

## THE EFFECT OF FLOODING ON FOOD SECURITY OF HOUSEHOLDS IN RURAL COMMUNITIES OF DELTA STATE, NIGERIA

**Akporise, Oruese Miracle**

Department of Agricultural Economics, Delta State University Abraka, Delta State, Nigeria.

&

**PROF. (MRS) R. N. Okoh**

Department of Agricultural Economics, Delta State University Abraka, Delta State, Nigeria.

### ABSTRACT

*The study was conducted to assess the effects of flooding on food security of households in rural communities of Delta State, Nigeria. A multi-stage sampling procedure was used to collect data from 160 respondents through the use of questionnaire. The data collected were analyzed using mean, frequency, percentage, likert scale, multiple regression and binary probit models. The result indicated that the majority (71.6%) of the farmers had farming experience of 1–14 years and had no contact with an extension agent. The mean result (mean = 2.88) showed that farmers sourced food from the wild as coping strategies during floods. The result showed that use of saving (mean = 3.26), reliance on stored foods (mean = 3.09), change in livelihood (mean = 3.07), were coping strategies adopted by farmers during floods in the study area. The result showed that majority of the respondents had low income which connoted food insecurity. The result showed that education, income level, contact with extension agent and access to credit, affected food security. There was a statistically significant relationship between flooding and food security among rural households. Based on the findings, it was recommended that Governments and local authorities should establish early warning systems and improve flood preparedness measures, such as building flood-resistant infrastructure, including roads, bridges, and housing, to reduce destruction during floods. Encouraging the construction of canals and raising ground levels, as identified coping strategies, should be expanded to all farmers.*

### INTRODUCTION

Flooding is categorized by many scholars and organizations as a common occurrence on the surface of the world. Flooding occurs when water levels in a lake, reservoir, stream, or coastal system rise to a point where they overflow the banks. Flooding happens when a river or stream's discharge cannot be contained within the bounds of its normal channels, causing the floods to spread over neighboring land. Furthermore, flooding happens when a significant area of land is covered by a river or rainfall (Mfon *et al.*, 2022).

Flooding is one of Nigeria's most common environmental dangers (Otekunrin *et al.*, 2021). People and infrastructure are increasingly vulnerable to floods and the hazards that go along with them. One of the hazards that people encounter is flooding, which has serious repercussions such as discomfort, fatalities, property destruction, and pollution. One of the main elements of the flooding concept is the connection between flooding and people. In addition to damaging property and endangering human and animal life, flooding has other effects. Soil erosion and silt deposition downstream are exacerbated by flooding, fish spawning grounds and other wildlife habitat are often destroyed by flooding. Travel is delayed and commercial land utilization is disrupted by persistently high floodwaters. Bridges collapse, structures within floodways may experience damage, and hydroelectric power and navigation are often affected. Flooding and its impacts have made headlines throughout the world and in Nigerian media, which has greatly alarmed farmers, engineers, economists, and others. Concern over food security is growing worldwide, particularly in poorer countries. Among the severe issues that many countries around the world, particularly those in Sub-Saharan Africa (SSA), are dealing with are food insecurity and hunger (Otekunrin *et al.*, 2021). "When all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for active and healthy life" is the holistic definition of food security that was approved at the World Food Summit in 1996. On the other hand, food

insecurity is the condition in which an individual lacks the financial and physical means to obtain enough wholesome food to meet their nutritional demands for an active and healthy life. Achieving food security in any nation serves as a safeguard against poverty and hunger, two issues that limit economic growth. In order to combat hunger and poverty, all developed and some emerging nations work hard to expand their capacity to produce food, particularly for crops with comparative production advantages. It is impossible to overstate the agriculture sector's significance to the Nigerian economy. In the opening quarter of 2023, agriculture accounted for 19.63% of the nominal GDP, according to NBS (2023). Extreme hydrological phenomena like excessive rainfall, floods, droughts, and storm surges are the result of human activity changing our climate system and will continue to do so, according to the Intergovernmental Panel on Climate Change (IPCC). Particularly in the era of global climate change, floods are being studied as one of the natural hazards that pose the most threat to people's lives, property, and the national economy. According to the Natural Resources Defense Council and the United States Geological Survey, flooding will become more common in the upcoming years due to climate change and other human-induced activities.

According to the World Bank Group (2016), flooding has impacted a number of nations worldwide. They stated that one of the most common and damaging natural disasters that is seriously damaging property and upsetting livelihoods globally is floods. According to the World Health Organization (2022), about two billion people were impacted by floods globally between 1998 and 2017. Nigeria follows a similar path to the rest of the world. Flooding continues to be a major environmental issue in Nigeria (Mfon *et al.*, 2022). The majority of Nigeria's states now experience yearly floods during the monsoon seasons and this can be due to increased precipitation which can be attributed to climatic changes, as rainfall durations and intensities have increased, causing large runoffs and flooding in many places in Nigeria (Haider, 2019). Every community is impacted by flooding issues brought on by climate change. Both wealthy and impoverished households were anticipated to be impacted by the 2015 Accra flood (Rentschler *et al.*, 2021), but not all societal strata would experience the same level of hardship. The quantity and duration of the occurrence affect the impact to some extent, but the vulnerability of the people will define the true significance of flooding. There is proof that rural households and communities are disproportionately affected by the frequent and recurring floods that happen in Dar es Salaam, Tanzania (Rentschler *et al.*, 2021). Rain-fed subsistence farming is a dominant source of income for rural communities, who primarily reside on tiny farm holdings allotted by the local village authority. According to Olagunju *et al.*, (2021), extreme weather events can have a negative influence on agriculture, and many rural livelihoods depend heavily on the environment and natural resource base. Floods can negatively influence agricultural production, and in Pakistan and the Philippines, they have had a major impact on the lives of rural villages that rely heavily on cash crops (Niazi *et al.*, 2022). Floods cause agricultural land to become salinized, which has a stronger impact on crops and production. Furthermore, due to the high rate of poverty in rural areas, the damages from flooding are more severe there than in metropolitan areas respectively. The authors have discovered a causal association between poverty and vulnerability to natural catastrophes. According to Hallegatte *et al.* (2017), people are now more susceptible to natural disasters as a result of extreme poverty. According to several research (Hallegatte *et al.*, 2020; United Nations Development Programme, 2023), the most vulnerable people in developing nations are the poorest, who have the fewest resources and the least ability to adopt. They are more vulnerable to disasters since they have fewer resources. Timely warnings are less likely to reach them. In addition, even if warnings were issued, they have fewer options of reducing losses in a timely manner. Therefore, poverty affects the resilience and the process of recovery from disasters.

Floods can disrupt business operations, worsen health risks in these areas, ruin infrastructure and create hurdles to accessing services, and destroy field crops, resulting in food scarcity. The existing researches (Komolafe *et al.*, 2015; Nkwunonwo, 2016; Bamidele and Badiora, 2019) demonstrated that flooding has detrimental effects on social, economic, and livelihood survival. Because of its destructive nature, flooding has been found to have a detrimental effect on human livelihood activities. Flooding has a significant

influence on food security because it damages farms, reduces agricultural output, and causes crop loss, all of which have a domino effect that puts the stability of food supplies at risk. When floods unexpectedly occur, farmers may be obliged to harvest crops earlier than planned, which can drastically reduce produce output and quality. Early harvesting often results in immature crops that lack the nutritional value and commercial viability of fully matured plants. As a result, farmers earn less money, and communities who rely on locally grown food face shortages and price rises (Hallegatte *et al.*, 2017). Furthermore, crop loss from floods is a typical issue since floodwaters quickly engulf fields, giving little time for produce to recover.

Floods often completely destroy crops, rendering the affected plants worthless and resulting in immediate food shortages in local and regional markets. Furthermore, unless extensive cleanup is done, floodwaters contaminate the soil with sediments, pollutants, and debris, making the land unfit for agriculture in the future. Soil erosion and contamination can have long-lasting consequences, forcing farmers to relocate to new plots or stop farming completely (Hallegatte *et al.*, 2017). Floodwaters deplete the soil of nutrients required for agricultural development, lowering land productivity and delaying and complicating recovery. Floods also disrupt the transportation and distribution networks that are essential for moving food from farms to markets. Damaged roads and bridges slow down the supply chain, resulting in food degradation and rising prices as supplies become more limited. The financial strain on agricultural communities caused by both immediate crop losses and the cost of relocating or repairing farming infrastructure exacerbates food insecurity in flood-affected areas (Komolafe *et al.*, 2015). Small-scale farmers, who often depend on a single crop or a limited variety of produce, are especially vulnerable, with few or no other options for feeding their families and communities, as a single flood event can wipe out an entire season's worth of work and investment. Furthermore, floods disrupt livestock production since they can cause animals to be killed, wounded, or relocated during severe flooding episodes. Not only does the loss of livestock reduce the supply of animal-based foods like meat, dairy, and eggs, but it also impacts farmers who rely on these animals for their livelihood. Additionally, flood damage can act as a haven for pests and diseases that, if left unchecked, can decimate crops and livestock. Food supplies are further strained as farmers struggle to sustain production levels due to a lack of healthy livestock and less arable land (Komolafe *et al.*, 2015). The psychological toll that farming communities face also affects food security, since farmers are discouraged from investing in new projects and renewing their crops due to repeated flooding. Some farmers choose to quit farming due to the possibility of unpredictable and frequent floods, which would reduce the region's ability to produce food. From the fields to the market, flooding impacts every aspect of food production and eventually impacts food availability, affordability, and accessibility, particularly for populations that are already at risk (Nkwunonwo, 2016). In light of climate change, this complex relationship highlights the need for efficient flood control strategies to protect food supplies and agricultural fields.

### **Statement of the Problem**

Food insecurity is already a major issue in most third-world countries, mostly due to declining production of food and supply as well as the rising food production costs. These problems strain these areas' capacity to feed their people and make their food systems more vulnerable. Similar factors affect local food security in Delta State, Nigeria, which reflects this overall trend (Nkwunonwo, Malcolm, and Brian, 2015). Due to limited supply caused by low agricultural yields and growing prices for farming inputs like seeds, fertilizer, and gasoline, food production is unreliable and unsustainable for many small-scale farmers. The state's unique geographic and climatic characteristics make it especially vulnerable to environmental hazards like flooding. Floods exacerbate shortages and make it more difficult for people to obtain reasonably priced and wholesome food by endangering the already precarious food supply (Nkwunonwo, Malcolm and Brian, 2015). In addition to disrupting the food supply chain, flooding forces local farmers to pay more for production because they must cope with contaminated farmlands, degraded soils, and damaged crops, all of which increase the cost and effort needed to restore agricultural land. Food insecurity is a persistent problem in Delta State, as it is in many other vulnerable areas. The unpredictability of flooding and other

extreme weather occurrences exacerbates this issue. Disasters, uncertainties, and erratic weather patterns have a significant influence on the agriculture sector, which is often the primary source of income for rural populations. According to Komolafe *et al.*, (2015), these pressures exacerbate an already unstable food system, leading to a rise in poverty, hunger, and health issues for affected people.

Further socioeconomic ramifications include the potential for increased food insecurity to fuel social vices like crime and conflict as people vie for limited resources. As hunger and poverty increase, societal stability is jeopardized, resulting in a vicious cycle of adversity that is hard to escape (Nwagbo, 2021). Understanding how flooding affects food security is crucial in this regard because it can guide measures and policies meant to preserve agricultural output and food supplies in areas vulnerable to floods. In this sense, Delta State is a crucial case study that emphasizes how vital it is to address the exacerbated effects of flooding on food insecurity. Strategies to reduce these risks, improve the resilience of regional food systems, and improve the quality of life for impacted populations can be created by looking at the connection between flooding and food security in Delta State. Rising food insecurity continues to be a major public policy challenge in developing countries including Nigeria. Therefore, achieving food security in any country is typically a safeguard against hunger as well as malnutrition, both of which hinder economic development. Several attempts have been made to address the issue of food security especially among rural dwellers and farmers as this helps improve their productivity and output and in turn helps to solve the problem of food insecurity. These attempts include setting up programs and projects aimed at improving food production in Nigeria. Regardless of the successive strategies and programmes implemented as related to food security, this issue is still a problem.

Ironically, farming households and especially most of the smallholder farmers are the most affected in terms of food insecurity in spite of their contributions to the feeding of the rest of the population. World Bank (2021) revealed that rural communities face a high risk of food insecurity due to poverty, income inadequacies, limited access to resources, underemployment and unemployment, and many barriers to self-sufficiency, which created family frailty and crisis. This has given rise to reduction in productivity and production of rural dwellers and also farmers in developing countries in the short and long runs, in terms of their sacrifices, in output and incomes, and in an increasing difficulty for families within developing nations to escape the cycle of poverty.

Rural communities in Africa are more susceptible to flooding, especially those that live close to rivers, at low elevations, or in places that get tropical storms (Munyai *et al.*, 2021). Flooding is a common occurrence with far-reaching effects in the Niger Delta, the states of southwest Nigeria, and villages downstream of dammed rivers in the North. Rainfall is the major cause of flooding in the southern regions of the country and the Niger Delta (Nkwunonwo, Malcolm, and Brian, 2015). 19. According to the Nigerian Metrological Agency's September 2022 flooding projection, locations along the Benue and Niger Rivers are more likely to experience flooding given their current conditions. Almost all the available land around these settlements is used for crop production, livestock farming and fishing, however, floodplains are natural flooding outlets for rivers. People, agriculture, and businesses on floodplains are always at some risk. As a result of the disadvantage of this geographical location, that is living along the riverbanks, the communities have limited capacity to control the hydrological events ensuing from the catchment of these water bodies, and the devastating impacts of flooding year-in-year-out from the year 2015, have defied every little effort at combating this (Mustapha, 2021).

People who live in Nigeria's low-lying regions have experienced floods to differing degrees and with diverse effects (Ubachukwu and Emeribe, 2017). Delta State was listed by NEMA as one of the states that experienced the most severe flooding in 2012 and 2022, respectively. According to Ubachukwu and Emeribe (2017), the socioeconomic standing and means of subsistence of residents in the Oleh and Aviara communities, located in Isoko South of Delta State, whose traditional occupations are farming and fishing, were negatively impacted by the 2012 floods. Reducing or decreasing vulnerability is made more difficult

by the fact that the communities' locations, economic standing, and excessive reliance on government involvement were the root causes of the people's susceptibility. Even though the floods only destroyed a small number of medical facilities, the damage to the roads and bridges made it difficult to access the existing medical services. Additionally, impassable roads, a submerged school building, and locals' fear of another flood calamity caused disruptions to school activities. More than half a million people were displaced by the nation's flooding in 2022, according to the NEMA (2022). The research that is currently available indicates that poor planning policy execution, stream and channel obstruction from careless waste disposal practices, and human activity in flood plains are the main causes of flooding in Nigeria (Ekpoh, 2015).

According to Anino (2022), the flooding crisis in Nigeria and other nations is a glaring example of insufficient social and governmental systems to counteract the pervasive effects of climate change. With careful planning and the installation of the required infrastructure, rainfall flooding—unlike some other natural disasters—can be managed (Komolafe *et al.*, 2015). However, the absence of pertinent legal and regulatory frameworks demonstrates how little priority is placed on managing and controlling floods in Nigeria at the federal, state, and municipal levels. The government has made little to no attempt to address this issue thus far. There is now no clear legislative framework or flood management strategy to deal with this enduring issue.

Emaziye (2021) summarized his research findings in his work, "Impacts of Climate Change on Fish Production among Rural Fishing Households in Delta State, Nigeria," stating that while there were a variety of climatic effects on rural fishing households, the most significant one was a loss of income. The most severe climatic and environmental impact was flooding, which destroyed the fishing business and had a significant impact on respondents. The aforementioned study, along with other studies by Sarah and Achoja (2023), examined the effects of floods and climate change on rural households in Delta State, Nigeria. When there are disasters, uncertainties and vagaries of weather, the already insecure food situation will be worsened and this will affect the health, socio status and economy of the people and that's why there is a need to examine the effects of flooding on food security and Delta State has been taken as a case study.

### Research Questions

- i. What are the socio-economic characteristics of the rural households in the study area?
- ii. To what extent has flood affected households in the study area?
- iii. What is the food security status of the rural households in the study area?
- iv. What are the determinants of food security?
- v. What is the relationship between flooding and food security?

### Objectives of the Study

The main objective of the study was to assess the effects of flooding on food security of the rural communities of Delta State, Nigeria.

The specific objectives were to:

- i. identify the socio-economic characteristics of the rural households in the study area.
- ii. identify the severity of flood in the study area.
- iii. analyze the food security status of rural households in the study area.
- iv. ascertain the determinants of food security in the study area.
- v. examine the relationship between flooding and food security of rural households.

### Hypotheses of the Study

The hypotheses are stated in their null forms:

**HO1:** There is no significant relationship between the socio-economic characteristics of rural households and the food security during flood.

**HO2:** There is no significant relationship between flooding and food security of rural households.

## Theoretical Review

**The Food and Agricultural Organization – Food Insecurity and Vulnerability Information Management Systems (FAO-FIVIMS) Framework:** The FAO-FIVIMS framework is a useful tool for conducting food security analysis as it provides a basis for responding to questions such as who is food insecure, where the food insecurity is located, and why people are food insecure (Akukwe *et al.*, 2020). The connection among the four food security dimensions and factors influencing them are explained in the FAO-FIVIMS framework at the individual, household, community, sub-national and national levels. Food insecurity is a complex phenomenon caused by factors that vary across households, communities, social groups and countries over time. These factors of food insecurity have been categorized into four groups, namely: the socio-economic and political environment; the performance of the food economy; care practices; and health and sanitation, and the four collectively represent potential vulnerability (Akukwe *et al.*, 2020).

**Livelihoods Framework (LF):** This framework investigates how climate change, particularly unpredictable rainfall patterns and extreme weather events, affects agricultural practices, fisheries, and other traditional livelihoods in Delta State. Understanding the diverse livelihood strategies and their sensitivity to climate impacts is crucial for designing appropriate adaptation measures that support food security and income generation (Nwafor *et al.*, 2017).

**Indigenous Knowledge and Traditional Ecological Wisdom (TEW):** Examining how local communities in Delta State have adapted to climate variability over generations through traditional knowledge of floodplains, resource management, and agricultural practices can inform culturally relevant adaptation strategies (Udoye and Afolayan, 2019).

**Feminist Political Ecology:** This framework analyzes how gender roles and inequalities shape vulnerability and access to resources in the context of climate change. Investigating the specific challenges faced by women in Delta State due to climate impacts can inform gender-sensitive adaptation policies.

## METHODOLOGY

### Study Area and Scope

This study was conducted in Delta State, Nigeria. The state consists of 25 local government areas. Delta State is an oil and agricultural producing state of Nigeria, with a population of 4,112,445 that comprises, male: 2,069,309, female: 2,043,136 NPC (2006). The state has a total land area of 16,842 square kilometer. The state covers a land mass of about 18,050 square kilometers of which 60% are lands (NPC 2006). The State was created on the 27th of August 1991 out of the former Bendel State. The state lies approximately between longitude 5° and 6.4° E and latitude 5° and 6.30° N, the state is bounded Northwards by Edo State, on the East by Anambra state, on the South East by Bayelsa state and on the South west by the Bight of Benin.

### Sampling Procedure and Sampling Size

A multistage sampling procedure was used for the study. In the first stage, 9 local government areas were selected from the three agricultural zones. At the second stage, 3 communities from each agricultural zone affected by flood were purposively selected totaling 27 communities. Finally, 7 respondents were selected and this gave a total of 189 respondents. Out of the 189 copies of questionnaire distributed, 160 copies were retrieved which amounted to 84.7%.

### Data Collection

The study was conducted using primary data which were collected through the administration of a semi-structured questionnaire. The questionnaire structured for the survey consisted of: information on the socio-economic characteristics of respondents, severity of flood, coping strategies of flooding of rural households, perception of rural households about public/government interventions and food security status of rural households in the study area.

### Data Analysis

Descriptive statistics such as, means, percentage and frequency count were used to analyze the socio-economic characteristics of the respondents. Multiple linear regression was used to ascertain the determinants of food security in the study area. Binary Probit regression analysis was used to examine the relationship between flooding and food security

### Model Specification

Multiple Linear Regression model was used to examine the relationship between the socio-economic characteristics of rural households and food security in Hypothesis 1.

It is stated explicitly as;

$$Y = X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 + \mu \text{-----(Equation 1)}$$

Where, Y= Food security (Income)

X<sub>1</sub>= Sex (male or female)

X<sub>2</sub> = Age of farmers (years)

X<sub>3</sub> = Marital Status (1=Single, 2=Married, 3 = divorced, 4= widowed)

X<sub>4</sub> = Household size (number of persons)

X<sub>5</sub> = Years of farm experience (years)

X<sub>6</sub> = Level of Education (1= No formal Edu, 2=Primary, 3=Secondary, 3= Tertiary Education)

X<sub>7</sub> = Contact with extension agent (1 = yes, 2= No)

X<sub>8</sub> = Income (amount in naira)

X<sub>9</sub> = Access to credit (0=No, 1=Yes)

μ= Error term

**Hypothesis 2:** There is no significant relationship between flooding and food security. This was achieved by the t-value generated from the binary probit regression analysis of the food security value (Y) and the flooding (X) in the study area. It was scored as: Affected =1, Not affected =0. The Probit regression model was used since the dependent variable (food security) is treated as a binary variable (0=food secured, 1 = food insecure). In the analysis of dichotomous outcome variable, the Probit model is preferable to others, since it can constrain probabilities within the range of 1 and 0 (Mpuga, 2008). It is stated explicitly as;

$$\frac{P_i}{1-p_i} = FS = \beta_0 + \beta_1 X_1 + \delta_1 \dots \mu \text{-----equation 2}$$

Where, FS = Food security (0=food secured, 1 = food insecure)

β<sub>0</sub> = An intercept.

β<sub>1</sub>, = A regression coefficient of the independent variable

X<sub>1</sub> = The independent variable (Flood; Affected =1, Not affected =0)

δ<sub>1</sub> = The dummy variable regression coefficient; and

P<sub>i</sub> = The probability with a value between 1 and 0.

μ = Error term

## RESULTS AND DISCUSSION

The analysis of responses from the distributed questionnaire was examined in this section and presented in the section and tables below:

### Socio economic Characteristics of Respondents

The result of socio-economic characteristics of farmers is shown in Table 4.1. The result showed that majority 40.0% of the respondents were within 30-39 years old. The mean result showed that the farmers were 40.5 years old. The highest percentage of farmers falling within the 30-39 age bracket suggests that a significant portion of the workforce in this sector comprises of individuals in their prime years of productivity and innovation. The prevalence of this age range among respondents aligns with observations from Gbigbi and Eghagha (2024). The demographic trend indicates a crucial period for the cultivation and development of farming practices, potentially contributing to the sector's growth and sustainability. Additionally, the mean age of 40.5 years reflects a relatively youthful workforce, indicating the potential

for long-term engagement and continuity within the farming community (Ibok *et al.*, 2014). This youthful vigor may facilitate adaptability to emerging technologies and market dynamics, fostering resilience against challenges such as climate change and economic fluctuations. Ultimately, this demographic profile underscores the importance of targeted interventions and support mechanisms to harness the energy and potential of these young farmers, ensuring food security and economic prosperity in the study area and beyond (Ibok *et al.*, 2014). The result showed that majority (61.3%) of farmers were females while males constituted 38.8%. The result suggests a gender disparity within the farming community in the study area. This imbalance may reflect traditional gender roles prevalent in agricultural activities, where men are often perceived as primary providers or decision-makers (Ergando and Belete, 2016). Consequently, this disparity highlights the need for gender-sensitive interventions to ensure equitable access to resources, knowledge, and opportunities within the sector. Addressing this gender gap can foster inclusive agricultural practices, enhance productivity, and contribute to broader socio-economic development in the region. The result in this study agrees with Haddabi *et al.*, (2019) who revealed that 72.32% of the farmers were female. This is similar to the findings of Adisa (2012) where the male farmers were 29.7% and female farmers were 70.3%. The result showed that majority (56.9%) of the farmers were married. The highest percentage of respondents being married suggests a significant portion of respondents in the study area have family responsibilities and potentially stable support systems. This marital status may indicate access to shared resources, labor, and emotional support, which could positively impact agricultural productivity and resilience against food insecurity (Ergando and Belete, 2016). Furthermore, married individuals may benefit from cooperative farming practices, pooling resources and knowledge to mitigate risks and optimize yields. Understanding the marital dynamics among farmers is crucial for tailoring interventions that leverage existing social structures to enhance food security and livelihoods within the community. The result in this study agrees with Haddabi *et al.*, (2019) who revealed that 75% were married. The result indicated that majority of the farmers had household size of 1 – 5 persons. The result suggests that a significant portion of farmers in the study area likely operate small-scale family farms. This household size indicates a more manageable unit for agricultural activities, potentially allowing for closer attention to cultivation practices and resource allocation (Douyon *et al.*, 2022). However, it also implies a limited labor force, which could affect the scale of production and income generation. For Akukwe and Ogbodo, (2015), a large household size of farmers is symptomatic of rural areas where majority of the population is illiterate. The implication of relatively large sizes of household may be as a result of more mouths to feed and, perhaps also more hands to work on the farm other than hiring external labour. The result showed that the majority (60.0%) of the farmers had no formal education. The highest percentage of farmers without formal education suggests a relatively low level of formal education attainment among farmers in the study area. This disagrees with the findings of Henneberry and Carrasco, (2014) which suggests that the higher the educational level of a head of household, the more food secure they are. Haddabi *et al.*, (2019) revealed that majority (72.33%) of the Cassava farmers had one form of formal education or the other. Akukwe and Ogbodo, (2015) viewed formal education as means of facilitating farmers use of written information sources and increasing their knowledge and comprehension of new farm practices. The result indicated that majority (71.6%) of the farmers had a farming experience of 1 – 14 years. This demographic trend indicates a relatively recent influx of individuals into farming, possibly driven by factors such as urbanization, changing economic opportunities, or government initiatives promoting agricultural entrepreneurship. While these farmers may bring fresh perspectives and energy to the sector, their relatively limited experience could also pose challenges in terms of skill development, access to markets, and resilience against agricultural risks. Addressing the needs of this burgeoning group of farmers is essential for fostering sustainable agricultural development and mitigating food insecurity in the region. The mean showed that the farmers in the study area had a farming experience of 13 years. This agrees with Haddabi *et al.*, (2019) who revealed that cassava farmer had a mean farming experience of 12 years. The result showed that majority (42.50%) of the respondents had no contact with extension agent. This result suggests a lack of structured and regular exchange of information, advice, and assistance, enhancing farmers' capacity to address challenges and adopt best practices in farm cultivation (Akukwe and Ogbodo, 2015). Table 4.1 shows that most (96.25%) of the respondents were not cooperative society while 3.75% were members.



Cooperative networks are beneficial in the sense that assistance may be readily available for most rural households after unfavorable situations such as flooding. This is not similar to the results of Franklin and Patience (2014) who reported 89.52% of respondents were members of farmers' cooperative societies. The result of the source of labour is shown in Table 4.1. The result showed that (10.0%) of the respondent used friends labour in farm production, 60% used hired labour and 30% used family. The predominance of both family labor, reflects the reliance on household resources and traditional labor arrangements within the local community.

**Table 4.1 Socio-Economic Characteristics of Respondents**

Parameters	Frequency	Percentage	Mean	SD
<b>Sex</b>				
Male	62	38.8		
Female	98	61.3		
<b>Age</b>				
20-29	22	13.8		
30-39	64	40.0		
40-49	38	23.8	40.5	8.630
50-59	28	17.5		
60-69	8	5		
<b>Marital status</b>				
Single	39	24.4		
Married	91	56.9		
Divorced	17	10.6		
Widowed	10	6.3		
Widower	3	1.9		
<b>Household size</b>				
1-5	88	55.1		
6-10	66	41.3	5	1.5
11-15	6	3.8		
<b>Education</b>				
No formal education	96	60.0		
Primary	22	13.8		
Secondary	38	23.8		
Tertiary	4	2.5		
<b>Years of farming experience</b>				
1-14	114	71.6		
15-29	24	15.1	13.7	3.1
30-44	22	14		
<b>Frequency of contact with extension agent</b>				
No contact	12	7.50		
Once in two Weeks	48	30.00		
Monthly	68	42.50		
Quarterly	32	20.00		
Twice in a year				
<b>Access to credit facilities</b>				
No Access	106	64.4		
Access	54	33.8		
<b>Membership of cooperative</b>				
Member	6	3.75		
Non-member	154	96.25		

Source: Field Survey, 2024

#### 4.2 Severity of Flood in the Study Area

The result indicated that majority (56.9%) of the respondents experienced very severe flooding in the study area.

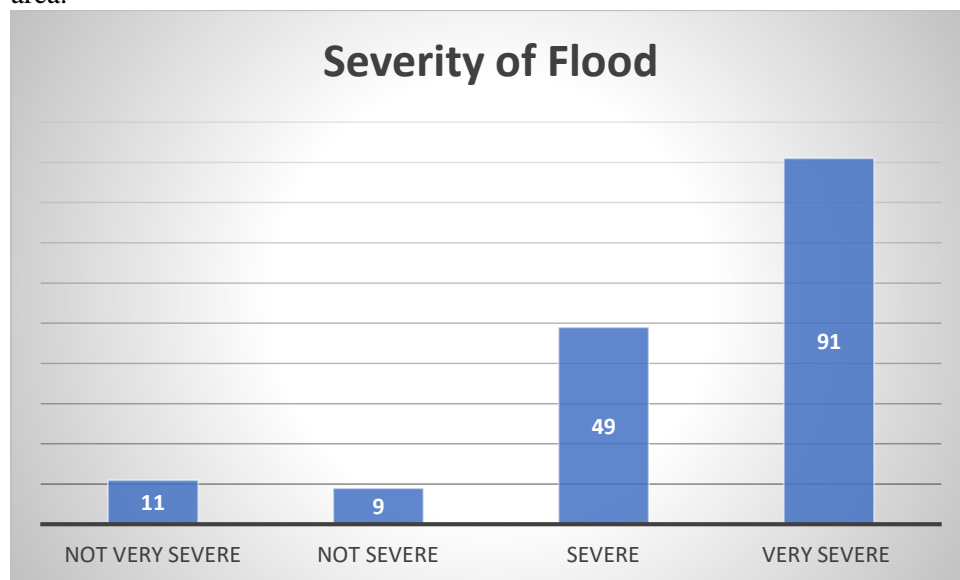


Figure 4.1: Severity of flood in the study area

#### Food Security Status of Respondents

##### Annual Income and Food Security Status of Respondents

The result showed that most (77.5%) of the farmers earned up to 500,000, 8.8% realized between 500,000-1,000,000, 7.5% realized 1,000,000-1,500,000 and 6.3% realized 1,500,000-2,000,000. The result implies that majority of the respondents are low income earners. This shows that the tendency of securing food will be low due to low income. The low income could be as a result of flood disaster in the study area which affected their farming operation and destruction of their farm produces. The mean result showed that more than half of the respondents had income of ₦450,000 per annum (₦1233/day), and with World Bank definition of poverty and the current rate of ₦1500/US dollar, more than half of the respondents were living below the poverty level and this indicates food insecurity. This finding agrees with Wudil *et al.*, (2023) who reported the case of low income due to flood. Flood disaster affects farm output and income which directly causes food insecurity. Haddabi *et al.*, (2019) revealed relationship between low income and flooding. This result also agrees with Emaziye, Okoh and Ike (2012).

**Table 4.5.1: Annual Income and Food Security Status of Respondents**

Annual income	Frequency	Percentage	Mean	SD	Food Security Status
0 - 500,000	124	77.5			Food insecure
500,000-1,000,000	14	8.8	450,000	36,794.9	Food insecure
1,000,000-1,500,000	12	7.5			Food secured
1,500,000-2,000,000	10	6.3			Food secured

Field Survey, (2024)

### Determinants of Food Security in the Study Area

To assess the effect of socio-economic characteristics on food security, multiple regression was performed. The overall model fit was 62.2% ( $R^2 = 0.622$ ,  $p < 0.05$ ) (see Table 4.6.1 and 4.6.2). This means that the variables can correctly predict food security by 62.2%.

**Table 4.6.1: Model Summary**

#### Multiple Regression Analysis

Model	R	R Square	Model Summary			Change Statistics			
			Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.437 <sup>a</sup>	.651	.622	.320	.191	8.926	9	150	.000

a. Predictors: (Constant), Access to Credit, Years of Farming Experience, Sex, Income Level, Age, House hold Size, Education, Extension Agent, Marital Status

**Table 4.6.2**

#### ANOVA<sup>a</sup>

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.617	9	.402	3.926	.000 <sup>b</sup>
	Residual	15.358	150	.102		
	Total	18.975	159			

a. Dependent Variable: Food Security

b. Predictors: (Constant), Access to Credit, Years Of Farming Experience, Sex, Income Level, Age, House hold Size, Education, Extension Agent, Marital Status

### Determinants of Food Security in the Study Area

Table 4.6.3 revealed the relationship between the socio-economic characteristics of rural households and food security in the study area. The result showed that sex has no statistically significant relationship with food security ( $t = -.717$ ). This implies that sex does not have a significant impact on food security and this suggests that gender differences may not play a critical role in determining an individual's food security status in the studied population. This finding disagrees with Aboaba, Fadiji, Hussayn, (2020) who reported that gender has a significant influence on food security. The result showed that age ( $t = .535$ ) has no statistically significant influence on food security in the study area. This implies that increase in age has no impact on food security. This implies that differences in age among farmers does not substantially affect their food security status within the population examined. Haddabi *et al.*, (2019) revealed that age of households' head was inversely related to food security status. The result indicated that there was a statistically significant relationship between marital status ( $t = -1.995$ ) and food security in the study area. The result implies that marital status has a significant impact on food security in the study area. This suggests that being married substantially affect their level of food security within the population examined. This finding agrees with Aboaba, Fadiji, Hussayn, (2020) who reported that marital status has significant influence on food security.

The result showed that household size ( $t = -2.235$ ) has a statistically significant influence on food security. The result suggested that as the number of household members increase, food security decreases. This imply that larger households did not benefit from greater resource pooling, shared responsibilities, or multiple income earners, which in turn could not enhances their ability to secure food. It may also reflect the social dynamics within households where larger families prioritize food availability could not meet the needs of all members. This finding corroborates with the findings of Ubokudom et al. (2017) who reported that household size has influence on food security. The result in this study is in line with the findings by Adebayo and Ojo (2012) who indicated significant relationship between household size and food security. Aboaba,

Fadiji, Hussayn, (2020) reported that household size has significant influence on food security. The result revealed that there was a statistically significant relationship between education and food security in the study area ( $t = 2.527$ ). This implies that higher levels of education are associated with higher food security in the study area. This could indicate that individuals with more education may have higher living costs, debt from education, or aspirations for better quality food, which could affect their immediate food security. Alternatively, the educated population might be more aware of food quality standards, perceiving themselves as high food secure due to higher expectations. This outcome may also reflect mismatches between education levels and local employment opportunities, increasing access to stable income necessary for food security. This finding is consistent with that of [Ahmed et al. \(2017\)](#) who reported that educational attainments were important productivity variables that played essential role in improving household food security. This finding also corresponds with the finding of [Mohammed et al. \(2021\)](#) who opined that education was an insulator against food insecurity. [Haddabi et al., \(2019\)](#) revealed that educational level of household heads was positively related to households' food security status. The result showed that years of farming experience has a statistically significant influence on food security ( $t = -1.992$ ). The result suggested that having more experience in farming can improve food security in the study area. Although, years of farming experience alone does not guarantee better food security unless coupled with access to modern techniques and resources in the study area. This result is in consonance with findings by [Ahmed et al. \(2017\)](#) who reported significant relationship between farming experience and food security. However, [Haddabi et al., \(2019\)](#) revealed that farming experience was positively related to households' food security status.

The result indicated that contact with extension agent has no ( $t = -.623$ ) statistically significant relationship with food security. The result suggests that contact with extension agents has no influence on food security, indicating that farmers who engage with extension agents are not likely to experience improved food security. This implies that access to extension agents does not necessarily enhance productivity and efficiency, leading to better food availability. However, [Ergando and Belete \(2016\)](#) revealed that access to extension services showed statistically significant effect on food security among rural households. The result revealed that income level of respondents ( $t = 3.251$ ) has a significant influence on food security. As similarly reported that Pakistan's food insecurity is exacerbated by low production due to credit constraints, lack of financial resources and low incomes. [Ergando and Belete \(2016\)](#) empirical results estimated using the survey data revealed that total annual income, total off-and farm income showed consistent and statistically significant effect on food security among rural households. [Haddabi et al., \(2019\)](#) revealed that total monthly income of household heads was positively related to households' food security status. The result showed that access to credit has a statistically significant influence on food security ( $t = 2.836$ ). This implies that credit enables households to invest in agricultural inputs, improve productivity, and smooth consumption during periods of low income or food scarcity. Access to financial resources through credit enhances their ability to purchase food or improve food production, thereby contributing to greater food stability and resilience against economic shocks. This finding is similar to the finding of [Aboaba, Fadiji, Hussayn, \(2020\)](#) who indicated that access to credit has significant influence on food security.

**Table 4.6.3 Determinants of Food Security in The Study Area  
Coefficients<sup>a</sup>**

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	.846	.214		3.950	.000
Sex	-.039	.055	-.056	-.717	.475
Age	.001	.002	.040	.535	.593
Marital Status	-.113	.057	-.215	-1.995	.048
Household Size	-.025	.011	-.172	-2.235	.027
Education	.093	.037	.221	2.527	.013
Years Of Farming Experience	-.008	.004	-.156	-1.992	.048
Extension Agent	-.032	.056	-.056	-.569	.570
Income Level	-1.105E-7	.000	-.152	-2.010	.046
Access to Credit	.162	.057	.301	2.836	.005

a. Dependent Variable: Food Security

#### **Relationship Between Flooding and Food Security of Rural Households**

The result on Table 4.7 showed that there was a statistically significant relationship between flooding and food security of rural households in the study area. With a negative coefficient of flooding (-.575), it implies that increase in flood will result in decrease of food security. Floods disrupt agricultural activities, leading to reduced crop yields, loss of livestock, and destruction of food storage systems, which directly impact food availability. Additionally, flooding limit access to markets and hinder food distribution, exacerbating food insecurity (Haddabi *et al.*, 2019). As rural households heavily rely on agriculture for their livelihoods and sustenance, the recurrence of floods poses a serious threat to their food security, leaving them vulnerable to hunger and economic instability during flood periods (Haddabi *et al.*, 2019). Okeleye et al., (2016) study was carried out to assess the impact of flood disasters on the livelihoods of farmers in Oke-Ogun Region of Oyo State, Nigeria, their study also revealed that flooding has huge impact on their farmlands and limited impact on their houses. Furthermore, the study found that the farmers had very low coping mechanisms as most of them do not have access to insurance facilities and do lack timely and precise flood early warning systems, flood local signs and community flood management committees. Ibrahim et al., (2019) examined the effects of flood on crop farmers in Niger State, Nigeria, to ascertain the frequency of occurrence of floods; and to determine the effects of floods on the food security of rural farmers. Ibrahim et al., (2019) reported that occurrence of floods had effects on the livelihood of farmers, the major flood control measures employed by the farmers were early planting, new farming practices.

**Table 4.7: Relationship Between Flooding and Food Security of Rural Households**

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			95% Wald Confidence Interval for Exp(B)		
			Lower	Upper	Wald Chi-Square	df	Sig.	Exp(B)	Lower	Upper
(Intercept)	-.771	.1821	-1.128	-.414	17.933	1	.000	.463	.324	.661
Flooding	-.575	.2531	-1.071	-.079	5.163	1	.023	.563	.343	.924
(Scale)	1 <sup>a</sup>									

Dependent Variable: Food Security

Model: (Intercept), Flooding

a. Fixed at the displayed value.

## CONCLUSION

The findings showed that there was a statistically significant relationship between flooding and food security among rural households.

## RECOMMENDATIONS

Based on the findings, it could be recommended that governments and local authorities should establish early warning systems and improve flood preparedness measures, such as building flood-resistant infrastructure, including roads, bridges, and housing, to reduce destruction during floods. Encouraging the construction of canals and raising ground levels, as identified coping strategies, should be expanded to all farmers. To address the immediate food insecurity during floods, governments should establish efficient food aid programs. Given the low reliance on food aid, efforts must be made to ensure timely distribution of food supplies and support to affected households during flood emergencies.

## REFERENCES

- Aboaba, K. O., Fadiji, D. M., Hussayn, J. A. (2020). Determinants of food security among rural households in southwestern Nigeria: USDA food security questionnaire core module approach. *J. Agribus. Rural Dev.*, 2(56), 113–124. <http://dx.doi.org/10.17306/J.JARD.2020.01295>
- Adebayo P.F., and Ojo E. O. (2012). Food Security in Nigeria: An Overview. *European Journal of Sustainable Development*, 1(2), 199. <http://doi.org/10.14207/ejsd.2012.v1n2p199>
- Adisa, Rashid. (2012). Land Use Conflict Between Farmers and Herdsmen Implications for Agricultural and Rural Development in Nigeria doi: 10.5772/45787
- Ahmed UI, Ying L, Bashir MK, Abid M, Zulfiqar F (2017) Status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan. *PLOS ONE* 12(10): e0185466. <https://doi.org/10.1371/journal.pone.0185466>
- Akukwe, T.I. Oluoko-Odingo, A.A. and Krhoda G.O. (2020). Do floods affect food security? A before-and-after comparative study of flood-affected households' food security status in South-Eastern Nigeria. *Bulletin of Geography. Socio-economic Series*, 47(47): 115-131.
- Akukwe, T.I., and Ogbodo, C. (2015). Spatial Analysis of Vulnerability to Flooding in Port Harcourt Metropolis, Nigeria. *Sage Open*, 5(1).

- Anino Arsekurubu (2022). The Nigeria Social Action Conference 2022: Addressing the Loss and Damage from Flood and Draught in Nigeria. <http://saction.org>
- Bamidele, O. F and Badiora, A. I (2019). Flood disaster vulnerability in North Central Nigeria. *International Journal of Research and Innovation in Social Science*, 3(12): 364-371
- Douyon A, Worou ON, Diama A, Badolo F, Denou RK, Touré S, Sidibé A, Nebie B and Tabo R (2022) Impact of Crop Diversification on Household Food and Nutrition Security in Southern and Central Mali. *Front. Sustain. Food Syst.* 5:751349. doi:10.3389/fsufs.2021.751349
- Ekpoh, I. J (2015). Climate change and recent severe flooding in Uyo, Akwa Ibom State, Nigeria. *Global Journal of Social Sciences*, 14, 23-3.
- Emaziye P. O., Okoh R. N., and P. C Ike, (2012)., "A Critical Analysis of Climate Change Factors and its Projected Future Values in Delta State, Nigeria," *Asian Journal of Agriculture and Rural Development, Asian Economic and Social Society*, vol. 2(2), pages 206-212.
- Emaziye, P. O. (2021). Impacts of Climate Change on Fish Production among Rural Fishing Households in Delta State, Nigeria. *International Journal of Research and Review*, 8(4), 402-407. <https://doi.org/10.52403/ijrr.20210447>
- Ergando H. M., and Belete D. H. (2016) Analysis of Household Food Insecurity and its Covariates in Girar Jarso Woreda, Oromia Regional State, Ethiopia. *Journal of Economics and Sustainable Development*. Vol 7. No. 3.
- Franklin E. Nlerum and Patience I. Ogu (2014). Role of Farmers' Cooperative Societies in Rural Development in Nigeria. *Journal of Rural Cooperation*. 42(2).
- Gbigbi T. M and Eghagha J. E. (2024). Assessing the Effects of Flood Risk on Fish Farming in the Coastal Region of Delta State, Nigeria. *International Journal of Oceanography & Aquaculture*, 8(1): 000298.
- Haider, H. (2019). *Climate change in Nigeria: Impacts and responses*. K4D Helpdesk Report 675, Brighton, UK:Institute of Development Studies. 1-38.
- Hallegatte, S., Vogt-Schilb, A., Bangalore, M., and Rozenberg, J. (2017). *Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters*. Climate Change and Development Series. Washington, DC: World Bank. 1-17. <https://doi.org/10.1596/978-1-4648-1003-9>
- Hallegatte, S., Vogt-Schilb, A., Rozenberg, J., Bangalore, M., and Beaudet, C. (2020). From Poverty to Disaster and Back: A Review of the Literature. *Economics of Disasters and Climate Change*, 4, 223–247. <https://doi.org/10.1007/s41885-020-00060-5>  
<http://www.macmillandictionary.com/dictionary/british/flooding>
- Henneberry, S., and Carrasco, D. (2014). Global Food Security: Emerging Economics and Diverging Food Markets. *Journal of Food Distribution Research* 45(1).
- Ibok, Otu & Basse, Nsikan & Ataire, Elizabeth & Obot, Oto-obong. (2014). Food Security Determinants among Urban Food Crop Farming Households in Cross River State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology*. 3. 79-60. 10.9734/AJAEES/2014/6560.
- Ibrahim, M., Ndatsu, J. A and Yisa, K. M. (2019). Effects of Flood on Crop Farmers in Riverine area in Niger State. *International Journal of Agriculture*. Vol 7: 2229-5518
- Komolafe, A.A., Adegboyega, S.A., and Akinluyi, F.O., (2015). A review of flood risk analysis in Nigeria. *American Journal of Environmental Sciences* 11(3), 157–166. doi: 10.3844/ajessp.2015.157.166
- Mfon, I. E., Oguike, M. C., Eteng, S. U., and Etim, N. M. (2022). Causes and effects of flooding in Nigeria: A review. *East Asian Journal of Multidisciplinary Research (EAJMR)*, 1(9), 1777-1792. <http://doi.org/10.55927/eajmr.v1i9.1261>
- Munyai, R. B., Chikoore, H., Musyoki, A., Musyoki, A., Chakwizira, J., Muofhe, T. P., Xulu, N.G., and Manyanya, T. C. (2021). Vulnerability and adaptation to flood hazards in rural settlements of Limpopo Province, South Africa. *Water*, 13(24), 1-24. <https://doi.org/10.3390/w13243490>
- Mustapha, K. G. (2021). Impacts of flooding on socio-economic livelihood of the people of Waribauri community in Yunusari Local Government, Yobe State.
- National Bureau of Statistics, NBS (2023). Nigerian Gross Domestic Product Report Q4 2023. <https://nigerianstat.gov.ng>elibrary>

- Niazi, I. U., Rana, I. A., Arshad, H. S. H., Lodhi, R. H., Najam, F. A., and Jamshed, I. (2022). Psychological resilience of children in a multi-hazard environment: An index-based approach. *International Journal of Disaster Risk Reduction*, 83, 103397<https://doi.org/10.1016/j.ijdrr.2022.103397>
- Nkwunonwo, U. C (2016). A review of flooding and flood risk reduction in Nigeria. *Global Journal of Human-Social Science: B Geography, GeoSciences, Environmental Science and Disaster Management*, 16(2): 23-41
- Nkwunonwo, U.C., Malcolm, W. and Brian, B. (2015). Flooding and Flood Risk Reduction in Nigeria: Cardinal Gaps. *Journal Geography and Natural Disaster* 5(1):1000136. <https://doi:10.4172/2167-0587.1000136>
- Nwafor, J. C., Onyenechere, I. O., and Okpala, D. C. (2017). Climate change impact on agricultural production in Delta State, Nigeria. *International Journal of Agriculture and Forestry*, 7(2), 31-40.
- Nwagbo, U. Z. (2021). Environmental impact of flooding on rural development in southeastern Nigeria. *Journal of Environmental Hazards*, 5(6), 1-8.
- Okeleye, S. O., Olorunfemi, F. B., Sogbedji, J. M., and Aziadekey, M. (2016). Impact assessment of flood disaster on livelihoods of farmers in selected farming communities in Oke-ogun region of Oyo State, Nigeria. *International Journal of Scientific and Engineering Research*, 7(8), 2067-2083
- Olagunju, O. E., Ariyo, O. C., Fadele, O. K., Alabi, O. F., and Olagunju, O.S. (2021) Effects of flood on rural household livelihood activities in Kano State, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 14(4), 500-514
- Otekunrin, O. A., Sawicka, B., and Pszczółkowski, P. (2021). Assessing Food Insecurity and Its Drivers among Smallholder Farming Households in Rural Oyo State, Nigeria: The HFIAS Approach. *Agriculture*, 11(12), 1-20. <https://doi.org/10.3390/agriculture11121189>
- Rentschler Maruyama, Jun Erik & Kim, Ella Jisun & Thies, Stephan Fabian & De Vries Robbe, Sophie Anne & Erman, Alvina Elisabeth & Hallegatte, Stephane, 2021. "Floods and Their Impacts on Firms: Evidence from Tanzania," Policy Research Working Paper Series 9774, The World Bank. <<https://ideas.repec.org/p/wbk/wbrwps/9774.html>>;
- Sarah, E., and Achoja, F. O. (2023). Impact of Flooding Disaster on Economic Returns of Fish Farmers in Rivers State Nigeria. *World Journal of Environmental Biosciences*, 12(4), 18-24. <https://doi.org/10.51847/wYBB1Pdfv4>
- Ubachukwu, N. N., and Emeribe C.N. (2017). The 2012 flooding in selected parts of Isoko South, Delta State: Assessment of socio-economic impacts. *Mediterranean Journal of Social Sciences*, 8(1), 353-357. <https://doi.org/10.5901/mjss.2017.v8n1p353>.
- Ubokudom, E.O., Namso, N.F., Egbe, B.E., Kesit, K.N. (2017). Household level food security status and its determinants among rural farmers in Akwa Ibom State, Nigeria. *Agric. Sci. Res. J.*, 7(10), 297–303.
- World Bank (2016). “Shockwaves: Managing the Impacts of Climate Change on Poverty”, Washington DC: The World Bank.
- World Bank (2021). “Enabling Private Investment in Climate Adaptation and Resilience: Current Status, Barriers to Investment and Blueprint for Action.” Washington DC: The World Bank
- World Health Organization (2022). Floods Overview. <https://www.who.int/health-topics>
- Wudil A. H., Ali A., Aderinoye Abdulwahab, S, Raza H. A, Mehmood H. Z and Sannoh A. B (2023). (Determinants of food security in Nigeria: Empirical evidence from beneficiaries and nonbeneficiaries rice farmers of the Kano River Irrigation Project. *Front. Sustain. Food Syst.* 7.999932