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Original Research Article

Gender and Food Security Status of Smallholder Upland and Swamp Rice Farmers in Ebonyi State, Nigeria

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Abstract: ***Aims***: This study examined gender and food security status of smallholder upland and swamp rice farmers in Ebonyi State, Nigeria. It aimed to: (i) describe the socioeconomic characteristics of farmers by gender; (ii) determine their food security status by gender; and (iii) estimate the effects of socioeconomic factors, technology gap, and economic efficiency on food security outcomes across gender and production systems. ***Study Design, Place, and Duration*:** A cross-sectional survey design was adopted. The study was conducted in Ebonyi State, Nigeria, between January and August 2025. ***Methodology*:** A multistage sampling technique was used to select 180 rice farmers, stratified into upland and swamp systems and by gender. Data were analysed using descriptive statistics, the Foster-Greer-Thorbecke (FGT) food security index, and binary logit regression. ***Results*:** Food insecurity was widespread, with 66.7% of households classified as food insecure. Gender and system-based variations were observed: food insecurity was highest among male swamp rice farmers (85.2%), followed by female swamp (68.5%), female upland (55.6%), and male upland (47.2%) farmers. The severity index was also highest for male swamp farmers (FGT_2 = 0.180). Binary logit regression revealed significant predictors of food security: education (β = -0.534, p<0.01), farming experience (β = 0.320, p<0.05), age (β = -0.165, p<0.10), and technology gap (β = -0.026, p<0.10) for male upland farmers. For female swamp farmers, age was positive (β = 0.140, p<0.10), while farming experience (β = -0.247, p<0.05) and technology gap (β = -0.203, p<0.10) negatively affected food security. ***Conclusion*:** Food insecurity among rice farmers in Ebonyi State is alarmingly high, with significant gender and ecological system disparities. Targeted, gender-responsive interventions addressing education, technology access, and institutional barriers are vital to improving household food security in both upland and swamp rice systems. The study recommended gender-sensitive agricultural extension services and incorporate climate-smart agriculture and risk mitigation training.

Keywords: Gender Disparity, Food Security, Rice Farmers, Upland System, Swamp System, Socioeconomic Factors, Ebonyi State.

INTRODUCTION

Rice is one of the major staple foods in Nigeria and the third most consumed food across all geopolitical zones and socioeconomic classes in Nigeria after cassava and yam (Food and Agriculture Organization, FAO, 2023). In 2022, the quantity of milled rice produced locally in Nigeria was estimated at 5.4 million metric tons, and Ebonyi State contributed about 1.5 million metric tons of rice, which is about 27.8% of the total quantity of rice produced annually in the country (Obialo, 2023; FAO, 2023; National Bureau of Statistics, 2021). In 2020, the State produced about 138,300 metric tons of rice with an average yield of 2.26 tons/ha (National Agricultural Extension and Research Liaison Service, NAERLS, and Federal Ministry of Agriculture and Rural Development, FMARD, 2020). Rice grows across all agroecological zones (AEZs) in Nigeria (African Rice Centre (ARC), 2018). According to Chima, Gberevbi, Duruji, Osimen, and Abasilim (2024), Nigeria is divided into six rice-growing environments (RGEs), and those environments; upland, hydromorphic, rain-fed lowland, irrigated lowland, Deep inland water, and Mangrove swamps. Farmers adopt a rice production system based on the topography of their location, planting material, and expected output.

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The continuous demand for rice production in Nigeria, and particularly Ebonyi State, is increasing as the population of people who consume rice within the state is also increasing. The available land for rice production is being affected by urbanization, land fragmentation, and degradation. It has become nearly impossible for farmers to carry out both intensification and extensive production (Chima *et al.*, 2024). Food insecurity widens despite all government intervention. Higher output levels are required to meet domestic consumption demand and to reduce the dependence on foreign rice imports. Unfortunately, the domestic production of rice has not met the local demand, leading to food shortage problems. This requires an integrated, multifaceted and sustainable approach that will increase both production per unit area and, at the same time, optimize the resource use efficiency of rice (Adeniyi and Dinbabo, 2020).

With a rapidly growing population of over three million people, coupled with the prevalence of hunger and malnutrition, ramping up local production of rice is crucial for Ebonyi to attain food security and lift millions of people out of poverty (Okutu, 2022). Food security is a situation where all people always have physical and economic access to safe, nutritious, and sufficient food that meets their dietary needs and food preferences for a healthy and active life (Munonye, Osuji, Olaolu, Okoisu, Eze, Ibrahim-Olesin, Njoku, Amadi, Izuogu and Azuamairo, 2022). There are five major components to assessing food security they are availability, accessibility, utilization, quality, and safety (Munonye, Matthew, Olaolu, Onyeneke, Obi, Amadi, Ibrahim, Izuogu and Njoku, 2023). Availability connotes the physical presence of food in a large quantity, utilization means sufficiency in both quantities of food for consumption and sustainability, and accessibility implies access and not losing such access (Munonye *et al*, 2022).

Food security may depend on the ways of ensuring that gender roles in rice production are well integrated into the food production system. In addition, mainstreaming gender dimensions in all aspects of rice production in the economy is thus important in ensuring the stability and sustainability of rice farming (Nur-Atikah, Norhashila, Rosnah, Hasfalina, and Che-Man, 2022). While discussing food security and production efficiency in upland and swamp rice production systems, it is imperative to note that gender is a critical factor in the degree to which production and production efficiencies are achieved or attained.

Gender refers to socially and culturally determined roles, rights, and responsibilities of men and women (Nur-Atikah *et al*., 2022). Consequently, gender is a determining factor in defining who does which activity, who owns resources, who decides, and who has power in the allocation of resources. However, the common rice production activities performed by males in most areas are farm clearing, tillage, chemical application, harvesting, and threshing, while women do the responsibilities of planting, weeding, fertilizer application, processing, storage, and marketing. These activities could be gender specific in one aspect, while in the other facet, due to certain circumstances such as female-headed households, the jobs performed by both genders may not differ (Ezeaputa, Onugu, Obiekwe, and Offiah, 2020). In making farm decisions on the allocation of agriculture, the roles and relationships between men and women and their access to and control of farm resources determine their level of contributions to farm decision-making. All over the world, both genders have contributed and played an important role in the rice production system. Their roles are contributed by several interrelated socioeconomic (including class, ethnicity, age, and religion), political, and environmental factors, and those roles are known as gender roles. These are dynamic and can change over time depending on changes in other factors (Ezeaputa *et al*, 2020).

The dominance of males in decision-making concerning agricultural production, even in areas where women are the key processors of agricultural produce, and the formulation of policies that are more favourable to males, not only underestimates the value of women as the major suppliers of farm labour for rice production but also discriminates against them. Female farmers, including those involved in rice farming, are among the voiceless, especially concerning influencing agricultural policies. This has become a challenge in rice production as Ashagidigbi *et al.,* (2022) assert that women occupy a central place in subsistence agricultural production and are accountable for about 80% of agricultural production. They are majorly involved in food production, processing, preparation, and marketing; despite these activities, women's contributions to food and agricultural production are still largely undervalued. Gender discrepancies in access to agricultural resources and services adversely influence their productivity and, subsequently, the food security of their households (Ojo and Baiyegunhi, 2023).

Rice production in Ebonyi State faces a myriad of interrelated challenges that hinder productivity and compromise the welfare of farming households. Despite the state's potential for large-scale rice cultivation, farmers consistently struggle with low yields and high production costs. These are further exacerbated by environmental and agronomic constraints such as drought, lodging, weed infestation, poor soil fertility, pest and disease outbreaks, flooding, and rodent attacks. Collectively, these challenges significantly reduce production efficiency, which contributes to persistent food insecurity, diminished income levels, and an overall rise in poverty among rice farming communities. The burden of these problems is not gender-specific; they affect both male and female rice farmers equally, thereby highlighting a systemic issue in the state's agricultural landscape. Unless these production challenges are urgently and comprehensively addressed, rice farmers in

Ebonyi State will remain trapped in a cycle of poverty and food insecurity, unable to meet both households' needs and market demand. This situation calls for strategic interventions aimed at enhancing efficiency, improving resilience, and empowering farmers through inclusive, gender-neutral solutions.

These are the reasons why this study will link up gender, food security status and production systems using the Foster-Greer-Thorbecke (FGT) food security index as a gap. To achieve this, the following objectives will be considered.

i. Describe the socioeconomic characteristics of smallholder upland and swamp rice farmers by gender in relationship to food security status.
ii. Ascertains the food security status of the smallholder rice farmers by gender in the upland and swamp rice production systems.
iii. Estimate the effect of socioeconomic factors, technology gap, and economic efficiency on the food security status of the smallholder rice farmers by gender in the upland and swamp rice production systems in the study area.

MATERIALS AND METHODS

This study was conducted in Ebonyi State, Nigeria. The state was established in 1996, making it one of the youngest states in Nigeria (Ibenegbu, 2017). It is situated within latitudes 7°30′1″N and 8°30′1″E, and longitudes 6°40′1″E and 6°45′1″N of the Greenwich Meridian. Ebonyi has three agricultural zones: Ebonyi North Zone, Ebonyi South Zone, and Ebonyi Central Zone. The state comprises thirteen Local Government Areas (LGAs) with an estimated population of 2.9 million in 2016 (National Population Commission, NPC, 2016), and a projected total population of 3.49 million in 2020, with an estimated growth rate of 3% (National Bureau of Statistics, NBS, 2022). It covers a total land area of approximately 5,935 km² (Obasi *et al*., 2015; Nwahia *et al*., 2020). Farming is a principal economic activity in Ebonyi, with about 85% of its population earning their livelihoods through agriculture (NBS, 2020). The economy is mainly agrarian, with agriculture as the primary source of livelihood for most residents. Ebonyi State features a humid tropical climate, with one rainy season lasting for eight months and one dry season lasting for four months. The average annual temperature is around 28°C, with humidity levels between 50% and 60%, and an average annual rainfall of 2,500mm (Nigerian Meteorological Agency, NiMet, 2021; Agbo *et al*., 2020).

Climatic conditions favour the cultivation of various crops, such as rice, yams, cassava, and vegetables. Ebonyi is particularly renowned for its rice production and is often called the "Home of Rice" in Nigeria, playing a significant role in enhancing food security at both local and national levels (NBS, 2023; Munonye *et al*., 2023).

Upland rice is mainly cultivated in the northern part of the state, particularly in Izzi and Ikwo LGAs, whereas swamp rice is predominantly grown in the central and southern parts, especially in Afikpo South, Ivo, Onicha, and Ohaozara LGAs (Chidiebere-Mark *et al*., 2019). The soil in Ebonyi is clayey and loamy, with swampy, clay-rich soil suitable for rice farming. Upland rice is produced in Izzi and Ikwo, while swamp rice is grown in Onicha, Ohaozara, Ivo, and Afikpo North. The map of the study area, shown in Figure 1, illustrates the locations where Upland and Swamp rice are cultivated.

A multi-stage sampling technique was employed for data collection, conducted through five stages. All three agricultural zones in the state were considered to ensure comprehensive coverage of rice farming areas. In stage 1, one Local Government Area (LGA) was purposively selected from each of the three zones based on the intensity of upland and swamp rice production, resulting in three LGAs: Izzi in the North, Ikwo in the Central, and Ohaozara in the South. Stage 2 involved randomly selecting three communities from each LGA, totalling nine communities. In stage 3, two villages were randomly picked in each community, making eighteen villages in total.

Stage 4 involved stratifying rice farmers within these villages into two primary groups: upland rice farmers and swamp rice farmers. Each group was further divided into four sub-groups: male upland rice farmers, female upland rice farmers, male swamp rice farmers, and female swamp rice farmers. In stage 5, a proportionate random sampling method was used to select two male and two female upland rice farmers, as well as three male and three female swamp rice farmers from each village. The list of 240 registered rice farmers obtained from village heads during the pre-test served as the sampling frame, which included 120 swamp and 120 upland rice farmers. Ultimately, 180 rice farmers were selected: 72 upland rice farmers (36 males and 36 females) and 108 swamp rice farmers (54 males and 54 females). These individuals constitute the sample for this study.

The data collected were primarily cross-sectional, capturing the prevailing conditions, behaviours, and outcomes in rice farming within Ebonyi State. The analysis employed both descriptive and inferential statistics. Descriptive statistics included measures such as mean, mode, and relative frequency distribution of respondents. Inferential statistics involved econometric tools, notably the Cobb-Douglas production function.

Figure 1: The map of Ebonyi State shows the location of the study area
Source: Chidiebere-Mark *et al.*, 2019

Model Specification

Foster-Greer-Thorbecke (FGT) for Food Security

Foster-Greer-Thorbecke (FGT) decomposable indices, as used by Amusan *et al*., (2023), were adopted for this study. The model is specified as follows;

$P_a = \frac{1}{n}\sum(\frac{Z-Y_i}{Z})^a$ x I (Y_i< Z) - - -Equation (1)

Where:

I (Y_i< Z) = is a food security indicator function that takes the value of 1(food secured) if Yi > Z, and 0 (food insecure) if Yi < Z.

Z = Minimum calorie requirements per day per adult equivalent (kcal)

Y_i = Average monthly expenditure of the individual farmers (₦)

α = Is a non-negative parameter that takes the value of zero (0) for the headcount ratio, 1 for the food insecurity gap index, and 2 for the squared food insecurity gap index.

n = Total sample size

The headcount ratio (HCR) is expressed as;

HCR = $\frac{N}{n}$ - - - Equation (2)

Where;

N = Number of farmers living below the recommended minimum calorie requirement per day

n = sample size

Food Insecurity Gap Index (ij) = $\frac{1}{n}\sum_{i=1}^{q}(\frac{Z-C}{Z})$ - - - Equation (3)

Where;

q_{ij} = Number of food-insecure households (households for food consumption C < Z)

Z_{ij} = food secured threshold (2,250kg/day)

C_{ij} = food consumption level (expenditure on food) of the i^{th} food-insecure household.

i = ith household by gender

j = jth production system

Binary Logit Regression Model

The binary logit regression model was used to estimate the food security status of the *i-jth* on socioeconomic factors, technology gap ratio, and economic efficiencies. The model is specified explicitly as used by Ameh (2021) as follows;

$Y^*_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + U$ - - - (4)

Where:

$Y^*_i = 0$ if $Y^*_i \leq 0$

Y^*_i if $0 < Y^*_i < 1$

1 if $Y^*_i \geq 1$

Y^*_i = Food Security status for the $i\ th$ farming gender household (1 = food secure, 0 = food insecure) as generated in Equation (1)

X_1 = Economic efficiency (AE x TE) scores

X_2 = Age (Years)

X_3 = Marital status of household head (1 = Married, otherwise = 0)

X_4 = Education attainment of household head (Number of years spent in school)

X_5 = Household size (Number of people)

X_6 = Farm size (Hectare)

X_7 = Farming Experience (Number of years spent in rice cultivation)

X_8 = Technology gap (index score)

U = Stochastic random error term

RESULTS AND DISCUSSION

Socioeconomic Characteristics and Food Security Status

Descriptive statistics, particularly frequency counts, percentages, and means, were employed to analyse the relationship between selected binary socioeconomic characteristics and food security status (MFSS) among smallholder upland and swamp rice farmers in Ebonyi State, Nigeria. Table 1 shows cross-tabulations disaggregated by gender and rice production system. Marital status appeared to be a significant factor in shaping food security outcomes.

Marital Status of the Respondents

The distribution of upland and swamp rice farmers by gender according to marital status showed that the majority across all groups were married: male upland (58.3%), female upland (69.44%), male swamp (77.8%), and female swamp (75.9%). Interestingly, the proportion of married male swamp rice farmers was higher than that of male upland rice farmers, while the proportion of married female swamp rice farmers exceeded that of their female upland counterparts. This pattern reflects the typical rural setting in Nigeria, where marriage is not only a social institution but also a functional strategy for mobilizing family labour in agricultural production. Such findings align with Wai and Hong (2021), who reported that most rice farmers in Myanmar were married, highlighting the role of household labour in sustaining production efficiency. Similarly, Igwe *et al*. (2015) noted that a high proportion of marriages among farmers creates a conducive environment for the development of personal integrity, good citizenship, and more efficient use of farm resources, all important for upland and swamp rice production.

In terms of food security, the analysis revealed gender and system-based differences. Among upland rice farmers, married males had a mean food security status (MFSS) of 0.57, while married females had 0.52, both indicating moderate food insecurity. Among the otherwise group (single, divorced, or widowed), male upland farmers had a MFSS of 0.33 (severe food insecurity) while female upland farmers surprisingly recorded a higher MFSS of 0.73, indicating mild food insecurity. In the swamp production system, married males showed a high MFSS of 0.88, clearly food secure, while married females had a MFSS of 0.61 (moderate food insecurity). The "otherwise" category among swamp farmers had MFSS of 0.75 for males (mild food insecurity) and 0.92 for females (food secure).

These findings suggest that while marriage provides a structural advantage in labour availability, it does not automatically confer food security, particularly for women. This resonates with broader literature that emphasizes the role of socio-cultural factors, gender roles, and intra-household decision-making dynamics in determining access to and control over food resources, even within married households.

Membership of Cooperatives

Table 1 further showed that 50% of male upland rice farmers were members of a cooperative. Despite this, they remained food insecure with a mean food security status (MFSS) of 0.56 (moderate food insecurity). Among female upland rice farmers, 41.67% belonged to a cooperative and had a higher MFSS of 0.73, indicating mild food insecurity. Among swamp rice farmers, 44.4% of male members of cooperatives recorded a MFSS of 0.83, while their female counterparts, also at 44.4% cooperative membership, had MFSS of 0.75. These values place male swamp cooperative members in the mild food insecurity to food secure category, and females within the mild food insecurity category.

Membership in cooperatives is generally associated with enhanced access to resources such as credit, production inputs, and market information. Eze and Nwankwo (2024) found that cooperative membership significantly increased access to inputs and information, improved productivity, and boosted food availability among rice farmers in Ebonyi State. Likewise, Nwofoke *et al*., (2024) observed that cooperatives were instrumental in disseminating rice technologies, especially in swamp rice systems. Ezeh *et al*., (2022) further highlighted that association membership not only meets social needs but facilitates information sharing on agricultural innovations.

However, the findings from this study suggest that membership alone does not guarantee food security, particularly for female farmers. This may be due to persistent gender-based constraints such as limited decision-making power within cooperatives, restricted access to resources, or social norms that inhibit the full utilization of support services. Umoh (2025) emphasized similar challenges, noting that female rice farmers in Southeast Nigeria often experience exclusion in cooperative benefits, undermining their food security outcomes.

Access to Extension Services

Access to extension services was relatively limited across all groups. Among male upland rice farmers, 41.7% had access to extension services, with a MFSS of 0.53, suggesting moderate food insecurity. For female upland rice farmers, 30.56% had access, with a MFSS of 0.55, also moderate food insecurity. Swamp rice farmers showed slightly better MFSS scores. Males who had access to extension services recorded a MFSS of 0.90, food secure, while females had a MFSS of 0.76, mild food insecurity.

These results underscore the important, yet uneven role of extension services in enhancing food security. While extension services can increase

awareness and access to improved technologies, their effectiveness often depends on the quality, frequency, and gender-responsiveness of the service. Ezeh *et al.,* (2022) and Odoemenem & Inakwu (2011) both emphasized that while awareness of technologies is high among Ebonyi rice farmers, actual use and resultant food security gains are constrained by institutional and financial limitations. Ojo and Baiyegunhi (2023) particularly highlighted that female farmers often experience lower efficiency gains despite extension contact due to limited land access, credit, and inputs.

Additionally, swamp rice farmers, particularly males, seem to benefit more from extension services, suggesting either more effective application of knowledge or better access to complementary resources. Nwokoye *et al*., (2019) and Thomas *et al*., (2023) noted that the mere availability of extension services is not enough; its relevance, delivery mode, and integration with input supply chains matter greatly. Javeid and Nawab (2021) strongly argued for gender-sensitive and locally tailored extension systems. Without these, improvements in food security remain uneven and insufficient, an observation well illustrated in the current study's findings.

Table 1: Cross-Tabulation of Binary Socioeconomic Characteristics of Smallholder Upland and Swamp Rice Farmers by Gender in Relation to Food Security Status

Variables	Upland Rice Farmers						Swamp Rice Farmers					
	Male			Female			Male			Female		
Marital Status	**F**	**%**	**MFSS**	**F**	**%**	**MFSS**	**F**	**%**	**MFSS**	**F**	**%**	**MFSS**
Married	21	58.3	0.57	25	69.44	0.52	42	77.8	0.88	41	75.9	0.61
Otherwise	15	41.7	0.33	11	30.56	0.73	12	22.2	0.75	13	24.1	0.92
Association												
Yes	18	50.0	0.56	15	41.67	0.73	24	44.4	0.83	24	44.4	0.75
No	18	50.0	0.39	21	58.33	0.48	30	55.6	0.87	30	55.6	0.63
Extension Contact												
Yes	15	41.7	0.53	11	30.56	0.55	21	38.9	0.90	17	31.5	0.76
No	21	58.3	0.40	25	69.44	0.60	33	61.1	0.82	37	68.5	0.65
Total	**36**			**36**			**54**			**54**		

Source: Computed from Field Survey Data Analysis, 2025, F = Frequency, % = Percentage, MFSS = Mean Food Security Status, MFSS ≥ 0.8 (food secure), MFSS 0.6 – 0.79 (mild food insecurity), MFSS 0.4 – 0.59 (moderate food insecurity), MFSS < 0.4 (severe food insecurity)

Food Security Status of Smallholders Upland and Swamp Rice Farmers by Gender

The food security status of smallholder rice farmers was achieved using the Foster-Greer-Thorbecke (FGT) index across upland and swamp rice farmers by gender in the study area.

The results are presented in Table 2.

The results of the food security analysis using the Foster-Greer-Thorbecke (FGT) index reveal important gender and system-based disparities among smallholder rice farmers.

In the upland production system, the headcount ratio indicates that 47.2% of male farmers were food insecure, compared to 55.6% of female farmers. This suggests that a higher proportion of female upland rice farmers experience food insecurity, highlighting a gender-based vulnerability. This finding agrees with Njoku *et al*., (2025), who reported that women in Ebonyi State face disproportionate barriers to accessing land, credit, and agricultural inputs due to entrenched discriminatory social norms and insecure tenure systems, all of which negatively affect their food security status.

Conversely, in the swamp rice production system, the pattern reverses. A striking 85.2% of male swamp rice farmers were food insecure, compared to 68.5% of female farmers. This indicates that male swamp farmers experienced significantly higher food insecurity than their female counterparts. This divergence suggests that contextual factors, such as access to farmland, labour distribution, or crop choice, may differentially affect male and female farmers across production systems. When examining the extent of food insecurity (FGT_1), which captures the average food intake shortfall among food-insecure households, the highest gap was observed among male swamp farmers (0.382), followed by female swamp farmers (0.257). In comparison, male upland (0.186) and female upland farmers (0.192) had lower depth indices, indicating relatively smaller calorie deficits among upland farmers.

Similarly, the severity of food insecurity (FGT_2), which reflects inequality among the food insecure, followed the same trend. Male swamp farmers had the highest severity score (0.180), while male upland farmers had the lowest (0.010). These results suggest that food insecurity in the swamp system is not only more prevalent but also more deeply entrenched and unequal, particularly among men. Looking at the pooled sample, the overall headcount ratio was 0.667, indicating that two-thirds (66.7%) of the surveyed households were food insecure. This is consistent with the findings of

Munonye *et al.,* (2023) and Esheya *et al.,* (2024), who reported widespread food insecurity in Ebonyi State, where over one-third of households experience hunger. They linked this trend to persistent poverty, limited access to inputs, and infrastructural challenges.

These findings also align with the Okike *et al*., (2021) study conducted in partnership with the International Institute of Tropical Agriculture (IITA) and the Farm and Infrastructure Foundation (FIF) across five states: Benue, Ebonyi, Kebbi, Ogun, and Sokoto. In Ebonyi, 25.6% of households live below the US$1.90/day poverty line, compared to the five-state average of 28.9%. Regarding hunger, 35.3% of households in Ebonyi experience hunger, with 18.6% moderately and 16.4% severely affected. These figures are consistent with the five-state average of 27.7%, where 17.1% and 10.6% of households suffer moderate and severe hunger, respectively.

Critically, 36.7% of Ebonyi households are both poor and experiencing severe hunger. While slightly below the five-state average of 45.4%, this overlap between poverty and hunger reveals a deeply vulnerable population. In this study, the food insecurity experienced by rice farmers, particularly female upland and male swamp farmers, underscores the need for targeted interventions that address both gender and production-system-specific vulnerabilities. These results led to the rejection of the null hypothesis which stated that there is no significant difference in the food security status of smallholder upland and swamp rice farmers across gender in the study area.

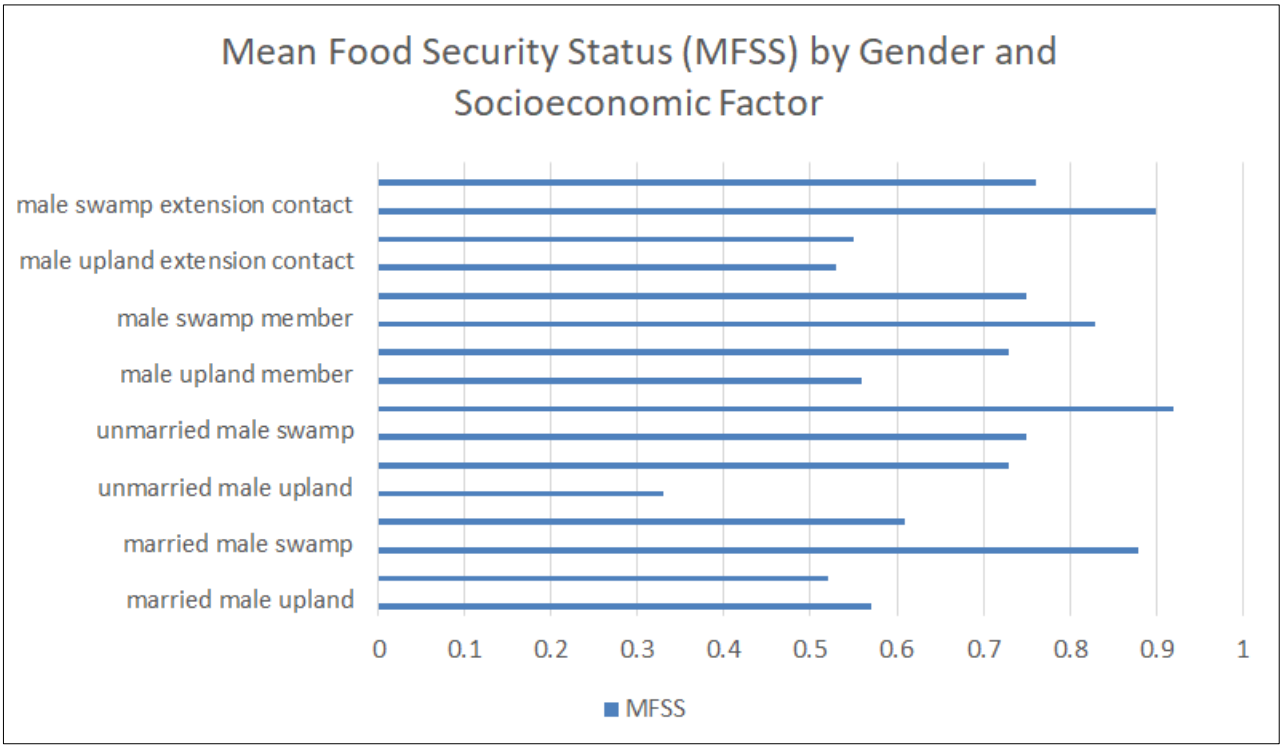

Figure 1: Computed Mean Food Security Status by gender and socio-economic factors from Field Survey Data, (2025)

Table 2: Food Security Status of the Smallholder Upland and Swamp Rice Farmers by Gender

Groups	(n)	Food Insecure	Headcount Ratio	Extent of Insecurity	Severity of Insecurity
Male Upland	36	17	0.472	0.186	0.010
Female Upland	36	20	0.556	0.192	0.050
Male Swamp	54	46	0.852	0.382	0.180
Female Swamp	54	37	0.685	0.257	0.120
Pooled Sample	**180**	**120**	**0.667**	**0.102**	**0.204**

Source: Computed from Field Survey Data Analysis, 2025, n (Sample sample)

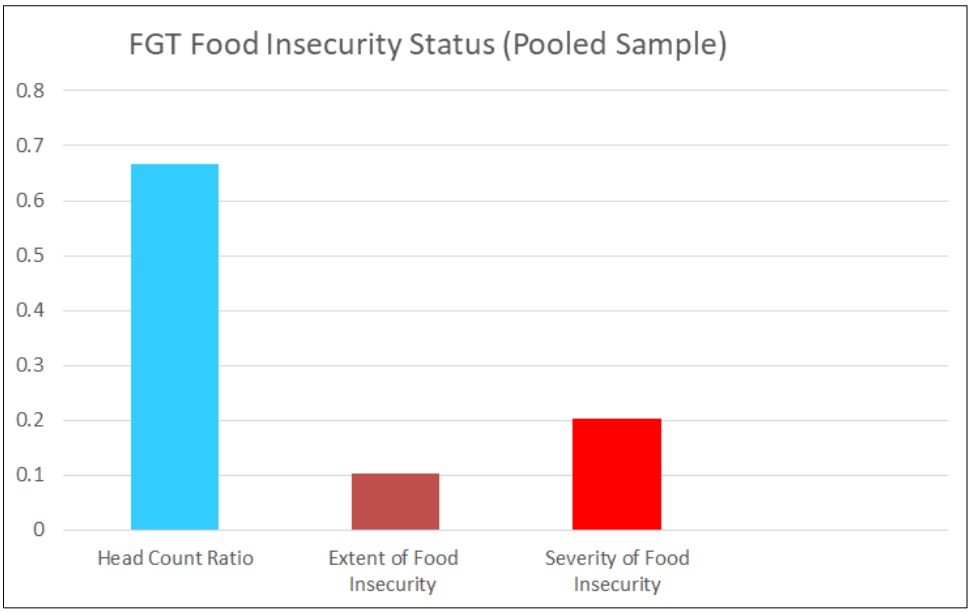

Figure 2: FGT Food Insecurity Status in Ebonyi State, Nigeria, 2025

Effects of Socioeconomic Factors, Technology Gap, and Economic Efficiency on the Food Security Status of Farmers by Gender in the Upland and Swamp Rice Production Systems

The effects of socioeconomic factors, technology gap, and economic efficiency on the food security status of farmers by gender in the upland and swamp rice production systems were analyzed using a binary logit regression model. Two stages of analysis were involved: firstly, a food security status (FSS) was obtained using FGT, and secondly, the binary logit regression model was used to estimate the food security status in relation to socioeconomic factors, technology adoption ratio, and economic efficiencies. The result is presented in Table 3.

The result in Table 3 shows that the pseudo R^2 values of 0.523 (male upland), 0.269 (female upland), 0.116 (male swamp) and 0.366 (female swamp) farmers explain a considerable proportion of the variance in food security. The chi-square statistics are significant at 1% across all models, indicating good model fit. This led to the rejection of the hypothesis, which stated that socio-economic factors, technology gap, and economic efficiency do not significantly and positively affect food security status by gender in the upland and swamp rice production systems in the study area.

Farming experience ($p<0.05$) was positive, age ($p<0.10$), level of education ($p<0.01$), and technology gap ratio ($p<0.10$) were negative and significantly related to food security status of the male upland farmers in the in the study area, while age ($p<0.10$) was positive, while farming experience ($p<0.10$) was negative and statistically significant to food security status of the female upland rice farmers. On the other hand, age ($p < 0.10$) and farming experience ($p < 0.10$) were positively related, while education ($p < 0.10$) was negatively related, and all were significantly related to the food security status of male swamp rice farmers. Similarly, age ($p<0.10$) was positive, and farming experience (0.05) was negative and both were significantly related to the food security status of the female swamp rice farmers in the study area.

The coefficient for education levels was highly significant at 1% and negatively associated with food security status. This indicates that as farmers become more educated, their food security tends to decrease. This finding aligns with the results of Nwachukwu *et al.,* (2022b), who reported that more educated farmers are less food secure, possibly because they are more involved in non-farm activities and less dependent on subsistence farming. Alternatively, educated individuals may have higher standards for food quality, which could impact their food security scores.

The coefficient of farming experience indicates a positive and significant effect at 5%. This demonstrates that as the number of years in farming increases, it contributes to improved food security. This suggests that more experienced farmers are more likely to be food secure. This aligns with findings by Umeh & Chukwu (2015) and Ogunniyi *et al*., (2021), who observed that farming experience enhances decision-making and risk management, both of which are essential for food security.

Age was negatively and significantly related at 10%. This indicates that older male farmers are more prone to food insecurity. This could be due to a decline in physical ability to undertake labour-intensive farming activities. This finding concurs with the results of Alabi (2023), who reported that older farmers are less capable of engaging in strenuous farming activities like their

younger counterparts, which affects their food security status.

The Technology Gap Ratio has a negative and significant effect ($p<0.1$), indicating that a larger gap in accessing or using improved technologies decreases food security. This aligns with the findings of Adebayo *et al*., (2023), who stated that closing the technology gap enhances productivity and food availability.

In the swamp production system, male farmers' food security was significantly influenced by age, education, and farming experience.

Age is positive and statistically significant at 10%. This shows that the younger the male swamp rice farmers, the higher their food security status. This implies that younger male swamp farmers are more food secure, possibly due to their strength and ability to engage in physical activities in rice production in the study area. This agrees with the findings of Edeh and Ugwu, (2021), who reported that younger farmers are capable in rice production activities.

Education has a negative and significant effect 0n the food security status at 10%. This means that as the farmers are more educated, it leads to a decrease in the food security status of the farmers. This result agrees with the findings of Nwachukwu *et al.,* (2022b), who reported that to more educated farmers are less food secure, possibly because they are more engaged in non-farm activities and less reliant on subsistence farming. Alternatively, educated individuals may demand higher food quality standards, altering their food security scores.

Farming experience is positively significant to food security status at 10%. ($p<0.1$), consistent with upland findings. This reinforces the value of long-term involvement in farming for maintaining food security. This shows that as the number of years in farming increases, it leads to an increase in food security. This implies that more experienced farmers are more likely to be food secure. This aligns with findings by Umeh and Chikwu (2015), who observed that farming experience improves decision-making and risk management, both essential for food security.

For female swamp rice farmers, age shows a positive significant effect to food security status at 10%. This means that as farmers increases in age, the food security status also increases. This implies that older female farmers, the more food secure they become. This could be attributed to experiences and established coping mechanisms employed to mitigate food insecurity. This aligns with the findings of Ifeanyi-Obi *et al*., (2022), who reported that more years of farming experiences and mitigation strategies developed over the years help in improving food security.

Farming experience has a significant negative effect at 5%, contrasting the male outcome. This might suggest that more years in farming do not necessarily equate to better food outcomes for women, possibly due to systemic constraints like lack of access to credit or land (Chikaire *et al*., 2021).

Finally, the coefficient of technology gap ratio was negative and statistically significant at 1%, indicating that female swamp rice farmers with higher technology gaps are more food insecure. This supports the findings of Onyeneke *et al.,* (2024) who reported that gender disparities in access to technology significantly affect agricultural outcomes.

Table 3: Effect of Socio-economic factors, technology gap, and Economic Efficiency on the Food Security Status of the farmers by Gender

Production System	**Male Upland**			**Female Upland**		
Variable	**Coefficient**	**SE**	**/t/**	**Coefficient**	**SE**	**/t/**
Economic Efficiency	-1.636	1.228	-1.332	-0.185	1.155	-0.160
Age	-0.165*	0.096	-1.719	0.096*	0.063	1.524
Marital Status	1.565	1.217	1.286	0.036	1.000	0.036
Education	-0.534***	0.115	-4.643	-0.035	0.083	-0.422
Household Size	-0.179	0.160	-1.119	-0.103	0.150	-0.687
Farm Size	-0.124	1.773	-0.069	-0.906*	0.712	-1.272
Farming Experience	0.320**	0.113	2.832	-0.145	0.096	-1.510
Technology Gap Ratio	-0.026*	0.017	-1.529	0.009	0.010	0.900
Constant	5.954	3.815	1.561	1.000	2.376	0.421
Chi-Square		17.895***		8.040***		
-2Log-Likelihood		31.901		40.862		
Pseudo R^2		0.523		0.269		
Observation		36		36		
	Male Swamp			**Female Swamp**		
Variable	**Coefficient**	**SE**	**/t/**	**Coefficient**	**SE**	**/t/**
Economic Efficiency	-0.648	0.691	-0.938	0.132	0.771	0.171
Age	0.124*	0.071	1.746	0.140*	0.070	2.000

Marital Status	-0.353	1.880	-0.188	-0.167	1.890	-0.088
Education	-0.157*	0.084	-1.869	-0.007	0.065	0.108
Household Size	0.143	0.185	0.773	-0.025	0.139	-0.107
Farm Size	-0.155	0.251	-0.618	-0.730	0.496	-1.472
Farming Experience	0.131*	0.082	1.598	-0.247**	0.105	-2.352
Technology Gap Ratio	0.167	0.232	0.720	-0.203*	0.140	-1.500
Constant	-0.120	2.600	0.046	0.946	2.362	0.401
Chi-Square		3.694***			16.312***	
-2Log-Likelihood		41.610			50.961	
Pseudo R^2		0.116			0.366	
Observation		54			54	

Source: Computed from Field Survey Data, 2025 * Significant at 10%, ** Significant at 5%, *** Significant at 1%

CONCLUSION

The study concludes that food insecurity among smallholder rice farmers in Ebonyi State is alarmingly high, with significant disparities across gender and production systems. Swamp rice farmers, particularly males, are more food insecure than their upland counterparts. Education, technology access, and farming experience emerged as critical determinants. The study also found that women, though vital to rice production, face institutional and social limitations that suppress their food security outcomes. Closing gender gaps in agricultural input access and empowering women with tailored extension services are necessary for sustainable rice production and equitable food access.

Recommendations

1. Gender-sensitive agricultural extension services should be promoted to address female-specific challenges in technology adoption and resource access.
2. Farmers' cooperative societies should be strengthened by stakeholders with inclusive policies that ensure equitable participation and benefit sharing across gender.
3. Encourage youth participation in rice farming through targeted training, as age and energy level positively influenced food security.
4. Incorporate climate-smart agriculture and risk mitigation training should be paramount to improve productivity and resilience in both upland and swamp systems.

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Authors' Contribution

K.H. Anyiam = Conceptualization, Methodology Design, Models Design, Data Analysis, Questionnaire Design, Data Collection, Data Sorting and Data Entering, Data Coding, Data Curation, Data Processing, Section Writing.

Prof. J.C. Nwaru = Questionnaire Design, Section Writing and Grammar Check, Model Design, Methodology Design.

Prof. K.C. Igwe = Questionnaire Design, Section Writing and Grammar Check, Model Design, Methodology Design.

Consent: All the authors consented to the peer review of the manuscript

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