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Assessing Food Insecurity and Its Drivers among Smallholder Farming Households in Rural Oyo State, Nigeria: The HFIAS Approach

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Abstract: Hunger and food insecurity take center stage in most debates in Africa, and in recent times with serious concerns about Nigeria. This study assessed food insecurity among farming households in rural Oyo State, Nigeria, using cross-sectional datasets from 211 farming households through a multi-stage sampling procedure. The Household Food Insecurity Access Scale (HFIAS) module was employed in assessing food insecurity status of farming households, and the ordered logit model (OLM) was used to analyze factors influencing food insecurity among farming households. The results revealed that 12.8% of the farming households were food secure while 87.2% had varying levels of food insecurity. The OLM results indicated that age, household head's years of schooling, gender, farm size, farm experience, non-farm income, food expenditure, and access to extension service significantly influenced food insecurity among farming households. Based on the findings, efforts should be geared towards promoting households' education-related intervention programs in order to improve their nutrition-related knowledge that can enhance their food security status. Additionally, there should be provision of rural infrastructural facilities such as piped water, rural electrification, and healthcare service that promote healthy living and enhance households' agricultural productivity.

Keywords: Household Food Insecurity Access Scale (HFIAS); food security; zero hunger; food access; smallholder farmers

Citation: Otekunrin, O.A.; Otekunrin, O.A.; Sawicka, B.; Pszczółkowski, P. Assessing Food Insecurity and Its Drivers among Smallholder Farming Households in Rural Oyo State, Nigeria: The HFIAS Approach. *Agriculture* **2021**, *11*, 1189. https://doi.org/10.3390/agriculture11121189

Academic Editor: Wojciech J. Florkowski

Received: 27 October 2021
Accepted: 19 November 2021
Published: 25 November 2021

1. Introduction

With an increasing undernourished population around the world in recent times, hunger and food insecurity remained on the front burner of most debates globally [1–3]. A recent report by Food and Agriculture Organization (FAO) revealed that 2020 global hunger under the influence of ravaging COVID-19 pandemic witnessed an unprecedented spike, reaching about 9.9 percent. With a 1.5 percent increase in prevalence of undernourishment (PoU) in just one year, this made the possibility of achieving Zero Hunger in less than a decade (2030) an insurmountable challenge [4,5]. The two regions of the world with highest PoU include Asia (418 million) and Africa, with 282 million people affected by hunger in 2020 [4]. Food insecurity has continued to increase worldwide, especially in the African region. Severe global food insecurity witnesses an unprecedented rise from 8.3% (604.5 million) in 2014 to 11.9% (927.6 million) in 2020 [4].

The African region recorded the second highest number of food-insecure people at both moderate and alarming levels globally (after Asia) with, alarmingly, the food insecure population increasing from 17.7% (203.5 million) in 2014 to 25.9% (346.6 million) in 2020, while Western Africa remained the most affected in the region with an unusual increase

from 8.6% (29.6 million) in 2014 to 28.8% (115.7 million) in 2020. Food insecurity is lowest in North Africa when compared with other sub-regions, increasing from 29.7% (65.1 million) in 2014 to 30.2% (74.5 million) in 2020 [4].

The Merriam-Webster dictionary defines "food insecurity" as "*the fact or an instance of being unable to consistently access or afford adequate food*", and this term was first used in 1950 [6]. At the 1996 World Food Summit, a definition of food security (the opposite of food insecurity) was adopted as follows: "*when all people, at all times, have physical and economic access to sufficient, safe and nutritious food meet their dietary needs and food preferences for active and healthy life*" [7]. Later, in 2001, food security was redefined in The State of Food Insecurity 2001 (to incorporate the social aspect of the concept) as "*a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meet their dietary needs and food preferences for an active and healthy life*" [8].

Moreover, food insecurity can further be referred to as: "*when people do not have adequate physical, social or economic access to food*" as defined above [9]. Household food insecurity (HFI) is referred to as a situation of uncertain, insufficient, or unavailable access, or use of food [10]. This has a link with insufficient intake of important nutrients and inadequate resources to afford sufficient food both for individual and household needs, which leads to poor nutrition. When an individual is food insecure, it will affect the productive capacity of that person, and by extension, reduce the productivity of the labor force and result in low-quality human capital development of a country [11–16].

Hunger and food insecurity are seriously ravaging the African countries where most of the countries (with the exception of North African countries) are currently grappling with moderate (40–59.9/100) to weak (20–39.9/100) food security score levels as presented in the 2020 Global Food Security Index (GFSI) scores released by Economic and Intelligence Unit (Table 1), capturing 32 African countries out of the total of 113 countries [17]. About 83.3 percent (10 out of 12) of countries in the category of weak score are all from SSA, while this portends grave challenge of food insecurity for the region. Table 1 revealed the new GFSI scores of the 32 African countries captured in 2012–2020 GFSI. From the 2020 GFSI scores, only North African countries (Morocco, 62.0; Algeria, 61.8; Tunisia, 61.4; Egypt, 61.1) were among the countries ranked in the category of a good (60–79.9/100) food security index score while four SSA countries (Sierra Leone, 37.0; Malawi, 36.7; Zambia, 36.6; Sudan, 36.0) were ranked among the lowest countries globally and in Africa with a weak food security index score [17].

In Nigeria, prolonged poor macroeconomic performance, high-level conflicts, and insecurity are among the principal drivers of food insecurity as these were aggravated by the devastating impact of the COVID-19 pandemic in recent times [1,18–20]. Nigeria (as of 12 October 2021) has an estimated population of 209,663,744 people with 86,849,507 living in extreme poverty (64% rural and 14% urban), under the poverty threshold of USD 1.90, which is equivalent to 41% of the total population [21]. The report revealed that poverty, hunger, and food insecurity are of great concern in the rural areas in Nigeria, where a larger percentage of smallholder farming households live and carry out their farming activities. Nigeria was judged to be the highest producer of cassava, yam, and cowpea globally in 2012, and the country has remained top producer of cassava, yam, and cocoyam until now. The gains of increased food production have not translated to larger percentage of the country being food secure [1,15,20,22,23].

The frightening food insecurity situation in Nigeria calls for urgent humanitarian assistance, especially with the increasing number of undernourished people in the country. Figure 1 reveals Nigeria's ranking in 2012–2020 GFSI scores with infinitesimal improvement in the score from 40.9/100 in 2012 to 40.1/100 in 2020, while Table 1 indicates Nigeria's 100th global rank among 113 countries and 22nd among 32 African countries captured in 2020 GFSI. With Nigeria's 2020 Global Hunger Index (GHI) score of 29.2 (serious category), and percentage of undernourished in the population increasing from 9.1 in 2000 to 12.6 in 2020, Nigeria is far from on track in their lofty pursuit of achieving Sustainable Development

Goal 2 (SDG 2), which aims at "*ending all forms of hunger, achieve food security and improved nutrition, and promote sustainable agriculture by 2030*" [1,13,24–26].

Table 1. Global Food Security Index (GFSI) Score (2012–2020) African countries. Source: author's compilation using 2012–2020 Global Food Security Index scores (African countries exported) EIU, 2021; Rank G/A means global/Africa rank; global rank from 113 countries; Africa rank from 32 countries Note: Δ = change in score/rank, comparing 2020 with 2019; ▲ = rank progressed; ▼ = rank declined; ↔ = No change in rank.

				Global Food Security Index (GFSI) Score (0–100)									
S/N	**Rank G/A**	**Δ**	**Country**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Δ**
1	58/2	▼1	Algeria	50.1	55.4	54.7	56.9	60.0	59.1	61.8	62.8	61.8	−1.0
2	97/19	▲3	Angola	41.6	41.7	39.1	36.1	35.6	38.4	41.1	40.5	42.1	+1.6
3	92/15	↔	Benin	41.2	43.0	43.3	41.5	44.5	46.6	45.7	46.1	46.2	+0.1
4	74/6	▲1	Botswana	53.3	54.7	53.7	54.2	52.8	54.2	55.0	54.3	55.5	+1.2
5	88/12	▼3	Burkina Faso	40.6	43.1	43.8	43.5	45.2	45.0	47.0	48.7	47.4	−1.3
6	107/27	▲5	Burundi	38.2	37.5	40.5	36.9	38.3	39.2	38.4	35.8	37.1	+1.3
7	94/17	↔	Cameroon	42.5	43.5	44.7	45.8	47.3	46.3	45.8	44.4	44.7	+0.3
8	103/24	↔	Chad	32.4	34.8	32.9	36.3	35.5	35.4	36.4	39.3	39.4	+0.1
9	98/20	▲3	Congo (Dem. Rep)	37.3	37.7	38.0	37.4	35.2	39.5	39.8	40.4	40.7	+0.3
10	82/9	↔	Cote d'Ivoire	45.0	46.1	46.2	44.6	46.3	46.1	48.5	50.9	51.0	+0.1
11	60/4	▼11	Egypt	63.2	59.3	64.0	62.9	60.0	60.1	62.9	65.4	61.1	−4.3
12	108/28	↔	Ethiopia	34.7	39.3	38.8	37.3	41.5	38.6	40.0	37.1	37.0	−0.1
13	77/7	▲4	Ghana	48.6	49.5	50.4	51.3	52.1	53.2	54.3	53.4	53.0	−0.4
14	102/23	▼5	Guinea	35.2	36.7	43.2	36.8	40.1	40.3	42.2	42.6	39.5	−3.1
15	86/10	↔	Kenya	43.2	41.7	42.2	41.1	42.2	46.5	48.7	48.5	49.0	+0.5
16	106/26	▲1	Madagascar	38.8	36.8	37.8	37.5	37.9	34.8	37.0	38.0	37.5	−0.5
17	110/30	↔	Malawi	32.2	34.6	35.2	32.5	32.9	37.7	42.3	36.1	36.7	+0.6
18	79/8	↔	Mali	49.7	50.9	50.4	50.2	49.6	49.8	51.7	51.9	52.7	+0.8
19	57/1	▲1	Morocco	55.4	57.8	58.7	60.2	60.1	60.3	61.7	61.4	62.0	+0.6
20	99/21	▲5	Mozambique	37.8	39.4	40.2	34.7	32.6	41.8	42.0	38.7	40.6	+1.9
21	87/11	▲2	Niger	43.2	42.7	42.6	44.7	44.1	42.9	47.0	47.9	47.6	−0.3
22	100/22	▼2	Nigeria	40.9	41.5	41.5	42.4	41.6	41.8	43.5	42.5	40.1	−2.4
23	104/25	▲1	Rwanda	38.0	42.1	45.2	40.8	39.6	44.6	45.1	38.5	38.8	+0.3
24	90/14	▼2	Senegal	44.4	44.9	45.6	49.2	46.3	47.3	47.0	48.1	46.4	−1.7
25	108/28	▼6	Sierra Leone	33.2	33.8	40.4	39.8	38.4	37.4	37.4	39.4	37.0	−2.4
26	69/5	▼2	South Africa	57.4	61.0	60.1	63.7	61.0	62.7	63.2	59.2	57.8	−1.4
27	112/32	▼3	Sudan	28.2	28.1	33.0	37.8	36.0	37.5	38.0	36.6	36.0	−0.6
28	89/13	▲4	Tanzania	37.8	40.4	40.4	39.9	44.1	45.1	47.0	45.6	47.1	+1.5
29	93/16	▼2	Togo	40.4	43.0	43.5	39.3	42.6	46.1	44.0	46.5	44.9	−1.6
30	59/3	▲2	Tunisia	56.8	57.8	59.5	60.4	61.3	59.4	62.2	60.8	61.4	+0.6
31	95/18	↔	Uganda	43.2	42.4	44.1	42.3	44.6	45.6	45.0	43.4	42.9	−0.5
32	111/31	▼5	Zambia	38.0	41.0	39.3	35.2	43.5	43.0	41.2	38.3	36.6	−1.7

Quite a few studies have investigated household food (in)security using both micro and macro data in different parts of the Nigeria [10,27–30]. Moreover, empirical studies have determined the food insecurity status [29–31], food poverty index [25], food consumption score [32] and Household Food Insecurity Access Scale (HFIAS) [33] to investigate HFI. Owoo (2020) [34] illustrated spatial patterns of food insecurity in Nigeria using fixed effects regression.

Furthermore, Obayelu and Oyekola (2018) [35] used HFIAS to assess food insecurity among Ibadan urban slum dwellers who were completely non-farming households residing within urban areas in the state. Similar studies that have used the HFIAS approach in assessing the prevalence of food insecurity in other part of the world include Nour and

Abdalla (2021) [36], who examined the incidence and variation of food insecurity in Kassala State, Eastern Sudan; and [37], who investigated the incidence and drivers of HFI in Takhar, Afghanistan. This study is the first of its kind in assessing food insecurity among smallholder farming households using primary data and employing the HFIAS approach in Nigeria. This study attempts to fill a research gap on food security literature in Nigeria. This study seeks to (i) assess food insecurity (food deprivation) among smallholder cassava farming households in rural Oyo State, Nigeria; and (ii) determine the factors influencing smallholder cassava farming households' food insecurity in rural Oyo State, Nigeria. This study would provide germane evidence for policymakers and practitioners by spotlighting drivers of food access vis-à-vis food deprivation and their individual contribution to HFI.

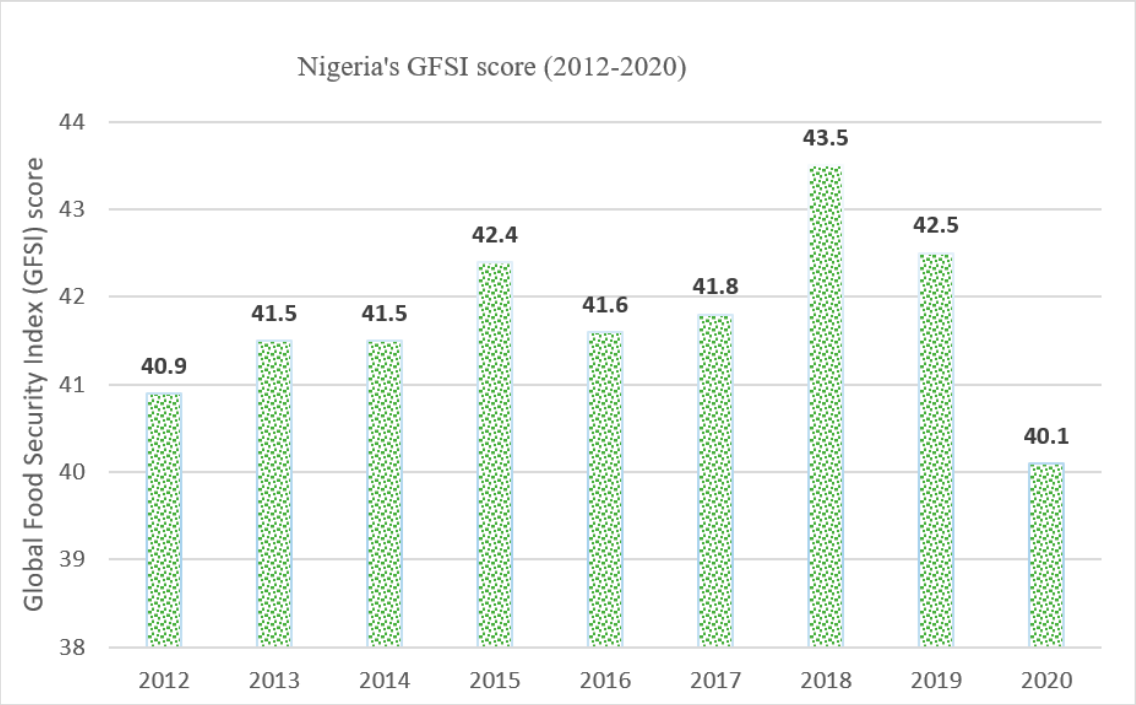

Figure 1. Nigeria's Global Food Security Index (2012–2020). Source: authors' graph using underlying GFSI 2012–2020 (Nigeria exported) [17].

2. Materials and Methods

2.1. Study Area

Oyo is one of the six states in south-west Nigeria. Other southwestern states in the region include Ekiti, Lagos, Ogun, Ondo, and Osun. Oyo State lies between latitude 8° 7.174′ N and longitude 3° 25.1732′ E and is the fifth most populous State in Nigeria with its capital in Ibadan and covers an area of 24,454 square kilometer [38]. Oyo State had an estimated population of 7,840,864 in 2016 [39]. The state is a Yoruba-speaking state as well as other south-west states but is not without various dialects and cultural differences. There are two seasons in Oyo: the rainy season and the dry season. Agriculture is predominantly the means of livelihood of most rural population in the states [19,40]. The popular cash crops mostly cultivated in Oyo State include cocoa, citrus, and timber, while the food crops are cassava, yam, maize, cowpea, melon, and millet. Livestock production includes pigs, rabbits, sheep, goats, poultry, and snails [19,40].

2.2. Sampling Procedure and Data Collection

The study was carried out from January to March 2020 and employed a multi-stage sampling procedure. In the first stage, Oyo State was purposively sampled from six cassava-producing states in the south-west region while the second stage involved the random selection of five local-government area (LGAs) known for the production of

cassava in the state, namely Egbeda, Ona-Ara, Ido, Afijio, and Oyo East. In the third stage, 13 villages (Badeku, Akintayo, Ajoda, Bodunde, Ajoda-Ajobo, Kupalo, Jago, Akinwaare, Morakinyo, Akinmoorin, Abujakan, Bodija-Omikiti, and Bodija-Tekun) were selected from the five LGAs while the fourth stage involved random selection of 17 cassava farming households, making up a total of 221 farming households. The data were gathered through a structured, interviewer-administered questionnaire which was in the English language but was interpreted to Yoruba for the respondents. These include: the HFIAS module, socioeconomic characteristics, food consumption, expenditure pattern, and other germane household information. After data cleaning, 10 of the questionnaires were discarded due to incomplete information.

2.3. Measuring Food Access through HFIAS

The HFIAS module is mainly employed in assessing household economic access to food, food preferences, anxiety about household food supply, and food quantity [41,42]. The questionnaire used in HFIAS has nine incidence questions that depict a rising category of extremity of food insecurity, and nine repetitiveness-of-condition questions that are asked immediately after each incidence question to investigate how frequently the situation happened. The repetitiveness-of-condition question was omitted only when the person affirmed that the situation related in the previous incidence question did not occur in the last 30 days. The questions establish the situation of all household members without age-group discrimination [41].

The food insecurity status of cassava farming households in Oyo State, Nigeria was assessed using HFIAS, which was developed by the Food and Nutrition Technical Assistance Project (FANTA) and its partners [41]. FANTA came up with a group of questions called Household Food Insecurity Access Scale Generic Questions (see Table 4) which have been used in several nations and attested to its ability to distinguish food-secure from food-insecure households. The HFIAS questions capture the HFI experience and can be used in categorizing households and populations in the order of extremity [10,35–37,41]. The information provided by HFIAS can be used to assess the prevalence of HFI and detect changes in the HFI situation of a population over time. Every question is asked within a 30-day recall period. First, the respondent is asked an incidence question to know if the situation in the question happened at all in the past 30 days (yes or no). If the answer was "yes", a repetitiveness-of-condition question was asked to establish whether the situation happened infrequently (1–2 times), occasionally (3–10 times), or repeatedly ($\geq$10 times) within a 30-day recall period [41]. It is important that the researcher strictly adhere to the "skip rules" in order to avoid asking repetitiveness-of-condition questions when they are not appropriate [41].

2.4. Household Food Insecurity Access Prevalence (HFIAP)

HFIAP is one of the four indicators of the HFIAS module that can be computed to assist in understanding the nature and changes in HFI among the population sampled. Other HFIAS indicators are the Household Food Insecurity Access-related *Conditions*, Household Food Insecurity Access-related *Domain* and HFIAS *Score*. However, HFIAP was employed in this study owing to the fact that it is the only indicator that reports the household food insecurity status distinctively. It provides the opportunity to categorize households into four levels of food insecurity: (i) food secure, (ii) mildly food insecure, (iii) moderately food insecure, and (iv) severely food insecure. It is worth noting that households are grouped as progressively food insecure as they reply emphatically to more severe situations and/or encounter those situations more often over a period of 30 days.

A brief explanation on the categories of household food insecurity levels as assessed through HFIAS module [41]:

(i) Food secure (FS): The household did not experience any of the food insecurity situation, or only had the experience of worrying about food, but rather infrequently ((Q1 = 0) + (Q1 = 1), Q1a = 1)).

(ii) Mildly food insecure (MiFI): The household worries about not having food to eat occasionally or frequently ((Q1 = 1), Q1a = 2 or = 3)), and/or being unable to consume choice foods ((Q2 = 1), Q2a = 1 or = 2 or = 3)), and/or having little variety of food ((Q3 = 1), Q3a = 1)), and/or some food referred to as unpalatable only on rare occasions ((Q4 = 1), Q4a = 1)).

(iii) Moderately food insecure (MoFI): The household consumes few varieties or unpalatable foods occasionally or frequently ((Q3 = 1), Q3a = 2 or = 3)) + ((Q4 = 1), Q4a = 2 or = 3)), and/or has begun to reduce the size or number of meals infrequently or occasionally ((Q5 = 1), Q5a = 1 or = 2)) + ((Q6 = 1), Q6a = 1 or = 2)) but did not experience any of the three extreme food insecurity situations (Q7a–9a).

(iv) Severely food insecure (SFI): The household has moved gradually to reducing the quantity of meal or number of meals most frequently ((Q5 = 1), Q5a = 3)) + ((Q6 = 1), Q6a = 3)), and/or experiencing the three most extreme situations such as "not having any food to eat", "going to bed without eating any food" or "going a whole day hungry", even infrequently ((Q7 = 1), Q7a = 1 or = 2 or = 3)) + ((Q8 = 1), Q8a = 1 or = 2 or = 3)) + ((Q9 = 1), Q9a = 1 or = 2 or = 3)). However, if any household experiences any of these three severe situations of food deprivation, only one in the last 30 days is regarded as being SFI [39]. Table 2 revealed the levels of food insecurity based on the household's reply to the set of nine questions which place each household in only one distinctive category.

Table 2. Food insecurity levels.

Question	Frequency		
	Rarely (1)	Sometimes (2)	Often (3)
Q1a			
Q2a			
Q3a			
Q4a			
Q5a			
Q6a			
Q7a			
Q8a			
Q9a			

Source: adapted from Coates et al. 2007 [41]. Color indicator: FS; MiFI; MoFI; SFI.

Moreover, following [41], a HFIA group variable was computed for each household by giving a code for the food insecurity group in which it falls. The repetitiveness-of-condition was coded as 0 for all cases where the answer to the corresponding incidence question was "no" (i.e., if Q1 = 0 then Q1a = 0, if Q2 = 0 then Q2a = 0, etc.) before giving the food insecurity group codes. The four food security groups were obtained progressively, in the same arrangement as indicated above, to ensure that households are categorized in accordance with their most severe response. It is worth noting that each individual household had a total HFIAS score, but this score was not enough to assign each household to a single food insecurity category because the score is a continuous rather than categorical measure of food insecurity. The results of the calculation based on the formula above [41] are the only acceptable means of ensuring the individual household is assigned a distinctive food insecurity prevalence category based on their responses to the most severe food deprivation situations. In this study, the HFIA category and HFIA prevalence formulas were employed in calculating the food insecurity status of farming households in rural Oyo State, Nigeria. From Table 2, the food insecurity levels of household can be determined by the HFIAS score, but not without caution. Table 2 revealed that households with a HFIAS score of $\geq$1 are FS; a HFIAS score of 2, 3, 4, 5, 6, 7, and 10 belonged to MiFI

households; a HFIAS score of 8, 9, 11, 12, 13, 14, 16, and 17 belonged to MoFI households; households with a HFIAS score of 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 27 are SFI [41].

2.5. Analytical Framework

In this study, the major concern was the food-insecurity categories in smallholder cassava farming households such as FS, MiFI, MoFI, and SFI. It is categorical in nature, depicting the degree of severity of food deprivation among the respondents. In the literature, ordered logit and probit models were used in determining such ordinal data [10,35,37,43–45]. Selecting between the two models is primarily a matter of choice, convenience, and popularity in the literature [37,46]. Moreover, this study employed an ordered logit model to analyze factors influencing food insecurity in farming households. This model is adopted when the response variable has more than two levels and the values of each level have an ordered serial structure where a value is indeed "higher" than the previous one [47].

The logit coefficients are in log-odds unit and are not interpreted as OLS coefficients; we rather need to estimate predicted probabilities of Y = 1 or the marginal effects to measure changes in the probability of food insecurity outcomes with respect to a change in explanatory variables. The likelihood of a drop in any of the levels is estimated using the natural log of the cumulative distribution [44,48]. A positive marginal effect estimate for a category indicates that a rise in that variable will increase the likelihood of being in that group while a negative estimate will bring down the likelihood of being in that group.

In the ordered logit model, there is an observed ordinal variable Y which is a function of another variable y^* that is not measured. The latent variable y^* has various threshold points. Following Greene (2012) [43] and Long and Long (1997) [45], Equation (1) specifies:

$$y_i^* = x_i'\beta + \varepsilon_i \quad (1)$$

where y_i^* is the latent variable of the food insecurity (access) categories of cassava farming household i, x'_i is a vector of regressors explaining farming household i, β is a vector of parameters to be estimated and ε_i is a random error term which follows a standard normal distribution. Following [39], the household food insecurity status is categorized into four outcomes: (1) FS, (2) MiFI, (3) MoFI, and (4) SFI.

Choice rule:

$$y_i = \begin{cases} 1 & if\ y_i^* \le \mu_1\ (food\ secure) \\ 2 & if\ \mu_1 \le y_i^* \le \mu_2\ (mildly\ food\ insecure) \\ 3 & if\ \mu_2 \le y_i^* \le \mu_3\ (moderately\ food\ insecure) \\ 4 & if\ y_i^* > \mu_3\ (severely\ food\ insecure) \end{cases} \quad (2)$$

Here, 1, 2, 3, and 4 are the levels (FS, MiFI, MoFI, and SFI), μ_1 to μ_3 are threshold values (cut-off points) to be predicted for any of the HFI levels.

3. Results and Discussion

3.1. Describing the Socioeconomic Features of Cassava Farming Households

The descriptive characteristics of cassava farming households are presented in Table 3. These include the explanatory variables included to predict the factors influencing food insecurity categories of smallholder farming households in the study area. These are: age of the household head, gender, years of schooling, marital status, farm size, household size, farm experience, farm income, non-farm income, membership of cooperative society, food expenditure, access to extension service, access to healthcare services and access to piped water. These variables, which are largely socioeconomic factors that may influence food insecurity levels of smallholder farming households in the study area, were selected based on literature and a priori expectation of this kind of study. However, the results of the socioeconomic characteristics in the sampled farming households revealed that the mean household head age was 50.2 years, implying that the cassava farmers in rural Oyo State are in their economically active age. This was similar to the mean age of 49.8 years

of crop farmers reported by [16]. About 85 percent of the household heads were male, revealing that cassava production is male dominated. This result agrees with [49–51] that cassava production, use, and marketing are male dominated in south-west Nigeria. The mean household size in the study area was 6 members, suggesting that cassava farming households have relatively large members, which could possibly be available as family labor against short fall of hired labor. These results corroborate the findings that a relatively large household size (especially of working age) reduces the constraint on labor demand in production, processing, and marketing [52,53].

Table 3. Distribution of socioeconomic characteristics of farming households.

Variable	Description	Mean	Std. Dev
AGE	Age of household heads (years)	50.18	11.72
GEND	Gender of farmers (1 male, 0 female)	0.85	0.36
MARSTAT	Marital status of household heads (1 married, 0 otherwise)	0.89	0.32
HHSIZE	Number of Household members	6.42	3.18
EDULEVEL	Number of years spent in school	6.84	4.93
FARMSIZ	Size of the farm used for cassava production (hectare)	1.51	1.05
FARMEXP	Cassava Farming experience (years)	15.23	10.87
FARMINC	Farm income of the farmers (Naira)	₦102,682.46	₦74,199.14
NONFARMINC	Non-farm income of the farmers (Naira)	₦47,052.13	₦79,839.14
COOPMEMSHP	Member of farmers' association (1 if yes, 0 otherwise)	0.16	0.36
EXTENSION	Access to extension services (if yes 1, 0 otherwise)	0.22	0.41
FOODEXP	Farmers' household Food expenditure (Naira)	₦21,535.55	₦11,180.02

Computed from field survey data, 2020. Note: exchange rate in February 2020, USD 1 = NGN 323.

The mean household head's years spent in school was 6.84 years, implying a low level of education among rural farming households. Table 3 also showed that the mean farm size for cassava production in the study area was 1.51 hectares, suggesting that most of the cassava farming households are smallholder farmers cultivating on farmland that is less than 5 hectares. Furthermore, the mean farm income and non-farm income of farming households were NGN 102,682 (USD 317.9) and NGN 47,052 (USD 145.7), respectively. The distribution of cassava farmers by their experience in farming activities indicated a mean cassava farming experience of 15.23 years. These results agreed with [54] in the study of smallholder cassava farmers in Madagascar with 15 years farming experience while [55] reported 17 years. In this study, the mean expenditure on food was NGN 21,535 (USD 66.7). The percentage of farm households belonging to cooperative society was 16 percent, while access to extension service among farming households was 22 percent.

3.2. Food Insecurity Prevalence in Rural Farming Households

Table 4 presented the HFIAS module of nine occurrence questions of food insecurity conditions among rural cassava farming households in the study area. It revealed that 22.3%, 22.3%, 23.2%, and 19.4% of the farming households did not experience questions 1–4 (responded "no" the occurrence questions), while 24.6%, 32.7%, 53.1%, 72.9%, and

92.9% of them responded "no" to questions 5–9. The remaining farming households responded affirmatively (saying "yes") to the nine HFIAS questions, as indicated in Table 4. Additionally, Table 4 indicated a consistent increase in the percentage of households that responded "no" to the questions, while there was a downward trend in the percentage of households that responded affirmatively to the nine HFIAS questions with a recall period of four weeks. Moreover, Table 5 indicated only households that responded affirmatively to all of the nine HFIAS occurrence questions while revealing the numbers of households based on their responses to the repetitiveness of the conditions. Based on households' responses, Table 5 indicated that only 17.1% out of 164 households responded that worrying about not having enough food (Q1a) happened to them only on a rare occasion, while 37.8% and 45.1% of the households responded that Q1a occurred sometimes and often, respectively. Likewise, only 8.0% of the farming households confirmed that they rarely eat monotonous food (Q3a), while 54.3% and 37.7% of the households responded that the food insecurity (access) condition occurred sometimes and frequently, respectively. Confirming the hard economic reality in Nigeria, 88.7% of the households responded that skipping meals (Q6a) sometimes or often happened to them while only 11.3% of the households confirmed that Q6a rarely happened to them within the 30-day recall period. The results in Table 5 equally revealed that the majority (73.3%) of farming households affirmed that they rarely go the whole day and night without eating anything (Q9a), indicating that as farmers, they may always find something to eat, though it may not be nutritious food, which is common in low- and middle-income countries [5,56].

Table 4. Distribution of farming households based on the incidence of food insecurity conditions.

		No	**Yes**
	Incidence Question (N = 211)	Frequency (%)	Frequency (%)
1	Concerned about not with food to eat?	47 (22.27)	164 (77.73)
2	Eating food you did not desire?	47 (22.27)	164 (77.73)
3	Eating monotonous foods?	49 (23.22)	162 (76.78)
4	Eating foods you did not want to eat?	41 (19.43)	170 (80.57)
5	Eating smaller size of meals?	52 (24.64)	159 (75.36)
6	Skipping some meals in a day?	69 (32.70)	142 (67.30)
7	No food to eat at all?	112 (53.08)	99 (46.92)
8	Go to bed hungry?	154 (72.99)	57 (27.01)
9	Not eating anything throughout the day (24 h)?	196 (92.89)	15 (7.11)

Source: field survey, 2020; Freq = frequency, i.e., number of households; % = percent.

Based on the formulas for calculating the HFIA category and HFIA prevalence (HFIAP) presented above, the prevalence of food insecurity in each of the cassava farming households in rural Oyo State, Nigeria was calculated and presented in Table 6. From the results in Figure 2, it revealed that out of 211 cassava farming households, only 12.8% (27) were FS, while 5.2% (11), 28.0% (59), and 54.0% (114) were MiFI, MoFI, and SFI, respectively. These findings indicated that the majority (87.2%) of the farming households in the study area were food insecure. This result was different from [16], who found that 76.8% of maize farming households were FS using a Foster–Greer–Thorbecke (FGT) food security analysis approach. The food insecurity (access) prevalence among farming households was 87.2% at different levels of food insecurity (MiFI, MoFI, and SFI). Considering only 184 food-insecurity households, about 62 percent of the households were severely food insecure while only 6 and 32% of the households were MiFI and MoFI, respectively, within the recall period of 30 days. These findings were similar to those of [35], who found the prevalence of food insecurity among households residing in urban slums to be 80.9%.

Table 5. Distribution of farming households based on repetitiveness of food insecurity conditions.

	Repetitiveness of Food Insecurity Condition			
Incidence Question	Rarely	Sometimes	Often	Total (N)
	Freq (%)	Freq (%)	Freq (%)	
1a. Concerned about not with food to eat?	28 (17.07)	62 (37.80)	74 (45.12)	164
2a. Eating food you did not like?	28 (17.07)	76 (46.34)	60 (36.59)	164
3a. Eating monotonous foods?	13 (8.02)	88 (54.32)	61 (37.65)	162
4a. Eating foods you did not want to eat?	21 (12.35)	100 (58.82)	49 (28.82)	170
5a. Eating smaller size of meals?	23 (14.47)	84 (52.83)	52 (32.70)	159
6a. Skipping some meals in a day?	16 (11.27)	81 (57.04)	45 (31.69)	142
7a. No food to eat at all?	29 (29.29)	48 (48.48)	22 (22.22)	99
8a. Go to bed hungry?	18 (31.58)	25 (43.86)	14 (24.56)	57
9a. Not eating anything throughout the day (24 h)?	11 (73.33)	3 (20.00)	1 (6.67)	15

Source: field survey, 2020; Freq = frequency i.e., number of households (N); % = percent.

Table 6. Distribution of socio-demographic characteristics of cassava farming households according to food insecurity category.

	Food Secure (n = 27)	**Mildly Food Secure (n = 11)**	**Moderately Food Secure (n = 59)**	**Severely Food Secure (n = 114)**	**Pooled (n = 211)**
	Frequency (%)	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
Age of household head					
≤40 years	4 (14.8)	2 (18.2)	7 (11.9)	27 (23.7)	40 (19.0)
41–50 years	10 (37.0)	5 (45.5)	28 (47.5)	45 (39.5)	88 (41.7)
51–60 years	9 (33.3)	2 (18.2)	10 (16.9)	28 (24.6)	49 (23.2)
>60 years	4 (14.8)	2 (18.2)	14 (23.7)	14 (12.3)	34 (16.1)
Gender					
Male headed households	26 (96.3)	11 (100.0)	52 (88.1)	91 (79.8)	180 (85.3)
Female headed households	1 (14.7)	0 (0.0)	7 (11.9)	23 (20.2)	31 (14.7)
Marital Status					
Married/Co-habiting	26 (96.3)	10 (90.9)	48 (81.4)	103 (90.4)	187 (88.6)
Single/Separated/Widow(er)	1 (3.7)	1 (9.1)	11 (18.6)	11 (9.6)	24 (11.4)
Education level (years)					
No formal education	7 (25.9)	3 (27.3)	17 (28.8)	24 (21.1)	51 (24.2)
Primary	9 (33.3)	6 (54.5)	26 (44.1)	47 (41.2)	88 (41.7)
Secondary	7 (25.9)	2 (18.2)	15 (25.4)	35 (30.7)	59 (28.0)
Tertiary	4 (14.8)	0 (0.0)	1 (1.7)	8 (7.0)	13 (6.2)
Household size (persons)					
≤5	11 (40.7)	6 (54.5)	24 (40.7)	54 (47.4)	95 (45.0)
6–10	15 (55.6)	3 (27.3)	29 (49.2)	50 (43.9)	97 (46.0)
11–15	1 (3.7)	1 (9.1)	6 (10.2)	8 (7.0)	16 (7.6)
>16	0 (0.0)	1 (9.1)	0 (0.0)	2 (1.8)	3 (1.4)
Membership of cooperative					
Yes	4 (14.8)	0 (0.0)	2 (3.4)	27 (23.7)	33 (15.6)
No	23 (85.2)	11 (100.0)	57 (96.6)	87 (76.3)	178 (84.4)
Food expenditure (Naira)					
≤₦10,000	4 (14.8)	3 (27.3)	7 (11.9)	11 (9.6)	25 (11.8)
₦11,000–₦20,000	17 (63.0)	5 (45.5)	32 (54.2)	63 (55.3)	117 (55.5)
₦21,000–₦30,000	2 (7.4)	1 (9.1)	8 (13.6)	21 (18.4)	32 (15.2)
>₦30,000	4 (14.8)	2 (18.2)	12 (20.3)	19 (20.3)	37 (17.5)
Extension service					
Have access	4 (14.8)	0 (0.0)	4 (6.8)	38 (33.3)	46 (21.8)
No have access	23 (85.2)	11 (100.0)	55 (93.2)	76 (66.7)	165 (78.2)

Source: computed from field survey data, 2020.

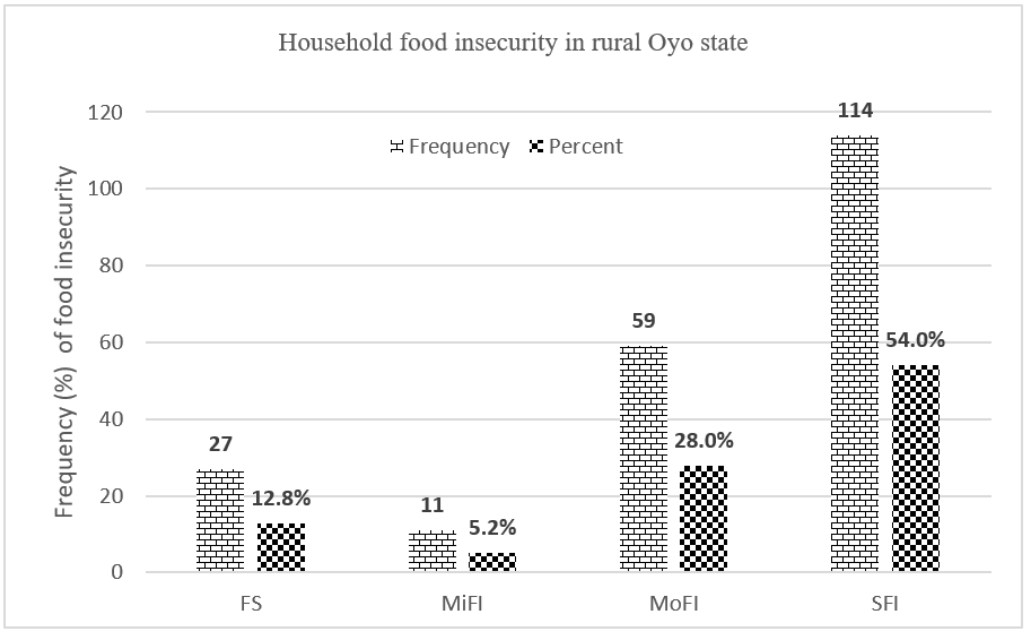

Figure 2. Food insecurity status among rural farming households in Oyo State, Nigeria. Source: authors' graph using farming households' food insecurity categories. FS = food secure; MiFI = mildly food insecure; MoFI = moderately food insecure; SFI = severely food insecure.

3.3. Socio-Demographic Characteristics of Farming Households According to Food Insecurity Category

Results from Table 6 indicated the socio-demographic characteristics of cassava farming households in rural Oyo State, Nigeria according to their food insecurity status. Farm household heads aged 41–50 years were the household age group with the highest percentage of MiFI (45.5%), MoFI (47.5%) and SFI (39.5%) among all the age-group categories. About 40 and 37% of household heads that were above 50 years were MoFI and SFI, respectively. This indicated that household heads that are 41–50 years and older (>50 years) are more likely to be SFI because of limited resources owing to reduced energy to engage in farming activities leading to reduction in productivity and income [10,57]. Male-headed households are more FS than their female-headed counterparts. Likewise in terms of food insecurity status, 96.8% of female-headed farming households were plunged into MoFI to SFI while 79.4% male-headed households were found to be MoFI to SFI. MoFI to SFI is more pronounced in female-headed farming households than among their male-headed counterparts. This may be due to their huge responsibility at the home front, from taking care of the children and other tasks which necessitated their reduced involvement in farming activities, which may result in limited access to productive assets. These findings were supported by [10,29].

The incidence of MoFI to SFI was prominent among household heads with no formal education (28.8% and 21.1%) and those with primary education (44.1% and 41.2%). Additionally, Table 6 revealed that 86.1% of the married household heads were reported to be experiencing different levels of food insecurity (from MiFI to SFI), while only 13.9% of them are food secure. This suggests that being married may not reduce food insecurity among farming households, especially those with a large family size, which demands a higher expenditure on food. This result is similar to that of [10], which reported that 82.7% of married household heads are food insecure in an urban slum of Ibadan. Moreover, 84.7% of household heads with secondary school education were also found to be experiencing moderate-to-severe food insecurity within the recall period of 30 days. With these findings, it is suggested that the level of education may not necessarily reduce food insecurity among cassava farming households because only 6.2% of the household heads had a tertiary school education, while 69.2% of them experienced mild-to-severe food insecurity within the recall period. This result is contrary to the findings of [10], who found

that the majority of household heads with no formal education were FS. The results also revealed that 47.4% of the households with ≤5 members and 43.9% of farm households with 6–10 members experienced severe food insecurity within the 30-day recall period. These findings indicated that severe food insecurity is common among households with ≤5 and 6–10 members (Table 6). This result is contrary to the findings by [16], who found only 6.4% food-insecurity incidence among maize farming households with ≤5 members in Ogun State. Furthermore, the majority of the farming households that did not belong to any cooperative society were moderately (96.6%) and severely (76.3%) food insecure within the recall period of 30 days. Additionally, farming households that spent between NGN 11,000 (USD 30.96) and NGN 20,000 (USD 61.92) were both the most moderately (54.2%) and severely (55.3%) food-insecure households based on the monthly expenditure on food. This is expected because the monthly total amount spent on food is low, owing to the bad economic situation of the country.

3.4. Farm-Level Characteristics of Households according to Food Insecurity Category

Most of the farming households in rural areas are usually smallholder farmers engaged in farming activities on less than 5 hectares of land with limited productive assets. However, Table 7 indicated that farm households with less than 1 hectare had the highest percent (45.6%) of households that were SFI. About 40% of the household heads with 1–2 hectares of farmland were also moderately food insecure. An increase in the farm size of crop farmers is believed to lead to an increase in food production, which is capable of reducing the prevalence of food insecurity among farming households [10,29]. The results also show that households with less than 10 years of farming experience had the highest level (47.4%) of severe food insecurity, while 44.4% of household heads with 10–20 years of farming experience were the most food-secure households among cassava farming households. Based on these findings, it is assumed that an increase in household heads' farming experience is likely to reduce the food insecurity (access) of the households. Furthermore, 40.7% of farm household heads with a farm income between NGN 51,000 (USD 157.9) and NGN 100,000 (USD 309.6) were found to be the most food secure. Meanwhile, 41.2% of household heads with farm income between NGN 101,000 (USD 312.7) and NGN 200,000 (USD 619.2) and 55.3% of household heads with non-farm income between NGN 101,000 (USD 312.7) and NGN 200,000 (USD 619.2) were found to be the most food insecure. Households with a higher farm income may still be food insecure if most of the income received from the sale of the crop harvest is ploughed back into the farming business instead of being spent on food to improve the quality of their diets and make them more food secure. This indicated that an increase in both farm and non-farm income may not necessarily lead to farm households being food secure if part of the income generated from both farm and non-farm economic activities were not spent on food to improve their food security status.

3.5. Distribution of Environmental and Health-Related Factors of Farming Households according to Food Insecurity Category

About 87% of the household heads (especially female headed) confirmed that they were not exposed to any form of nutrition training that can help in improving the nutrition and healthy living of household members (Table 8). Consequently, 81.6% of households that were SFI were those with no access to nutrition training. All (100%) and 96.6% of households that are MiFI and MoFI, respectively, are those with no access to nutrition training. This is similar to the studies by [58], who found a low level of mothers' nutrition-related knowledge among rural households in Nigeria. However, 96.6% and 67.5% of household heads that did not have access to electricity were found to be MoFI and SFI, respectively. From Table 8, about 80% of the farming households did not have access to electricity. This result is more than the national average (61.1%) of rural households with no access to electricity as reported by 2018 Nigeria Demographic and Housing Survey (NDHS) [59]. This may be due to the fact that most of the rural farming households in

Nigeria are not connected to the national grid, leading to a higher percentage of households with no access to electricity.

Table 7. Farm level distribution of households according to food insecurity category.

	Food Secure (n = 27)	**Mildly Food Secure (n = 11)**	**Moderately Food Secure (n = 59)**	**Severely Food Secure (n = 114)**	**Pooled (n = 211)**
	Frequency (%)	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
Farm size (hectare)					
≤1.00	10 (37.0)	5 (45.5)	16 (27.1)	52 (45.6)	83 (39.3)
1.01–2.00	7 (25.9)	2 (18.2)	20 (33.9)	36 (31.6)	65 (30.8)
2.01–3.00	8 (29.6)	3 (27.3)	12 (20.3)	18 (15.8)	41 (19.4)
>3.00	2 (7.4)	1 (9.1)	11 (18.6)	8 (7.0)	22 (10.4)
Farm experience (years)					
≤10	9 (33.3)	6 (54.5)	25 (42.4)	54 (47.4)	94 (44.5)
11–20	12 (44.4)	4 (36.4)	23 (39.0)	35 (30.7)	74 (35.1)
21–30	4 (14.8)	1 (9.1)	5 (8.5)	18 (15.8)	28 (13.3)
>30	2 (7.4)	0 (0.0)	6 (10.2)	7 (6.1)	15 (7.1)
Farm income (Naira)					
≤₦50,000	9 (33.3)	1 (9.1)	12 (20.3)	26 (22.8)	48 (22.7)
₦51,000–₦100,000	11 (40.7)	2 (18.2)	17 (28.8)	32 (28.1)	62 (29.4)
₦101,000–₦200,000	5 (18.5)	5 (45.5)	27 (45.8)	47 (41.2)	84 (39.8)
>₦200,000	2 (7.4)	3 (27.3)	3 (5.1)	9 (7.9)	17 (8.1)
Nonfarm income (Naira)					
≤₦50,000	6 (22.2)	3 (27.3)	15 (25.4)	27 (23.7)	51 (24.2)
₦51,000–₦100,000	9 (33.3)	5 (45.5)	36 (61.0)	63 (55.3)	113 (53.6)
₦101,000–₦200,000	9 (33.3)	2 (18.2)	6 (10.2)	21 (18.4)	38 (18.0)
>₦200,000	3 (11.1)	1 (9.1)	2 (3.4)	3 (2.6)	9 (4.3)
Transport cost (Naira)					
≤₦2000	3 (11.1)	1 (9.1)	10 (16.9)	19 (16.7)	33 (15.6)
₦2100–₦4000	17 (63.0)	7 (63.6)	38 (64.4)	61 (53.5)	123 (58.3)
>₦4000	7 (25.9)	3 (27.3)	11 (18.6)	34 (29.8)	55 (26.1)

Source: computed from field survey data, 2020; USD 1 = NGN 323 (February 2020).

Table 8. Distribution of environment and health-related factors of farming households according to food insecurity category.

	Food Secure (n = 27)	**Mildly Food Secure (n = 11)**	**Moderately Food Secure (n = 59)**	**Severely Food Secure (n = 114)**	**Pooled (n = 211)**
	Frequency (%)	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
Access to nutrition training					
Have access	4 (14.8)	0 (0.0)	2 (3.4)	21 (18.4)	27 (12.8)
No access	23 (85.2)	11 (100.0)	57 (96.6)	93 (81.6)	184 (87.2)
Access to Electricity					
Have access	4 (14.8)	0 (0.0)	2 (3.4)	37 (32.5)	43 (20.4)
No access	23 (85.2)	11 (100.0)	57 (96.6)	77 (67.5)	168 (79.6)
Access to Piped water					
Have access	3 (11.1)	0 (0.0)	0 (0.0)	5 (4.4)	8 (3.8)
No access	24 (88.9)	11 (100.0)	59 (100.0)	109 (95.6)	203 (96.2)
Access to improved toilet					
Have access	4 (14.8)	0 (0.0)	2 (3.4)	32 (28.1)	38 (18.0)
No access	23 (85.2)	11 (100.0)	57 (96.6)	82 (71.9)	173 (82.0)
Access to healthcare service					
Have access	11 (40.7)	2 (18.2)	18 (30.5)	57 (50.0)	88 (41.7)
No access	16 (59.3)	9 (81.8)	41 (69.5)	57 (50.0)	123 (58.3)

Source: computed from field survey data, 2020.

About 96% and all (100%) households that were SFI and MoFI, respectively, were without access to improved drinking water (improved piped water). It is worth noting that about 4% of the farming households sampled had access to a potable source of drinking water at the time of the survey being carried out. This is far lower than the national average (58.4%) reported in the 2018 NDHS for rural households in Nigeria [59]. Table 8 also revealed that only 18.0% of the farming households had access to improved toilet facilities while a higher percent (96.6 and 71.9%) of households who did not have access to improved toilet facilities were found to be MoFI and SFI, respectively. All (100%) farming households that were found to be MiFI have no access to improved toilet facilities. This result (18.0%) is abysmally lower than the national average of 39.1% of rural households with access to improved toilet facilities [59]. However, this result corroborated the report of the United Nations Children's Fund (UNICEF), which ranked Nigeria second (2nd) globally with 38 million people practicing open defecation [60]. Furthermore, the results indicated that only 41.7% of the farming households had access to healthcare, while 69.5 and 50.0% of households with no access to healthcare service were found to be moderately and severely food insecure, respectively.

3.6. Drivers of Food Insecurity among Rural Farming Households

The factors influencing food insecurity among farming households are presented in Table 9. The HFI was ordered and the categories were significant ($p < 0.001$) (Table 9). The threshold value indicating the food insecurity categories; μ_1 , μ_2 , and μ_3, (cut1, cut2, and cut3) indicated that the categories are ranked in an ordered manner. The dependent variable is the food insecurity prevalence levels categorized into four outcomes (1 = FS, 2 = MiFI, 3 = MoFI, and 4 = SFI). The predicted probabilities of Y = 1 or the marginal effects were estimated, which measured changes in the probability of food insecurity (access) outcome with respect to a change in explanatory variables. Table 9 indicated that the results of the ordered logistic regression and the marginal effects of each of the explanatory variables on the probability of food insecurity prevalence categories.

The marginal effects give an understanding of how the independent variables shift the probability of food insecurity between the four ordinal categories. The statistical significance of the coefficients and the marginal effects are discussed as follows: age, gender, years of schooling, farm size, farm experience, food expenditure, access to extension service and access to healthcare were the explanatory variables that had a significant influence on the food insecurity status of cassava farming households (Table 9).

A unit increase in the age of the household head increases the likelihood of the household being FS, MiFI, or MoFI by 0.3%, 0.1%, and 0.5%, respectively. Similarly, an additional year in the age of the household head would reduce the likelihood of the household being SFI by 0.89%. However, a one-year increase in the years of schooling of the farming household head increases the likelihood of the households being FS, MiFI, and MoFI by 1.2%, 0.5%, and 2.0%, respectively. Similarly, a one-year increase in the years of schooling of the household heads reduces the probability of the households being severely FS by 3.7%. This indicates that with an increase in the years of education of the household head, it is more likely that the household is FS and less likely that it is SFI. Other studies, such as [16,29,61–64], have corroborated these findings. This study emphasized the importance of education in improving the livelihood of farming households through access to information on agricultural production and new technologies, as well as making economic farm decisions.

The farming household head's gender is significant and negatively associated with food insecurity in rural Oyo State. The findings revealed that being male-headed increases the probability of the household being FS, MiFI, or MoFI but reduces the probability of being SFI. This result was supported other studies such as [10,44,65,66] who equally found that being male-headed increases the likelihood of being FS among households in Nigeria. Contrariwise, [67] reported that households headed by a female in Uganda are more food-secure than their male counterpart.

Furthermore, a unit increase in farm size increases the likelihood of the farming households being FS, MiFI, or MoFI by 2.6%, 1.1%, and 4.5%, respectively. In contrast, it reduces the probability of the households being SFI by 8.2%. This result emphasizes the importance of the expansion of households' farmland for increased productivity and revenue. Increasing the size of farmland reduces the probability of the households being SFI. Additionally, a year increase in household head farm experience reduces the likelihood of FS, MFI, or MoFI by 0.3%, 0.1%, and 0.6%, respectively. Similarly, a year increase in household head farming experience increases SFI by 1.0%. These findings indicated that as the household heads have more farming experience, as reflected in the increase in the number of years engaging in farming, the more likely the household heads become severely food insecure. This implied that rural farming household heads are less likely to be food secure as they advance in age. As the household head grows older with increased farming experience, the energy and vigor to engage in rigorous farm activities reduces, leading to lower income and making them prone to food insecurity [10,65].

Table 9. Drivers of household food insecurity.

		Food Secure	Mildly Food Insecure	Moderately Food Insecure	Severely Food Insecure
Variable	**Coefficients**	**dy/dx**	**dy/dx**	**dy/dx**	**dy/dx**
Age	0.0365 ** (0.0185)	0.0029 ** (0.0014)	0.0012 * (0.0007)	0.0049 * (0.0027)	−0.0089 ** (0.0045)
+Gender	1.3049 *** (0.5022)	0.0719 *** (0.0228)	0.0323 ** (0.0131)	0.1754 *** (0.0621)	−0.2796 *** (0.0858)
+Marital Status	−0.4313 (0.4348)	−0.0388 (0.0442)	−0.0153 (0.0172)	−0.0530 (0.0488)	0.1071 (0.1081)
Household Size	0.0129 (0.0588)	0.0010 (0.0046)	0.0004 (0.0019)	0.0017 (0.0079)	−0.0032 (0.0144)
Years of schooling	0.1498 ** (0.0600)	0.0117 ** (0.0050)	0.0049 ** (0.0024)	0.0201 ** (0.0088)	−0.0368 ** (0.0147)
Farm Size	0.3360 *** (0.1292)	0.0263 ** (0.0107)	0.0110 ** (0.0049)	0.0452 ** (0.0194)	−0.0824 *** (0.0315)
Farm Experience	−0.0412 ** (0.0178)	−0.0032 ** (0.0013)	−0.0014 * (0.0007)	−0.0055 ** (0.0027)	0.0101** (0.0043)
Farm Income	-8.53×10^{-7} (1.97×10^{-6})	-6.67×10^{-8} (0.0000)	-2.79×10^{-8} (0.0000)	-1.15×10^{-7} (0.0000)	2.09×10^{-7} (0.0000)
Non-farm Income	4.00×10^{-6} ** (1.87×10^{-6})	3.12×10^{-7} ** (0.0000)	1.31×10^{-7} * (0.0000)	5.37×10^{-7} ** (0.0000)	-9.81×10^{-7} ** (0.0000)
+Membership of Cooperative	−0.3875 (0.9964)	−0.0272 (0.0617)	−0.0117 (0.0279)	−0.0538 (0.1416)	0.0927 (0.2305)
Food Expenditure	−0.000036 ** (0.00002)	-2.79×10^{-6} ** (0.0000)	-1.17×10^{-6} * (0.0000)	-4.81×10^{-6} * (0.0000)	8.77×10^{-6} ** (0.0000)
+Access to extension service	−2.2925 *** (0.7985)	−0.1182 *** (0.0383)	−0.0516 *** (0.0190)	−0.2741 *** (0.0680)	0.4439 *** (0.1038)
+Access to piped water	1.2061 (1.6349)	0.1478 (0.2886)	0.0473 (0.0653)	0.0923 *** (0.0311)	−0.2874 (0.3398)
+Access to healthcare services	−0.8199 * (0.4711)	−0.0615 * (0.0349)	−0.0258 (0.0162)	−0.1093 * (0.0637)	0.1966 * (0.1090)
/cut1	2.4761 (0.9205)				
/cut2	4.1299 (0.9565)				
/cut3	4.5726 (0.9740)				

(+) is dummy variable from 0 to 1, *** significance at 1% level; ** significance at 5% level; * significance at 10% level. Figures in parentheses are robust standard errors. Number of observations = 211; log pseudo likelihood = −206.1367, Wald chi^2 (14) = 50.69; probability > chi^2 = 0.0000; pseudo R^2 = 0.1778.

The results also revealed that the non-farm income is an important factor influencing the food insecurity incidence of farming households in the study area. Table 9 also indicated that an increase in non-farm income of farming households increases the probability of being FS, MiFI, or MoFI, and consequently reduces the probability of the household of

being SFI. This suggests that as the farming households receive more income from non-farm activities, it increases their purchasing power, which may lead to more access to food for a better diet and reduce their susceptibility to food insecurity [37,68]. However, this finding was contrary to that of [69], who reported that the non-farm income of households reduces the likelihood of households being FS in Zambia. However, with an increasing number of households engaged in farming in rural areas in Nigeria, food insecurity still persists among smallholder farming households. From Table 9, the result revealed that a unit increase on food expenditure of farm households reduces the probability of being FS, MiFI, or MoFI, but consequently increases the probability of the household being SFI. This suggests that many of the household food purchases may be less nutritious food, and these foods may be eaten monotonously, which may not improve their food insecurity status. Food consumption is not only in terms of the quantity alone but also the quality.

Moreover, a unit increase in household head access to extension services reduces the likelihood of farming households being FS, MiFI, or MoFI, while it increases the likelihood of the households being SFI. This may be contrary to expectations because the extension services rendered by the extension officers should lead to more awareness of new agricultural technologies and other valuable information that can promote the healthy living of farming households. These findings may not be disconnected from the fact that many of the households in the study area did not benefit from the services rendered by the extension officers because they did not have access to them. Consequently, it increases the food insecurity situation of the households.

Access to healthcare services is also an important factor influencing food insecurity of farming households in the study area, as indicated in Table 9. However, a unit increase in household head access to healthcare services reduces the probability of being FS, MiFI, or MFI by 6.2%, 2.6%, and 0.9%, respectively. Consequently, a unit increase in the healthcare service of farming households increases the probability of the households being SFI by 19.7%. This is contrary to the expectation that the more access farming households have to healthcare services, the better their health status, and by extension, their agricultural productivity. This may not be disconnected from the fact that most of the healthcare centers are either non-existent or healthcare personnel are not available to attend to the health needs of the farming household members [70].

3.7. The Study Limitations

This study employed the use of the HFIAS module in assessing food insecurity among farming households, which, in the literature, is not a very common method of analyzing food insecurity among households. Other methods of investigating food insecurity among households may produce different results from this study; therefore, the findings in this study should not be generalized for other household food (in)security studies within or outside Nigeria. Additionally, this study was conducted among rural smallholder farming households only, with no consideration for non-farming households in the study area. However, only farming households with less than 5 hectares of farmland were captured in this study, while those cultivating above 5 hectares of farmland (including commercial farming households) were excluded, which may provide different results from those generated from this study.

4. Conclusions and Recommendations

The results of the evaluation of household food insecurity prevalence in rural Oyo State indicated that 12.8% of smallholder farming households were FS, 5.2% MiFI, 28.0% MoFI, and 54.0% SFI. It indicated that about 88 percent of the households are facing varying degrees of food insecurity. The study revealed that less than a quarter of the farming households did not experience HFIAS questions 1–4, while 25–93 percent of them responded "no" to questions 5–9. The availability of environment- and health-related infrastructural facilities such as piped water, improved toilet facilities, and electricity are abysmally low and below the national average. Age, gender, years of schooling, non-

farm income, food expenditure, farm size, farm experience, and access to healthcare and extension services are the salient drivers of food insecurity among smallholder cassava farming households.

Based on the findings, the study emphasized that stakeholders should promote nutrition training, especially for women, in order to improve household nutrition-related knowledge, thereby enhancing the food security of the farming households. Additionally, the education of the farming households should be prioritized by the stakeholders as it helped in improving the livelihood of farming households through access to information on agricultural production processes with new technological innovations.

Furthermore, increase in non-farm income of smallholder farming households portends a significant avenue to improving the food security status of the households. Stakeholders should facilitate more extension visits of extension personnel among rural smallholder farming households in order to benefit from extension services such as the dissemination of new agricultural technologies and other valuable programs that can promote food security and enhance healthy living of the farming households. Stakeholders should equally facilitate the provision of rural infrastructural facilities such as improved drinking water sources, constant power supply, improved toilet facilities and functional healthcare services that are capable of improving the food security status of rural farming households.

Author Contributions: Conceptualization, O.A.O. (Olutosin A. Otekunrin); methodology, O.A.O. (Olutosin A. Otekunrin) and O.A.O. (Oluwaseun A. Otekunrin); formal analysis, O.A.O. (Olutosin A. Otekunrin) and O.A.O. (Oluwaseun A. Otekunrin); data collection, O.A.O. (Olutosin A. Otekunrin); writing—original draft preparation, O.A.O. (Olutosin A. Otekunrin); writing—review and editing, O.A.O. (Olutosin A. Otekunrin), O.A.O. (Oluwaseun A. Otekunrin), B.S. and P.P.; funding acquisition, B.S. and P.P. All authors have read and agreed to the published version of the manuscript.

Funding: The APC was funded by the University of Life Sciences in Lublin, Akademicka 13 str., 20-95 Lubin, Poland.

Institutional Review Board Statement: The study was approved by the Department of Agricultural Economics and Farm Management Review Board of Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. Additionally, the Oyo State Ethics Review Committee of the Ministry of Health, Department of Planning, Research & Statistics approved this study with Reference Number: AD13/479/4420^{A}.

Informed Consent Statement: Informed consent was obtained from the respondents before the survey was carried out, and the respondent data are fully anonymized.

Data Availability Statement: The data that support the findings of this study are available upon reasonable request from the authors.

Acknowledgments: All authors sincerely appreciate all the farming households in rural Oyo State that participated in the data collection.

Conflicts of Interest: The authors declare that there are no conflict of interest.

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