

Article

The Role of Institutional Credit in Enhancing Food Security Among Farming Households in Kano State, Nigeria

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Abstract

Food insecurity remains a structural impediment to rural welfare in sub-Saharan Africa (SSA), with smallholder farming households in northern Nigeria among the most severely affected. This study examined the socioeconomic determinants of food security among farming households in Kano State, Nigeria, with emphasis on the role of institutional credit access, using the Food Consumption Score (FCS) methodology. Data were collected through semi-structured face-to-face interviews using multi-stage cluster sampling and analyzed using descriptive statistics, chi-square analysis, one-way ANOVA, and multiple linear regression. Slightly fewer than half of the sampled households met the food-secure threshold, and food security status was significantly associated with the level of access to institutional credit, with a noticeable gap in food security status between high-access and no-access households. Multiple regression confirmed that access to institutional credit, farming experience, and farm size were significant and positive determinants of food security, while household size was a significant negative determinant. These findings demonstrate that institutional credit is an important, policy-actionable pillar of rural food security in Kano State Nigeria, best pursued alongside corresponding investments in farmer experience-transfer, land access, and household welfare.

Keywords: food security; institutional credit; food consumption score; credit access; farming households



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1. Introduction

Food insecurity remains one of the most persistent and structurally entrenched developmental challenges of the twenty-first century, particularly in low- and middle-income countries (LMICs) where smallholder agriculture constitutes the primary livelihood strategy for the majority of rural populations [1,2]. According to the State of Food Security and Nutrition in the World (SOFI) 2025 report, approximately 673 million people, representing 8.2% of the global population, experienced hunger in 2024, while an estimated 2.3 billion people faced moderate or severe food insecurity [1]. Sub-Saharan Africa (SSA) bears a disproportionate share of this burden: over one in five Africans experienced chronic undernourishment in 2024, and projections suggest that approximately 512 million people

could remain chronically food insecure by 2030, with nearly 60% of them concentrated in Africa. Without structural intervention, the achievement of Sustainable Development Goal 2 (SDG 2: Zero Hunger) will therefore remain an increasingly distant prospect [1,3].

The concept of food security has evolved considerably since its formal introduction at the 1974 World Food Conference. The classical four-pillar framework—availability, access, utilization, and stability—has been progressively extended in the scholarly literature to incorporate two additional dimensions: agency (the capacity of individuals and communities to make autonomous food-system choices) and sustainability (the ability of food systems to maintain food security across generations without compromising the natural resource base) [4,5]. This six-pillar framework reflects a growing recognition that structural inequalities, environmental constraints, and governance failures are inseparable from household-level food security outcomes [5]. In this study, the six-pillar framework serves as the conceptual framing for the research motivation; the empirical analysis, in line with the FCS methodology, operationalizes only the availability, access, and utilization dimensions, while agency and sustainability are not independently measured—a scope limitation acknowledged in Section 5.

Nigeria presents one of the most acute and paradoxical food security crises in the world. Despite being Africa's largest economy and most populous nation, with approximately 70.8 million hectares of arable land, Nigeria ranked 110th out of 127 nations in the 2024 Global Hunger Index [6]. The number of Nigerians experiencing acute food insecurity escalated from 66.2 million in early 2023 to approximately 100 million—about 37% of the total population—by early 2024 [7]. A 2025 FAO projection warns that 30.6 million Nigerians may face acute food insecurity between June and August 2025 alone [8]. This crisis is driven by a convergence of factors, such as, the Boko Haram insurgency in the northeast, rural banditry in the northwest and Middle Belt, climate variability, and food inflation exceeding 29% in 2024—pressures that are felt most acutely in rural areas, where over 70% of the population depends on smallholder agriculture [7,8].

In this constrained environment, access to institutional credit represents a potentially transformative yet critically underutilized pathway [9]. Economic theory and empirical evidence from SSA consistently document that credit access can break the low-productivity trap by enabling farmers to finance yield-enhancing inputs, smooth consumption during lean periods, and build resilience against covariate shocks [10,11]. However, traditional lending institutions perceive agricultural credit as high-risk due to seasonal cash flows, weather-related shocks, collateral scarcity, and information asymmetries, thereby systematically excluding the majority of smallholder farmers from formal financial services [12,13]. Without credit, farmers cannot invest in productivity-enhancing inputs; without productivity gains, they cannot generate surplus income; and without income growth, they remain trapped in subsistence agriculture and persistent food insecurity [10].

Despite extensive research on credit access and the determinants of food security in Nigeria, the empirical nexus between institutional credit, in particular and household food security, measured through validated dietary-quality indices, remains understudied and methodologically fragmented. Existing studies either examine determinants of credit access in isolation [14,15] or assess food security status without adequately linking it to the credit dimension [16,17]. While the credit-food security nexus has been examined in other agro-ecological and national contexts, to the authors' knowledge no prior study has jointly examined institutional credit access and household food security, measured through a validated dietary-quality index, among smallholder farmers in Kano State, Nigeria's second most populous state, whose predominantly smallholder agricultural economy operates in a semi-arid agro-ecological zone. The present study therefore offers a context-specific empirical contribution rather than claiming an entirely novel research direction.

Against this background, the study evaluates the nexus between institutional credit access and rural household food security in Kano State, Nigeria. Specifically, the objectives are as follows: (i) to assess the food security status of rural farming households using the FCS methodology; (ii) to examine the statistical association between institutional credit access levels and household food security status; and (iii) to identify the socioeconomic determinants of food security, with particular emphasis on credit accessibility. The findings are intended to generate evidence-based policy insights for simultaneously improving financial inclusion and food security in northern Nigeria and analogous contexts across SSA.

2. Materials and Methods

2.1. Study Area

This study was conducted in Kano State, located in northwestern Nigeria (11.5° N, 8.5° E) (Figure 1). Kano is one of Nigeria's most populous states with approximately 13.4 million inhabitants, of whom over 70% reside in rural areas and depend on agriculture for their livelihoods. The state experiences a semi-arid climate with mean annual rainfall of 600–800 mm, concentrated between May and September. Major crops include millet, sorghum, maize, cowpea, and groundnut. The state is divided into three agricultural zones based on ecological and farming system characteristics.

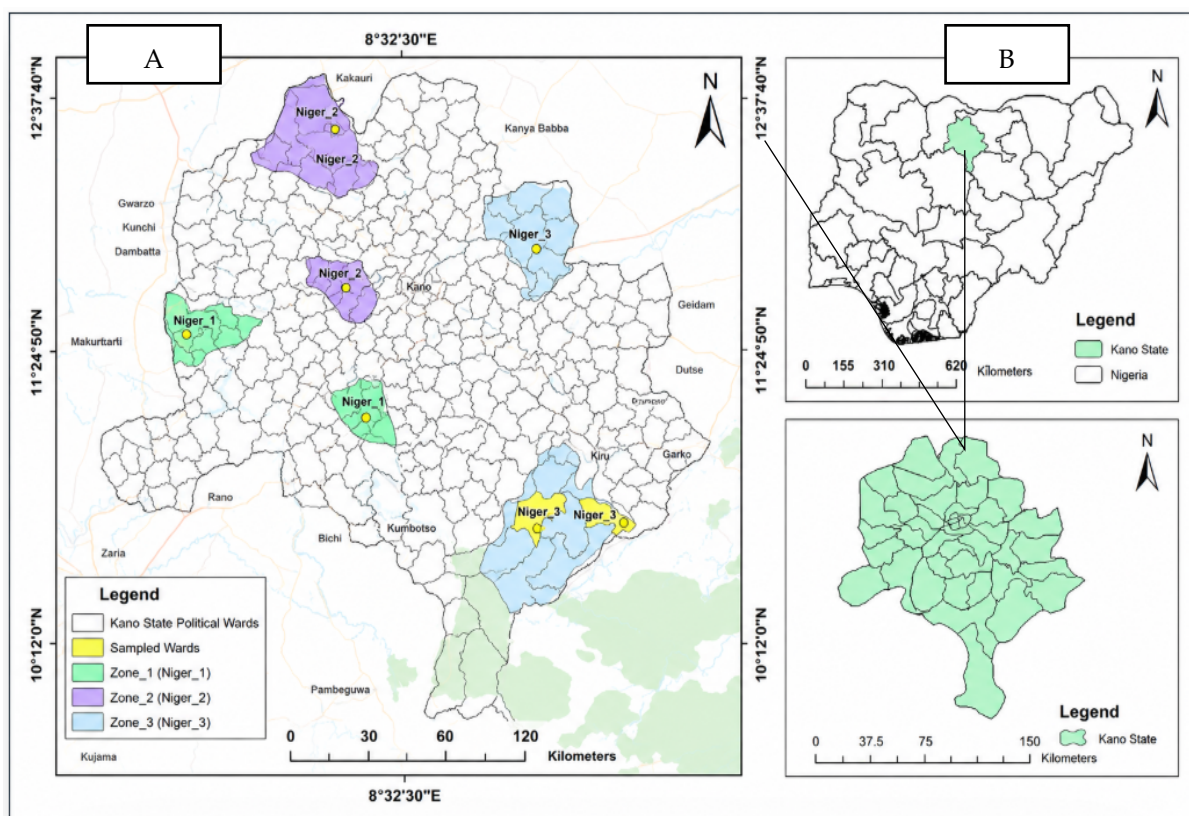


Figure 1. Map of the study area: (A) location of Kano State within Nigeria; (B) the six sampled Local Government Areas (LGAs) within Kano State.

2.2. Sampling Procedure and Sample Size

A multi-stage cluster sampling technique was employed. In the first stage, Kano State was stratified into three agricultural zones, and two local government areas (LGAs) were randomly selected from each zone, yielding six LGAs. In the second stage, 12 wards were purposively selected based on agricultural activities and population size, with two wards drawn per selected LGA to ensure balanced representation of the varying agro-ecological

and livelihood conditions within each LGA while keeping the fieldwork manageable within the study timeframe. Sample size was determined using Yamane's (1967) formula, as cited in Hasan and Kumar [18].

$$n = \frac{N}{1 + N[e]^2}$$

where N = estimated farming household population (49,900) and e = margin of error (0.05), yielding a minimum sample of 397. This was doubled to a target of 800 to account for non-response and improve statistical power. Proportionate sampling was used to allocate respondents across wards based on population estimates (Table 1); the ward-level proportionate allocations summed to 799, one short of the 800-target due to rounding, and one additional questionnaire was administered in the highest-population ward to reach the target. Systematic random sampling was then applied within each village. Of 800 questionnaires administered, 745 (93.1%) were retrieved. After data cleaning to remove incomplete responses and outliers, 739 questionnaires (92.4% response rate) were analyzed.

Table 1. Sampling procedure.

Zone	Local Government Area	Wards	Est. Farming Household Population	Number Sampled
Zone 1	Gwarzo	Mainika	4000	64
		Kutama	7000	112
	Garun Malam	Garun malam	5000	80
		Galadimawa	2500	40
Zone 2	Kunchi	Kunchi	3000	48
		Gwarmai	2600	42
	Tofa	Zango Kaaba	2800	45
		Yansabo	2000	32
		Gani	3500	56
Zone 3	Sumaila	Rimi	5500	88
		Gurama	3000	48
	Gabasawa	Zakirai	9000	144
			49,900	799

2.3. Data Collection

Data were collected between January and August, 2024 using semi structured questionnaires administered through face-to-face interviews. The questionnaire was pre-tested with 30 farmers from a non-study village and refined based on feedback. Enumerators received two days of training on interview techniques and ethical considerations. The questionnaire captured: household demographics (age, education, household size, and farming experience); economic indicators (income, assets, and farm size); credit access information (sources, amounts, frequency, and constraints); training (a binary indicator of whether the household head had received any formal agricultural extension training in the preceding two years, irrespective of provider); practice of sustainable agriculture (a binary indicator of whether the household had adopted at least one recognized sustainable agricultural practice, e.g., minimum tillage, crop rotation, agroforestry, or organic manure application, in the preceding cropping season) and food consumption patterns (a 7-day dietary recall for FCS calculation).

2.4. Data Analysis

SPSS version 27.0 was used for the data analysis. Descriptive statistics was used to estimate farming household characteristics and food security (FS) status. A chi-square test evaluated the association between access-to-credit categories and FS status. In addition, paired *t*-tests were used to compare mean FCS across credit-access categories. Finally,

multiple linear regression was used to examine the determinants of FS (with FCS measured as a continuous variable).

2.4.1. Food Consumption Score

Food security was measured using the Food Consumption Score (FCS), a composite indicator developed by the World Food Programme (WFP) that reflects dietary diversity, food frequency, and nutritional importance of food groups [19].

$$FCS = \sum (FGF \times FGW) \quad (1)$$

where

FGF = Food group frequency.

FGW = Food group weight.

Similarly, the Food Consumption Gap Ratio (FCGR) is estimated as:

$$FCGR = \frac{R - C}{R}$$

where

R = Threshold, *C* = Actual consumption score.

The threshold is the minimum FCS required to be classified as food secure, and AFCS is the mean FCS for the group. A negative FCGR indicates a consumption surplus, while a positive value indicates a consumption deficit.

FCS Construction Procedure

To construct the FCS, data on household-level food consumption were collected using a list of food items and food groups relevant to the study area. Respondents were asked how frequently their household had consumed each food group over the preceding seven days. Food items were then grouped into eight different food groups based on the WFP standard (main staple, pulses, vegetables, fruits, meat and fish, milk and dairy products, sugar and sugar products, and oils and fats). In addition, the weights assigned to each food group were as follows: Staples (cereals, roots, and tubers) = 2, Pulses/legumes = 3, Vegetables = 1, Fruits = 1, Meat/fish/eggs = 4, Milk/dairy products = 4, Sugar/honey = 0.5, and Oils/fats = 0.5. The consumption frequencies of each food group were summed. Any frequency values greater than 7 were set to 7. The values found for each food group were multiplied by the weight of the food group. The summation of the weighted food group scores is the FCS. Households' food security status was categorized using WFP standard thresholds: Food Insecure: $FCS \leq 21$; Borderline: $FCS 21.5\text{--}35$; Food Secure: $FCS > 35$.

2.4.2. Chi-Square

A chi-square analysis was employed to examine the relationship between access to credit, categorized as (highly accessible, moderately accessible, partially accessible, and not accessible, and the food security status of the respondents, categorized as food secure, borderline, and food insecure. Mathematically:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^c \left(\frac{o_{ij} - E_{ij}}{E_{ij}} \right)^2 \quad (2)$$

Description of the Access to Credit Methodology

For the purpose of this study, institutional credit is operationally defined as credit obtained from formally regulated sources, i.e., commercial banks, microfinance

banks/institutions, government agricultural development banks or schemes, and registered farmer cooperatives, as distinct from informal sources such as family, friends and moneylenders. Access to credit was measured using a composite index based on the following questions: Did the farming household receive credit in the past year? How many credit sources did the respondent access? Was the amount received adequate? Did the credit arrive on time? Each of the four questions was scored (yes/adequate/timely responses scored higher than no/inadequate/delayed responses), and the summed score was used to construct two versions of the access-to-credit measure: (i) a four-category ordinal variable, used in the chi-square and ANOVA tests, and (ii) the same underlying summed score retained in its continuous form, used as a predictor in the multiple regression model reported in Section 3.6. The categorical and continuous versions are, therefore, two representations of the same underlying composite index rather than independently derived measures. Based on the responses, the respondents were classified into four groups: (1) highly accessible (obtained adequate credit from ≥ 2 formal sources when needed); (2) moderately accessible (obtained credit from 1 to 2 sources but with some constraints); (3) partially accessible (obtained insufficient credit or with significant delays); and (4) not accessible (no credit obtained despite attempts, or no access to credit sources). These four categories were constructed jointly from the responses to the four questions above (number of sources, adequacy, timeliness, and receipt), rather than from a single threshold value; a household was classified as “highly accessible” only if credit was obtained from at least two formal sources and reported as both adequate and timely, while “not accessible” captures households reporting no credit obtained. While credit amounts and frequency were captured in the questionnaire, interest rates and repayment terms were not, and the descriptive detail on credit amounts and sources is not reported in the present analysis; this is acknowledged as a limitation in Section 5.

2.4.3. One-Way ANOVA

The dependent variable FCS is measured on an interval scale, which satisfies the parametric assumptions for ANOVA. Similarly, accessibility to credit, consists of four distinct groups (highly accessible, moderately accessible, partially accessible, and not accessible). Therefore, a one-way ANOVA was considered to be a suitable analytical method. The model is estimated as:

$$F = \frac{MS_{between}}{MS_{within}} = \frac{SS_{between}/df_{between}}{SS_{within}/df_{within}} \quad (3)$$

$$SS_{between} = \sum_{j=1}^k n_j (\bar{X}_j - \bar{X}_{grand})^2 \quad (4)$$

$$SS_{within} = \sum_{j=1}^k \sum_{i=1}^{n_j} (X_{ij} - \bar{X}_j)^2 \quad (5)$$

$$SS_{total} = SS_{between} + SS_{within}$$

The degrees of freedom are calculated as $K - 1$ between groups, $N - K$ within groups, and $N - 1$ in total.

The mean square is given as; $MS_{between} = \frac{SS_{between}}{K - 1}$ $MS_{within} = \frac{SS_{within}}{N - K}$.

Decision rule: If $F > \text{Critical}$, reject H_0 , H_0 : means are equal across the group ($\mu_1 = \mu_2 = \dots = \mu_k$), H_1 : at minimum one group mean differs.

2.4.4. Multiple Regression Analysis

Multiple regression analysis was used to examine the effects of socioeconomic determinants on food security, with particular emphasis on credit accessibility.

The model was specified as:

$$\text{FCS} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + \epsilon_i \quad (6)$$

where

FCS = Food Consumption Score (outcome variable).

$X_{1i} + X_{2i} + \dots + X_{ki}$ = Exogenous variables (age, education, household size, credit access, farm size, experience, training, sustainable practices) β_0 = Constant, $\beta_1 + \beta_2 + \dots + \beta_k$ are coefficients, ϵ = Error term.

Model Diagnostics

Multicollinearity was checked using the variance inflation factor (VIF); all variables were within the acceptable range ($\text{VIF} < 10$). Normality was assessed using a histogram of the residuals, and homoscedasticity was inspected using residual plots. Statistical significance was set at the 5% level.

2.5. Ethical Considerations

Ethical approval was obtained from the Federal University Dutse Research Ethics Committee (REC). Informed consent was obtained from all respondents after explaining the study's purpose, voluntary participation, and confidentiality.

3. Results

3.1. Socio-Economic Characteristics of the Respondents

The socioeconomic profile of the 739 analyzed households is presented in Table 2. The mean age of household heads was 40.16 ± 11.40 years, indicating a predominantly working-age farming population. Prime-age farmers in this bracket typically possess better access to institutional services—including formal credit—than their younger or elderly counterparts [20]. Mean farming experience was 15.72 ± 10.81 years, reflecting substantial accumulated agronomic knowledge; experience was well documented as a significant positive predictor of input efficiency and adaptive capacity under resource constraints [21]. Educational attainment was markedly low (mean = 6.56 ± 3.59 years, equivalent to incomplete primary education). Low human capital constrains farmers' ability to navigate formal credit application procedures and assimilate extension messages [22]. Household size averaged 9.00 ± 5.43 persons, sustained by a polygynous household structure (mean 2.00 wives). Large households simultaneously generate a labor pool advantage and elevate aggregate food consumption demands, creating a tension predicted by the resource-dilution hypothesis to depress per capita dietary quality [23]; the resource-dilution hypothesis is used here as an interpretive lens for the observed negative household-size coefficient and was not itself formally tested as a distinct statistical model. Farm holdings were exceedingly small (mean = 0.87 ± 0.35 ha), with 88% of respondents operating below 1 ha, substantially amplifying dependence on external capital to finance the inputs necessary for food security [24].

Table 2. Socio-economic characteristics (n = 739).

Variables	Minimum	Maximum	Mean	S.D.
Age of the farmers	18	67	40.16	11.4
Farming experience	1	43	15.72	10.81
Number of wives	0	4	2	0.784
Education (years)	0	16	6.56	3.59
Household size	2	18	9	5.43
Farm size (Acre)	1	7	0.87	0.35

3.2. Food Security Status of the Respondents

Table 3 presents the distribution of food security status. Fewer than half of sampled households (47.63%; n = 352) met the food-secure threshold (FCS > 35), while 26.39% (n = 195) were borderline and 25.98% (n = 192) were food insecure. The population-level mean FCS of 31.16 falls below the food-security threshold of 35. The aggregate FCGR of 0.11 indicates that the sampled population must, on average, increase dietary consumption by 11% to meet minimum acceptable food security standards. Food-secure households recorded a mean FCS of 43.67 and a negative FCGR of −0.25, confirming a dietary surplus 25% above threshold. Borderline households recorded a positive FCGR of 0.16, indicating a 16% consumption deficit, rendering them acutely vulnerable to seasonal and economic shocks. Food-insecure households recorded a mean FCS of 19.32 and an FCGR of 0.45, indicating a 45% consumption shortfall—a depth of deprivation associated with stunted child growth, reduced labor productivity, and intergenerational poverty traps in comparable SSA contexts [23,25].

Table 3. Food security status of farming households.

Food Security Status	Frequency	Percentage	Mean Score	FCGR
Food Secure (FCS ≥ 35)	352	47.63	43.67	−0.25
Borderline (FCS > 21 < 35)	195	26.39	29.43	0.16
Food insecure (FCS ≤ 21)	192	25.98	19.32	0.45
Total	739	100	31.16	0.11

FCGR = Food Consumption Gap Ratio.

3.3. Association Between Access to Credit and Food Security

Pearson Chi-Square analysis (Table 4) confirmed a statistically significant association between institutional credit access and household food security status ($\chi^2 = 18.155$, df = 6, $p = 0.006$). The Cramér's V of 0.211 indicates a moderate effect size, consistent with the conceptual position that credit operates within a broader constellation of structural determinants [26]. The Likelihood Ratio corroborated this result (19.112, $p = 0.004$). The non-significant Linear-by-Linear Association ($p = 0.101$) suggests a non-strictly monotonic relationship, indicating threshold dynamics further explored in Section 3.5.

Table 4. Chi-square tests (Access to credit Food security).

	Value	DF	Significance (2 Sided)
Pearson Chi-Square	18.155	6	0.006
Likelihood Ratio	19.112	6	0.004
Linear-by-Linear Association	2.685	1	0.101
N of Valid Cases	739		
Cramér's V	0.211		

3.4. Food Security Status Disaggregated by Credit Access

Table 5 reveals a pronounced, monotonically ordered gradient between credit access level and food security prevalence. Among households with high credit access, 72.22% were food-secure and only 16.67% were food-insecure. Among households with no credit access—the largest group ($n = 418$; 56.6% of total)—only 30.14% were food secure, while 51.20% were food insecure. This represents a 42-percentage-point differential in food security prevalence between the credit-access extremes, a difference with major policy significance [11,27]. Borderline households showed comparatively modest variation across credit levels (11.11% to 32.85%), suggesting that credit exerts its most decisive influence at the distributional extremes—either enabling households to cross into food security or preventing them from descending into food insecurity. This heterogeneity in food security returns to credit is consistent with evidence from West and East Africa documenting that credit’s nutritional benefits are conditioned by complementary resources and context [27,28].

Table 5. Relationship between credit access and food security.

Access to Credit	Food Secure	Borderline	Food Insecure	Total
Highly accessible	39 (72.22)	6 (11.11)	09 (16.67)	54 (100.00)
Moderately Accessible	76 (58.46)	38 (29.23)	16 (12.31)	130 (100.00)
Partially accessible	57 (41.61)	45 (32.85)	35 (25.55)	137 (100.00)
Not accessible	126 (30.14)	78 (18.66)	214 (51.20)	418 (100.00)
Total	352 (47.63)	195 (26.39)	192 (25.98)	739 (100.00)

Figures in parentheses are percentages.

3.5. Mean Food Security Comparison Among Different Levels of Credit Access

ANOVA results (Table 6) confirmed statistically significant differences in mean FCS across most credit-access pairings. The significance value of F statistics ($3735 = 29.31$, $p < 0.001$) indicates a significant difference at the 1% level across the group means. This implies that at least one of the four groups has a significantly different mean from the others. The η^2 (eta-squared) of 0.107 indicates that about 10.7% of the total variance was explained by group membership, which corresponds to a medium-to-large effect by Cohen’s [29] conventional benchmarks ($\eta^2 \geq 0.06$ medium, ≥ 0.14 large). Similarly, the Cramér’s V of 0.211 (Section 3.3) falls in the small-to-moderate range on the same convention and is broadly comparable in magnitude to credit-food security associations reported in related SSA smallholder studies [26,27], suggesting that credit access is an important factor operating alongside the socioeconomic factors examined in the regression model rather than a dominant standalone driver.

Table 6. ANOVA result of the mean differences in the food security status of the respondents based on the differences in credit access.

	Sum of Squares	df	Means Square	F	Sig
Between Groups	37,446.739	3	12,482.246	29.308	0.000
Within Groups	313,034.927	735	425.898		
Total	350,481.668	738			

Post hoc pairwise comparisons using the Tukey HSD test (Table 7) show a clear variation in food security status of the respondents across the credit accessibility groups. Respondents with no credit access had a significantly lower FCS ($M = 26.27$) than all other groups ($p < 0.001$). Similarly, the result indicates that respondents with partial access to credit scored significantly lower than those with moderate and high accessibility ($p < 0.05$).

However, no significant difference was observed between the moderately accessible and highly accessible groups. A possible interpretation is that once a modest level of credit is secured, additional accessibility does not necessarily translate into further improvement in food consumption outcomes [28,30].

Table 7. Post hoc test of the mean differences in the food security status of the respondents based on the differences in credit access.

Comparison (I vs. J)	Mean Diff.	Std. Error	Sig	95% Confidence Interval	
				Lower Bound	Upper Bound
Highly vs. moderately	1.68718	3.34113	0.958 NS	−6.916	10.2903
Highly vs. Partial accessible	8.70706	3.31598	0.044 **	0.1687	17.2454
Highly vs. Not accessible	17.86108	2.98427	0.000 ***	10.1768	25.5453
Moderately vs. Partially	7.01988	2.52683	0.029 **	0.5135	13.5263
Moderately vs. not accessible	16.17391	2.07245	0.000 ***	10.8375	21.5103
Partially vs. not accessible	9.15403	2.03166	0.000 ***	3.9227	14.3854

NS = Not Significant; ** highly significant; *** very highly significant.

3.6. Socioeconomic Determinants of Food Security: Multiple Linear Regression

The multiple regression model (Table 8) showed high explanatory power: adjusted $R^2 = 0.88$; $F(8, 730) = 138.74$; $p < 0.001$. This value is notably higher than the adjusted/pseudo- R^2 typically reported for cross-sectional food-security regression models in comparable smallholder settings, which commonly fall in the 0.15–0.40 range [23,24,31]. The authors cannot fully rule out that this reflects unmeasured shared variance among the eight predictors and the FCS outcome in this specific sample; this atypically high value should therefore be interpreted with caution, and independent replication incorporating additional covariates not captured here (e.g., market prices, seasonality, cultural food preferences, health status) is recommended before generalizing the magnitude of explained variance beyond this sample. VIF values ranged from 1.15 to 1.67, indicating no harmful multicollinearity. Residual diagnostics (histogram of residuals and residual-versus-fitted-values scatterplot; no formal statistical test for heteroscedasticity, e.g., Breusch-Pagan, was conducted) supported approximate normality, and no obvious pattern of non-constant variance was visually apparent [29]. Institutional credit access ($B = 0.525$; $p = 0.002$) was a significant positive predictor: a one-unit increase in the credit access index was associated with a 0.525-point improvement in FCS. Farming experience was the model's strongest predictor ($B = 0.873$; $p < 0.001$): each additional year was associated with a 0.873-point improvement in FCS, likely reflecting the compounding of agronomic knowledge, market relationships, and input-use efficiency [20,21]. Household size exerted a significant negative effect ($B = -1.230$; $p = 0.023$): each additional household member was associated with a 1.23-point decline in FCS, consistent with the resource-dilution mechanism [23]. Farm size had a positive coefficient that did not reach conventional statistical significance at the 5% level ($B = 0.511$; $p = 0.058$), though the direction of the effect is broadly consistent with, and suggestive of, prior evidence that even incremental land expansion meaningfully improves dietary quality among land-poor smallholders [24]. Age and education were non-significant. The near-uniformly low educational attainment may create a ceiling effect, suppressing variation. The negative coefficient for training ($B = -0.819$; $p = 0.047$) is counterintuitive; plausible explanations include targeting bias (programs serving the most food-insecure), temporal lag between training and yield gains, curriculum-context misalignment, and residual confounding [29]. The negative sign of the sustainable agriculture coefficient ($p = 0.040$) likely reflects transition-period consumption costs before productivity gains materialize [32].

Table 8. Multiple linear regression: socioeconomic determinants of household food consumption score (n = 739).

Variables	Coefficients	Std. Error	T-Value	Sig.	VIF
Constant	23.793	4.951	4.81	0.000 ***	
Age	−0.045	1.007	−0.044	0.965 NS	1.23
Size of the household	−1.23	0.537	−2.30	0.023 ***	1.45
Access to institutional credit	0.525	0.168	3.13	0.002 ***	1.18
Education	1.70	1.722	0.989	0.325 NS	1.67
Farm Experience	0.873	0.040	21.75	0.000 ***	1.34
Farm size	0.511	0.267	1.92	0.058 *	1.29
Training	−0.819	0.408	−2.01	0.047 **	1.15
Practice of Sustainable Agriculture	-2.035×10^{-5}	0.000	−2.07	0.040 **	1.22
R ² Adjusted	0.88				
F-Value	138.74				

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$; NS = not significant at the 10% level. The same significance-level convention is applied consistently in Table 7.

4. Discussion

This study examined food security status and its socioeconomic determinants, with emphasis on institutional credit access among 739 smallholder farming households in Kano State, Nigeria. The findings contribute substantively to the literature on rural finance and household nutrition security in SSA, with direct relevance to the SDG 2 agenda.

The aggregate food security prevalence of 47.63% situates Kano State's rural farming population within the range documented by comparable northern Nigerian studies. Anugwa and Agwu [17] found that 42% of farming households in Kano State had a worsening food security situation. Mustapha et al. [33] reported 51% food security in Kano State using a different measurement approach, while Thomas et al. [34] documented 75% food insecurity in an earlier Kano study, suggesting that absolute food insecurity may have moderated over the intervening decade, yet the pace of improvement remains critically inadequate given accelerating pressures from conflict, macroeconomic deterioration, and climate variability [7,8]. The mean FCS of 31.16, below the threshold of 35, indicates that more than 52% of households are either food-insecure or borderline food-insecure, rendering the SDG 2 zero-hunger target by 2030 an increasingly distant prospect without decisive structural intervention.

The statistically significant association between institutional credit access and food security ($\chi^2 = 18.155$, $p = 0.006$; Cramér's $V = 0.211$) provides empirical support for credit as a structural determinant of dietary quality. These findings corroborate Kehinde and Kehinde [11], who documented that credit access and cooperative membership significantly improved food security in Southwestern Nigeria using propensity score matching; Mounirou and Lokonon [35], who demonstrated microcredit's positive effect on food security in Benin using two-stage least squares; and Salima et al. [36], who confirmed that formal credit access improved food security in Malawi while informal credit was associated with adverse outcomes. The present study advances this evidence base by (i) employing the continuous FCS as the regression dependent variable, yielding more statistically efficient estimates than binary food security indicators; and (ii) operating in a semi-arid, conflict-affected northern Nigerian context where covariate shocks and market failures constitute a uniquely challenging environment for credit-to-welfare transmission, making the significant credit–FCS relationship especially compelling. A caution applies to all of the above comparisons: the cross-sectional design cannot rule out reverse causality, whereby more food-secure, better-resourced households are more likely to meet lenders' collateral, credit-history, and repayment-capacity criteria, nor omitted-variable bias from unobserved

factors such as business acumen, risk preference, and social network strength, which could jointly drive both credit access and food security. The associations reported here should accordingly be interpreted as evidence consistent with, rather than definitive proof of, a causal credit-to-food-security pathway; instrumental-variable or panel-data designs would be required to identify the causal effect with confidence.

The 42-percentage-point differential in food security prevalence between high-access and no-access households (72.22% vs. 30.14%) is the study's most policy-salient finding. This gradient is consistent with the theoretical prediction that institutional credit loosens the binding input-financing constraint trapping smallholder farmers in low-productivity equilibria: credit enables timely procurement of improved seed varieties, fertilizers, and crop-protection inputs, generating yield and income gains that translate into higher dietary diversity [10,11]. The progressive dose–response pattern documented in the *t*-test analysis—with FCS improvements scaling monotonically with credit access, except at the moderate-to-partial transition—clarifies that credit must reach a minimum adequacy threshold to shift household food security outcomes. Below this threshold, partial disbursements fail to meet the financing requirements for a complete input package, leaving production and consumption patterns largely unaltered [28,30]. This finding has direct implications for program design: microcredit schemes calibrated to subsistence-level loan minimums are likely to yield negligible food security returns, and instruments must be sized to the actual input costs faced by semi-arid smallholder farmers in northern Nigeria.

The emergence of farming experience as the dominant regression predictor ($B = 0.873$; $p < 0.001$) reinforces the irreplaceable value of accumulated tacit knowledge in smallholder systems characterized by low formal educational attainment and limited extension reach [20,21]. Each additional year of experience was associated with a 0.873-point FCS improvement—a larger marginal effect than any other predictor, including institutional credit. This carries an underappreciated policy message: structured farmer-to-farmer knowledge-transfer programs and mentorship schemes linking experienced senior farmers with younger cohorts can be highly cost-effective food security interventions in contexts where formal agricultural education is inaccessible. The significant negative household size effect ($B = -1.230$; $p = 0.023$), combined with a documented mean of nine persons per household, suggests that family planning services integrated within agricultural extension and women's empowerment programs could generate meaningful food security co-benefits by moderating the rate of household consumption demand growth [23].

The farm size coefficient ($B = 0.511$; $p = 0.058$), while not statistically significant at conventional levels, points in a direction consistent with the primacy of land access at the extreme lower end of the smallholder size spectrum, where even marginal increases in cultivated area can meaningfully improve production and dietary quality [24]. This argues for sustained policy attention to land tenure security, legally enforceable smallholder rights, and facilitated access to state-owned land for land-poor households—a politically complex but potentially high-impact policy space in northern Nigeria. The counterintuitive negative effects of training and the adoption of sustainable agriculture should not be interpreted as evidence against these interventions. The explanations that follow are offered as hypothetical inferences rather than confirmed mechanisms, since this cross-sectional dataset cannot decide between them: selection bias (targeting the most deprived), temporal mismatch between skill acquisition and dietary outcome measurement, and reductions in transition-period consumption are well-documented methodological artifacts in cross-sectional program evaluations [29,32], any of which is plausible here but none of which can be confirmed with the present data. Longitudinal and experimental designs are necessary to identify the causal effects of these programs properly, and to formally test which of the above explanations, if any, accounts for the observed negative coefficients.

Collectively, these findings position institutional credit as a necessary but insufficient condition for rural food security. Credit amplifies agricultural productivity primarily when farmers possess agronomic experience to deploy it effectively, sufficient land to generate returns, and household composition dynamics that do not outpace income growth. This points toward an integrated rural development model in which financial inclusion is deliberately packaged with land tenure security reform, farmer knowledge networks, and household welfare services [26,31]. As the 2030 SDG horizon approaches, the findings from Kano State offer evidence-based guidance for designing targeted, contextually grounded interventions to address both the immediate and structural drivers of rural food insecurity in northern Nigeria and analogous semi-arid smallholder contexts across SSA.

5. Conclusions

This study provides empirical evidence that access to institutional credit is significantly associated with enhanced food security among farming households in rural Kano State, Nigeria; given the cross-sectional design, this association should not be read as establishing a strictly one-directional causal effect (see Section Limitations). The findings of this study call for an integrated policy response that combines: (i) expansion of institutional agricultural credit through development banks, microfinance institutions, digital financial services, and farmer cooperative credit schemes; (ii) calibration of credit disbursements to actual input-financing thresholds, as partial credit increments below the adequacy threshold show negligible food security returns; (iii) structured farmer-to-farmer knowledge transfer programs to leverage the strong experience–food security relationship; (iv) land tenure security reforms to expand effective farm size for land-poor households; and (v) integration of family planning and women’s empowerment services within agricultural development programs to moderate household size growth. The counterintuitive negative coefficients observed for training and for the practice of sustainable agriculture should not be read as evidence that these interventions are harmful; as noted in Section 4, these are more plausibly attributable to selection bias, whereby programs and practices are disproportionately targeted at, or adopted by, the most food-insecure households, and to a temporal lag between adoption and measurable dietary gains. Programs should therefore continue, paired with longitudinal monitoring capable of separating targeting effects from genuine program impact. The findings of this study carry some important policy implications. Government and development partners should prioritize institutional credit expansion through agricultural development banks offering favorable terms, microfinance institutions trained in agricultural lending, digital financial services that reduce transaction costs, and farmer cooperative credit schemes. There is a need to integrate credit with extension services, combining credit provision with technical assistance to maximize productivity impacts. There is also a need for targeted credit windows for vulnerable households and for the integration of nutrition and family planning services into agricultural development programs.

Limitations

This study is subject to several limitations. First, the cross-sectional design precludes conclusive causal inference; the observed credit–food security association may partly reflect reverse causality (better-resourced, food-secure households may more easily meet lenders’ criteria) or omitted-variable bias. Second, the remarkably high adjusted R^2 (0.88) reported in Section 3.6, while accompanied by acceptable VIF diagnostics, is atypical relative to comparable food-security regression studies and should be interpreted cautiously pending independent replication. Third, no formal statistical test for heteroscedasticity (e.g., Breusch-Pagan) and no additional robustness checks (alternative model specifications, sensitivity analyses, or instrumental-variable approaches) were conducted in this

study. These represent avenues for methodological extension in future work. Fourth, the seven-day dietary recall period may be subject to recall bias, though the FCS methodology is validated and widely used. Fifth, data collection between January and August 2024 spans the period of relative abundance (January–March), the planting period (May–June), and the heavy rainfall season (July–August), which could introduce seasonal bias into food consumption patterns; this was not separately tested in this study. Sixth, the access-to-credit index used in the regression is a proxy measure; data on credit amounts and sources were collected but not analyzed in depth here, and interest rates and repayment terms were not captured (Section Description of the Access to Credit Methodology). Seventh, findings specific to Kano State may not generalize to other Nigerian regions with different agro-ecological and socioeconomic conditions. Finally, the response rate reported here (745 of 800 questionnaires administered retrieved, 93.1%) is relative to questionnaires administered; the rate relative to the number of households initially approached in the field, including those who declined to participate, was not systematically tracked and is acknowledged as a data-collection limitation.

Future research should focus on longitudinal analyses tracking households' food security status over multiple seasons. It is also imperative to examine the mechanisms connecting credit to food security using mediation or intervening-variable analysis. Future studies should collect detailed credit transaction data, because the access-to-credit index used here is a proxy measure.

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References

1. FAO; IFAD; UNICEF; WFP; WHO. *The State of Food Security and Nutrition in the World 2025: Financing to End Hunger and Malnutrition*; FAO: Rome, Italy, 2025. [\[CrossRef\]](#)
2. Wudil, A.H.; Usman, M.; Rosak-Szyrocka, J.; Pilař, L.; Boye, M. Reversing years for global food security: A review of the food security situation in Sub-Saharan Africa (SSA). *Int. J. Environ. Res. Public Health* **2022**, *19*, 14836. [\[CrossRef\]](#) [\[PubMed\]](#)
3. Dhillon, R.S.; Moncur, Q. Small-scale farming: A review of challenges and potential opportunities offered by technological advancements. *Sustainability* **2023**, *15*, 15478. [\[CrossRef\]](#)
4. FAO. *An Introduction to the Basic Concepts of Food Security*; FAO: Rome, Italy, 2009.
5. Webb, P.; Thorne-Lyman, A.; Blaney, S.; Lapping, K. Viewpoint: The case for a six-dimensional food security framework. *Food Policy* **2021**, *106*, 102164. [\[CrossRef\]](#)
6. Ezenwajobi, C.C. *Tackling Food Insecurity and Boosting Agricultural Productivity and Food Access in Nigeria: Areas for Legislative Intervention*; National Institute for Legislative and Democratic Studies: Abuja, Nigeria, 2025.
7. Ukwe, C. Nigeria and food security challenges: Intertwining of climate change and non-state armed groups and policy interventions. In *Proceedings of the IntechOpen Conference*; IntechOpen: London, UK, 2025. [\[CrossRef\]](#)

8. Asaju, K.; Kwakano, A. Armed conflict on food security in Nigeria. *Int. J. Recent Adv. Multidiscip. Res.* **2025**, *12*, 1151–1161. [[CrossRef](#)]
9. Chibueze, T.; Adeshina, L.U.C.; Ewubajo, S.D.; Ebere, L. Access to credit and financial inclusion of MSMEs in sub-Saharan Africa: Challenges and opportunities. *Int. J. Financ. Manag. Econ.* **2025**, *8*, 12. [[CrossRef](#)]
10. Ehui, S.; Pender, J. Resource degradation, low agricultural productivity, and poverty in sub-Saharan Africa: Pathways out of the spiral. *Agric. Econ.* **2005**, *32*, 225–242. [[CrossRef](#)]
11. Kehinde, A.D.; Kehinde, M.A. The impact of credit access and cooperative membership on food security of rural households in Southwestern Nigeria. *J. Agribus. Rural Dev.* **2020**, *57*, 255–268. [[CrossRef](#)]
12. Céu, M.S.; Gaspar, R.M. A review on climate change, credit risk and agriculture. *Rural Sustain. Res.* **2024**, *51*, 38–49. [[CrossRef](#)]
13. Silong, A.K.F.; Gadanakis, Y. Credit sources, access and factors influencing credit demand among rural livestock farmers in Nigeria. *Agric. Financ. Rev.* **2020**, *80*, 68–90. [[CrossRef](#)]
14. Adigun, G.T. Determinants of credit access among smallholder women farmers in Kwara State, Nigeria. *Niger. Agric. J.* **2022**, *53*, 121–128.
15. Ukwuaba, I.C.; Owutuamor, Z.B.; Ogbu, C.C. Assessment of agricultural credit sources and accessibility in Nigeria. *Rev. Agric. Appl. Econ.* **2021**, *23*, 3–11. [[CrossRef](#)]
16. Biam, C.K.; Tavershima, T. Food security status of rural farming households in Benue State, Nigeria. *Afr. J. Food Agric. Nutr. Dev.* **2020**, *20*, 15677–15694. [[CrossRef](#)]
17. Anugwa, I.Q.; Agwu, A.E. Perceived causes of household food insecurity and policy implications for food production in Kano State, Nigeria. *J. Appl. Sci.* **2019**, *19*, 513–519. [[CrossRef](#)]
18. Hasan, M.K.H.; Kumar, L.K. Determining adequate sample size for social survey research. *J. Bangladesh Agric. Univ.* **2024**, *22*, 146–157. [[CrossRef](#)]
19. Wiesmann, D.; Bassett, L.; Benson, T.; Hoddinott, J. *Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of Household Food Security*; International Food Policy Research Institute: Washington, DC, USA, 2009; IFPRI Discussion Paper 00870.
20. Kipkoge, S.; Han, J.; Mwalupaso, G.; Tanui, J.; Brenya, R. The synergistic effects of microcredit access and agricultural technology adoption on maize farmer's income in Kenya. *PLoS ONE* **2025**, *20*, e0316014. [[CrossRef](#)] [[PubMed](#)]
21. Adeyanju, D.; Mburu, J.; Gituro, W.; Chumo, C.; Mignouna, D.; Ogunniyi, A.; Akomolafe, J.K.; Ejima, J. Assessing food security among young farmers in Africa: Evidence from Kenya, Nigeria, and Uganda. *Agric. Food Econ.* **2023**, *11*, 7. [[CrossRef](#)] [[PubMed](#)]
22. Zulu, N.S.; Hlatshwayo, S.I.; Ojo, T.O.; Modi, A.T.; Mabhaudhi, T.; Slotow, R.; Ngidi, M.S.C. Determinants of household food insecurity among urban small-scale crop farmers in Sub-Saharan Africa: A systematic literature review. *Sustainability* **2025**, *17*, 9999. [[CrossRef](#)]
23. Akbar, A.; Darma, R.; Fahmid, I.M.; Irawan, A. Determinants of household food security during the COVID-19 pandemic in Indonesia. *Sustainability* **2023**, *15*, 4131. [[CrossRef](#)]
24. Hlatshwayo, S.I.; Ojo, T.O.; Modi, A.T.; Mabhaudhi, T.; Slotow, R.; Ngidi, M.S.C. The determinants of market participation and its effect on food security of the rural smallholder farmers in Limpopo and Mpumalanga Provinces, South Africa. *Agriculture* **2022**, *12*, 1072. [[CrossRef](#)] [[PubMed](#)]
25. Mthembu, N.; Ngidi, M.S.C.; Ojo, T.O.; Slotow, R.; Hlatshwayo, S.I. Impacts of crop production and value chains on household food insecurity in KwaZulu-Natal: An ordered probit analysis. *Sustainability* **2024**, *16*, 700. [[CrossRef](#)]
26. Tesfaye, K.; Simane, B.; Ademe, D.; Ejeta, A.T.; Gebremariam, T.; Getaneh, F.; Ndour, A.; Sida, T.; Amede, T.; Snapp, S. Sustainable farming in practice: Building resilient and profitable smallholder agricultural systems in Sub-Saharan Africa. *Sustainability* **2023**, *15*, 5731. [[CrossRef](#)]
27. Oyelaran-Johnson, A.; Akinwale, J.; Kehinde, A.D.; Adeyemo, R. Is there a linkage between credit access, land use, and crop diversification in achieving food security? Evidence from cocoa-producing households in Nigeria. *Heliyon* **2024**, *10*, e35844. [[CrossRef](#)] [[PubMed](#)]
28. Kyeremateng, J.D.; Kwapong, N.A.; Asante, B.O. Credit, gender, and food security: Empirical evidence of determinants to access, affordability, and consumption in Cameroon. *World Food Policy* **2024**, *10*, e12069. [[CrossRef](#)]
29. Hair, J.F.; Black, W.C.; Babin, B.J.; Anderson, R.E. *Multivariate Data Analysis*, 8th ed.; Cengage Learning: Hampshire, UK, 2019.
30. Bekele, T.G.; Tefera, D.A. Impact of credit on household food security: The case of Omo microfinance institution in southern Ethiopia. *J. Agric. Food Res.* **2023**, *14*, 100903. [[CrossRef](#)]
31. Salima, W.; Manja, L.P.; Chiwaula, L.S.; Chirwa, G.C. The impact of credit access on household food security in Malawi. *J. Agric. Food Res.* **2023**, *11*, 100490. [[CrossRef](#)]
32. Simtowe, F.; Asfaw, S.; Abate, T. Determinants of agricultural technology adoption under partial population awareness: The case of improved pigeonpea varieties in Tanzania. *Agric. Food Econ.* **2016**, *4*, 7. [[CrossRef](#)]
33. Otekunrin, O.A.; Mukaila, R.; Otekunrin, O.A. Factors affecting food security among households in Nigeria: The role of crop diversity. *Sustainability* **2023**, *15*, 8534. [[CrossRef](#)]

34. Mustapha, M.; Kamaruddin, R.B.; Dewi, S. Factors affecting rural farming households food security status in Kano, Nigeria. *Int. J. Manag. Res. Rev.* **2018**, *8*, 1. [[CrossRef](#)]
35. Thomas, S.; Umar, S.; Yahaya, M.K. Food security status of farming household in Kano State, Nigeria. *Savannah J. Agric.* **2016**, *11*, 1–10. [[CrossRef](#)]
36. Mounirou, I.; Lokonon, B.O. Can micro-credit improve food security? Evidence from Benin-West Africa. *J. Dev. Areas* **2022**, *56*, 155–167. [[CrossRef](#)]

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