_4$ = Household Size(Numbers)

$X_5$ = distance to market (Km)

$X_6$ = Income (Naira)

$N_1$ = Dummy of Sex

$N_2$= Dummy of Access to extension

$N_3$= Dummy of Landownership

$N_4$ = Dummy of Occupation

$N_5$-$N_{10}$ = dummy of Zones

$N_5$ = Dummy of North-Central (1=Yes, 0=otherwise)

$N_6$= Dummy of North-East (1=Yes, 0=otherwise)

$N_7$= Dummy of North-West (1=Yes, 0=otherwise)

$N_8$ = Dummy of South-East (1=Yes, 0=otherwise)

$N_9$ = Dummy of South-South (1=Yes, 0=otherwise)

$N_{10}$ = Dummy of South-West (1=Yes, 0=otherwise)

$\varepsilon_i$ = error term

The effect of shocks on resilience of household was determined with the aid of Fixed Effects Model in line with d'Erico *et al.* (2016). Following Gujarati (2004) it is specified as:

$$\text{RCIi} = \alpha_1 + \beta_{it} X_{it} + \gamma_{it} L_{it} + \varepsilon_{it} \qquad (3.7)$$

$RCI_i$ = Resilience capacity index

$L_{it}$ = dummy variables

$X_1$ = distance to market (Km)

$L_1$ = Dummy of Gender of Sex(1=Male, 0=otherwise)

$L_2$= Dummy of credit access(1=Yes, 0=otherwise)

$L_3$ = Dummy of Occupation(1=Agriculture, 0=otherwise)

$L_4$ = Dummy of pest invasion (1=Yes, 0=otherwise)

$L_5$ = Dummy of deathshocks (1=Yes, 0=otherwise)

$L_6$ = Dummy of drought (1=Yes, 0=otherwise)

$L_7$ = Dummy of flooding (1=Yes, 0=otherwise)

$L_8$ = Dummy of illness(1=Yes, 0=otherwise)

$\varepsilon_i$ = error term

3.6

The Markov chain is a way of assessing the future state of people in terms of the observed. The Markov chain is a direct generalization of the scheme of independent trials. The Markov process exhibits no carry-over effect. That is the conditional distribution of the random variables in a future given their values now, is the same as their conditional distribution now and at all times.Food insecurity transition matrix and resilience transition matrix was determined using the Markov chain. This study follows Ribar and Hamric (2003), Ayantoye *et al.* (2011). The items in the transition matrix shown in simple first order Markov model in table 3.1 are converted into probability values of entering and exiting food insecurity by dividing each item by the corresponding row total to give the following transition matrix in equation 3.8

$$\begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} \quad 3.8$$

$c_{11}$ and $c_{22}$ represent the stationary states of food security and food insecurity respectively. These households remained in their status in year 1 and 2. While $c_{12}$ represents the transitional states of those households that have moved from being food secure to being food insecure during the two years, $c_{21}$ represents the transitional states of food security, that is, those households that have exited food insecurity during the two years.Also the vector of initial probability P(o) was obtained by dividing each column total by the grand total. This gives the proportion of households that will be in each category in the subsequent periods as shown in equation 3.9

$$P(k) = P(o)*Pk \quad 3.9$$

Where k is the time period in years

The long term equilibrium when the proportion of households entering food security equals the proportion exiting it was obtained by equation 3.10

$$eP = e \quad 3.10$$

Where e represent equilibrium and eP represent probability at equilibrium

$$(b_1 b_2)\begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = (b_1, b_2) \quad 3.11$$

The solution to the matrix in equation 3.11 produced $b_1$ and $b_2$ which are the proportion of the households that will be food secure, and food insecure at equilibrium in the long run Where

$b_1$ = probability that the households will be food secure at equilibrium.

$b_2$ = probability that the households will be food secure at equilibrium.

## Table 3.1 Food Insecurity Transitions using Markov chain

| | | | |
|---|---|---|---|
| | FS | FIS | |
| FS | $c_{11}$ | $c_{12}$ | $C_1$ |
| FIS | $c_{21}$ | $c_{22}$ | $C_2$ |
| | $C_1$ | $C_2$ | |

*et al.*

[redacted]

[redacted]

This section discussed the socio-economic characteristics among the respondents. This includes sex age and marital status of the household head, household size, per capita income educational level, farm size, livelihood activities, remittance, membership of cooperatives, and access to credit.

[redacted]

Sex differentiate male from female, biologically. The result from Table 4.1 showed that 81% of the household heads are males while 19% are females. It indicates that there are more male than female household heads among rural households in Nigeria. This is confirmed by Ahmed *et al.* (2015) and Adebayo (2012) who found that there are more male than female household heads among rural households. This could be because of the cultural and religious beliefs which assign the role of head of the home to males. It could explain why there are more male household heads than female household heads.

[redacted]

The distribution of age among the respondent is shown in Table 4.1. It indicates that 5% of the household heads are below 35years, 29% are between the ages of 36 to 45years 34% are between the age of 46 and 60years and about 31.4% are older than 60years. The mean age of the household head is 53.3years. This implies that most household heads are still energetic and within their productive age. This could contribute positively to food security among households. This supports the findings of Olayiwola *et al.* (2017), Adepoju and Adejare (2013), and Falowo and Adebo (2014) who found that most household head in rural areas are within the active age of 35-60 years. It suggests that the household heads are old enough to take on the responsibilities of providing for the members of their households.

| [illegible] | [illegible] | [illegible] | |
|---|---|---|---|
| [illegible] | | | |
| Male | 2,013 | 80.52 | |
| Female | 487 | 19.48 | |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | | |
| <35 | 119 | 4.76 | |
| 36-45 | 737 | 29.48 | (53± 14.86) |
| 46-60 | 859 | 34.36 | min= 18 |
| >60 | 785 | 31.4 | max =103 |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | | |
| Married | 1,864 | 74.56 | |
| Unmarried | 636 | 25.44 | |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | | |
| 1-3 | 377 | 15.08 | |
| 4-6 | 724 | 28.96 | (7.29± 3.70) |
| 7-10 | 952 | 38.08 | min= 1 |
| >10 | 447 | 17.88 | max =34 |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | | |
| Non formal | 909 | 36.36 | |
| Primary level | 625 | 25 | |
| Secondary level | 442 | 17.68 | |
| Tertiary level | 524 | 20.96 | |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | | |
| <25000 | 1,401 | 56.04 | (31363.79± 30374.42) |
| 25000.01-50000 | 718 | 28.72 | min= 3922.16 |
| >50000 | 381 | 15.24 | max =280988.20 |
| [illegible] | [illegible] | [illegible] | |
| **Farm Size (Ha)** | | | |
| <0.5 | 1,954 | 78.16 | (0.45± 0.38) |
| 0.5-1 | 323 | 12.92 | min= 0.01 |
| >1 | 223 | 8.92 | max =5 |
| **Total** | **2,500** | **100** | |

**Source: Author's computation 2018**

[redacted]

The marital status among the household is shown in Table 4.1, it reveals that 74.56% of the respondents are married and 25.44% of the respondents are unmarried. These indicate that those who are married among the respondents are more than those who are unmarried. It implies that most of the respondents will have responsibilities to meet the needs of their families. This could influence the food security within their households. This concurs with findings from Adetunji and Ojo (2013) and Yusuf *et al.* (2015) who found that most household heads in rural areas are married. This could be associated with the religious and traditional practices among rural households which attach high importance to marriage.

[redacted]

The mean household size among the respondents is 7.29. As shown in Table 4.1, 15.08% of the households have a household size of 1-3, 28.96% have 4-6, 38.08% have a household size of 7-10, and 17.88% have a household size of greater than 10. It implies that the respondent will have more members who could contribute to family labour among the households. This could contribute to food security among the households. In addition, household size could affect expenditure and consumption patterns among the households. Households with large household sizes could have higher expenditure and consumption needs than households with smaller household sizes. This could influence food security among the household. It supports findings of Adeniyi and Ojo (2013) and Yussuf *et al.* (2015) who found that rural households have large household sizes.

[redacted]

The result of the study (table 4.1) showed that 33.56% of the households have no formal education, 25.00% have primary education, 17.68% have secondary education, and 20.96% have tertiary education. As shown in Table 4.1, a large number of the respondents have no formal education. It implies that a large number of the respondent will not be able to apply the knowledge that comes from educational attainment to their economic activities. This could affect their productivity and it may negatively influence their food security status. This is in line with

findings of Adetunji (2015), they found that educational level among rural households is very low and a large number of the people residing in the rural areas have no formal education.

### 4.[redacted]

The distribution of monthly income among the households is presented in table 4.1. The mean monthly income is ₦31363.79. It was found that 56.04% earn less than ₦25000 monthly, 28.72% earn between ₦25000 and ₦50000 monthly and 15.24% earn above ₦50000. The result indicates that more than half of the respondents earn less than ₦25000 monthly. It could affect the ability of the households to purchase sufficient food to meet the needs of their households due to high inflation in the prices of food commodities. This could affect the level of food security among the households. This agrees with Yussuf *et al.* (2015) who found that most households in rural areas are low-income earners.

### 4.[redacted]

The mean farm size among the household is 0.45hectares. The results (table 4.1) revealed that 78.16% of the households have less than 0.5hectares, 12.92% of the households have 0.5-1hectare and 8.92% have more than 1hectare. This indicates that most of the households have less than 0.5hectares. As a result, majority of the households may not be able to cultivate enough land to produce sufficient food to feed their households. This could expose the households to food insecurity. These result support findings of Adeniyi and Ojo (2013) and Yussuf *et al.* (2015) who found that most rural households are small farmholder and their farm size are less than 1hectare.

### 4.[redacted]

The Occupation of the household could influence their income and their wellbeing. As presented in table 4.2, 89.5% of the households are engaged in farming and 10.48% of the households are engaged in non-farming activities. This indicates that most of the households engaged in farming. It implies that most of the respondents could cultivate crops to feed their households. It could contribute to food security among households. This supports findings of Yussuf *et al.* (2015) and Ganiyu and Omotayo(2016) that most of the households are engaged in farming activities.

[illegible]

| [illegible] | [illegible] | [illegible] |
|---|---|---|
| [illegible] | | |
| Agriculture | 2,238 | 89.52 |
| Non Agriculture | 262 | 10.48 |
| [illegible] | 2,500 | 100 |
| [illegible] | | |
| No | 2,445 | 97.8 |
| Yes | 55 | 2.2 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| Yes | 448 | 17.93 |
| No | 2,051 | 82.07 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | | |
| Agriculture | 886 | 35.44 |
| Manufacturing | 335 | 13.4 |
| Mining | 5 | 0.2 |
| Repair , Engineering and Construction | 58 | 2.32 |
| Services | 229 | 9.16 |
| Trading | 880 | 35.2 |
| Transport | 107 | 4.28 |
| [illegible] | [illegible] | [illegible] |

**Source: Author's computation 2018**

### 4.[redacted]

Remittance could serve as additional income for households to purchase food to meet their consumption needs. As shown in Table 4.2, 97.2 % of the households did not receive remittance and 2.2% of the households received remittance. It implies that the majority of the households may not be able to obtain additional income which they could use to purchase food to feed their households. This may lead to an increase in food insecurity among households.

### 4.[redacted]

Access to credit could help households to expand their economic activities. It was found that 82.07% do not have access to credit while 17.93% of the households were able to obtain credits. It implies that the majority of the households may not be able to obtain much-needed funds to increase their scale of production. This could limit their ability to increase their output from their farming activities. It could affect food security among households.

### 4.[redacted]

Households engage in various livelihood activities to fetch additional income to meet their needs. As shown in Table 4.2, 35.44% engage in agriculture-related activities, 13.4% engage in manufacturing, 0.2% engage in mining, 2.32% engage in repair construction and engineering, 9.16% engage in services, 35.2% engage in trading, and 4.28% engage in transport. The result showed that most of the households engage in agricultural activities. It may be due to the fact that agriculture is the main occupation among rural households. It could help the households to cultivate crops which could help to meet the consumption needs of their household. This could increase food security among the households.

### 4.[redacted]

This section discusses the level of food security among households. It also discussed the distribution of food security across household socio-economic characteristics such as sex, age, marital status, educational level, and household size.

The food security status among the households was determined using the aggregate calorie benchmark of 2260Kcal. Households that have per capita kcal consumption above the benchmark were classified as food secure, While households whose per capita kcal consumption fall below the benchmark were classified as food insecure. The Forster Greer and Thorbecke (FGT) approach was used to generate the incidence, depth, and severity of food insecurity among the household. It was found that 60.96% of the households are food secure and 39.04% are food insecure. The incidence of food insecurity among the households was found to be 0.39. It indicates that about 39% of the households are food insecure. The depth of food security is 0.19.It indicates that the households must consume 19% of the calories benchmark (2260kcal) to come to the food security line and escape food insecurity. The severity of food insecurity talks about how severe food insecurity is among the households that are food insecure. The severity of food insecurity is 0.08.

The result from table 4.3 indicates that more than half of the respondents(61%) are food secure, this may because the Nigerian government has carried out many programs and policies such as growth enhancement scheme(GES), FADAMA I and II, e-wallet fertilizer subsidy to help to boost agricultural production in Nigeria. It may have contributed to increased food security among rural households. It supports findings from Yussuf *et al.* (2015) and Ganiyu and Omotayo(2016) who found that food security is high among rural households in Nigeria.

| | | |
|---|---|---|
| Food secure | 1,524 | 60.96 |
| Food insecure | 976 | 39.04 |
| Total | 2,500 | 100 |
| Food insecurity incidence | 0.3904 | |
| Food insecurity depth | 0.1568 | |
| Food insecurity Severity | 0.0836 | |

**Source: Author's computation GHS, (2015/2016)**

The distribution of food security across sex is presented in Table 4.4. It was found that 61.56% of the households that are food secure are headed by males and 58.49% and are headed by females. It revealed that households that are headed by males are more food secure than households that are headed by females. This is probably because males may be more active and energetic than their female counterparts thus ensuring food security in their households.

The distribution of food security status by age revealed that 66.4% are food secure among household heads of less than 35years, 61.5% are food secure among household heads who are between ages 36 to 45years, 58.4% are food secure among household heads who are between ages 46 to 60years, 61.4% are food secure among household heads who are ages that are greater than 60. These revealed that household heads that are less than 35years have the highest level of food security. It could be because people who are less than 35years are in their active working age. This may contribute to food security in their households. These support finding from Omonona and Agoi (2007) and Yusuf *et al.* (2015). It implies that having household heads that are active, young, and energetic could contribute to food security among rural households.

The distribution of food security by marital status among the respondents is presented in table 4.4. It was found that 61.8% of those who are married are food secure and 58.6% of the household heads that are unmarried are food secure. This indicates that the respondents that are married have the highest percentage among those that are food secure. This is probably because respondents that are married could pool their resource together to meet the household

consumption need, thereby reducing the problem of food insecurity among their members. These agree with Yusuf *et al.* (2015) who found that household heads that are married tend to be more food secure compared to the unmarried ones.

[redacted]

| | Food Security Status | | Total |
|---|---|---|---|
| | Food insecure | Food secure | |
| **Gender** | | | |
| Male | 773(38.44) | 1,238(61.56) | 2,011(100) |
| Female | 203(41.51) | 286(58.49) | 489(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |
| **Age** | | | |
| <35 | 99(33.56) | 196(66.44) | 295(100) |
| 36-45 | 217(38.54) | 346(61.46) | 563(100) |
| 46-60 | 358(41.63) | 502(58.37) | 860(100) |
| >60 | 302(38.62) | 480(61.38) | 782(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |
| **Marital Status** | | | |
| Married | 711(38.18) | 1,151(61.82) | 1,862(100) |
| Unmarried | 265(41.54) | 373(58.46) | 638(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |
| **Household size** | | | |
| <3 | 69(18.40) | 306(81.60) | 375(100) |
| 4-6 | 27(37.29) | 454(62.71) | 724(100) |
| 7-10 | 418(43.82) | 536(56.18) | 954(100) |
| >11 | 219(48.99) | 228(51.01) | 447(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |
| **Educational level** | | | |
| No formal | 362(39.91) | 545(60.09) | 907(100) |
| Primary | 294(47.04) | 331(52.96) | 625(100) |
| Secondary | 155(34.99) | 288(65.01) | 443(100) |
| Tertiary | 165(31.43) | 360(68.57) | 525(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |
| **Per capita income** | | | |
| <25000 | 899(42.73) | 1,205(57.27) | 2,104(100) |
| 25000.01-50000 | 65(23.30) | 214(76.70) | 279(100) |
| 50000.01-75000 | 2(50.00) | 2(50.00) | 4(100) |

| | | | |
|---|---|---|---|
| >75000 | 10(8.85) | 103(91.15) | 113(100) |
| **Total** | 976(39.04) | 1,524(60.96) | 2,500(100) |

[redacted]

[redacted]

The results from Table 4.4 revealed that among those that have no formal education 60.1% are food secure. Among those that have a primary school level of education 52.96% are food secure. Among those that have a secondary school level of education 65.0% are food secure. Among those that have a tertiary level of education 68.6% are food secure.

It is shown from the table (4.4) that those with tertiary education have the largest percentage among those that are food secure and those with primary education have the smallest percentage among those that are food secure. This agrees with Omonona and Agoi (2007) and Yusuf *et al.* (2015) who found that household heads with tertiary education are more food secure compared to other household heads with lower educational attainment.

[redacted]

The distribution of food security by household size is presented in Table 4.4. Among those that have a household size of less than 3, 81.60% are food secure among that have a household size of 4-6, 62.71% are food secure. Among those that have a household size of 7-10, 56.2% are food secure. Among those that have a household size of more than 10, 51.01% are food secure. It indicates that households with less than 3people are most food-secure among the respondents. The Households with have fewer members may have lower consumption needs than households with larger numbers of people. It implies that having a smaller household size could contribute to food security among rural households.

[redacted]

As shown in Table 4.4, among those that earn less than ₦25000, 57.27% are food secure among those that earn ₦25000-₦50000, 76.70% are food secure. Among those that earn greater than ₦75000, 91.15% are food secure. The table showed that with highest of food security earn above ₦75000. It implies that earning higher income could contribute to food security among rural households. An increase in income could help the household to purchase food to meet their consumption needs. This could make the households less vulnerable to food insecurity.

### 4.[illegible]

The distributions of food security across different occupations are presented in Table 4.5. Among the households that engage in Agriculture, 61.98% are food secure and 58.88% of households whose primary occupations are in non-agricultural activities are food secure. It implies that engaging in farming activities makes rural households more food secure than when they engage in non-agricultural activities. Often, farming households do not have to purchase all the commodities that they consume. This could make them less affected by the frequent increase in prices of food commodities, thereby making the households that engage in agriculture more food secure.

### 4.[illegible]

As shown in Table 4.5, among those involved in agriculture 59.03% are food secure among those involved in mining 60.00% are food secure, among those that engage in manufacturing 67.16% are food secure, among those that engage in engineering repairs and construction 72.41 % are food secure, among those that engage in trading 59.89% are food secure, among those that engage in transport 57.01% are food secure, and among those that engage in services 62.45% are food secure. Those who engage in engineering, repair, and construction are the most food-secure among all the different livelihood activities. The use of mechanical and electronic devices which are solely repaired by those who work in engineering repairs and construction have increased overtime, this could increase their revenue and thus contribute to food security in their households.

Households that could obtain credit would be able to expand their farming and other economic activities. It could enable the rural household to generate more revenue from their farming activities. Results from Table 4.5 showed that among the respondents among those who could not obtain credit 59.52% are food secure. Among those who have access to credit, 61.30% are food secure. The result showed that more people are food secure among those that have access to credit than those that couldn't obtain credit. This implies that access to credit could make household food secure among the respondents. Access to credit could provide additional money for farmers to expand their farming activities. This could increase their crop production and thereby make them more food secure.

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| Agriculture | 638(38.02) | 1,040(61.98) | 1,678(100) |
| Non Agriculture | 338(41.12) | 484(58.88) | 822(100) |
| | **976(39.04)** | **1,524(60.96)** | **2,500(100)** |
| | | | |
| No | 949(39.31) | 1,465(60.69) | 2,414(100) |
| Yes | 27(31.40) | 59(68.60) | 86(100) |
| | **976(39.04)** | **1,524(60.96)** | **2,500(100)** |
| | | | |
| Yes | 795(38.70) | 1,259(61.30) | 2,054(100) |
| No | 181(40.58) | 265(59.42) | 446(100) |
| | **976(39.04)** | **1,524(60.96)** | **2,500(100)** |
| | | | |
| Agriculture | 363(40.97) | 523(59.03) | 886(100) |
| Manufacturing | 110(32.84) | 225(67.16) | 335(100) |
| Mining | 2(40.00) | 3(60.00) | 5(100) |
| Repair, Engineering and Construction | 16(27.59) | 42(72.41) | 58(100) |
| Services | 86(37.55) | 143(62.45) | 229(100) |
| Trading | 353(40.11) | 527(59.89) | 880(100) |
| Transport | 46(42.99) | 61(57.01) | 107(100) |
| | | | |
| | | | |
| Yes | 957(39.30) | 1,478(60.70) | 2,435(100) |
| No | 19(29.23) | 46(70.77) | 65(100) |
| | **976(39.04)** | **1,524(60.96)** | **2,500(100)** |

| [illegible] | | | |
|---|---|---|---|
| <0.5 | 648(41.89) | 899(58.11) | 1,547(100) |
| 0.5001-1 | 122(34.96) | 227(65.04) | 349(100) |
| >1 | 206(34.11) | 398(65.89) | 604(100) |
| [illegible] | **976(39.04)** | **1,524(60.96)** | **2,500(100)** |
| [illegible] | | | |
| Yes | 223(43.90) | 285(56.10) | 508(100) |
| No | 753(37.80) | 1,239(62.20) | 1,992(100) |
| [illegible] | [illegible] | [illegible] | [illegible] |

**Source Author's computation 2018**

[illegible]

Membership of association provides a form of identity and a certain sense of belonging to rural households. Besides, it is a platform that brings different people (with different ideas and resources) together to achieve a common goal. As shown in Table 4.5, 70.77% of those that do not belong to any association are food secure and 60.70% of those that belong to associations are food secure. This implies that there are more people that are food secure who do not belong to associations than those who belong to associations.

[illegible]

Remittance could serve as an additional source of funds for rural households in times of need. The distribution of food security by remittance among the respondents is presented in Table 4.5. It was found that 60.69% of the households who do not receive any remittance are food secure and 68.60% of those who received remittance are food secure. This indicates that more people are food secure among those who received remittance than those who do not receive remittance. It implies that being able to receive remittances could increase food security among rural households.

[illegible]

Landownership enables farming households to carry out their farming activities it provides an assurance of the production of food that will be used to feed members of the household and

generation of revenue that will be used to meet other needs in the households. As shown in Table 4.5, among the households that do not own any land 62.20% are food secure, and those that own a piece of land 56.10% are also food secure. It indicates that more people are food secure among those who do not own land than those who own their lands. People can acquire land through other means (e.g lease and rent). Hence, their production of food may not be hindered by lack of ownership of land on which they carry out various farming activities

Similarly, in some communities land ownership are communal; hence land is divided out to the members of the community at the outset of each farming season, and land is held in trust for the people by the community. Joint ownership prevents crashes and crises that are usually associated with the acquisition of land among rural households. It ensures access to land by all the households in the community. Thus it contributes to food security among rural households. It implies that not having direct ownership of land may not reduce food security among rural households, as the households could acquire land through other means, which will enable them to produce food to feed the members of their households.

[redacted]

Farm size could influence the amount of output from farming activity. Among the households that have farm size that is less than 0.5 hectares, 58.11% are food secure, among those that have farm size that is between 0.5001-1 hectares 65.04% are food secure, and among those that have farm size that is greater than 1 hectare 65.89% are food secure. The table shows that increase farm size makes the household more food secure. An increase in farm size could contribute to increase in the quantity food produced by the farming households. It implies that rural households that cultivate larger farm area would be more food secure than those cultivate smaller farm areas.

[redacted]

This section discussed the level of Resilience among the rural households. It also discussed the distribution of resilience across the household's socioeconomic characteristics. It discussed further the level of resilience across different categories of socio-economic characteristics among the rural households in Nigeria.

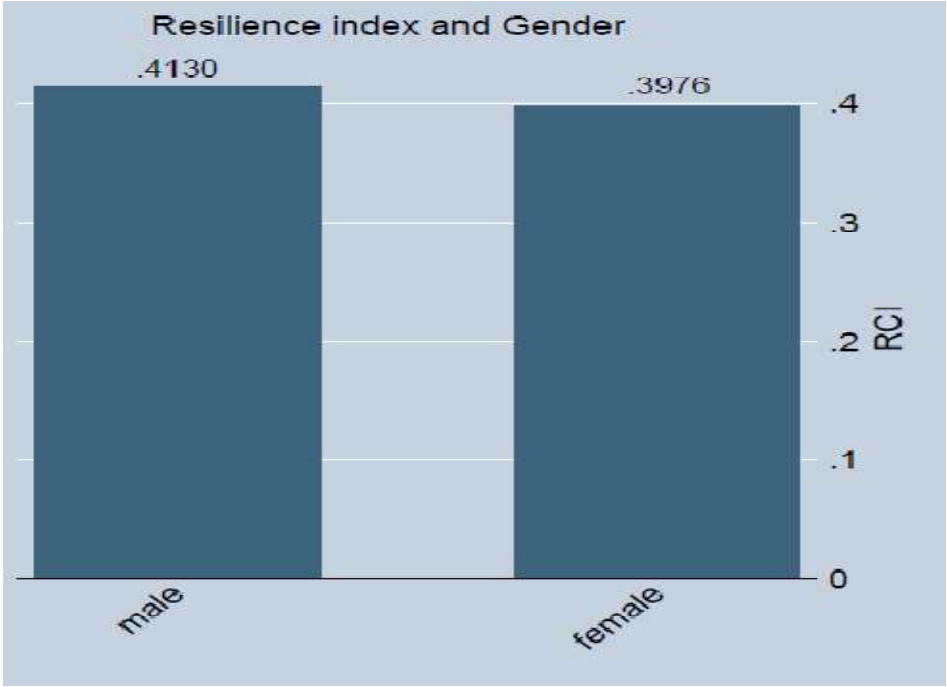
The mean resilience index among the households is 0.41± 0.06. This is low and could affect the ability of the household to withstand shocks that threaten their food security. An increase in the frequency of shocks could weaken resilience among rural households (FAO, 2016). This could explain the low resilience among households in Nigeria. In addition, NBS (2019) reports that about 40% of the Nigerian population is below the poverty line. A high poverty rate may limit the ability of households to withstand prolonged shocks like drought and disease outbreaks like covid-19. This could contribute to a low level of resilience among rural households in Nigeria. Low resilience would make the effect of shocks more severe among rural households; this will make the households more vulnerable to food insecurity. As a result, low resilience could contribute to increased food insecurity among rural households in Nigeria.

Resilience varies between male and female household heads. As shown in Figure 4.1 resilience is higher among male household heads than female household heads. More roles are assigned to males than their female counterparts as a result of the religious and cultural beliefs among the rural households. Also, males enjoy more access to resources and privileges in society than their female counterparts. This could make the households that are headed by males more resilient than households that are headed by females.

Decision on resources within the home hare often made by the males. The females often relies on the males to meet their basic needs this could make the male more resilient than their female counterparts.In addition male are considered to be stronger physically than the females this can enable them to carry out more activities to generate income to meet their need. They could also employ income generated from multiple sources to cope with the effects of shocks thus making the males more resilient.

Furthermore,the male children are often regarded as the bearer of the legacy of the households or the family heirloom; hence they are disprortionately favoured above the females in terms of access to inheritance and other resources within the family. They are given better education and support to attain highest level of development in life. On the other hand the female children are

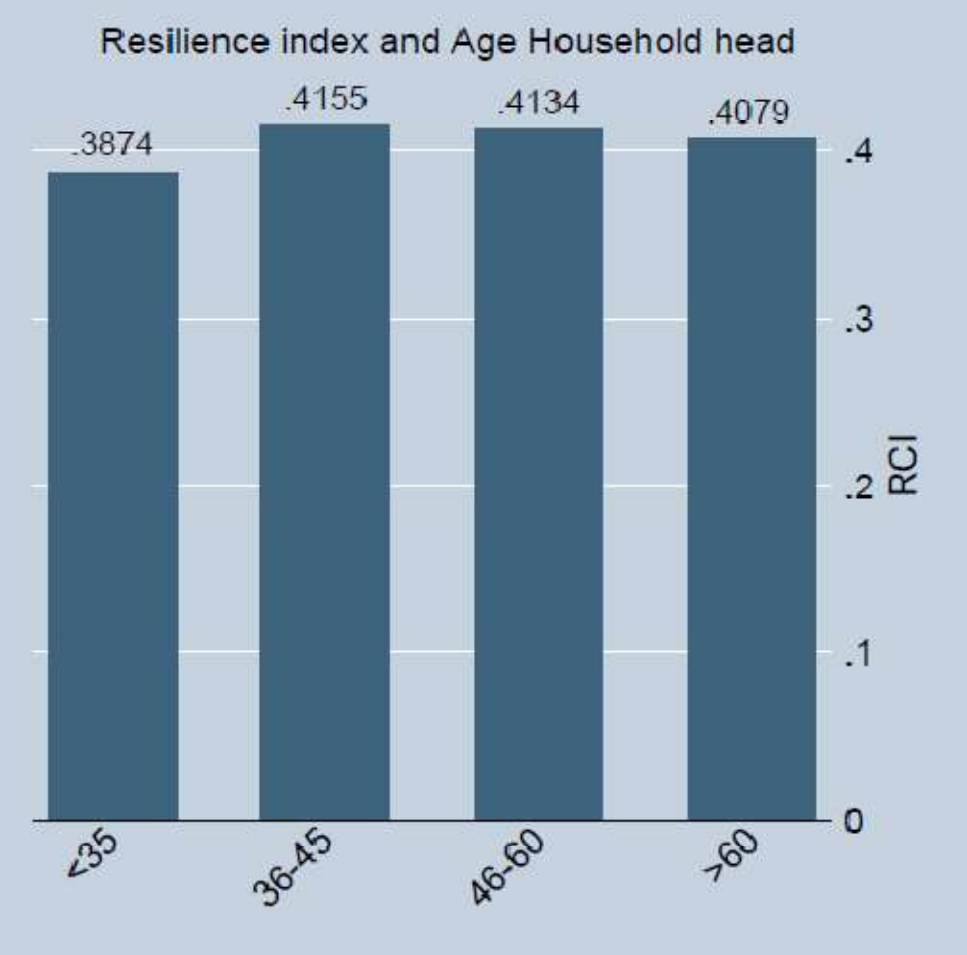
given basic training and support and married off earlier in life. This could make the females weak and vulnerable to shocks. It could make them less resilient than the males. This practices is fostered by various cultural and religious practices among the rural households.



4.2.1 Age

Age is measured in years; often it reflects maturity and experience. The distribution of resilience across the age of the household head is presented in Figure 4.2. It revealed that household head that is less than 35years has the lowest level of resilience among the households while the household head within the age of 36-45years has the highest level of resilience. Age could contribute to resilience among households. Household heads that are less than 35years old are often less experienced and dependent on other relatives to carry out their responsibilities to the members of their households. This could explain why resilience is lowest among those in this age group. On the other hand, household heads that are within the age group of 36-45 years are more mature and experienced. It could increase the ability of the household to undertake various activities to meet the needs of the member of the households. It could increase the level of resilience among the household heads that are within the age group of 36-45 years.

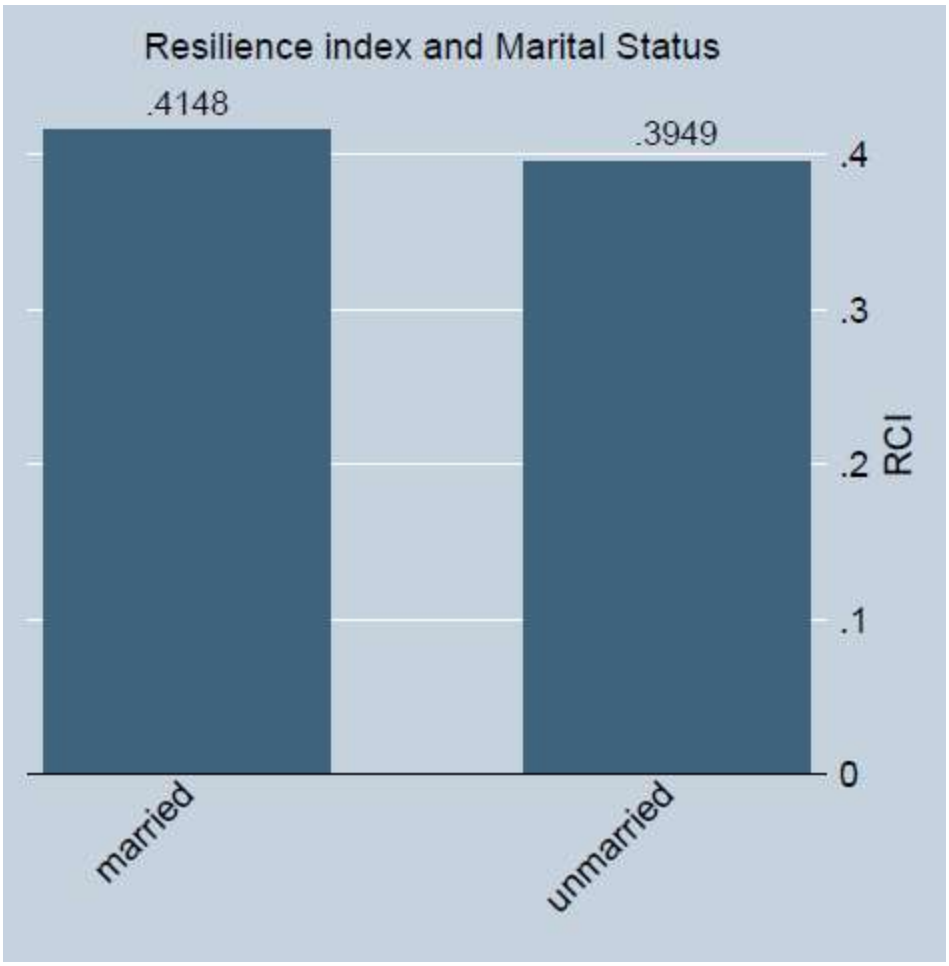
Resilience however declined among household heads that are older than 60years. The household heads in this age group(>60years) are no longer in the active working age. This may limit their ability to undertake different activities to meet the needs of the members of their households. This could increase the level of poverty among the households in this age group(>60years). This will reduce their ability to withstand shocks and it will lead to a decrease in resilience among the households(FAO, 2016).


Resilience index and Age Household head
.3874
.4155
.4134
.4079
.4
.3
.2
.1
0
RCI
<35
36-45
46-60
>60

Marital status entails marriage among rural households. It reflects whether household heads are married or otherwise. The distribution of resilience across the marital status of households (as shown in figure 4.3) indicates that households that are married are more resilient than unmarried households. The households can pool their resources together in times of need; this could help to reduce poverty among rural households. Furthermore, married households could combine effort to withstand the shocks. This could strengthen resilience among the households. It could help to reduce exposure to food insecurity.

However unmarried respondents would rely on sole efforts to withstand shocks. It may increase poverty among the respondent that are unmarried. It could also make respondent that are unmarried more exposed to food insecurity. Hence repeated or prolonged shocks could lower resilience among unmarried households. Therefore unmarried household heads are less resilient than the household heads that are married.

This implies that household heads that are married may be more resilient than the household head that are unmarried. It implies that being married could increase resilience among rural households. It could also contribute to food security among rural households.

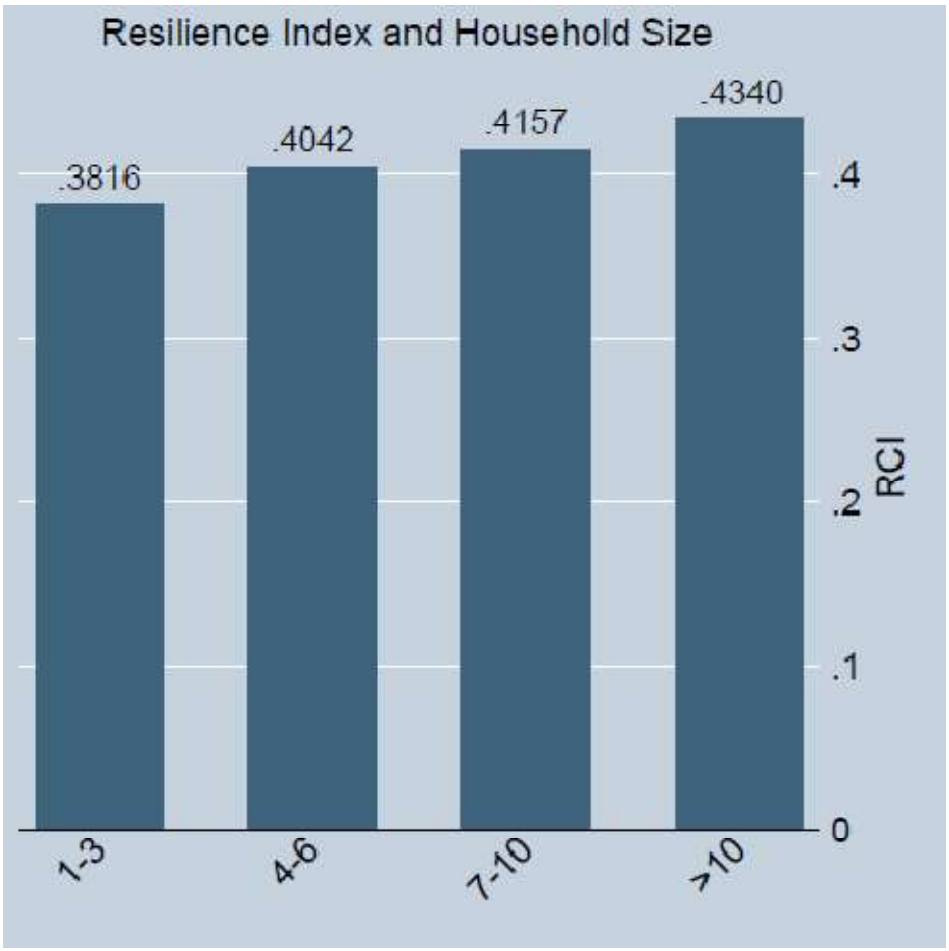

Resilience index and Marital Status
.4148
.3949
.4
.3
.2
.1
0
RCI
married
unmarried

Household sizes are measured in the number of persons within a household. As shown in Figure 4.4, resilience increases as household size increases. The households with less than 3 members have the lowest level of resilience while households with members higher than 10 members have the highest level of resilience. This is because a higher household size provides additional farm labour for farming households.

Shocks weaken resilience among households. Households with fewer members may not be able to withstand shocks that extend for a long period such as the Covid-19 shock (World Bank, 2020) When facing shocks households employ different methods to withstand the effects of shocks on their food security in the short term households with fewer members may be able to cope by meeting their consumption needs. However, as the shock stretches on resources within the households will gradually reduce. This lowers the resilience among households with fewer members it makes them unable to cope with long-term shocks.

Households with large members may be able to combine effort to withstand the long-term effect of shocks. This is because members within large households fall within different age categories often some are mature enough to engage in different activities to add to the resource within the households. This could help them to withstand shocks for longer periods. It could contribute to an increase in resilience among the households.

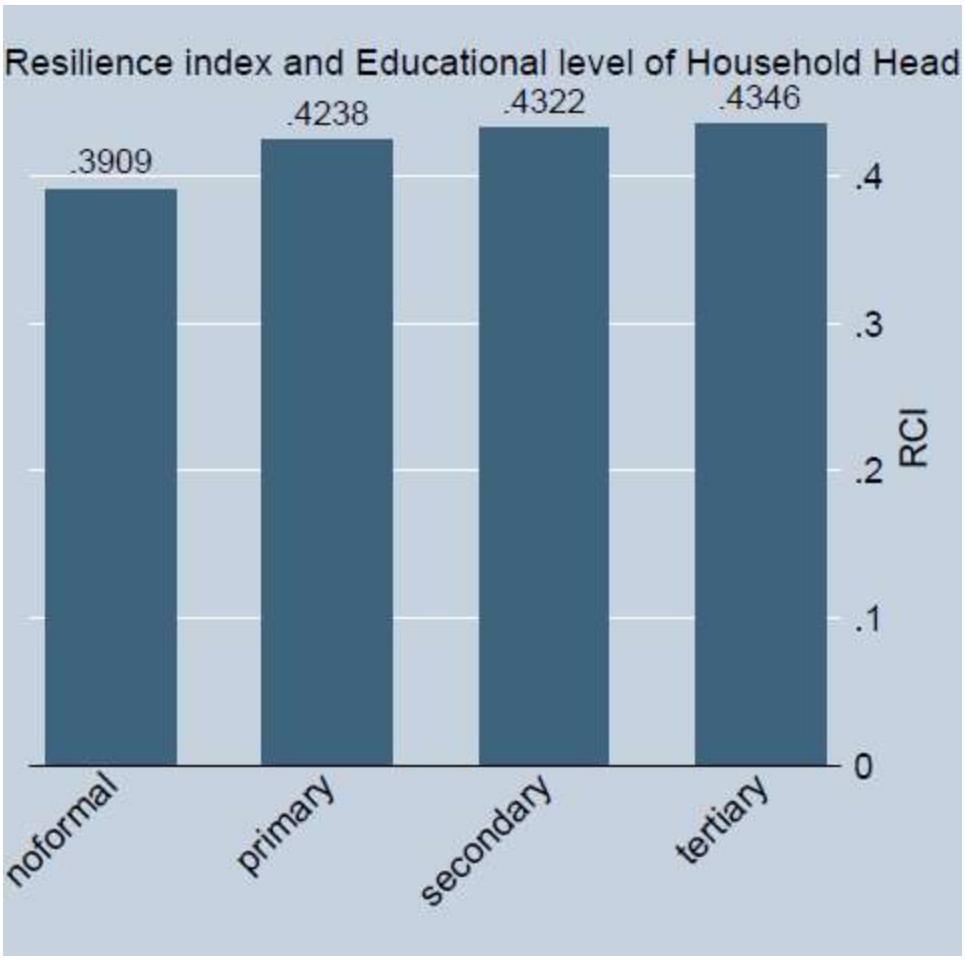
This implies that having a large household size contributes to an increase in resilience among rural households. This could contribute to food security among rural households.


Resilience Index and Household Size
.3816
.4042
.4157
.4340
1-3
4-6
7-10
>10
0
.1
.2
.3
.4
RCI

Education increases knowledge and awareness of new practices and development among households. The distribution of resilience across educational level among rural households is presented in Figure 4.5. It indicates that resilience increases as educational level increases among the households. The figure shows that households that have no formal education have the least resilience while the households who have the tertiary level of education have the highest resilience among the households.

Households with no formal education will be unable to apply the knowledge that comes with educational attainment to their farming activity. This could result in lower output and productivity which could increase the level of poverty among their households. The increased poverty means that households with no formal education will not be able to withstand the various shocks that occur to their households. This will reduce the level of resilience and it will expose them to food insecurity.

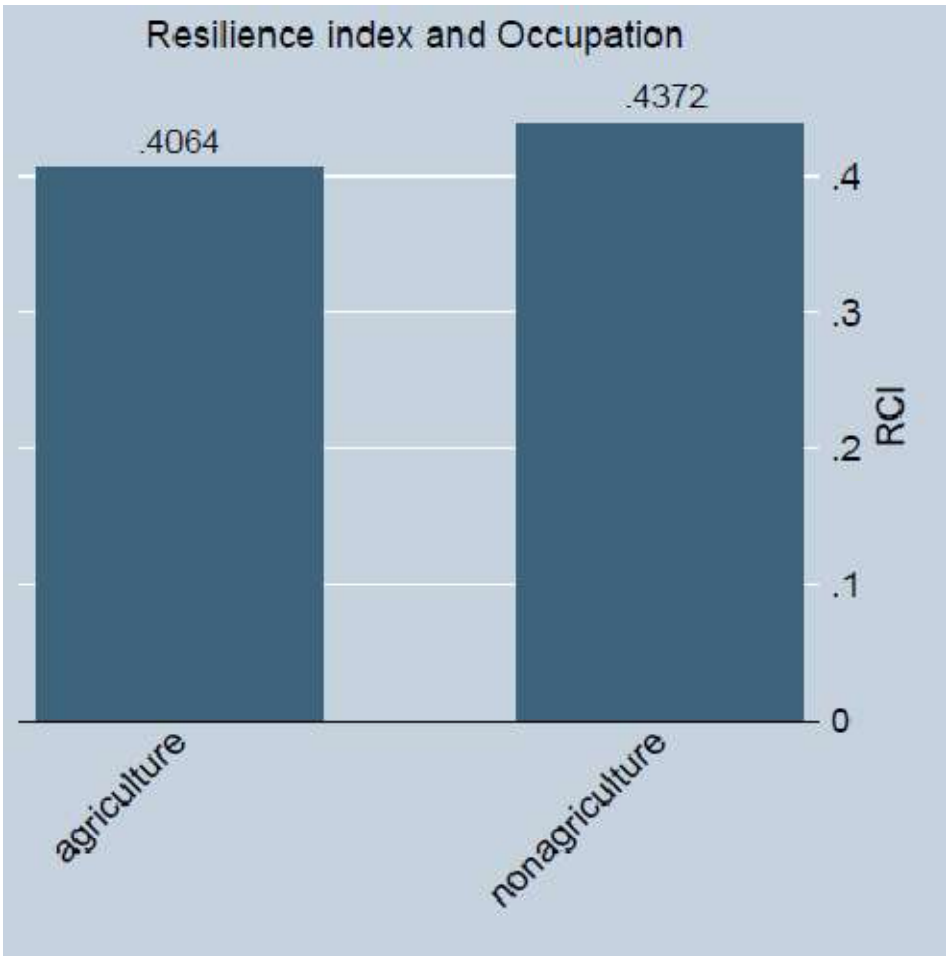
Households that have one form of education or the other (e.g primary, secondary or tertiary) will be able to apply the knowledge that they have acquired from schooling to their farming activities. Their educational qualification will enhance the adoption of improving farming techniques among rural households. This could increase their output and productivity. It will lead to a reduction in poverty among rural households. The poverty reduction could enable the households to withstand shocks better. This will lead to an increase in resilience among the household. It will make the households less vulnerable to food insecurity. This implies that education is crucial to poverty reduction among rural households. It could help the households to withstand the short and long-term effects of shocks. It could lead to an increase in resilience among the households. This could contribute positively to food security among rural households.


Resilience index and Educational level of Household Head
.3909
.4238
.4322
.4346
.4
.3
.2
.1
0
RCI
noformal
primary
secondary
tertiary

Occupation entails the activities that households undertake as their main source of income. The distribution of resilience across the occupation of the household head is presented in figure 4.6. It shows that household head that engages in non-agricultural activities are more resilient than households that engage in agricultural activities. This is probably because income from non-agriculture is more consistent and supportive than income from agricultural activities which are subject to weather shocks such as drought flooding and rainstorm and all these combine to reduce the quantity of food produced and level of income generated from agricultural activities. This feature makes those that engage in agricultural activities less resilient compared to those that engage in non-agricultural activities.

Most rural households are small farm holders that are characterized by low output, low income and high poverty rates. These reduce the ability of the households to withstand recurrent shocks such as flash floods and high inflation rates. This could reduce resilience among the households and make them exposed to food insecurity. In addition to the above, most rural households in Nigeria carry out rain-fed agriculture that has two distinct seasons (wet and dry season). In the off-season also known as the dry season, few farming activities take place and the farmers are most vulnerable to shocks. This could lead to low resilience level among the households this could make them vulnerable to food insecurity.

However, non-agricultural activities are carried out all around the year and they are less affected by climate and weather-related shocks. The prospect of earning income all through the year reduces the poverty level among households that engage in non-agricultural activities. It could households withstand shocks better. This could lead to an increase in resilience among households that engage in non-agricultural activities.

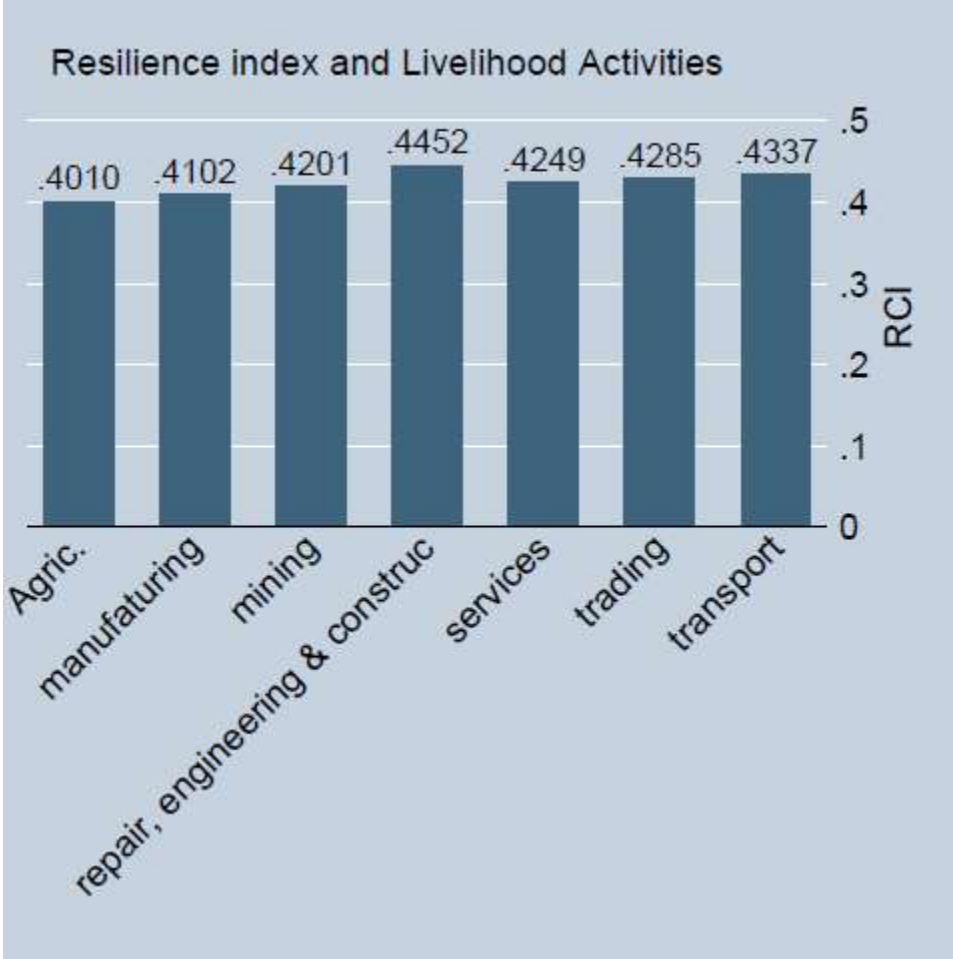

Resilience index and Occupation
.4064
.4372
.4
.3
.2
.1
0
RCI
agriculture
nonagriculture

Livelihood activities provide multiple sources of income for rural households. The distribution of resilience across livelihood activities as shown in Figure 4.7, indicates that engineering and construction have the highest level of resilience followed by transport followed by trading. This reveals that households that engage in engineering and construction are more resilient than households that engage in other livelihood activities. This may be due to the fact that their income is not subject to weather variability like those that are involved in agriculture. As a result, they tend to have more consistency and stability in their income and this could make them more resilient than those that are involved in other livelihood activities.

Livelihood activities serve as an additional income source among rural households. It could be used to supplement income from the main occupation in times of need. Households usually engage in different activities as part of strategies to cope with shocks. Shocks with a prolonged duration such as Covid-19 underscore the need for households to engage in various activities to increase the income generated among the rural households.

Some livelihood activities generate more income than others. Livelihood activities that could generate more income will help the households to withstand the effect of shocks for a longer period. It will increase resilience among the households and it will make the households less vulnerable to food insecurity.

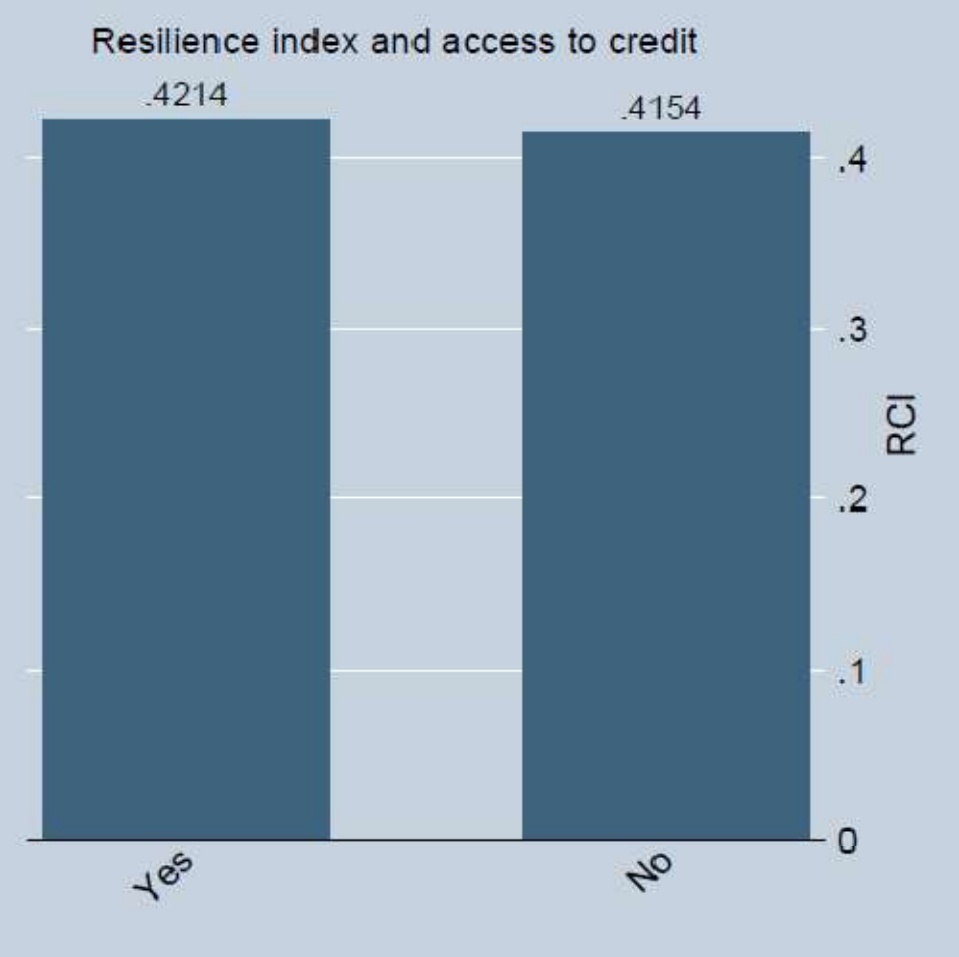
The import of this result is that households could undertake livelihood activities specifically those that have to do with engineering repair and construction, trading and transport also contribute to increasing in resilience among the household. This is because after farming trading and transport is the most common occupation among the rural household. It will help households to withstand shocks. It will lead to an increase in resilience and it will contribute to food security among the rural households in Nigeria.


Resilience index and Livelihood Activities
.4010
.4102
.4201
.4452
.4249
.4285
.4337
.5
.4
.3
.2
.1
0
RCI
Agric.
manufaturing
mining
repair, engineering & construc
services
trading
transport

The distribution resilience across access to credits is shown in Figure 4.8. It indicates that households that could obtain credit are more resilient than households that could not obtain credit. Additional credit could help the households to expand their farm operations and other economic activities. This will enable the households to generate more income from their various economic activities. It could make the households more resilient to shocks.

Credit access provides alternative sources of funds for households. It could be used by the household to help to continue the farming activities or increase the scale of their farming. This could lead to an increase in output and income generated by the households from their economic activities. The increase in income will help to reduce the level of poverty among rural households. This will help the households to cope with recurrent shocks among the rural households. It could increase resilience among the households and make the households less vulnerable to food insecurity

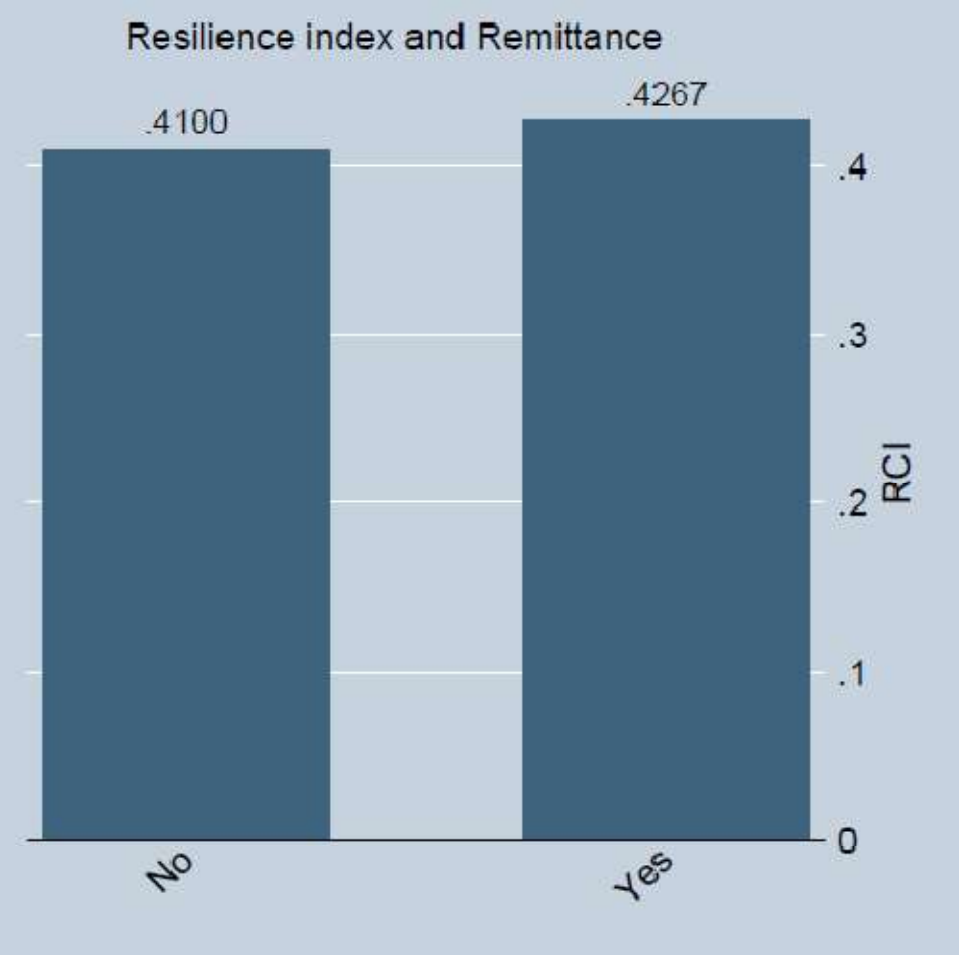
This implies that households that have access to credit will be able to cope with shocks than households that do not have access to credits. This could increase resilience among households that have access to credit than the households that do not have access to credit. This indicates that having access to credit could help to increase resilience among rural households. It could help to contribute positively to food security among rural households.


Resilience index and access to credit
.4214
.4154
.4
.3
.2
.1
0
RCI
Yes
No

Households that received remittance have higher resilience than households that do not receive remittance; this is shown in Figure 4.9. This is because remittance provides an alternative source of income to meet household consumption needs. This makes them more resilient than household holds that do not receive remittance who have only one source of income.

An increase in remittance will help to reduce the level of poverty among the rural households. This could help the household to withstand the shocks. This could make the households more resilient. It could make the households less exposed to food insecurity. Households that do not have access to remittance are more vulnerable to shocks. The recurrence of shocks could further increase poverty among the households that do not receive remittance. This could make the households less resilient and more vulnerable to food insecurity

This implies that access to remittance could lead to increase resilience among rural households. This could contribute positively to food security among rural households. It could help to cushion the effect of shocks among rural households.


Resilience index and Remittance
.4100
.4267
.4
.3
.2
.1
0
RCI
No
Yes

The distribution of resilience across zones is presented in Figure 4.10. It was found that South-South has the highest level of resilience followed by southeast followed North-West. The level of resilience is lowest in the South-West. The levels of resilience differ across regions for different reasons. In the South-West high poverty rate and unemployment makes the households cope with shocks that threaten their food security this reduces the level of resilience among the rural households in the south-west and makes them more vulnerable to food security. In the North-East shocks like conflicts and violence have become persistent which has led to an increased poverty rate among the rural households in the North-Eastern part of Nigeria. The frequent conflict has destroyed lives and properties among rural households it has displaced the people from their primary source of income. This could account for the low resilience in the region and it could make them more vulnerable to food insecurity.

Across the six regions, the value of resilience among rural households is generally low. It stems from the high rate of poverty in Nigeria which currently stands at 40% (NBS, 2020), and the high rate of inflation in prices of goods and commodity at 18.17% (CBN Report, March 2021) all this combine to limit the ability of households to withstand shocks. These contribute to reduced resilience across rural households and make them more vulnerable to food insecurity.


Resilience index and Zones
.4028
.3948
.4043
.4235
.4337
.3999
.4
.3
.2
.1
0
RCI
N.C
N.E
N.W
S.E
S.S
S.W

[redacted]

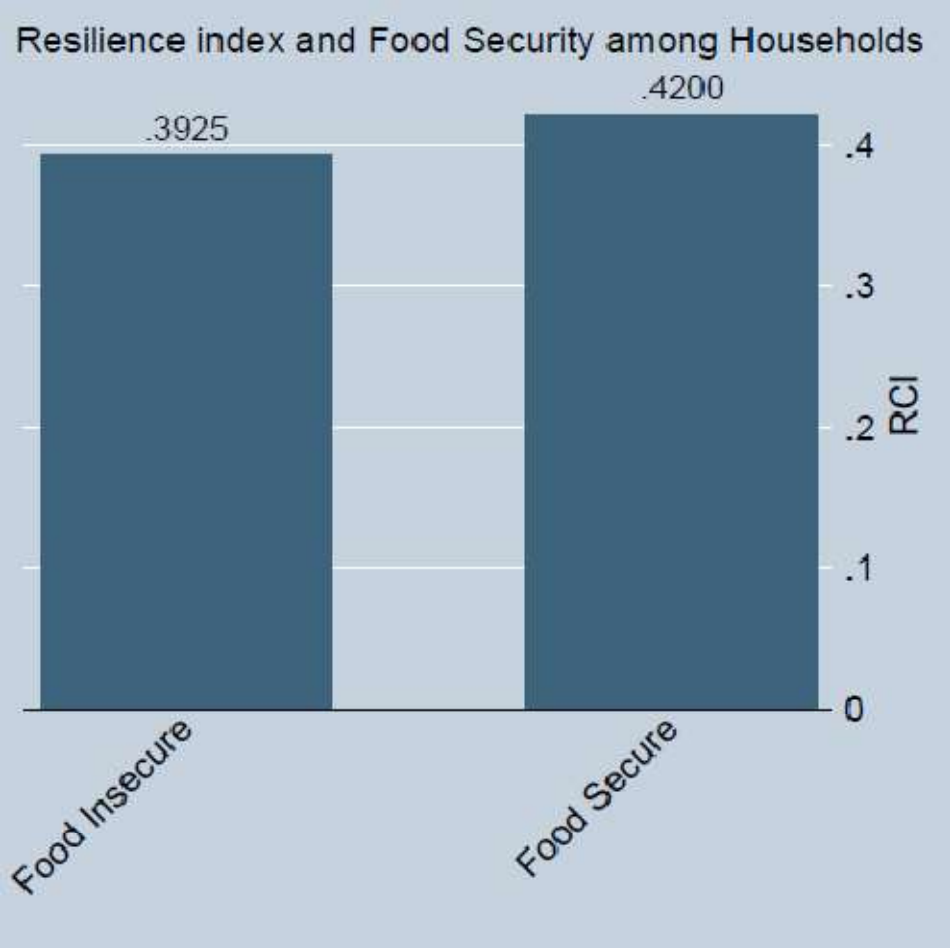
As shown in Figure 4.11, households that are food insecure are the least resilience, while households that are food secure have the highest resilience. This is because resilience helps households to overcome shock to food security. Hence the increase in resilience contributes to an increase in food security among rural households.

A high level of poverty means the most household will be unable to purchase food to feed the members of their households. This could lead to increased food insecurity among rural households in Nigeria. According to NBS (2020), 40% of the population lives below the poverty line this could explain the high level of food insecurity among the rural households in Nigeria. Furthermore, the level of unemployment in Nigeria is about 33% (NBS, 2021). High unemployment indicates that most of the households will be unable to earn income regularly to help to meet the needs of their households. This could contribute to food insecurity among rural households.

In addition, the high inflation rate of 18.17(CBN Report, March 2021) has made it increasingly difficult for households to purchase food to meet their household consumption needs; this could further increase food insecurity among rural households. Shocks like conflict and violence have become more frequent in Nigeria and it cuts across all regions

and sectors in the country. These conflicts occur as kidnap, farmers-herder, and other forms of violence. The persistent conflict has created increased insecurity of lives among households in Nigeria. This is contributing to low resilience among rural households. It has made rural households more vulnerable to food insecurity.

The above high poverty rate, high unemployment rate, and high inflation rate are contributing to increased food insecurity among rural households. This leads to low resilience among the rural. Reducing food insecurity may help to increase resilience among rural households. It implies that increasing food security could help to increase resilience among rural households in Nigeria.


Resilience index and Food Security among Households
.3925
.4200
.4
.3
.2
.1
0
RCI
Food Insecure
Food Secure

[redacted]

This section discussed the factors that determine resilience among the households. These are assets safety nets, adaptive capacities, and access to basic service. The Multiple Indicators Multiple Causes (MIMIC) model was used to find out the determinants of resilience. The test of the robustness of the result of the MIMIC model is displayed at the bottom of table 4.6. The Root Mean Square Error of Approximation (RMSEA) evaluates the fit of the model base on deviance between the estimated and real covariance. Hence RMSEA value of 0.04 indicates that the model has a good fit. Brown and Cudeck (1993) assumed that values smaller than 0.05 imply a good model fit which corresponds to a probability close to unity. The two fit indices suggested by Bentler (1990) are the Comparative Fit index (CFI) and Tucker Lewis Index (TLI). The CFI analyzes the model fit by examining the discrepancies between the data and the hypothesized model while adjusting for the issues of sample size inherent in the chi-square test of model fit and the normed fit index. CFI values range from 0 to 1 with larger values indicating better fit. That is the closer to 1 the value of CFI the better the fit of the model. TLI measures a relative reduction in misfit per degree of freedom. They indicate a good model fit with values close to unity. This agrees with Hu and Bentler (1999). As a result of this, the CFI (0.985) and TLI (0.986) in Table 4.6 are close to 1. It indicates there is the goodness of fit in the model.

[redacted]

One standard deviation rise in assets contributes 0.67 standard deviation increase in resilience capacity index. Assets have a positive relationship with the resilience capacity index of households. This implies that as assets increase the household is likely to be more resilient. This result agrees with FAO (2016), d'Erico *et al.* (2016), and Gambo *et al.* (2016) which found that assets contribute to an increase in resilience among the households. This feature is underlined by the fact that when households experience shocks that precipitate food insecurity they often sell their assets to acquire income with which they meet their consumption needs.

| Resilience capacity index | Coefficient | Std. Err. | Z | P>z |
|---|---|---|---|---|
| Access to basic service | -0.4749 | 0.3018 | -1.57 | 0.1160 |
| Adaptive capacity index | -0.3674* | 0.1997 | -1.84 | 0.0660 |
| Assets index | 0.6662*** | 0.2516 | 2.65 | 0.0080 |
| Safety net index | 3.0575*** | 0.4738 | 6.45 | 0.0000 |
| Foodexp<- resilience | 1 | | | |
| Simpson index <- resilience | -.0113 | 0.0026 | -4.19 | 0.0000 |
| No of observations | 3197 | | | |
| Chi square | 293.79 | | | |
| Prob>chi2 | 0.0000 | | | |
| RMSEA | 0.04 | | | |
| Probability RMSEA<0.05 | 0.995 | | | |
| CFI | 0.985 | | | |
| TLI | 0.956 | | | |

As shown in Table 4.6, one standard deviation increase in access to basic service leads to a 0.47 standard deviation decrease in resilience capacity index. Access to basic service has a negative relationship with the resilience capacity index. It implies that access to basic service help household does not considerably influence resilience among households. Findings from FAO (2016) and d'Erico *et al.* (2016) seem to state otherwise where access to basic service leads to an increase in resilience among households. The reason for the result from this study which reveals that access to basic service leads to a decrease in resilience among households is not far-fetched this may because basic services such as electricity good water, health facilities are scarce and barely functional in rural areas of Nigeria.

As shownin Table 4.6 a standard deviations increase in adaptive capacity leads to 0.37 standard deviation decrease in the resilience capacity index of households. It implies that adaptive capacity does not contribute to an increase in resilience among households. This might be because most rural households generally have low educational levels which are a major component of adaptive capacity. Other components of adaptive capacity are dependency ratio household head wage and employment status. Most rural households usually have a high dependency ratio this could explain why adaptive capacity does not contribute to an increase in resilience among the rural households. In addition, most rural households are smallholder farmers that are characterized by low output and low income this could affect the income of the household head among rural households and it could influence the level of adaptive capacity among the rural households. Furthermore, the employment status of the household head is also used in constructing adaptive capacity among rural households. However, the high unemployment rate in Nigeria currently at 33% (NBS, 2021) could influence the level of adaptive capacity among rural households. This could explain why adaptive capacity does not contribute to resilience among rural households.

Hence adaptive capacity leads to a decrease in resilience among the households. This feature is in contrast to FAO (2016), d'Erico *et al.* (2016), which found that safety net contributes to an increase in resilience among the households. However, it agrees with Gambo *et al.* (2016) which found that adaptive capacity has a negative relationship with resilience capacity among the rural households in Niger. The upshot of this is that in Nigeria adaptive capacity is quite low, and as a

result it does not contribute sufficiently enough to increase resilience among the rural households.

One standard deviations increase in the safety net leads to 3.06 standard deviation increase in the resilience capacity index of households. From the table (table 4.6), the safety net index has a positive relationship with the resilience capacity index of households. It indicates that as the safety net increases resilience also increases among the households this agrees with FAO (2016), d'Erico *et al.* (2016), and Gambo *et al.* (2016) which found that the safety net contributes to an increase in resilience among the households.

Assistance from governmental and non-governmental agencies, charities, and access to transfer and remittance were used in the construction of the social safety net index. The non-governmental organizations and charities carry out various activities to help to reduce poverty among rural households. Sometimes they provide training, equipment, and funds that help to improve the lives of people in rural areas of Nigeria. This has gradually improved the welfare of rural households it has made them more able to withstand shocks that occur to the households. It has increased resilience among rural households.

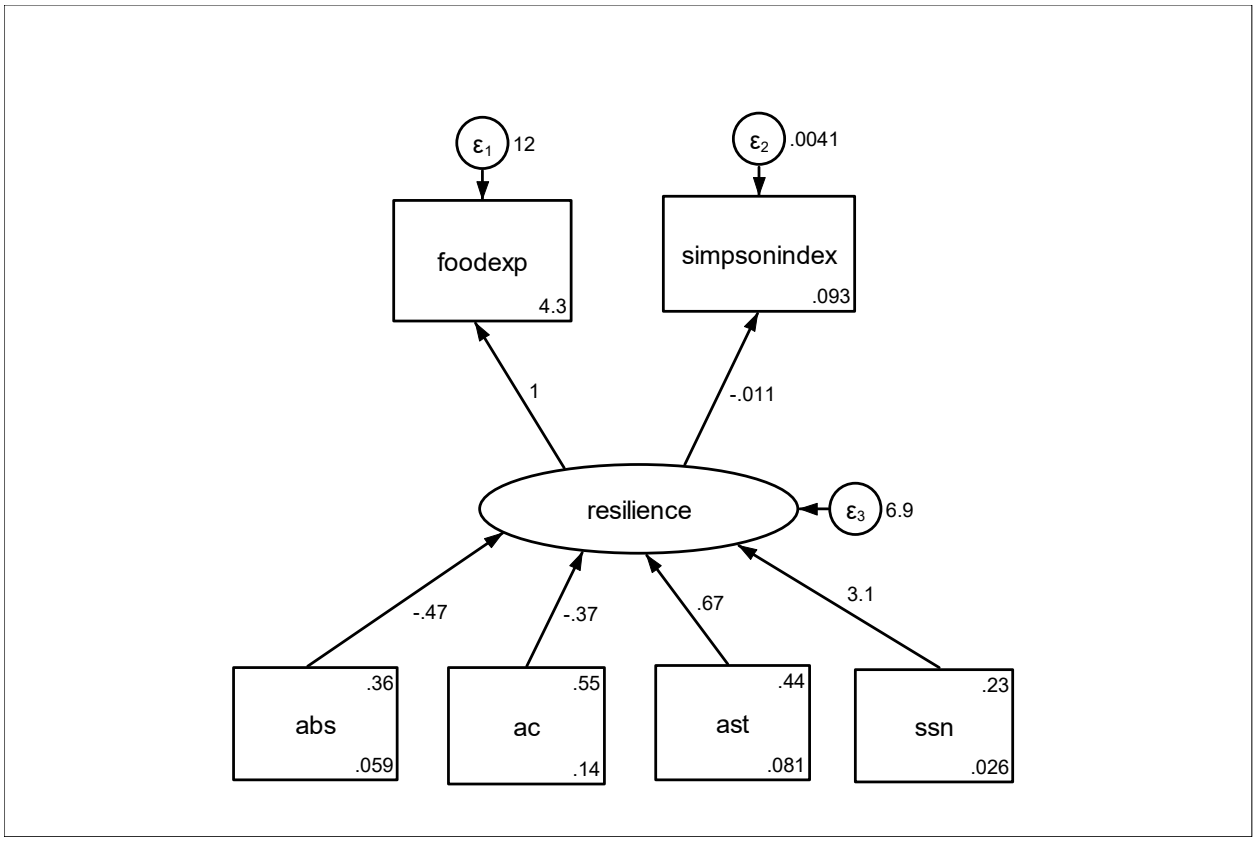
The government has provided various transfer programs such as the N-power program which provide funds for unemployed youths across the different sector of the economy. Other programmes carried out by the government are the Growth Enhancement Scheme (GES), the e-Wallet Programme, and Trader Moni. These programmes provide cash, equipment and inputs for rural households, and this has led to improving the welfare of the rural households. This could increase the social safety net among the rural households, thereby making the households more resilient.

**4.[redacted]n**

The resilience path diagram is a pictorial representation of the resilience estimation procedure. It shows in a diagram, the figures that are presented in table 4.6. Thus it is an alternative means of presenting the result of the MIMIC model. The coefficient of the pillars ($AST_i$, $AC_i$, $SSN_i$, and $ABS_i$ ) of resilience are shown on the arrows pointing from each pillar to the circle inside which resilience is written.

As shown in Figure 4.12, $ABS_i$ and $AC_i$, have a coefficient of -0.47 and -0.37 as indicated on the arrows pointing from each of them to the circle. It indicates that both $ABS_i$ and $AC_i$, have a negative relationship with resilience among rural households. This is the same as the results presented in table 4.6. Furthermore figure 4.12 shows that $AST_i$, and $SSN_i$ have coefficients of 0.67 and 3.1 as indicated on the arrows pointing from each of them to the circle at the centre. It indicates that both $AST_i$, and $SSN_i$ have a positive relationship with resilience. This is also the same as the results discussed in Table 4.6.

In addition, the values on the arrow pointing from the circle at the centre to foodexp and Simpson index are coefficients of food expenditure and Simpson index respectively. The values on the arrow pointing from the error terms to the circle represent the coefficient of the error term for the structural equation(the pillars of resilience).


ε1
12
ε2
.0041
foodexp
4.3
simpsonindex
.093
1
-.011
resilience
ε3
6.9
-.47
-.37
.67
3.1
.36
abs
.059
.55
ac
.14
.44
ast
.081
.23
ssn
.026

### [redacted]

This section discusses the fixed effect regression of the effect on resilience on food insecurity among rural households. The p-value of 0.0000($p<0.05$) indicates that the model has a good fit. The Hausman test was used to decide on which is more suitable between the fixed effect model and random effect model in Table 4.10. A Hausman test p-value of 0.000($P<0.05$) indicate that the fixed effect regression model is the most suitable estimate of the effect of resilience on food insecurity among rural households.

### [redacted]

A unit increase in the resilience index leads to 10.7% decrease in food insecurity among the households. As shown in table 4.7 resilience has a negative relationship with food insecurity. This agrees with d'Erico *et al.* (2015) and FAO (2015) which found that an increase in resilience contributes to the reduction in food insecurity. This implies that increasing resilience could help to reduce food insecurity among rural households in Nigeria.

Shocks have increased in frequency and severity among rural households. In Nigeria, shocks like conflict between herder and farmers are increasing insecurity of lives and properties among the rural households. The increase in the frequency of these conflicts could lead to decreased production of both food crops and livestock among rural households and this could result in an increase in food insecurity among the rural households. Other shocks that have recently occurred among rural households include disease outbreaks such as the Covid-19 virus disease which has affected food production among many households in many countries around the world and Nigeria. This could reduce food security among these households. Hence resilience is crucial in helping households to overcome this shock

This emphasizes the result of this study which found that an increase in resilience contributes to a decrease in food insecurity among rural households in Nigeria.

[illegible]

| [illegible] | [illegible] | | | [illegible] | | |
|---|---|---|---|---|---|---|
| | Coef (std. error) | Z | P>z | Coef (std. error) | Z | P>z |
| Resilience | -0.1072* (0.0658) | -1.63 | 0.1030 | -0.3179*** (0.0320) | -9.94 | 0.0000 |
| Age | 0.0013 (0.0066) | 0.2 | 0.8410 | 0.0047* (0.0029) | 1.62 | 0.1040 |
| Gender of Household head (female) | 0.7368** (0.3020) | 2.44 | 0.0150 | 0.3118*** (0.1149) | 2.71 | 0.0070 |
| Years of formal Education | -0.0393** (0.0185) | -2.12 | 0.0340 | -0.0011 (0.0083) | -0.14 | 0.8870 |
| Household size | -0.0664** (0.0326) | -2.04 | 0.0410 | -0.1657*** (0.0151) | -10.96 | 0.0000 |
| Farm size( Hectares) | 0.0803 (0.0930) | 0.86 | 0.3880 | 0.0343 (0.0563) | 0.61 | 0.5430 |
| Access to Extension | 0.8458*** (0.3289) | 2.57 | 0.0100 | 0.5470*** (0.1562) | 3.5 | 0.0000 |
| Distance Road | -0.0318** (0.0136) | -2.34 | 0.0190 | -0.0122** (0.0053) | -2.31 | 0.0210 |
| Remittance (yes) | 0.1116 (0.7594) | 0.15 | 0.8830 | -0.5709* (0.3429) | -1.66 | 0.0960 |
| North East | 0.3648 (0.3023) | 1.21 | 0.2280 | -0.2028 (0.1401) | -1.45 | 0.1480 |
| North West | -0.1635 (0.3493) | -0.47 | 0.6400 | -1.0172*** (0.1481) | -6.87 | 0.0000 |
| South East | 0.6501* (0.3709) | 1.75 | 0.0800 | 0.6418*** (0.1405) | 4.57 | 0.0000 |
| South South | 0.8010** (0.3338) | 2.4 | 0.0160 | 0.8349*** (0.1413) | 5.91 | 0.0000 |
| South West | -0.5889 (0.4004) | -1.47 | 0.1410 | -0.1953 (0.1878) | -1.04 | 0.2980 |
| LR chi2(14) = 71.46 P value=0.0000 | | | | Wald chi2(14) = 479.19 P value=0.0000 | | |

[illegible]

[illegible]

[redacted]

Sex of the household head has a positive relationship with the food insecurity among the households.An increase in household heads that are female will lead to increase in food insecurity by 0.7368 compared to household heads that are males (as presented in table 4.7). It indicates that female-headed households are more likely to be food insecure than households with male heads. The male household heads culturally undertake more roles in society than their female counterpart.

[redacted]

A unit increase in years of formal education leads to decrease in food insecurity among the households by 0.0393. It implies that increase in years of formal educationwill help to reduce food insecurity among the households as shown in the table (table 4.4). An increase in years of education will equip the household heads with more knowledge. This knowledge will bring about improvement in the farming techniques used by the households. It could enable the ease of adoption of new technologies by the rural household.

[redacted]

A unit increase in household size leads to decrease in food insecurity among the households by 0.0064. It can be seen from table 4.7 that increase in household size contributes to the decrease in food insecurity among the rural households. This is because an increase in household size will could contribute additional family labour and it could lead to increase in output among the rural households. This could increase food production and thereby decrease food insecurity among rural households.

[redacted]

Contact with extension officers has a positive relationship with food insecurity among the households. This showed that extension contact does not reduce food insecurity among households. This could be due to low access to extension among rural households. This is contrary to findings from Agbola (2014) which found that access to extension helps to reduce food insecurity among households.

[redacted]

Households in the southeast will have food insecurity increased by 65% compared to households in the North-Central. It implies that households in South-East are more food insecure than households in North-Central. This may be due to the high poverty rate in Nigeria. The NBS, (2020), reports that 40% of the Nigerian population is below the poverty line. This could limit the ability of rural households to meet their consumption needs. This could lead to an increase in food insecurity among the households in the region.

[redacted]

Households in the South-South will have food insecurity increased by 80% compared to households in the North-Central. It implies that households in South-East are more food insecure than households in North-Central. The CBN (2021) reports that the inflation rate is about 18.17% and this high inflation rate could contribute to increasing food insecurity among rural households. This could explain why food insecurity is higher among households in South-South than households that are in North-Central Nigeria. In addition, the level of poverty is higher in the South-South than in North-Central Nigeria.

[redacted]

The Hausman test was used as a decision rule in selecting between fixed and random effects models. The null is that the two models are suitable in panel data analysis and that therefore they should yield similar coefficients. The alternative hypothesis is that the fixed effects (FE) estimation is suitable and the estimation of the random effects is not. If the Hausman test statistic is significant (i.e. $P<0.05$), It implies that the FE results are most suitable for the study. In table 4.8, the p-value is 0.0000 ($P<0.05$), this implies the FE model is most appropriate. Hence the fixed is used to determine the effect of resilience on food insecurity among rural households in Nigeria.

[redacted]

| | (b) | (B) | (b-B) | sqrt(diag(V_b V_B)) |
|---|---|---|---|---|
| | **Fixed** | **random** | **Difference** | **S.E.** |
| Resilience | -0.1072 | -0.4252 | 0.2107 | 0.0575 |
| Age | 0.0013 | 0.0047 | -0.0034 | 0.0059 |
| Sex (female) | 0.7368 | 0.3118 | 0.4249 | 0.2792 |
| Years of Education(years) | -0.0393 | -0.0404 | -0.0381 | 0.0166 |
| Household size(no of persons) | -0.0664 | -0.2322 | 0.0993 | 0.0289 |
| Farm size( Ha) | 0.0803 | 0.0343 | 0.0461 | 0.0740 |
| Access to Extension | 0.8458 | 0.5471 | 0.2988 | 0.2895 |
| Distance Road | -0.0318 | -0.0441 | -0.0195 | 0.0125 |
| Remittance (yes) | 0.1116 | -0.5709 | 0.6826 | 0.6776 |
| North East | 0.3648 | -0.2028 | 0.5676 | 0.2679 |
| North West | 0.6501 | -1.1808 | 0.8537 | 0.3163 |
| South East | 0.6501 | 0.6419 | 0.0082 | 0.3432 |
| South South | 0.8010 | 0.8349 | -0.0339 | 0.3025 |
| South West | -0.5889 | -0.7842 | -0.3935 | 0.3536 |
| p-value= 0.000 | | | | |

[redacted]

### [redacted]

This section discussed the effect of shocks on resilience. Shocks found to have a significant effect on resilience include drought, illness death shock, pest invasion, and zones where the household reside.

### [redacted]

Death shocks entail loss of the spouse or the household head or other members of the household. It often leads to reduction income generated within the household it could also lead to loss of protection within the households. As shown in table 4.9, a unit increase in households that experience death shock leads to 0.0056 decrease in the resilience of households. This implies that households that experience death shocks are less resilient compared to households that do not experience death shock. This is because death causes almost irreparable damage both in human and material terms.

### [redacted]

Illness make people to be indisposed, it reduces their ability to function at optimum level. It increases expenditure on health and make the people unable to meet their other need such as consumption. A unit increase in households that does not experience illness (as presented in table 4.9) leads to 0.0028 increase in the resilience of households. This implies that households that do not experience illness will be more resilient compared to households that experience illness. This could be because illness leads to diversion of income and other resources that could be used to meet household consumption needs.

### [redacted]

Pests include both insects and animals, they reduce total output produced by the households and this often leads to low income among the households. As shown in Table 4.9, a unit increase in households that does not experience pest invasion leads to 0.0028 increase in the resilience of households. It was found that households that do not experience pest invasion are more resilient compared to households that experience pest invasion. This is probably because pest invasion

leads to destruction of crops and it could reduce the quantity of food produced by the households.

[illegible]

| [illegible] | [illegible] | | [illegible] | |
|---|---|---|---|---|
| | **C** | **T** | **C** | **Z** |
| Death shock | | | | |
| Yes | -0.05665 | 0.26 | -0.1563* | 1.74 |
| | (0.2149) | | (0.0899) | |
| Illness | | | | |
| NO | 0.0028 | 0.01 | -0.3713** | 2.23 |
| | (0.3110) | | (0.1662) | |
| Pest invasion | | | | |
| NO | 0.2257 | 0.33 | 0.2339 | 0.61 |
| | (0.6836) | | (0.3837) | |
| Drought | | | | |
| NO | 0.3181 | 0.95 | 0.0307 | 0.20 |
| | (0.3347) | | (0.1559) | |
| Flooding | | | | |
| NO | 0.7769*** | 5.86 | 0.6954*** | 8.34 |
| | (0.1326) | | (0.0833) | |
| Distance to Market | -0.0003 | 0.13 | -0.0058*** | 6.33 |
| | (0.0019) | | (0.0009) | |
| Zone | | | | |
| North East | -0.3587 | 1.37 | -0.210732* | 1.83 |
| | (0.2618) | | (0.1149) | |
| North West | 0.0803 | 0.29 | -0.1904* | 1.71 |
| | (0.2740) | | (0.1111) | |
| South East | 0.1848 | 0.62 | 0.1891* | 1.61 |
| | (0.2973) | | (0.1176) | |
| South South | 0.8012*** | 2.89 | 0.7286*** | 6.30 |
| | (0.2772) | | (0.1157) | |
| South West | 0.5135* | 1.67 | 0.2054 | 1.34 |
| | (0.3082) | | (0.1537) | |
| P-value=0.0000 | | | P-value=0.0000 | |

[illegible]

***** 1%  ** 5% *10%**

Drought occurs when rainfall is delayed for long periods of time. It often leads to shorter food production cycle and it could reduce food production among the households.A unit increase in households that do not experience drought leads to increase in the resilience of households by 0.3181 as shown in table 4.9. This indicates that households that do not experience drought will be more resilient compared to households that experience drought. This could be because drought lowers quantity of food among the households. It could make household that experience drought less resilient than households that do not experience drought.

A unit increase in households that do not experience flooding will lead to a likelihood of 0.1326 increase in resilience compared to households that experience flooding as shown in table 4.9. Households that do not experience flooding will be more resilient compared to households that experience flooding. Flooding usually destroys all the seeds planted the farmers. This could reduce the output among the farming households.It could also reduce the amount of food available to meet the consumption needs of their households. This will reduce the level of resilience among households and it will make them vulnerable to food insecurity.

Nearness to market could influence the sale of farm products by the households. A unit increase in distance to market leads to 0.0003 decrease in resilience among the households. It implies that as the distance to market increase among the households, the level of resilience decrease. An increase in distance to market could lead to an increase in the cost of production among the farming households and it may reduce the level of income generated among the farming households. This could increase the level of poverty among the farming households and it could reduce the ability of the households to withstand the long-term effect of shocks. This could lead to a decrease in resilience among rural households.

[redacted]

As shown in Table 4.9, South-South has a positive relationship with resilience households using the FE model. It indicates that an increase in households that reside in South-South Nigeria will lead to a likelihood of an increase in resilience by 0.8012 compare to rural households in North-Central Nigeria. It implies that rural households in the South-South may be more resilient than rural households in the North-Central region of Nigeria.

[redacted]V

South-West has a positive relationship with the resilience of households using the FE. It revealed that an increase in rural households in the South-West region of Nigeria will lead to a likelihood of an increase in resilience by 0.5135 compare to rural households in North-Central Nigeria. Households in the South-West are more resilient than households in the North Central as shown in the table (table 4.9). The southwest has a more favorable climate than households in the north-central this promotes agricultural activities and this could explain why resilience is higher in the southwest more resilient than in the North-Central. In addition, the poverty rate is lower among households in the South-West region of Nigeria compared to the North-Central.
This could help the households to withstand recurrent shocks that they experience. It could lead to an increase in resilience among rural households. Furthermore frequent migration of people from northern regions of Nigeria in search of opportunities to make a living could be a result of high resilience in South-West Nigeria compared North-Central Nigeria.

[redacted]

The Hausman test is used as a decision rule in selecting between fixed and random effects models. The null hypothesis states that the two models are suitable in panel data analysis and that therefore they should yield similar coefficients. The alternative hypothesis is that the Fixed effects (FE) estimation is suitable and the estimation of the random effects is not. If the Hausman test statistic is significant (i.e. $P<0.05$), it implies that the FE results are most suitable for the study. As shown in table 4.10 the Hausman test statistic is significant, the p-value is 0.0106

(P<0.05), this implies the FE model is most appropriate. Hence the fixed is used to determine the effect of shocks on resilience among rural households in Nigeria.

[illegible]

| | [illegible] | | | |
|---|---|---|---|---|
| | [illegible] | [illegible] | [illegible] | [illegible] |
| Household that experience deathshock | -0.0567 | -0.2129 | 0.0996 | 0.1952 |
| Household that do not experience illness | 0.0028 | -0.3713 | 0.3741 | 0.2629 |
| Household that do not experience pestinvasion | 0.2257 | 0.2339 | -0.0082 | 0.5659 |
| Household that do notexperience drought | 0.3180 | 0.0307 | 0.2873 | 0.2961 |
| Household that do not experience flooding | 0.7769 | 0.6954 | 0.0815 | 0.1032 |
| Distance to market | -0.0003 | -0.0060 | 0.0055 | 0.0017 |
| Zone | | | | |
| North-East | -0.3587 | -0.5694 | -0.1479 | 0.2352 |
| North-West | 0.0803 | -0.1904 | 0.2707 | 0.2505 |
| South-East | 0.1848 | 0 .1891 | -0.0043 | 0.2730 |
| South-South | 0.8013 | 0 .7286 | 0.0726 | 0.2519 |
| South-West | 0.5135 | 0 .2053 | 0.3081 | 0.2672 |
| P-value=0.0106 | | | | |

[illegible]

Transition in food insecurity from 2010 to 2012, 2010 to 2015, and 2012 to 2015 are discussed in this section. The Markov Chains was used to determine Transition in food security among rural households in Nigeria.

Household food security status changes from one year to another. The results of transition in food security are presented in Table 4.11. It was found that 52.63% of those who are food secure in 2010 remained food secure in 2012, while 47.37% of those who were food secure in 2010 transitioned to food insecurity in 2012, furthermore 51.01% of those who were food insecure in 2010 transitioned to food security in 2012, while 48.99% of those were food insecure in 2010 remained food insecure in 2012. In addition, it was found that in the short run 52.1% of households in rural Nigeria will be food secure and 47.9% will be food insecure. Similarly, in the long run, 51.9% of rural households will be food secure and 48.9% will be food insecure. This could be attributed to the rising cost of living and high poverty levels among households in rural Nigeria. This agrees with Ayantoye *et al.* (2011) who posits that being food secure today does not imply food security tomorrow as shocks could occur at any time thereby making the household food secure.

The food insecurity transition matrix and its probabilities between 2010 and 2015are presented in table 4.11. As shown in table 4.11, 68.2% of the rural households that were food insecure in 2010 and 2015(always food secure), 31.76% of the households moved from being food secure in 2010 to being food insecure in 2015(entered food insecurity), 68.44% of the households transitioned to food security in 2015(exited food insecurity), while 31.56% of the households were food insecure in 2010 and 2015(always food insecure). Furthermore, the result showed that 68.3 of the rural households will be food-secure in the long run and 31.7% will be food insecure. This may be due to the high rate of poverty among households in rural Nigeria recently Nigeria was ranked as the country with the highest population of extreme poor in sub-Saharan Africa

(World Bank Report, 2018). This could account for the high level of probability that a household will be food secure in rural Nigeria.

[illegible]

| [illegible] | | [illegible] | [illegible] |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | |
| Food Secure | 899(0.5263) | 809(0.4737) | 1708 |
| Food Insecure | 404(0.5101) | 388(0.4899) | 792 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |
| Food Secure | 1040(0.6824) | 668(0.3176) | 1708 |
| Food insecure | 484(0.6844) | 308(0.3156) | 792 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |
| [illegible] | | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |
| Food Secure | 813(0.6239) | 490(0.3761) | 1303 |
| Food insecure | 711(0.5940) | 486(0.4060) | 1197 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | |

[illegible]

[illegible]

The food insecurity transition matrix and their probabilities between 2012 and 2015 are shown in table 4.11. As shown in the table, 62.4% of rural households were food secure in 2012 remained food secure in 2015, 37.6% of rural households that were food secure in 2012 transitioned into food insecurity in 2015, 59.4% of households that were food insecure in 2012 transitioned to food security in 2015, while 40% of households that were food insecure in 2012 remained food insecure in 2015. In the long run, 61.2% of the household will be food secure and 38.7% will be food secure. This implies that there will be more households that are food secure than the households that are food insecure in the long run. The Nigerian government has carried out many programmes aimed at improving food security among the rural households this includes the Cash Transfer Programmes, the Growth Enhancement Scheme(GES), and the E-wallet programmes. All this could contribute to an increase in food production and it could contribute to food security among the rural households.

This section discussed the distribution of food security transition between 2010 and 2015 across household socio-economic characteristics.

The distribution of food security transition across sex is presented in table 4.12. Among those that are always food secure females have higher percentage (43.70%) than males (41.58%). Among those that are entering food insecurity females are have higher percentage(29.88%) than males(26.05%) while among those that were exiting food insecurity there are more males(20.12%) than females(15.24%). Lastly among those that remained food insecure in 2010 and 2015 there more males(12.25%) than females (11.18%). This indicates that transition in food security is higher among male than female and this is probably because there are more males among the respondents than females.

The distribution of food security transition by age category is presented in Table 4.12. It was found that among those that were always food-secure household head that is between 46 to 60years have the highest percentage followed by a household head that is less than 35years old while household head that is older than 60 years have the lowest percentage. Among households that entered into food security households that are aged between 46 to 60years have the highest percentage followed by the household that aged between 36 to 45years while household head that aged less than 35years has the lowest percentage. Among those that exited food insecurity household head that is less than 35years old have the highest percentage followed by a household head that is older than 36 to 45years. The household head that is aged 46 to 60years has the lowest percentage. Among those that are always food-insecure household head that aged between 36 to 45years have the highest percentage followed by a household head that is older than 60years. Household heads that are aged less than 35years have the lowest percentage.

Sex is presented in table 4.12. It indicates females have a higher percentage(43.70%) among those that are always food secure than males(41.58%); It also revealed that females are have a higher percentage(29.88%) among those that are entering food than males(26.05%) while among

[redacted]

| | Always food Secure | Entering food insecurity | Exiting food insecurity | Always food insecure | Total |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| Male | 835(41.58) | 523(26.05) | 404(20.12) | 246(12.25) | 2,008 |
| Female | 215(43.7) | 147(29.88) | 75(15.24) | 55(11.18) | 492(100) |
| **Total** | 1,050(42) | 670(26.8) | 479(19.16) | 301(12.04) | 2,500(100) |
| **Age** | | | | | |
| <35 | 128(42.95) | 68(22.82) | 71(23.83) | 31(10.4) | 298(100) |
| 36-45 | 224(40.22) | 141(25.31) | 119(21.36) | 73(13.11) | 557(100) |
| 46-60 | 375(43.5) | 263(30.51) | 129(14.97) | 95(11.02) | 862(100) |
| >60 | 323(41.25) | 198(25.29) | 160(20.43) | 102(13.03) | 783(100) |
| **Total** | 1,050(42) | 670(26.8) | 479(19.16) | 301(12.04) | 2,500(100) |
| **Marital status of household head** | | | | | |
| Married | 775(41.69) | 479(25.77) | 376(20.23) | 229(12.32) | 1,859(100) |
| Unmarried | 275(42.9) | 191(29.8) | 103(16.07) | 72(11.23) | 641(100) |
| **Total** | 1,050(42) | 670(26.8) | 479(19.16) | 301(12.04) | 2,500(100) |
| **Educational attainment** | | | | | |
| No formal Education | 330(36.07) | 235(25.68) | 222(24.26) | 128(13.99) | 915(100) |
| Primary | 269(43.04) | 224(35.84) | 64(10.24) | 68(10.88) | 625(100) |
| Secondary | 209(47.83) | 104(23.8) | 77(17.62) | 47(10.76) | 437(100) |
| Tertiary | 242(46.27) | 107(20.46) | 116(22.18) | 58(11.09) | 523(100) |
| **Total** | 1,050(42) | 670(26.8) | 479(19.16) | 301(12.04) | 2,500(100) |
| **Household size** | | | | | |
| 1-3 | 215(56.58) | 45(11.84) | 96(25.26) | 24(6.32) | 380(100) |
| 4-6 | 315(43.51) | 184(25.41) | 139(19.2) | 86(11.88) | 724(100) |
| 7-10 | 375(39.56) | 301(31.75) | 161(16.98) | 111(11.71) | 948(100) |
| >10 | 145(32.37) | 140(31.25) | 83(18.53) | 80(17.86) | 448(100) |
| **Total** | 1,050(42) | 670(26.8) | 479(19.16) | 301(12.04) | 2,500(100) |

[redacted]

As shown in Table 4.12, household heads that are unmarried have the highest percentage while the married household head has the lowest percentage, among those that are always food secure. Among those that entered into food insecurity household head that are unmarried have the higher percentage than the household head that are married. Among those that exited food insecurity household head that is married have the higher percentage than the household head that are unmarried. Among those that are always food insecure household head that is married have the higher percentage than the household head that are unmarried.

The distribution of food security transition by educational levels is shown in table 4.12. It revealed that among those that were always food secure those that have attained tertiary education have the highest percentage followed by those that have secondary education those that have no formal education have the lowest percentage. Among those that transitioned to food insecurity those who attained only primary educational level has the largest percentage while those with tertiary education have the lowest percentage. Among those that exited food insecurity those that have no formal educational attainment have the highest percentage while those with primary education have the lowest percentage. Among those that were always food insecure those that have no formal education attainment have the highest percentage.

Households with less than 3 members have the highest percentage among those that were always food secure they are followed by households with 4 to 6members while households with greater than 10members have the lowest percentage as shown in table 4.12. Among households that entered into food insecurity households that have 7 to 10members have the highest percentage this is followed by households with more than 10members and households with less than 3members have the lowest percentage. Furthermore, among those that exited food insecurity households with less than 3members have the highest percentage followed by households with 4to 6members, while household that has 7 to 10members have the lowest percentage. Similarly,

among those that were always food insecure households with more than 10members have the highest percentage followed by households with 4 to 6members and 7 to 10members respectively, while households with less than 3members have the lowest percentage.

[redacted]

This section discussed the resilience transition between 2010 and 2012, 2010 and 2015 and 2012 to 2015 respectively. The households were categorized into least resilient moderately resilient and most resilient following FAO, (2016). Furthermore, resilience levels in the short run and equilibrium (long run) are also covered in this section.

[redacted]

The transition in resilience between 2010 and 2012 is presented in table 4.12. It was found that 30.96% of the households that were least resilient in 2010 remained least resilient in 2012, 60.16 of households that were least resilient in 2010 transitioned to moderately resilient in 2012 while 0.08% of households that were least resilient in 2010 moved to most resilient in 2012. 42.81% of households that were moderately resilient in 2010 transitioned to least resilient in 2012, 46.71% of households that were moderately resilient in 2010 remained moderately resilient in 2012, while 10.47% of households that were moderately resilient in 2010 transitioned to most resilient in 2012. 42.42% of households that were most resilient in 2010 transitioned to least resilient in 2012, 40.91% of households that were most resilient in 2010 transitioned to moderately resilient in 2012, while 16.17% of households that were most resilient in 2010 remained most resilient in 2012. Further analysis shows that in the short run the probability that the households will be least resilient is 0.3740, moderately resilient is 0.5252, and most resilient is 10.08. At equilibrium (in the long run), the probability, that a household will be least, moderately, and most resilient is 46.96%, 47.96%, and 0.05% respectively.

| [illegible] | | [illegible] | | [illegible] |
|---|---|---|---|---|
| [illegible] | Least Resilient | Moderately Resilient | Most Resilient | |
| Least Resilient | 352(0.3096) | 684(0.6016) | 101(0.0888) | 1137 |
| Moderately Resilient | 527(0.4281) | 575(0.4671) | 129(0.1047) | 1231 |
| Most Resilient | 56(0.4242) | 54(0.4091) | 22(0.1617) | 132 |
| Total | [illegible] | [illegible] | [illegible] | [illegible] |
| Probability Vector | [illegible] | [illegible] | [illegible] | |
| | | [illegible] | | [illegible] |
| [illegible] | Least Resilient | Moderately Resilient | Most Resilient | |
| Least Resilient | 365(0.3210) | 716(0.6297) | 56(0.0492) | 1137 |
| Moderately Resilient | 729(0.5922) | 437(0.3549) | 65(0.0528) | 1231 |
| Most Resilient | 80(0.6061) | 46(0.3484) | 6(0.0455) | 132 |
| Total | [illegible] | [illegible] | [illegible] | [illegible] |
| Probability Vector | [illegible] | [illegible] | [illegible] | |
| | | [illegible] | | [illegible] |
| [illegible] | Least Resilient | Moderately Resilient | Most Resilient | |
| Least Resilient | 495(0.5294) | 378(0.4043) | 62(0.0663) | 935 |
| Moderately Resilient | 555(0.4227) | 706(0.5377) | 52(0.0396) | 1313 |
| Most Resilient | 124(0.4921) | 115(0.4563) | 13(0.0516) | 2520 |
| Total | [illegible] | [illegible] | [illegible] | [illegible] |
| Probability Vector | [illegible] | [illegible] | [illegible] | |

[illegible]

**Source Authors computation GHS (2010/2011, 2012/2013 and 2015/2016)**

[illegible]

The transition in resilience between 2010 and 2015 revealed that 32.10% of the households that were least resilient in 2010 remained least resilient in 2012, 62.97 of households that were least resilient in 2010 transitioned to moderately resilient in 2012 while 4.92% of households that were least resilient in 2010 moved to most resilient in 2012, as shown in table 4.13. 59.22% of households that were moderately resilient in 2010 transitioned to least resilient in 2012, 35.49% of households that were moderately resilient in 2010 remained moderately resilient in 2012, while 5.28% of households that were moderately resilient in 2010 transitioned to most resilient in 2012. 60.61% of households that were most resilient in 2010 transitioned to least resilient in 2012,

34.84% of households that were most resilient in 2010 transitioned to moderately resilient in 2012, while 4.55% of households that were most resilient in 2010 remained most resilient in 2012. Further analysis shows that in the short run the probability that the households will be least resilient is 46.96, moderately resilient is 47.96, and most resilient is 5.08. The probability, that the household will be least, moderately, and most resilient in the long run are 46.40%, 48.04%, and 5.05% respectively.

The transition in resilience between 2010 and 2012 indicates that 52.94% of the households that were least resilient in 2010 remained least resilient in 2012, 40.43% of households that were least resilient in 2010 transitioned to moderately resilient in 2012 while 6.63% of households that were least resilient in 2010 moved to most resilient in 2012, as shown in table 4.13. Also, 42.27% of households that were moderately resilient in 2010 transitioned to least resilient in 2012, 53.77% of households that were moderately resilient in 2010 remained moderately resilient in 2012, while 3.96% of households that were moderately resilient in 2010 transitioned to most resilient in 2012. 49.21% of households that were most resilient in 2010 transitioned to least resilient in 2012, 45.63% of households that were most resilient in 2010 transitioned to moderately resilient in 2012, while 5.16% of households that were most resilient in 2010 remained most resilient in 2012. Further analysis shows that in the short run the probability that the households will be least resilient is 46.96, moderately resilient is 47.96, and most resilient is 5.08. At equilibrium, the probability, that the households will be least, moderately, and most resilient is 47.37%, 46.89%, and 5.24% respectively.

The study found that 81% of the household heads are males while 19% are females. The average age among the respondents is 53years. It was found that 74.56% are of the household heads were married. The average household size among the respondents is 7.3. The mean monthly income was ₦31,363.79. It was found that 33.4% of the household had no formal education. The study revealed that 36.6% of the households were food insecure while 63.4% of the households were food secure. The study revealed that food insecurity among males (68.9%) was higher than the female-headed household (29.8%), while food insecurity among married households (38.0%) was lower than that of unmarried households (41.0%).

The mean resilience among rural households is 0.47. The study found that male household heads have higher resilience (0.41) than female household (0.39), resilience is higher among households that are married (0.41) than a household that is unmarried (0.39). Households with more than 10members have the highest level of resilience(0.43) and households with less than 10members have the lowest level of resilience(0.38)The household that has attained tertiary education have the highest level of resilience (0.44) while households have no formal education have the lowest resilience level (0.39).

The study found that assets have a positive relationship with the resilience capacity index of households. Also, the study revealed that the safety net index has a positive relationship with the resilience capacity index of households. However, the study found that access to basic service and adaptive capacity has a negative effect on the resilience capacity index among households. The study found that resilience decreased food insecurity among households. It was found that years of formal education, access to extension, and sex reduced food insecurity among rural households. It was found that 68.2% of those that were food secure, in 2010 remained food secure in 2015, while 31.8% of households that were food secure in 2010 moved to food insecure in 2015. Also, 68.5% of households that were food insecure in 2010 moved to food secure in 2015, while 31.6% of households that were food insecure in 2010 remained food insecure in 2015. The probability that a household would be food secure in the long run was 68.3% and 31.7% for food insecure.

It was found that 32.1% of the households that were least resilient in 2010 remained least resilient in 2015, 62.9% of households that were least resilient in 2010 moved to moderately resilient in 2015 and 4.9% of households that were least resilient in 2010 moved to most resilient in 2015. It was found that 59.2% of households that were moderately resilient in 2010 moved to least resilient in 2015, 35.5% of households that were moderately resilient in 2010 remained moderately resilient in 2015, while 5.3% of households that were moderately resilient in 2010 moved to most resilient in 2015. Also, it was found that 60.6% of households that were most resilient in 2010 moved to least resilient in 2015, 34.8% of households that were most resilient in 2010 moved to moderately resilient in 2015, while 4.6% of households that were most resilient in 2010 remained most resilient in 2015. The probability, that a household will be least, moderately, and most resilient in the long run are 46.4%, 48.0%, and 5.1% respectively.

## [redacted]

The findings of this study have shown that food insecurity is still prominent among rural households in Nigeria, with 36% of the households being food insecure. The study found that assets and safety net tend to increase the resilience of households. It was found that resilience reduced food insecurity among the respondents therefore boosting resilience among households will help them to more food secure. It was found that shocks like flooding pest invasion and death tend to reduce resilience among rural households.

## [redacted]

The following recommendation derives from the findings of the study

- The study found that assets contribute to the increase in resilience of households, hence it is pertinent for government to strengthen policies that will increase income among households as a means of helping them to acquire assets. This could help to increase resilience among the rural households
- Safety net contributes to an increase in resilience among the rural households while it is commendable that government already has various safety net programmes such as the cash transfer programmes. Efforts should be made to increase the amount of cash transfer and its coverage among the rural households and this could help to increase resilience among the rural households.

- Education was found to reduce food insecurity among rural households hence efforts should be made to provide training for the rural household. This will help them to apply the knowledge to their farm practices this will increase food production and it will reduce food insecurity among the rural households.
- Shocks were found to reduce resilience among the rural households hence policies and programmes that will help households recover from shocks should be carried out by the government. This will contribute to an increase in resilience among rural households.

[redacted]

This study has helped to understand what determines resilience among rural households. It has revealed that asset and social safety net are the factors that contribute most to resilience among households. More importantly, it showed that resilience reduces food insecurity among the household. Hence resilience could serve as a reliable means of combating the rising food insecurity in Nigeria. The study revealed that households that do not experience shocks have higher resilience than households that experience shocks. The finding is pivotal because it implies that if resilience is strengthened among the households, the effect of shocks will be less severe among the household and this is good for the households and the nation at large.

[redacted]

Resilience literature concerning food security is still at the infant stage; vast work still needs to be done, a lot of vague places need to be clarified. As this is done more will be known and estimation will be improved. As of now, different schools of thought have come up with different methods, without a uniform agreement on the best approach of estimating resilience among the households. Resilience estimation is associated with intense computational rigour hence their need for proper care and guidance while estimating resilience.

Another limitation of the study arises with the structure and nature of data available for analysis of resilience within the food insecurity context; to a large extent, most of the variables required in the RIMA model are present in the general household survey(GHS) data. However, a major shortfall is the volume of the missing data present in the GHS, while this could be easily addressed by different data cleaning methods. However, it poses a potential risk of distorted data and reduced sample size. In addition to the above, the way response to shock is captured in the

GHS makes it less easy to compute the detailed index for shocks this could be improved in subsequent surveys.

## [redacted]

This study has been an eye-opener on how resilience influences food insecurity among the household. Resilience itself is not directly observable; yet it is a major contributor to food security among households a lot still needs to be done to find out if other factors influence resilience that is not yet captured by the RIMA II approach Furthermore, the research was done basically among rural households in Nigeria and it could be extended to cover the entire country. This would demand a large amount of resources, the kind of which the federal government could easily fund together with its development partners. This is because, apart from the fact that resilience could help to stimulate national growth and development, it will also help the government to have a clear understanding of how households behave in terms of crisis and help the government to prepare well in advance of such events. Lastly, how resilience influences other spheres of household welfare should be keenly examined as they could reveal a spring well of information that will help the government improve the lives of people in rural areas of Nigeria.

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[redacted]

| SN | Item | Kg |
|---|---|---|
| 1 | Yam tuber | 128 |
| 2 | Maize | 341 |
| 3 | Rice polished raw | 353 |
| 4 | Wheat | 326 |
| 5 | Cassava Tuber | 153 |
| 6 | Cassava Flour | 335 |
| 7 | Yam Flour | 312 |
| 8 | Cocoyam | 129 |
| 9 | white beans | 319 |
| 10 | Brown beans | 318 |
| 11 | Potato | 80 |
| 12 | Fish | 144 |
| 13 | Bread | 249 |
| 14 | Garri | 363 |
| 15 | Egg | 139 |
| 16 | Salt | 0 |
| 17 | Dry Pepper | 45 |
| 18 | Soya Beans | 410 |
| 19 | Sugar | 400 |
| 20 | Melon | 593 |
| 21 | Guinea Corn/Sorghum | 344 |
| 22 | Smoked Fish | 144 |
| 23 | Cheese | 364 |
| 24 | Milk | 328 |
| 25 | Beef white | 126 |
| 26 | Groundnut | 577 |
| 27 | Okra Fruit | 33 |
| 28 | Amaranthus | 39 |
| 29 | Cabbage | 28 |
| 30 | Cucumber | 15 |

| | | |
|---|---|---|
| 31 | Egg Plant | 30 |
| 32 | Tomato Red(ripe and raw) | 22 |
| 33 | Tomato Paste | 89 |
| 34 | Bannana White Flesh Raw | 99 |
| 35 | pepper red ripe and raw | 33 |
| 36 | Banana Yellow Flesh and Raw | 106 |
| 37 | Plantain Ripe and Raw | 140 |
| 38 | Water Melon | 29 |
| 39 | Onion Raw | 37 |
| 40 | Beef Red | 235 |
| 42 | Wheat flour | 351 |
| 43 | Water melon | 29 |
| 44 | Sweet potato | 115 |
| 45 | Millet | 348 |
| 46 | Pineapple | 56 |
| 47 | Milk(Canned) | 328 |
| 48 | Milk(Powder) | 495 |
| 49 | Mango | 76 |
| 50 | Leaves(Cocoyam, Spinach, Amaranth) | 41 |
| 51 | Kola nut | 342 |
| 52 | Honey | 326 |
| 53 | Coffee powder | 354 |
| 54 | Coconut | 389 |
| 55 | Chicken | 264 |
| 55 | Cheese | 367 |
| 56 | Cashew | 56 |
| 57 | Butter/ Margarine | 730 |
| 58 | Bread(wheat) | 249 |
| 59 | Baby milk | 519 |
| 60 | Palm wine | 34 |
| 61 | Pork meat | 550 |
| 62 | Mutton | 324 |
| 63 | Goat meat | 221 |
| 64 | Bush meat | 330 |
| 65 | Beer | 35 |
| 66 | Avocado pear | 154 |
| 67 | Apple | 53 |

**Source: FAO, (2012)**