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ASSESSMENT OF RAINFALL PATTERN AND HOUSEHOLD FOOD SECURITY IN OLUYOLE AND IDDO LOCAL GOVERNMENT AREAS OF OYO STATE, NIGERIA

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A B S T R A C T

Food security and appropriate nutrition are essential for making progress towards sustainable development. It has been reported that about two (2) billion people worldwide, particularly those living in rural and semi-urban regions, face moderate to severe food insecurity, whilst hunger rates have risen in recent years after falling steadily for decades. The Food and Agriculture Organization of the United Nations (FAO) ascribed much of this growth to climate change. There is a lack of empirical evidence on the relationship between climatic conditions and food security in Ibadan metropolis, a city with a mosaic of rural, semi-urban, and urban areas. Therefore, an assessment of the Rainfall Pattern (RP) and Household Food Security (HFS) was conducted in Oluyole and Iddo Local Government Areas (LGAs) of Oyo State, Nigeria. Climatic data (RP) for the research locations were collected from the International Institute of Tropical Agriculture's (IITA) Ibadan Meteorological Station between 2018 and 2019. The sample included 265 families from 37 enumeration areas (EAs), and was intended to be representative of Oluyole and Iddo LGAs. Multi-stage cluster sampling was employed, and the EAs represented the entire LGA, which were randomly picked using a GPS offset of 0 to 10*km*. Follow-ups were undertaken in 2020-21 and 2022-2023, with an attrition rate of approximately 3% per cycle. Sets with fixed effects Regression models were used to investigate the relationships between rainy season precipitation and two household food security indicators: the Food Consumption Score (FCS) and the Reduced Coping Strategies Index (rCSI). Data were analysed using descriptive and inferential statistics with α=0.05. In 2018-19, 2020-21, and 2022-23, rainy season precipitation averaged (1375.60*mm*, 1398.34*mm*, and 1420.18*mm*, respectively). Each home has an average family size of five, and 56.3% of respondents are involved in farming and related activities. The primary income of chosen households was derived from staple crop (Maize) farming, with farm sizes ranging from 1-6*ha*. Maize yield was 15% higher on average, resulting in net returns ranging from ₦2900 to ₦4795 per hectare. There is a significant link between the FCS (2.78) and rCSI (−0.014*), indicating that rainfall pattern affected food security of households. Households in Oluyole and Iddo LGAs are particularly susceptible to changes in rainfall pattern. Interventions, such as increasing access to agricultural extension services, expanding agricultural index insurance, and implementing programs to mitigate climate-induced food insecurity, may promote climate change resilience in Oyo State's Oluyole and Iddo Local Government Areas.

1. Introduction

Food security has been defined as having consistent access to a sufficient quantity of affordable, nutritious food (FAO, 2010). The United States Department of Agriculture-USDA (2018) emphasised in a working paper that "on the other hand, this is a situation of limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways." There have been reports of households experiencing severe food security concerns, as not all family members have constant access to enough food for an active, healthy life (Gary, 2014). Scientists have noted that there are numerous reasons for food insecurity. High food costs and disruptions in global food supplies, such as those caused by conflict, are among the most widely discussed. For example, the effects of climate change on food security have been said to reduce crop, livestock, fisheries, and aquaculture productivity by modulating water availability and quality, causing heat stress, shifting phenology, and altering the pest and disease environment, including the faster spread of mycotoxins and pathogens. Increased frequency and intensity of floods, droughts, storm surges, and extreme events can cause significant disruptions in food supply chains due to crop failures and infrastructure damage, as well as rivalry among food production systems (Cottrell *et al*., 2019). Climate extremes are becoming increasingly common, co-occurring, and persistent in some parts of tropical Africa, which is a net food exporter (Pradhan *et al*., 2022). For example, it was reported by Gbadebo (2018) that recent exposure of residents of Nigeria, a tropical African country, to heatwaves, droughts, and floods can harm their food security, health, and nutrition, as well as lower their productivity. This could also affect their livelihoods and incomes, particularly for those living in climate-sensitive geographical areas of the country (Farinloye, 2018; Kuhla *et al*., 2021).

This exposure can have a significant impact on more vulnerable low- and middle-income rural dwellers, those who rely on rain-fed agriculture, and specific social and economic groups, such as smallholder farmers and farmworkers, low-income households, the elderly, women, and children (De Lima *et al*., 2021; Kuhla *et al*., 2021). Chronic food insecurity increases vulnerability to hunger and famine. Gujahan (2019), a well-known Sri Lankan scientist, observed that prolonged hunger and malnutrition in childhood can cause stunted growth in children. He further emphasised that once stunting has begun, greater dietary intake after the age of roughly two years is ineffective in reversing the harm. Severe malnutrition in early childhood frequently causes cognitive development problems. However, climate change challenges, which have been identified as a cause of food insecurity, have received inadequate attention, especially in tropic regions such as the Ibadan metropolis in Nigeria. There is a lack of empirical evidence on the relationship between climatic conditions and food security in Ibadan metropolis, a city in Nigeria with a mix of rural, semi-urban, and urban areas; thus, this study attempted to conduct an assessment of the Rainfall Pattern (RP) and Household Food Security (HFS), which was conducted in Oluyole and Iddo Local Government Areas (LGAs) of Ibadan.

2. Methodology

2.1 *Description of the Study Area*

Ibadan is located in south-western Nigeria, in the southeastern region of Oyo State, around 119*km* (74miles) northeast of Lagos and 120*km* (75miles) east of Nigeria's international border with Benin (Adeyemo, 2021). It is totally within the tropical forest zone but on the border of the forest and the derived savannah, whilst the city's elevation fluctuates from 150m in the valley to 275*m* above sea level on the broad north-south ridge that runs through its centre King, 2022). The city is naturally drained by five rivers with numerous tributaries: the *Ona* River in the north and west, the *Ogbere* River in the east, the *Ogunpa* River that flows through the city, and the *Kudeti* River in the centre of the metropolis (Gbadebo, 2018). The *Ogunpa* River is a third-order stream with a channel length of 12.76*km* and a catchment area of 54.92km^2, while *Eleiyele* Lake is located in the city's northwest. On the other hand, the Osun River and *Asejire* Lake border the city to the east, and the fifth river, known as the Odo-ogun River, runs through Lagos State, Ogun State, Osun State, Iseyin Town, and Eruwa Town (Aiyeloja, 2017). Ibadan has a tropical wet and dry climate (Köppen climatic classification Aw), with a long wet season and relatively stable temperatures throughout the year. The wet season in Ibadan lasts from March to October, except August when precipitation is low. This lull divides the wet season into two distinct seasons. The city's dry season runs from November to February when Ibadan endures the classic West African harmattan. Ibadan receives an average of 1,230*mm* (48 *inches*) of rainfall per year, spread out across 123 days. Rainfall occurs in two distinct peaks: June and September. The average daily temperature is 26.46°C (79.63°F), the mean minimum is 21.42°C (70.56°F), and the relative humidity is 74.55% (Sumonu, 2018).

2.2 Data Collection

A sample of 265 households from 37 enumeration areas (EAs) was chosen from more than 331 village families in Iddo and Oluyole LGAs to be representative of Oluyole and Iddo LGAs. Multi-stage cluster sampling was used, and the EAs represented the entire LGA, which were selected at random using a GPS offset of 0 to 10*km*. Follow-ups were carried out in 2020-21 and 2022-2023, with an attrition rate of around 3% every cycle. Primary data were gathered using structured and semi-structured questionnaires. The second stage involved gathering basic data on household demographics such as agricultural and animal production, food security, changes in rainfall and temperature, and household adaption techniques. Secondary data Climatic data (especially rainfall, RP) for the research locations were collected from the International Institute of Tropical Agriculture's (IITA) Ibadan Meteorological Station from 2018 to 2019. Triangulation of data from the home survey and meteorological data using a Focus Group Discussion (FGD) was carried out. The key topics examined included changes in precipitation (rainfall), crop and livestock diseases, food security status, and household and community adaptation measures created in response to climate change.

To gather the participants' perspectives, group members were chosen among people aged 55 and older, as well as community leaders and women leaders. Sets with fixed effects Regression models were used to study the connections between rainy season precipitation and two household food security indicators: the Food Consumption Score (FCS) and the Reduced Coping Strategies Index (rCSI). The data was examined using descriptive and inferential statistics at α=0.05.

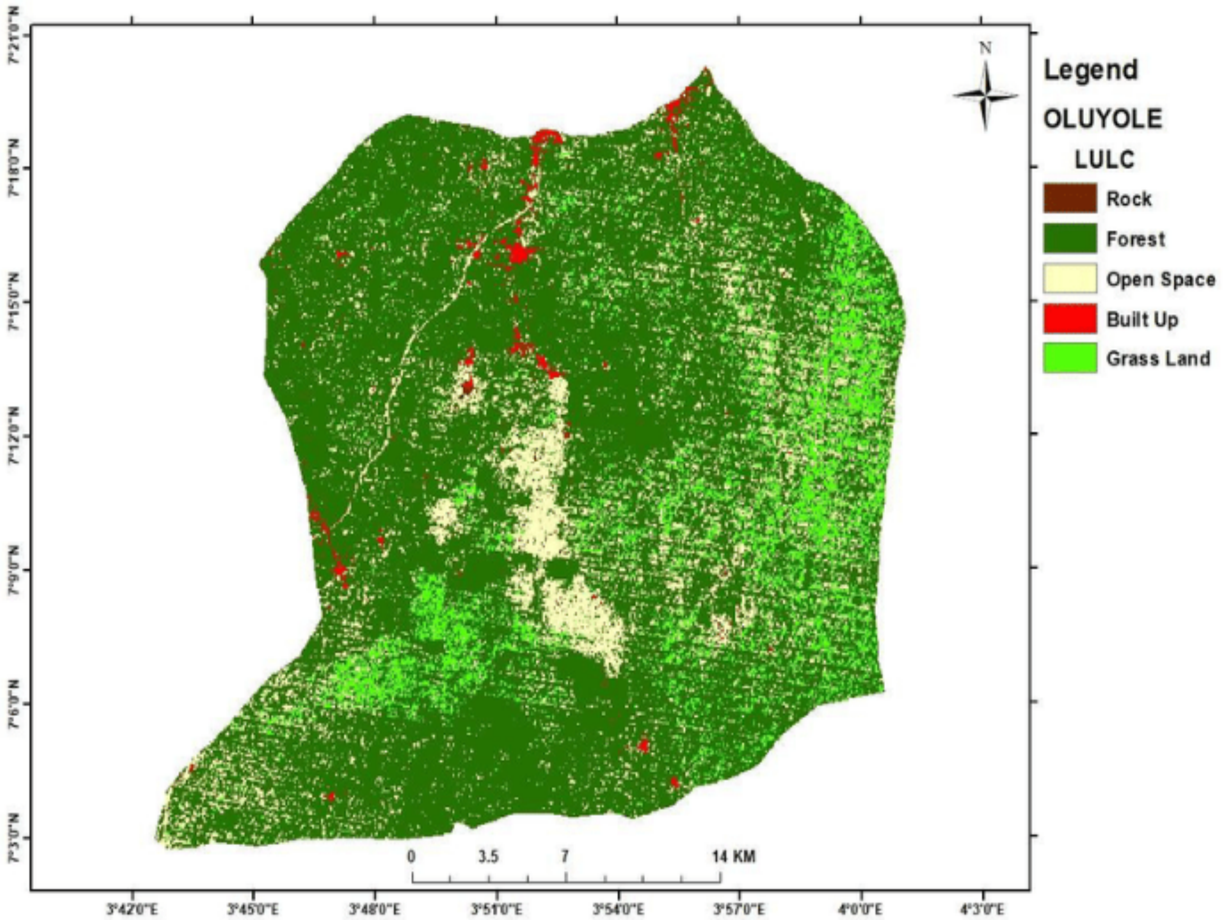

Figure 1: Map of Oluyole LGA
Source: Field survey, 2023

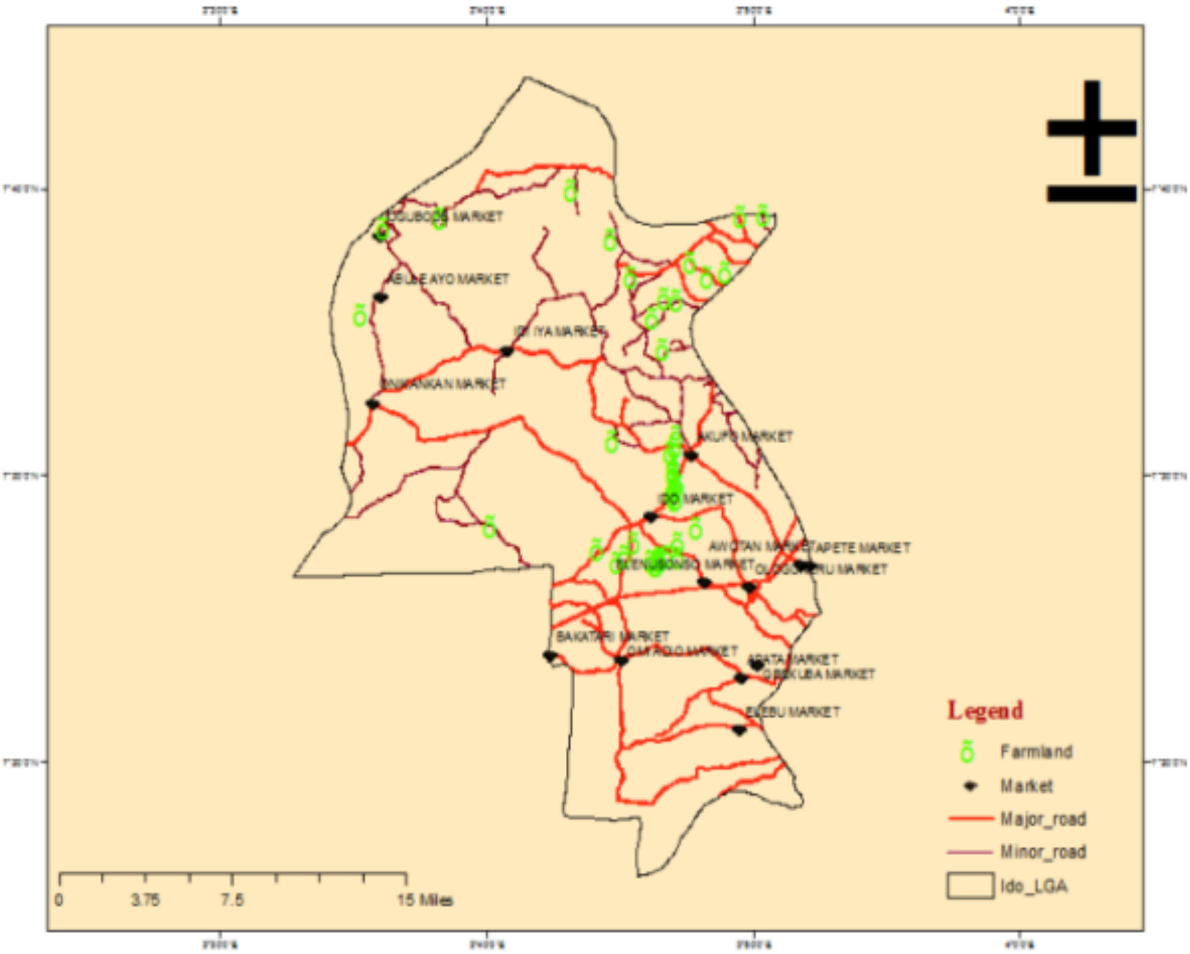

Figure 2: Map of Iddo LGA
Source: Field survey, 2023

3. Results

Table 1: Demographic and resources of households

Variables	Min	Max	Mean	St. D
Age	18	73	45.5	9.6
Family size	3	13	8.0	3.7
Active labour size	2	7	4.5	1.5
Farmland size	1	6	3.5	0.9
Crops	2	8	5.0	1.8
Livestock	2	5	3.5	0.9
Able to read and write	3	12	45.5	9.6
Unable to read and write	3	13	8.0	3.7
Male headed	2	7	4.5	1.5

Source: Field survey, 2023

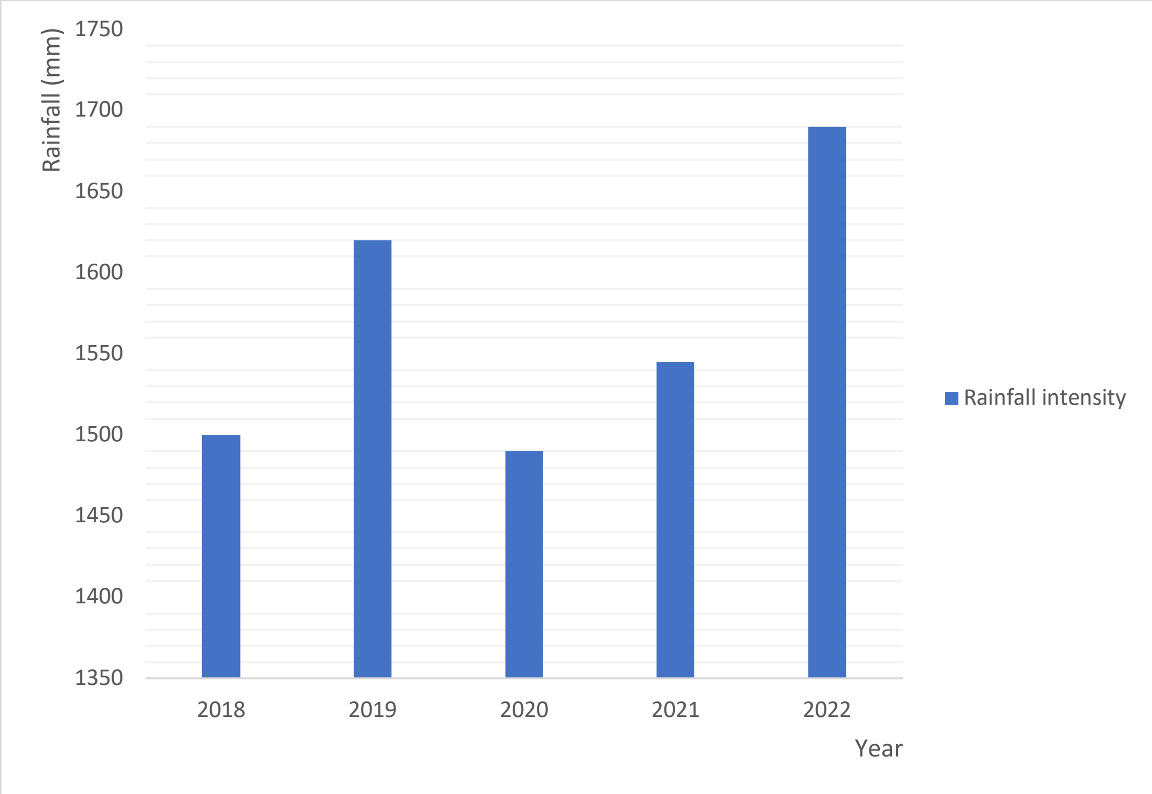

Figure 3: Cumulated data on Rainfall intensity within the study period

Source: Field survey, 2023

Table 2: Binary Logistic Regressions (BLR) predicting the likelihood of food security based on precipitation and sociodemographic characteristics

Variables	**Food secure (FCS)**	**Food secure (rCSI)**	**Food secure (FCS and rCSI)**
Rainy season precipitation	1.216 ** (0.084)	1.108 * (0.052)	1.179 *** (0.054)
Households	0.848 (0.163)	0.639 *** (0.082)	0.699 ** (0.094)
Age of head	0.989+ (0.006)	0.997 (0.005)	0.994 (0.005)
Education of head [less than primary is baseline]:			
Primary or greater	1.167 (0.183)	1.518 ** (0.222)	1.384 ** (0.168)
Number of members ages 0 to 6	1.123 + (0.075)	0.936 (0.062)	1.014 (0.059)
Number of members ages 7 to 15	1.168 * (0.079)	0.937 (0.045)	1.022 (0.051)
Number of members ages 16 to 64	1.124 + (0.067)	1.159 ** (0.056)	1.174 *** (0.054)
Number of members ages 65+	1.232 (0.218)	0.881 (0.117)	0.946 (0.139)

Source: Field survey, 2023

Table 3: Binary Logistic Regressions (BLR) predicting the likelihood of food security based on farming activities and size of farmlands

Variables	**Food secure (FCS)**	**Food secure (rCSI)**	**Food secure (FCS and rCSI)**
Housing quality index	1.712 *** (0.158)	1.765 *** (0.187)	1.857 *** (0.175)
Under N1000.90/day poverty line	0.929 (0.168)	0.856 (0.127)	0.896 (0.140)
Crops and/or livestock	1.030 (0.144)	0.912 (0.131)	0.902 (0.116)
Farm size [> 0 Ha and <=1 Ha is baseline]:			
No farm	0.924 (0.311)	1.308 (0.329)	1.189 (0.305)
>1 Ha and <=2 Ha	0.790 (0.183)	1.208 (0.208)	1.028 (0.153)
>2 Ha	1.130 (0.246)	1.640 * (0.348)	1.447 * (0.271)
Harvests from farmland	1.144 (0.261)	1.301 (0.316)	1.243 (0.267)

Source: Field survey, 2023

Table 4: Correlation predicting the likelihood of food security based on livestock characteristics

Variables (Livestocks)	**Food secure (FCS)**	**Food secure (rCSI)**	**Food secure (FCS and rCSI)**
Cattle	0.701 (0.217)	0.950 (0.352)	0.875 (0.197)
Sheep	0.16	0.19	0.19
Goats	1.030 (0.141)	0.912 (0.121)	0.902 (0.126)
Poultry (Free-range)	11.43 **	5.04 $^{+}$	13.52 **
Poultry (Intensive)	1.028 (0.144)	0.612 (0.121)	0.902 (0.116)
Pigs	1.012 (0.144)	0.712 (0.121)	0.502 (0.116)
Rabbits	0.024 (0.311)	1.308 (0.329)	1.189 (0.305)

Source: Field survey, 2023

Table 5: Binary Logistic Regressions (BLR) predicting the likelihood of food security based on precipitation and sociodemographic characteristics

Outcome variables	Mean	SD	Min	Max
Food secure (FCS)	0.84		0	1
Food secure (rCSI)	0.74		0	1
Food secure (FCS and rCSI)	0.65		0	1

Source: Field survey, 2023

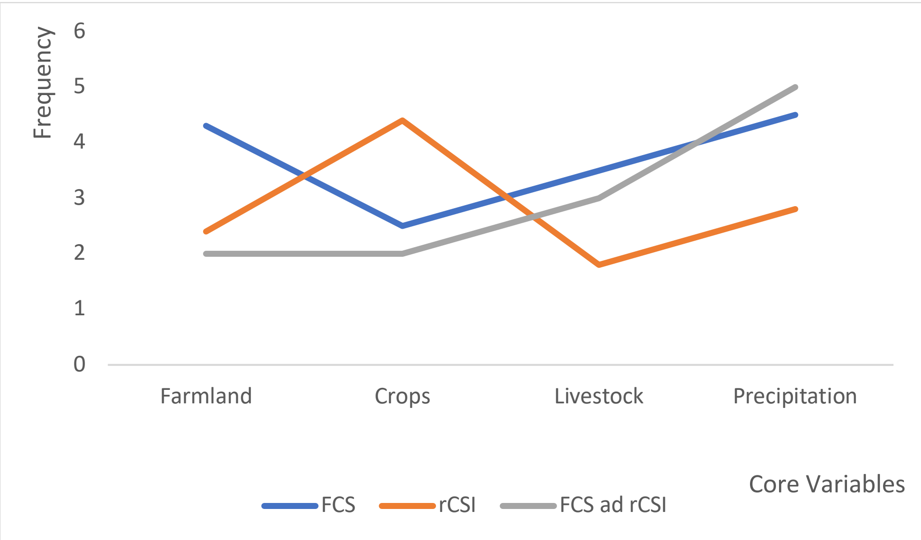

Figure 4: Logistics interactions between the core variables
Source: Field survey, 2023

Plate 1: A farmland and some goats at *Idi-ya* village in Iddo LGA
Source: Field survey, 2023

Plate 2: A farmland with cassava at *Onikoko* Village in Oluyole LGA
Source: Field survey, 2023

Plate 3: A maize farm at *Idi-Ayunre* village in Oluyole LGA
Source: Field survey, 2023

4. Discussion

The results showed the descriptive statistics for the analytic sample, which included 1,245 observations from 325 households that were initially interviewed. Approximately 72% of household observations were food secure in terms of FCS, 54% in terms of rCSI, and 45% in both categories. Total rainy season precipitation averaged 9.63*mm* and ranged from 3.99 to 22.17*mm*. Initially, three-quarters of families were headed by men, and 43% of household heads had completed at least primary school. Housing quality varied greatly, and 40% of households fell below the $1.90/day poverty level. Crops and/or animals were the principal income for 43% of households, with 56% farming zero to two hectares of land. Finally, 12% of household heads had lived in the study area for less than a decade. Multivariate binary logistic regression models were used to estimate the chance of being food secure in terms of FCS, rCSI, and both FCS and rCSI at the same time, using precipitation and cropland conditions from the most recent rainy season.

To account for additional factors influencing food security, a set of home controls was assessed. Village clusters were found to be responsible for non-independence among households residing in the same village. The results were interpreted as comparing two household observations from the same village but with different exposures to the current rainy season precipitation circumstances. This study looked at the links between recent meteorological conditions and household food security in Nigeria, where agriculture employs 65% of the workforce and 31% of the population suffers from malnutrition (United Nations, 2019; von Grebmer *et al*., 2019). Most studies on climatic conditions and food security have used indirect—and insufficient—proxies, such as caloric consumption or child anthropometry (Headey and Ecker, 2013; Maxwell *et al*., 2014; Mulmi *et al*., 2016). Instead, it is recommended to use a combination of experience indicators that capture the underlying characteristics of food security. This study used the Food Consumption Score (FCS), which measures dietary diversity and the nutritional value of foods consumed by households, and the Reduced Coping Strategies Index (rCSI), which addresses household coping behaviours in response to food shortages, such as dietary change, rationing, and help-seeking.

Among the study population, the two variables were only weakly associated, implying that they describe separate aspects of food security. The findings show that more precipitation during the most recent completed rainy season is connected with a higher likelihood of being food secure in terms of FCS, rCSI, or both FCS and rCSI at the same time. When precipitation and temperature interactions are taken into account, it was observed that wet conditions are connected with the highest probability of food security, whilst dry conditions are related with the lowest probability. These findings suggest that low rainfall, particularly when combined with a cool, rainy season, has a negative impact on households' ability to access food, resulting in reduced dietary diversity, food shortages, and, in turn, coping strategies such as limiting portion sizes or restricting food consumption by adults to feed young children. Furthermore, the findings indicating increased rainy season precipitation is advantageous for food security in Sub-Saharan Africa are consistent with those of several other research (Cooper *et al*., 2019; Tankari, 2020). This is most likely driven by increased crop yields, which boost food availability and household income. Oluyole and Iddo LGAs in Oyo state, Nigeria, are significant leaders in maize and cassava production, with both crops cultivated throughout the LGAs and serving as the primary food crop for most households (Arce and Caballero, 2015).

The study also discovered that increased rainfall improved yields (Laudien *et al.*, 2020). Indeed, both maize and cassava are very susceptible to pest damage and thrive under favourable climatic conditions (Sánchez *et al*., 2014). Furthermore, it was revealed that households with a higher proportion of working-age members were less vulnerable to the negative effects of low precipitation on food security. At low rainy season precipitation levels, households with four working-age members (aged 16-64 years) were 24 percentage points more likely to be food secure on both metrics than those with one working-age person. This shows that households with a larger labour pool are better equipped to endure the negative effects of drought conditions. In response to insufficient precipitation, members may increase labour allocation to agricultural output and/or diversify into non-agricultural income-generating activities (Asfaw *et al*. 2019).

5. Conclusion

The findings revealed that disparities in vulnerability to food insecurity were mostly due to observed differences in socio-demographic variables such as education, age, and household income. The study's findings revealed that a household's resilience to food insecurity throughout the study period was heavily reliant on resourcefulness and assets (farmland size, crops, and animals), which determine the household's level of entitlement. Respondents, for example, were more vulnerable to environmental stress and calamities because they relied largely on nature. They were also considered as lacking the capacity and resources necessary to recover from their current condition. Furthermore, food-insecure and impoverished communities are expected to suffer severely as a result of inadequate access to water resources, healthcare, and public infrastructure services. The study found a considerable gap in access to economic resources between households in Oluyole and Iddo LGAs, respectively. Households in Oluyole and Iddo LGAs may be as well off as households with comparable resources and entitlements, such as cattle, agricultural land, income, and demographics. This study has significant Agricultural and Environmental sustainability policy implications for Nigeria as well as other low- and middle-income countries, particularly those that rely largely on maize and cassava production to forestall any imminent food insecurity.

6. Recommendations

It is suggested that targeted social protection policies focused on equality in these areas could successfully reduce food insecurity and vulnerability. Offering social protection against risks and adversity, such as social insurance and social transfer payments to help and empower the poor and vulnerable, could considerably improve households' ability to achieve long-term food security based on their current circumstances.

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