Agricultural Credit, Female Participation in Agriculture and Food Security: An FMOLS Examination in Nigeria

Rowland A. BASSEY[*]
Mercy ADETIFA[**]
Timothy ADEREMI[***]
Ikenna T. NNOLI[****]
Titilayo FOLATORI[*****]

Abstract: *Using the Fully Modified Ordinary Least Squares (FMOLS) method, this study investigated the impact of agricultural credit and female participation in agriculture on food security in Nigeria from 1998 to 2023. The specific objectives were to determine the relationship between agricultural credit, female participation in agriculture, and food security outcomes, measured by the Prevalence of Undernourishment (PU) and the Food Production Index (FPI). The study employed secondary data obtained from the World Development Indicators (WDI), FAO, and Central Bank of Nigeria (CBN) statistical bulletins. The dependent variables were Prevalence of Undernourishment and Food Production Index, while the independent variables included Agricultural Credit (AGC), Female Participation in Agriculture (FPA), Arable Land (ARL), Female Education (FEDU), and the Agricultural Credit Guarantee Scheme Fund (ACGSF). The FMOLS regression results showed that agricultural credit and female participation have a significant and positive impact on food production, and a negative impact on undernourishment in Nigeria. The study concludes that enhancing access to agricultural credit and improving female participation are essential strategies for reducing hunger and*

---

[*]   Bells   University   of   Technology,   Nigeria,   Corresponding   author: bassey.rowland@yahoo.com.

[**] Bells University of Technology, Nigeria, E-mail: foluso.aribaba@fuoye.edu.

[***]   Bells University of Technology, Nigeria, E-mail: obek@gmail.com.

[****] Bells University of Technology, Nigeria, E-mail: gbengabisi2002@gmail.com.

[*****] Bells University of Technology, Nigeria, E-mail: sojikol@yahoo.com.

achieving SDG 2 in Nigeria. It recommends targeted policies that support rural credit delivery and gender inclusive agricultural programs.

Keywords: *Agricultural Credit; Female Participation; Zero Hunger; Food Production Index; Sustainable Development; WDI; Nigeria*

1. Introduction

Despite Nigeria's fertile arable land and vast human resources, undernourishment and food insecurity remain major problems (FAO, 2023). More than 12% of Nigeria's population remains undernourished because the production indices in the food industry cannot match the demands of a rapidly growing population (Hussaini et al., 2024). According to the 2023 Global Hunger Index, Nigeria stands at number 109 out of 125 countries with a score of 28.3, classifying its hunger as "serious" (Kasuwa, 2024). Despite the prevalence of undernourishment having declined slightly from 21.1% in 2013 to 20.8% in 2018 (Oweibia et al., 2024), it has gone down since 2015, indicating a worsening food security crisis (Oweibia et al., 2024). This is a broader African issue, with 19.7% of the African population being undernourished in 2022 and contributing to the global hunger burden among 282 million people (Rahman et al., 2025).

Various drivers of food insecurity exist in Africa, including population growth, climate uncertainty, pest infestation, poor infrastructure, and low farm productivity (Dolapo et al., 2025). In Nigeria, these constraints are exacerbated by limited access to farm credit and deep-seated gender discrimination in the agricultural economy (Osuafor & Okoli, 2021). Women constitute a majority of the farm labour force but face structural barriers such as inadequate access to land, inputs, extension services, and, most significantly, credit (Osabohien et al., 2021; Olaleye, 2023; Ilesanmi, 2024; Okunola, 2024). These constraints suppress their productivity despite confirmation that women-owned cooperatives enhance food production and resilience (Osabohien et al., 2021; Okeke et al., 2021). Eze and Onwuka (2023) cite that cassava producers enjoying credit access and participatory decision-making have 30% higher yields, whereas Onoh et al. (2023) emphasize the role of women in promoting climate-resilient agricultural systems.

Credit for agriculture is central in improving food access and production, as it enables farmers to invest in improved seeds, fertilizers, mechanization, and irrigation. Research by Usman and Ibrahim (2020) confirms that access to credit improves crop yield, sustainability, and food production indices. Similarly, Raufu et

al. (2025) conclude that Nigeria's Agricultural Credit Guarantee Scheme Fund (ACGSF) enhances animal and crop productivity, but Obayelu et al. (2024) find that women's access to credit reduces household food insecurity. However, structural barriers, such as excessive collateral requirements, poor financial infrastructure, and gender bias in lending, still work to marginalize smallholder farmers and women (Sasa et al., 2022).

Most of the earlier studies target agricultural credit and gender participation as standalone variables. Research by Usman and Ibrahim (2020), Igwemeka and Ekwunife (2020), Bello and Akinyemi (2023), and Likius (2024) targets the effect of credit on agricultural productivity but not gender. Conversely, research such as that of Osabohien et al. (2021), Mose (2024), Okeke et al. (2021), and Njoku et al. (2025) targets gender participation in agriculture but not credit availability. Fewer studies, such as Eze and Onwuka (2023) and Ajayi and Balogun (2021), examine their combined impact, but these have recourse to univariate simple regression estimates that ignore cointegration and endogeneity. This study closes these gaps through the application of the Fully Modified Ordinary Least Squares (FMOLS) approach to analyse the long-run impacts of agricultural credit and women's involvement on food security in Nigeria. Through the provision of more robust empirical evidence, this study supports Nigeria's pursuit of Sustainable Development Goal 2 (Zero Hunger) and offers realistic policy recommendations for policies that enhance agricultural productivity, empower women, and enhance national food security simultaneously.

2. Literature Review

Igwemeka and Ekwunife (2020) examined the challenges of accessing credit by smallholder farmers and the potential of agricultural value chain financing for sustainable development. This research focused on Nigeria, covering smallholder farmer. The study Found Smallholder farmers face challenges accessing credit, Agricultural financing policies focused on primary production, neglecting marketing, financial institutions emphasize value chain financing, exacerbating access issues, Farmer linkages and organization can enhance access to improved inputs and markets. It recommended the Improvement of access to improved seeds, fertilizers, and production technology. Enhancing farmer integration into seed production, processing, and marketing chains.

Okeke et al. (2021) evaluated how women's leadership roles in agriculture influenced sustainable agricultural practices and food security in the Southeastern part of Nigeria. The study emphasizes women's potential to inspire change and promote sustainable practices. In-depth interviews and case studies with content analysis and sustainability performance metrics were used to analyze the collected data. Sample size of 50 women leaders of farming cooperatives. The findings of the study indicates that women leaders significantly influenced their groups to adopt organic farming methods, reducing pesticide use by 30% and women-led cooperatives improved household food security by 45%. The recommendations included in the study were supporting women leaders in agriculture with credit facilities and mentorship programs and encouraging male allies to support women's leadership roles in farming cooperatives.

Adebayo and Adekunle (2021) examined the effect of agricultural credit schemes on smallholder farmers' productivity and their contribution to sustainable agricultural development in Nigeria which lasted 2015–2020. This examination focused on the part of Northern Nigeria, especially on farmers in Kaduna and Kano states. The study posits that farmers make decisions to access credit based on the perceived benefits to maximize productivity and improve livelihoods. The study adopted the collection of data sample: 500 smallholder farmers participating in the Anchor Borrowers' Programmed, structured questionnaires and interviews. Econometric regression models to measure the impact of credit on agricultural output. The findings of the study indicate that farmers who accessed credit recorded a 35% increase in crop yield compared to those without credit and also late disbursement and high-interest rates limited the program's full potential. Recommendations of this study include: Simplify credit access procedures and reduce interest rates to encourage wider participation. Strengthen extension services to guide farmers on effective credit utilization.

Ajayi and Balogun (2021) explored how access to credit and gender inclusion can address food insecurity in rural communities in Northern and Southwestern Nigeria, focusing on maize and sorghum farmers. The implementation of Empowerment Theory was used to highlights the need for empowering disadvantaged groups (e.g., women and smallholder farmers) to improve societal outcomes. The methods used for collecting and analyzing data include structured questionnaires and focus group discussions, mixed-method analysis combining qualitative insights and quantitative regression models with sample size of 400 farmers (60% male, 40% female). The study found out that female farmers who accessed credit reported a 45% increase in food output compared to male

counterparts. Barriers included lack of awareness about available credit schemes and insufficient collateral. Recommendations given in this study was creation gender-focused agricultural awareness programs. Reduction of collateral requirements for rural women to improve access to financial resources.

Nwankwo et al. (2022) analyze the impact of agricultural credit on women-led agribusinesses and its role in rural economic development in Southeastern Nigeria, focusing on women in poultry farming and crop production from 2019–2022. Theory used was the Human Capital Theory that emphasizes the role of skills, education, and financial empowerment in boosting productivity and sustainable growth. The methods used for collecting and analyzing data include semi-structured interviews and surveys, Descriptive statistics and impact assessment with sample size of 300 women entrepreneurs in agriculture. The findings of the study indicate that women with access to agricultural credit increased their farm sizes by an average of 50%. A majority invested in mechanized equipment, reducing labor costs by 30%. Recommendations of this study include: Provision of specialized agribusiness loans for women. Promotion of mentorship programs for female farmers to optimize loan use.

Shang et al. (2024) examined globalization's impact on food security in Sub-Saharan Africa from 2001 to 2021 using the Heckscher-Ohlin trade theory and Generalized Method of Moments (GMM). Food availability and accessibility were measured through food production indices and GDP per capita. The study found globalization positively but insignificantly impacted food availability, while it negatively and significantly affected food accessibility. Innovation improved accessibility. Recommendations included integrated trade and infrastructure policies to enhance food access. Limitations included focusing only on Sub-Saharan Africa and excluding other food security dimensions, suggesting future studies explore different regions and variables.

3. Methodology

3.1 Model Specification

In other to achieve the research objective, the study adapts the model developed Ijaiya et al. (2017), which examined the relationship between Agricultural credit guarantee scheme and food security in Nigeria. Modifications were made to align with this study's focus on the impact of agricultural credit and female participation in agriculture on food security in Nigeria.

The adapted model incorporates agricultural credit as a key independent variable and replaces economic development with sustainable development as the dependent variable.

The original model was specified as:

$FS_t = \beta_0 + \beta_1 ACGSt + \beta_2 ACGS + \mu$……………………………………………………… (1)

Where:

Where:

FS_t = food security in Nigeria (proxied by changes in food crop production).

$ACGS_t$ = Agricultural Credit Guarantee Scheme on food security (in million Naira)

β_0 = Intercept

β_1-β_2 = The parameter estimates

To align with the focus on agricultural credit, female participation, and food secuirty in Nigeria, this study modifies Ijaiya et al. (2017) to attain model 2 below;

$FS_{it} = f (AGC_t, FPA_t, FEDU_t, ARL_t)$ …………………………..2

Where FS_i (Food security) is SDG 2 namely Zero hunger.

Explicit Model Specification

The econometric form of the model is written thus:

Model for Food production index:

$FPI_t = \beta_0 + \beta_1 AGC_t + \beta_2 FPA_t + \beta_3 FEDU_t + \beta_4 ARL_t + \beta_5 ACGSF_t + \epsilon_t$……………3

Model for No Hunger (SDG 2)**:**

$PU_t = \alpha + \alpha_1 AGC_t + \alpha_2 FPA_t + \alpha_3 FEDU_t + \alpha_4 ARL_t + \alpha_5 ACGSF_t + \epsilon_t$………………4

Where:

FPI = Food production index

PU_t = Prevalence of Hunger

AGC_t = Agricultural Credit

FPA_t = Female Participation in Agriculture

$FEDU_t$ = Female Education

ARL_t = Arable Land

$ACGSF_t$ = Agriculture credit guarantee scheme fund

β_0, α_0 = Intercepts of Inequalities Food Production Index model and Prevalence of Hunger model.

β_1 to β_5 : Coefficients for the Food Production Index model

$\alpha_1,$ to α_5: Coefficients for the Prevalence of Hunger model.

ϵ_t and μ_t = Error terms for each model.

3.3 Measurement and description of variables

Table 1. Measurement and Sources of Data

Variable	Representation	Measurement	Data Source (Year)	Reference
Dependent Variable				
Food Security	FPI	Food production index	World Development Indicators (WDI, 2023)	Liu et al. (2019)
	PU	Prevalence of undernourishment or food security index	Food and Agriculture Organization (FAO, 2023)	Afridi et al. (2021)
Independent Variable				
Agricultural credit	AGC	Total credit allocated to agriculture as a % of total bank credit	Food and Agriculture Organization (FAO, 2023)	Ozdemir (2024); Mogbolu (2024)
Agricultural Credit Guarantee Scheme Fund	ACGSF	Agricultural Credit Guarantee Scheme Fund disbursement	Central Bank of Nigeria (CBN, 2023)	Reuben (2020)
Female participation in agriculture	FPA	Percentage of female employment in agriculture	Food and Agriculture Organization (FAO, 2023)	Folarin et al. (2021)
Control Variable				
Female education	FEDU	Female school enrollment as a % of total enrollment	World Development Indicators (WDI, 2023)	Zaman et al. (2021); Bruno et al. (2021)
Arable land	ARL	Percentage of total land area suitable for agriculture	World Development Indicators (WDI, 2023)	Rubio et al. (2025)

Source: Authors' Compilation, 2025

3.3 Estimation Techniques

To achieve the objectives of this study, descriptive statistics will be used to provide an overview of the dataset by calculating measures such as mean, median, standard deviation, minimum, and maximum values. These statistics will help to identify

patterns, detect outliers, and assess the distribution and variability of each variable, offering insights into the characteristics of the data. A unit root test will be conducted using time-series-specific methods such as the Augmented Dickey-Fuller (ADF) test to assess the stationarity of the data and avoid spurious regression results. For the regression analysis, the mixed stationarity result led to the employment of the Fully Modified Ordinary Least Squares which estimates long-run relationships. This approach ensures a comprehensive and robust analysis of the impact of agricultural credit and female participation in agriculture on food security in Nigeria.

4.0 Presentation and Discussion of Results

4.1 Descriptive Statistics

The descriptive statistics of the dependent and independent variables employed in the model in this study are reported in Table 4.1 below;

Table 2. Descriptive Statistics

	FPI	PU	AGC	ACGSF	FPA	FEDU	ARL
Mean	88.65603	9.682479	8.042329	34586.34	34.55795	36.95338	39.53455
Median	84.49500	9.000000	5.698318	23681.00	32.78719	40.38205	39.51272
Maximum	119.8500	15.90000	19.65762	72322.00	44.67342	52.22863	40.48443
Minimum	61.35000	6.400000	1.434999	19945.00	28.35833	22.24407	37.33105
Std. Dev.	19.09101	2.574295	6.204915	17256.73	5.845295	8.716976	0.737539
Skewness	0.259848	1.049249	0.696009	0.773212	0.488834	-0.316826	-0.848722
Kurtosis	1.714530	3.233589	1.934381	2.251519	1.674524	1.869366	4.435952
Jarque-Bera	2.082727	4.829780	3.329360	3.074635	2.938782	1.819836	5.355212
Probability	0.352973	0.089377	0.189251	0.214957	0.230066	0.402557	0.068727
Sum	2305.057	251.7444	209.1006	864658.5	898.5066	960.7878	1027.898
Sum Sq. Dev.	9111.671	165.6749	962.5242	7.15E+09	854.1867	1899.642	13.59908
Observations	26	26	26	25	26	26	26

Source: Authors' computation (2025)

The descriptive statistics provide information regarding the distribution, variance, and normality of the data set, including Food Production Index (FPI), Prevalence of Undernourishment (PU), Agricultural Credit (AGC), Agricultural Credit Guarantee Scheme Fund (ACGSF), Female Participation in Agriculture (FPA), Female Education (FEDU), and Arable Land (ARL). FPI has a mean of 88.66 and SD of 19.09, high variability in food production with weak positive skew (0.26) and platykurtic distribution (1.71). PU has a mean of 9.68, SD of 2.57, high positive skewness (1.05), and leptokurtosis (3.23) with periodical sudden spikes in the level of

undernourishment. AGC has a mean of 8.04 with high variability (SD 6.20), moderate right skewness (0.70), and flat distribution (1.93).

ACGSF exhibits high mean (₦34,586.34) and high dispersion (SD ₦17,256.73), with little right skewness (0.77) and moderate kurtosis (2.25), which indicates variability in guaranteed funds. FPA has a mean of 34.56 and low variability (SD 5.85), with mild right skewness (0.49) and flat shape (1.67). FEDU averages 36.95 with moderate variability (SD 8.72), low left skewness (-0.32), and platykurtic behavior (1.87), which implies an even distribution with little outliers. ARL is of a constant mean value 39.53 (SD 0.74), but negative skewness (-0.85) and leptokurtosis (4.44) suggest clustering around the mean with fatter tails. Jarque-Bera test for normality shows all variables meet normal distribution criteria (p-values > 0.05), though PU (0.089) and ARL (0.069) show minor deviations and need to be treated with care in future analysis.

4.2 Correlation Analysis

Table 3. Correlation Matrix

Correlation Probability	FPI	PU	AGC	ACGSF	FPA	FEDU	ARL
FPI	1.000000						

PU	0.745507	1.000000					
	0.0000	-----					
AGC	-0.811117	-0.442365	1.000000				
	0.0000	0.0268	-----				
ACGSF	0.914784	0.834738	-0.718890	1.000000			
	0.0000	0.0000	0.0001	-----			
FPA	-0.856267	-0.521559	0.944409	-0.783634	1.000000		
	0.0000	0.0075	0.0000	0.0000	-----		
FEDU	0.763708	0.566906	-0.841483	0.688343	-0.916222	1.000000	
	0.0000	0.0031	0.0000	0.0001	0.0000	-----	
ARL	0.780365	0.573651	-0.670877	0.653051	-0.765908	0.776047	1.000000
	0.0000	0.0027	0.0002	0.0004	0.0000	0.0000	-----

Source: Authors' Computation (2025)

Correlation matrix elicits significant correlation between study variables. Food Production Index (FPI) correlates positively and strongly with ACGSF (0.91), FEDU (0.76), and ARL (0.78), but negatively with AGC (-0.81) and FPA (-0.86). Prevalence of Undernourishment (PU) increases as ACGSF (0.83), FEDU (0.57), and ARL (0.57) rise, but falls as AGC (-0.44) and FPA (-0.52) rise. AGC is positively correlated with

FPA (0.94) but negatively correlated with most others, including ACGSF (-0.72) and FEDU (-0.84). ACGSF is negatively correlated with FPA (-0.78) but positively with FEDU (0.69) and ARL (0.65). FPA is strongly negative with FEDU (-0.92) and ARL (-0.77), while FEDU and ARL are strongly positively correlated (0.78), showing interrelated effects among variables.

4.3 Stationarity Test

This study employed the Augmented Dickey-Fuller unit root test (ADF) on all the variables. Below, the table 4.3 presents the result of the ADF unit root test.

Table 4. ADF Panel Stationarity Test

Variables	Number of differencing	t-statistics (probability)	Order of integration
FPI	Level	-0.414488 (0.8921)	1(1)
	First Diff.	-8.134425 (0.0000)	
PU	Level	0.095335 (0.9588)	1(1)
	First Diff.	-3.259640 (0.0287)	
AGC	Level	-1.401870 (0.5650)	1(1)
	First Diff.	-6.968014 (0.0000)	
ACGSF	Level	1.361288 (0.9981)	I(1)
	First Diff.	-3.811802 (0.0095)	
FPA	Level	-1.851478 (0.3484)	I(2)
	First Diff.	-1.641262 (0.4470)	
	Second Diff.	-4.378676 (0.0024)	
FEDU	Level	-1.516579 (0.5089)	I(1)
	First Diff.	-6.251295 (0.0000)	
ARL	Level	-3.492144 (0.0169)	I(0)
	First Diff.	NA	

Source: Authors' Computation (2025)

Augmented Dickey-Fuller (ADF) test was employed to check for stationarity of variables. Food Production Index (FPI), Prevalence of Undernourishment (PU), Agricultural Credit (AGC), Agricultural Credit Guarantee Scheme Fund (ACGSF), and Female Education (FEDU) are not stationary at level but become stationary upon first differencing, i.e., they are integrated of order one, I(1). On the other hand, Food Production Index per capita (FPA) is non-stationary at level and first difference but only becomes stationary after second differencing and hence is I(2). Arable Land (ARL) is stationary at level with a p-value of 0.0169 and thus is integrated of order zero, I(0). This combination of I(0), I(1), and I(2) variables suggests that traditional regression may be invalid because spurious results may arise from them. Therefore, advanced econometric techniques such as cointegration analysis are required to identify long-run relationships among these variables so that valid statistical inference is achieved.

4.5 Regression Result

The table below show the regression result of this study using the fully modified least square method.

Table 5. Regression Result (FMOLS)

Variables	Dependent Variables	
	Food Production Index (Model 3 - FPI)	Prevalence undernourishment (Model 4 - PoU)
AGC	–0.8712	–0.0078
	(0.1540)	(0.9287)
ACGSF	0.0007	0.0002
	(0.0000)	(0.0000)
FPA	0.0131	0.5630
	(0.9890)	(0.0008)
ARL	9.6858	0.3996
	(0.0132)	(0.4465)
FEDU	–0.3912	0.2467
	(0.2953)	(0.0002)
C	–296.5229	–40.7558
	(0.0502)	(0.0644)
R-squared:	0.902719	08427.14
Adjusted R-squared:	0.874107	0.796453
S.E of regression:	6.477081	1.118813
Long-run variance:	31.12995	0.668269

Variables	Dependent Variables	
	Food Production Index (Model 3 - FPI)	Prevalence undernourishment (Model 4 - PoU)
Mean dependent variable:	87.88246	9.408213
S.D dependent variable:	18.25484	2.479852
Sum squared residuals:	713.1939	21.27964

Source: Authors' computation (2025)

In the first model, which measures the determinants of food production, the regression results indicate that Agricultural Credit Guarantee Scheme Fund (ACGSF) has a positive and statistically significant effect on food production in Nigeria, with a coefficient of 0.000677 and a p-value of 0.0000. In addition, Arable Land (ARL) also demonstrated a strong and significant positive impact on food production, with a coefficient of 9.6858 and a p-value of 0.0132. Other variables, such as Agricultural Credit (AGC), Female Participation in Agriculture (FPA), and Female Education (FEDU), were not statistically significant in the food production model. Although AGC had a negative coefficient (-0.8712), it was not significant. While FPA and FEDU had coefficients of 0.0131 and -0.3912 respectively, both with p-values far above 0.05.

The second model estimates the determinants of undernourishment. The results indicate a more complex relationship. Surprisingly, ACGSF, FPA, and FEDU all had positive and statistically significant effects on the prevalence of undernourishment. ACGSF had a coefficient of 0.000173 with a p-value of 0.0000. Female Participation in Agriculture (FPA) showed a significant positive effect (coefficient = 0.5630; p = 0.0008) and Female Education (FEDU) also showed a positive and statistically significant effect on undernourishment (coefficient = 0.2467; p = 0.0002), which is counterintuitive.

5. Discussion of Findings

The Panel FMOLS regression results reveal long-run effects of funding agriculture, land access, gender participation, and women's empowerment on Nigerian food security, as measured by the Food Production Index (FPI) and Prevalence of Undernourishment (PU).

The Agricultural Credit Guarantee Scheme Fund (ACGSF) in the FPI model is highly, positively significant (β = 0.000677, p < 0.001), confirming that guaranteed credit increases small-scale farmers' access to finance, reduces the risk of lending, and promotes investment in inputs and technology. This agrees with Raufu et al. (2025), who confirmed that ACGSF raises crop and animal production. Arable Land (ARL) also has a significant positive impact on FPI (β = 9.6858, p = 0.0132) in supporting FAO (2023) findings that land access remains a valid factor in enhancing agricultural production. Agricultural Credit (AGC) is, however, negative and insignificant (β = –0.8712, p = 0.1540) as reflective of poor implementation and low targeting as noted by Adanacıoğlu et al. (2025). Female Participation in Agriculture (FPA) and Female Education (FEDU) are both insignificant (p = 0.9890 and 0.2953), according to Obayelu et al. (2024), who raise women's low productivity contribution to factors like insecure land rights, weak access to extension services, and low empowerment.

For the PU model, ACGSF again has a strong and positive effect (β = 0.000173, p < 0.001), as it raises food output but hasn't reduced undernourishment. This agrees with FAO (2023), which continues that higher food output does not necessarily equate to equal food access. FPA is highly positive (β = 0.5630, p = 0.0008), indicating that increased female involvement in agriculture has not brought an end to hunger due to underlying structural inequalities that hinder the productivity of women (Obayelu et al., 2024). Similarly, FEDU has a positive and significant correlation with undernourishment (β = 0.2467, p = 0.0002), possibly because education removes women from agriculture but does not provide conducive income or resources to improve the household food supply, as noted by FAO (2023), which points out that the return on education is dependent on broader economic and institutional assistance. AGC (β = –0.0078, p = 0.9287) and ARL (β = 0.3996, p = 0.4465) fail to explain undernourishment, suggesting that production-based factors alone do not correct hunger unless complemented with inclusive food systems and nutrition-sensitive programs.

Generally, findings suggest that ACGSF and land availability enhance food production but not necessarily improved nutrition outcomes. Land and credit policies need to be more narrowly focused and fused with social protection, gender-sensitive measures, and equitable food distribution to reduce hunger. Women's education and involvement need to be followed by access to land, capital, and extension services in order to become reality for better food security (Obayelu et al., 2024; FAO, 2023).

6. Summary and Conclusion

The study utilized panel data of 25 years (1998–2023) and the Panel Fully Modified Least Squares (FMOLS) approach to investigate the long-run impact of agricultural lending, female participation, education, and land availability on food security in Nigeria. Mixed orders of integration were revealed by stationarity tests, validating the strategy.

Results of the baseline model (Food Production Index) indicated that Agricultural Credit Guarantee Scheme Fund (ACGSF) and arable land (ARL) were key drivers in improving food production, reflecting the role of institutional credit facilitation and land access. However, agricultural credit (AGC), female agriculture participation (FPA), and female education (FEDU) were not significant, necessitating additional policy action.

In the second model (Prevalence of Undernourishment), ACGSF, FPA, and FEDU were significant and positive, suggesting that while these factors augment output or capacity, they may not directly reduce hunger without access, empowerment, and targeted interventions. AGC and ARL were insignificant in reducing hunger. Overall, evidence points to an imbalance between improvements in productivity and improved nutrition outcomes. Increased access to credit and land raises production but, in the absence of effective food distribution, gender equity, and institutional support, undernourishment persists.

It concludes that Zero Hunger (SDG 2) in Nigeria can be attained not only by increasing agricultural production but also by ensuring access to resources, gender empowerment, and greater linkages between production and distribution systems. A multidimensional strategy considering both food security supply and demand sides is essential.

6.1 Recommendations

Based on the findings and conclusion of this study, the following policy recommendations are proposed:

i. Strengthen and effectively target institutional credit schemes, particularly the Agricultural Credit Guarantee Scheme Fund (ACGSF), to ensure that smallholder and food-crop farmers are the primary beneficiaries. Proper targeting will help improve both production and household food access.

ii.   Expand access to arable land and secure land tenure, especially for women and youth, through land reform and allocation policies. This will promote inclusive agricultural growth and boost national food output.

iii. Support female farmers with complementary interventions such as mechanization, access to improved inputs, training, extension services, and credit, to ensure that their increased participation contributes meaningfully to food production and security.

iv. Align educational policies with agricultural and nutrition development goals by promoting vocational, entrepreneurial, and technical agricultural training, especially in rural areas, to enhance the contribution of education to household food and income security.

v.   Improve food distribution systems and market access infrastructure, particularly in rural and food-insecure areas, to ensure that gains in food production are equitably distributed and accessible to vulnerable populations.

vi. Establish and strengthen monitoring and evaluation systems to track the impact of agricultural credit, land reforms, and gender-based interventions on food production and nutritional outcomes. This will enable evidence-based policy adjustments for better results.

7. References

Adanacıoğlu, H., Raufu, M., & Tunde, O. (2025). The Impact of Agricultural Credit Guarantee Scheme Fund on Agricultural Output in Nigeria. *International Journal of Business and Management Studies*, *11*(3), 168–182.

Adebayo, S., & Adekunle, F. (2021). The role of agricultural credit in Nigeria's rural development. *Nigerian Journal of Agricultural Economics*, *12*(3), 45–60.

Afridi, G. S., Jabbar, A., Khan, S., & Akmal, N. (2021). An analysis of food insecurity in Pakistan: Prevalence of undernourishment (Pou) and Food Insecurity Experience Scale (FIES). *Journal of Applied Economics and Business Studies*, *5*(1), 175–190. https://doi.org/10.34260/jaebs.519

Ajayi, J., & Balogun, O. (2021). Addressing food insecurity through agricultural credit and gender inclusion in Nigeria. *Journal of Development Studies*, *18*(3), 98–115.

Bello, K., & Akinyemi, A. (2023). The welfare impact of agricultural credit on rural households in southern Nigeria. *Journal of Agricultural Finance*, *20*(5), 102–118.

Bruno, P., & Lewis, C. M. (2021). Equity in high school computer science: Beyond access. *Policy Futures in Education*, 147821032110630. https://doi.org/10.1177/14782103211063002

Dolapo, A. O., Onyeaka, H., Ekwueme, C. T., Njoagwuani, E. I., Ayomikun, O. O., Ngene, C. E., Olatunji, C. A., Oladunjoye, I., Michael, I. M., Akegbe, H., Tamasiga, P., & Ghosh, S. (2025). Evaluating consumer perceptions and safety of Genetically Modified Foods in Africa: A comprehensive review. *Food Science & Nutrition*, *13*(6), e4730. https://doi.org/10.1002/fsn3.4730

Eze, A. C., & Onwuka, C. (2023). Assessing agricultural credit and gender inclusivity for sustainable food systems in Nigeria. *International Journal of Agricultural Research*, *15*(1), 120–137.

Folarin, E. M., Osabuohien, E. S., Okodua, H., Onabote, A., & Osabohien, R. (2021). Male and female employment in agriculture and agricultural productivity in Nigeria. *IOP Conference Series. Earth and Environmental Science*, *665*(1), 012066. https://doi.org/10.1088/1755-1315/665/1/012066

Food and Agriculture Organization of the United Nations. (2023). *The state of food security and nutrition in the world 2023*. https://www.fao.org/documents/card/en/c/CC3017EN

Food and Agriculture Organization. (2023). *Agriculture in Nigeria*. https://www.fao.org

Hussaini, A. S., Oladimeji, Y. U., Musa, U., Balan, I. M., & Firu Negoescu, G. A. (2024). The Dynamics Of The Undernourished Population In Nigeria Compared To Africa. *Agricultural Management/Lucrari Stiintifice Seria I, Management Agricol*, *26*(3).

Igwemeka, E. O., & Ekwunife, F. C. (2020). Agricultural value chain financing: Panacea for sustainable development in Nigeria. *UNIZIK Journal of Business*, *3*(1).

Ijaiya, M. A., AbdulRaheem, A., & Abdullahi, I. B. (2017). Agricultural credit guarantee scheme and food security in Nigeria. *Ethiopian Journal of Environmental Studies and Management*, *10*(2), 208-218.

Ilesanmi, O. T. (2024). *A Climate Smart Agricultural Productivity Assessment of Smallholder Women Farmers in Farming Associations in Nigeria: A Mixed Methods Study*.

Kasuwa, P. F. (2024). Nigeria: Hungry Nation in a Land of Plenty. *Przegląd Prawno-Ekonomiczny*, (3), 9-32.

Likius, N. (2024). *Assessing the impact of credit finance on agricultural productivity in Namibia (Doctoral dissertation, Doctoral dissertation)*.

Liu, Y., Wang, S., & Chen, B. (2019). Optimization of national food production layout based on comparative advantage index. *Energy Procedia*, *158*, 3846-3852.

Mogbolu, F. (2024). The relevance of bank lending behaviour for the efficiency of public credit guarantee: Evidence from Nigeria. *African Development Finance Journal*, *7*(3), 70–95.

Mose, N. (2024). Economic growth and female participation in the labour market: Gender disaggregated data. *Business and Economic Research*, *14*(2), 93. https://doi.org/10.5296/ber.v14i2.21796

Njoku, C. L., Mezu, O., Izuogu, C. U., Olesin-Ibrahim, S., Olaolu, M. O., Azuamairo, G. C., ... & Udokure, U. J. (2025). Sex-Based Constraints in Accessing Agricultural Resources in Ebonyi State, Nigeria. *Journal of Agricultural Extension*, *29*(1), 1-8.

Nwankwo, C., Udo, I., & Chika, E. (2022). Empowering women through agribusiness credit: A case study of southeastern Nigeria. *African Journal of Agricultural Economics*, *14*(2), 54–72.

Obayelu, O. A., Okoruwa, V., & Yusuf, S. A. (2024). Women's Empowerment in Agriculture and Household Food Insecurity in Nigeria. *Multidisciplinary Journal of Agricultural Economics*, *31*(1), 22–35.

Okeke, C., Uzochukwu, E., & Nnadi, F. (2021). Women's leadership in agriculture and sustainable food practices in Nigeria. *Journal of Sustainable Development in Africa*, *23*(2), 67–82.

Okeke, U., Nwankwo, I., & Chukwu, L. (2021). Women's leadership roles in agriculture and their impact on sustainable agricultural practices and food security in Southeastern Nigeria. *Journal of Gender and Rural Development*, *7*(2), 45–60.

Okunola, J. (2024). Women's Role in Agricultural Development in Oyo State. In *Unveiling Challenges, Opportunities for Success, and Pathways to Sustainable Growth*.

OLALEYE, O. M. (2023). *Migratory Patterns And Livelihood Activities Of Female Migrant Workers In Rural Areas Of Ondo West Local Government Area, Ondo State, Nigeria* (Doctoral dissertation).

Onoh, U. C., Erezi, E., & Clement, B. (n.d.). Analyzing the role of women in climate resilience building and sustainable farming practices in Nigeria. *IIARD International Journal of Geography and Environmental Management*, *9*(4), 65–87.

Osabohien, R., Olurinola, I., Matthew, O., Azuh, D., & Aderounmu, B. (2021). Female participation in agriculture and economic development in 33 African Countries. *African Journal of Reproductive Health*, *25*(s5), 107–115. https://doi.org/10.29063/ajrh2021/v25i5s.10

Osuafor, G. N., & Okoli, C. E. (2021). Application of the Theory of Gender and Power to Examine Sexual and Reproductive Autonomy Among Women in Mahikeng in South Africa. *African Journal of Gender*, *10*(3).

Oweibia, M., Elemuwa, U. G., Akpan, E., Daniel, E. T., Oruikor, G. J., Tarimobowei, E., Okoho, E. E., Elemuwa, C. O., Raimi, M. O., & Babatunde, A. (2024). Analyzing Nigeria's journey towards Sustainable Development Goals: A comprehensive review from inception to present. *Qeios*. https://doi.org/10.32388/8o5qeg

Ozdemir, D. (2024). Reconsidering agricultural credits and agricultural production nexus from a global perspective. *Food and Energy Security*, *13*(1). https://doi.org/10.1002/fes3.504

Rahman, M. M. A., Khan, A. U. I., & Vergil, H. (2025). Reducing Food Insecurity in Sub-Saharan Africa: The Role of Institutions and Financial Stability. *Journal of Agriculture and Environment for International Development (JAEID)*, *119*(1), 413–438.

Raufu, M., Fajobi, D. T., Dlamini-Mazibuko, B., Miftaudeen-Raufu, A., & Olalere, J. (2025). Agricultural Credit Guarantee Scheme funds and agricultural performance in Nigeria. *International Journal of Multidisciplinary Approach Research and Science*, *3*(01), 1–13. https://doi.org/10.59653/ijmars.v3i01.1190

Reuben, J. (2020). Agricultural credit guarantee scheme fund and its effect on agricultural output in Nigeria. *Review of Agricultural and Applied Economics*, *23*(2), 102–111. https://doi.org/10.15414/raae.2020.23.02.102-111

Rubio, J. L., Recatalá, L., & Andrew, V. (2025). European desertification. *WIT Transactions on Ecology and the Environment*.

Sasa, S., Adebayo, E., & Maurice, D. (2022). Constraints To Women Participation in Agriculture and Economic Development in Nigeria: A Review. *Constraints*, *8*(5), 72–80.

Shang, Y., Lv, Y., Chen, Z., Bassey, R., Aderemi, T. A., & Enilolobo, O. (2024). Globalization and food security in Sub-Saharan Africa. *Frontiers in Sustainable Food Systems*, *8*, 1325172.

Usman, Y., & Ibrahim, A. (2020). Agricultural credit, female participation, and environmental sustainability in northern Nigeria. *Journal of Sustainable Agriculture*, *12*(1), 78–95.

Zaman, Q. uz, Wang, Z., Zaman, S., & Rasool, S. F. (2021). Investigating the nexus between education expenditure, female employers, renewable energy consumption and CO2 emission: Evidence from China. *Journal of Cleaner Production*, *312*(127824), 127824. https://doi.org/10.1016/j.jclepro.2021.127824