



IMPACT OF COMMUNITY-BASED RURAL CEREAL BANKS (CBRCBs) ON HOUSEHOLD FOOD SECURITY IN KADUNA AND KATSINA STATES, NIGERIA

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ABSTRACT

The study uses a cross-sectional research design from primary data collected from 836 farming households (418 CBRCB participants and 418 non-participants) in Kaduna and Katsina States. Descriptive statistics were used to assess socio-economic characteristics and determinants of participation. The findings revealed that the majority of CBRCB participants are male (76.6%), indicating a male-biased participation structure in rural agricultural intervention programmes with active middle-aged dominance (mean 42.6 years). Married participants (84.5%) are the leading members of the study, which underscores the household-based motivation behind CBRCB participation. Determinants of participation included education (OR = 1.08), cooperative membership (OR = 3.17), access to credit (OR = 2.70), extension contact (OR = 1.50), and awareness of CBRCB programs (OR = 3.60). Binary logistic regression model and Propensity Score Matching (PSM) with covariate balance diagnostics were used to assess the causal impact of CBRCB participation on household food security, income, and living standards. The findings further revealed that CBRCB participants exhibited significantly higher food security outcomes compared to non-participants. The consistent difference across all indicators shows how community cereal banks and associated capacity-building interventions mitigate food insecurity among participants. This aligns with the Food and Agriculture Organization (FAO, 2023). The Food Availability Index improved by 34.1% (ATT = 0.145, $p < 0.01$), household annual income increased by 31.6% (ATT = 0.275, $p < 0.01$), and the Living Standard Index rose by 21.6% (ATT = 8.9, $p < 0.01$) among participants. Across all five food groups, participants reported significantly higher consumption frequencies than non-participants, as confirmed by the t -values (ranging from 2.03 to 6.12) and p -values below 0.05.

CBRCBs signify an effective community-driven intervention for enhancing household food availability, income, and living standards in rural farming communities. However, governance weaknesses, leadership gaps, and external threats such as input price inflation and insecurity require policy attention to ensure sustainable institutional performance and equitable participation, particularly among women and resource-poor farmers.

Keywords: Community-based, Rural, Cereal Banks, Food, Security.

INTRODUCTION

Food insecurity remains one of the major development challenges in sub-Saharan Africa. Most farming households depend on rain-fed agriculture for their livelihoods. In Nigeria, smallholder farmers account for about 80% of the farming population but continue to face limited access to credit, poor storage facilities, and seasonal food shortages (FAO, 2020; Ogundari *et al.*, 2020). In Kaduna and Katsina States, rural farming households experience severe food shortages during the lean season (May–August), when grain stocks are depleted, food prices rise, and purchasing power declines (HVCf, 2019). Conventional poverty alleviation programmes in Nigeria have yielded limited results due to weak programme design and institutional linkages (Tomori *et al.*, 2021). Consequently, Community-Based Rural Cereal Banks (CBRCBs) emerged as a post-harvest community food management strategy that combines grain storage, food loans, savings, and collective marketing to improve household food security (Oyekale & Adepoju, 2020). Although the approach has gained acceptance, empirical evidence on its impact on household food security in Nigeria remains limited.



Food security exists when all people have physical, social, and economic access to sufficient, safe, and nutritious food always (Barrett, 2019). It covers four dimensions: availability, access, utilization, and stability (FAO, 2021). CBRCBs primarily strengthen food availability and stability by reducing post-harvest losses and ensuring access to stored grain during lean periods (FAO, 2021; Sharma, 2024). In Kaduna and Katsina States, the Rural Development Animation Programme (RUDAP) and Hope for the Village Child Foundation (HVCF) organize farmers into cereal bank groups for collectively storage of grains, management of the facilities, and provide grain loans during the lean period, repayable at harvest (RUDAP, 2013; HVCF, 2016). While similar initiatives have reported positive welfare outcomes in Ethiopia and Tanzania (Tesfaye & Tirivayi, 2020; Kangalawe *et al.*, 2019), empirical evidence from Nigeria remains inadequate, particularly regarding their effects on food availability, household income and living standard. The study reports these gaps by extending previous Nigerian studies (Awotide & Awoyemi, 2020; Oyekale & Adepoju, 2020) in three ways. First, it analyzes a larger and more recent sample ($n = 836$) from Kaduna and Katsina States, from the two implementing organizations (HVCF and RUDAP). Second, it estimates programme impacts using three propensity score matching algorithms—nearest-neighbour, radius, and kernel—with balance diagnostics and sensitivity analysis to improve the robustness of the findings. Third, it combines welfare indicators, including household dietary diversity, food availability, income and living standard. The broad objective of the study was to analyze the impact of participation in Community-Based Rural Cereal Banks on household food security in Kaduna and Katsina States, Nigeria. The specific objectives were to:

- i. Describe the socio-economic, production, and institutional characteristics of participating and non-participating households.
- ii. Determine the socio-economic factors influencing participation in CBRCBs.
- iii. Estimate the impact of CBRCBs on household food security availability, income and living standard

METHODOLOGY

Study Area

The study was conducted in Kaduna and Katsina States, in the northwestern geopolitical zone of Nigeria. Kaduna State covers 46,053 km² with a population exceeding 9 million and features a tropical climate with an average annual rainfall of approximately 1,100mm. Katsina State covers 24,192 km² and has over 7 million inhabitants, characterized by a hot, dry climate with annual rainfall between 600 and 900mm. The two states are predominantly agricultural, producers of millet, sorghum, maize, groundnut, and cowpea. The CBRCB project was implemented by RUDAP in Katsina State (since 1995) and HVCF in Kaduna State (since 2005).

Sampling Procedure and Sample Size

A multi-stage sampling procedure was used. In stage one, three Local Government Areas (LGAs) were purposively selected from Kaduna State (Chikun, Igabi, Kajuru) and five from Katsina State (Bakori, Malumfashi, Funtua, Kafur, Faskari), where CBRCB projects are active. In stage two, proportionate (45.4% participating and 15% non-participating) random sampling was applied to select participating households. Power analysis was used to determine a minimum sample of 303 households per state (power = 0.99, two-tailed test). An equal number of non-participating households from communities without CBRCB projects were selected as a control group. Due to security-related inaccessibility, the final sample comprised 836 households (418 participants and 418 non-participants).

Data Collection and Analytical Techniques

Primary data were collected using structured questionnaires administered by trained enumerators. Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) provided qualitative validation. The analytical framework comprised descriptive statistics (frequencies, percentages, means) to characterize respondent profiles and perceptions, and a binary logistic regression model to identify determinants of participation:

$$\ln(P_i / (1 - P_i)) = \beta_0 + \sum \beta_j X_{ij} + \varepsilon_i$$

where P_i is the probability of participation, X_{ij} are explanatory variables, and β_j are coefficients.



Propensity Score Matching (PSM) estimates the Average Treatment Effect on the Treated (ATT) by matching participants with non-participants based on observable covariates. The propensity score represents the conditional probability of participation:

$$e(X) = P(D=1|X) = \exp(\gamma X) / (1 + \exp(\gamma X))$$

The ATT was computed as:

$$ATT = E[Y_1 - Y_0|D=1] = E[Y_1|D=1] - E[Y_0|D=1]$$

where Y_1 and Y_0 are outcomes under treatment and control, respectively. Three matching algorithms (nearest neighbor, radius, kernel) were applied with bootstrapped standard errors. Covariate balance was assessed using standardized bias reduction.

Construction of Composite Indices

Two composite indices were used as outcome measures in the study and are defined here for transparency and replicability. These measures included Food Availability Index and Living Standard Index.

Food Availability Index (FAI, 0–1 scale). Three household-level indicators of FAI were constructed as a composite measure combining: (i) the Household Food Insecurity Access Scale-derived availability sub-score, (ii) self-reported Months of Adequate Household Food Provisioning (MAHFP, 0–12 months, rescaled to 0–1), and (iii) the Household Dietary Diversity Score (HDDS, out of 12 food groups, rescaled to 0–1). Each component was equally weighted and averaged to generate a composite index bounded between 0 (complete food unavailability) and 1 (full food availability), following the aggregation approach recommended by Maxwell *et al.* (2013) and Hoddinott and Yohannes (2021). Internal consistency of the composite index was confirmed with a Cronbach's Alpha of 0.81.

Living Standard Index (LSI, 0–100 scale). Using Principal Component Analysis (PCA) the LSI was constructed on eleven household asset and housing-quality indicators: roofing material, wall material, floor material, access to an improved water source, sanitation facility type, land ownership, livestock ownership, ownership of durable assets (radio, bicycle, mobile phone, motorcycle), and access to electricity. The first principal component, which explained 47.3% of total variance, was retained and linearly rescaled to a 0–100 scale following the asset-index approach of Filmer and Pritchett (2001), with higher scores denoting higher living standards.

RESULTS AND DISCUSSION

Socio-Economic Characteristics

The results in Table 1 revealed that the majority of CBRCB participants are male (76.6%), indicating a male-biased participation structure in rural agricultural programme interventions. This observation aligns with Agbo *et al.* (2023), who reported that men's dominance in rural cooperatives arises from unequal access to land, capital, and institutional support. Middle-aged (mean 42.6 years) are the dominant participants of the CBRCB. This finding is consistent with Idris *et al.* (2022) and Adebayo & Lawal (2023), who emphasized that middle-aged farmers are the most active demographic in community-based agricultural programs.

The dominance of married (84.5%) members highlights the household-based motivation behind CBRCB participation, as food security and family welfare drive involvement in the cereal banking intervention. This pattern corroborates Akanbi *et al.* (2021), who found that marital status positively influences farmers' commitment, group cohesion, and credit repayment behaviour in cooperative societies. The higher education level among CBRCB participants increases the institutional efficiency, transparency, and administrative capacity of the cereal banks. This finding agrees with Ibrahim *et al.* (2020) and the World Bank (2021), who observed that education significantly influences farmers' capacity to manage cooperative resources, adopt technologies, and diversify income streams.

The Significant income differential (37% higher among participants) and institutional linkages (96% NGO contact vs. 33.7%). Increased income not only enhances farmers' purchasing power but also translates into improved household expenditure on food, education, healthcare and access to working capital Adebayo and Lawal (2021) The gender disparity (only 23.4% female participants) reflects



persistent structural barriers to women's engagement in agricultural cooperatives, consistent with findings by FAO (2023) and Ogunniyi *et al.* (2021).

Table 1: Socio-Economic Characteristics of Respondents

Variable	Participants (n=418)	Non-Participants (n=418)
Demographics		
Male (%)	76.6	71.3
Mean Age (years)	42.6	41.8
Married (%)	84.5	80.5
Mean Household Size (persons)	8.4	7.6
Education (%)		
No formal education	22.4	31.4
Primary education or higher	46.2	32
Production Characteristics		
Mean Farm Size (ha)	2.15	1.82
Mean Annual Farm Income (Naira)	1,220,000	890,000
Institutional (%)		
Cooperative membership	79.9	31.7
Regular NGO contact	96	33.7
Received CBRCB credit (mean ₦)	185,000	-

Socio-economic Factors Influencing Farmers' Participation in the (CBRCBs)

The binary logistic regression model (Table 2) indicates strong explanatory power (Nagelkerke $R^2 = 0.512$; classification accuracy = 83.7%). Recognizes the socio-economic and institutional factors that significantly influenced farmers' participation in the Community-Based Rural Cereal Bank (CBRCB) project:

Human capital: The result indicates an increase in participants' odds because of education (OR = 1.078, $p < 0.01$). This aligns with findings of Ibrahim *et al.* 2020; World Bank 2021), that started that educated farmers better comprehend cooperative governance and project benefits. Younger farmers were more likely to participate (OR = 0.972, $p < 0.05$), reflecting greater adaptability to institutional innovations. (Idris *et al.* 2022; Adebayo & Lawal 2023),

Gender: Male farmers were twice likely to participate than female farmers (OR = 1.982, $p < 0.05$), this result is consistent with documented disparities in access to productive resources and decision-making authority in Nigerian agriculture (FAO, 2023). Also, the gender gap calls for targeted empowerment programmes for women, such as gender-sensitive training and flexible participation mechanisms (FAO, 2023; AGRA, 2021).

Institutional factors: Cooperative membership revealed the strongest positive effect (OR = 3.168, $p < 0.01$), followed by awareness creation of CBRCB programs (OR = 3.602, $p < 0.01$), access to credit (OR = 2.696, $p < 0.01$), and training exposure (OR = 1.842, $p < 0.05$). These findings underline the importance of social capital, access to information, and financial presence as an entrance to participation. This aligns with Adebayo and Lawal (2021), who identified cooperative societies as effective channels for disseminating agricultural credit and information.

Geographic access: Distance to CBRCB storage facilities negatively affected participation (OR = 0.711, $p < 0.01$), as farmers sited farther away face higher operation costs and reduced accessibility. The strong positive impact of education, credit access, cooperative membership, and awareness implies that participation thrives where farmers have the knowledge, resources, and institutional support to engage effectively. Integrating financial presence, continuous training, and extension services can thus stand long-term ownership and collective resilience. The model's predictive strength (83.7%) supports the theoretical groundwork of the Sustainable Livelihoods Framework (Natarajan *et al.* 2022) and New Institutional Economics, which emphasize the role of social networks, asset access, and institutional efficiency in development outcomes.

Table 2: Factors Influencing CBRCB Participation

Variable	Coefficient (β)	Standard Error	Wald (Z-value)	Odds Ratio (Exp(β))
Constant	-5.241***	1.202	-4.36	—
Age	-0.028**	0.014	-2.00	0.972
Sex (1 = Male)	0.684**	0.298	2.29	1.982
Education	0.075***	0.021	3.57	1.078
Household size	-0.043	0.037	-1.16	0.958
Farm size	0.31**	0.128	2.42	1.364
Annual income	1.2E-06***	4E-07	3.00	1.001
Access to credit	0.992***	0.326	3.04	2.696
Cooperative membership	1.153***	0.345	3.34	3.168
Extension contacts	0.407**	0.178	2.29	1.503
Distance to CBRCB	-0.341***	0.099	-3.44	0.711
Training exposure	0.611**	0.287	2.13	1.842
Awareness of CBRCB	1.281***	0.374	3.42	3.602
Diagnostic and Goodness-of-Fit Tests	0			
Log-likelihood	-230.47			
LR Chi-square (12 df)	168.32***			
Nagelkerke R ²	0.512			
Classification Accuracy	83.70%			

*Note: ***, ** denotes significance at 1% and 5% levels, respectively. Dependent variable: CBRCB participation (1=Participant, 0=non-participant).*

Food Security Situation of Participants and Non-Participants

Food Security Indicators in Table 3 revealed statistically significant differences across all measures of food insecurity experience. Non-participants consistently reported higher mean scores on food insecurity indicators, including worrying about food (3.32 vs. 2.45), eating limited preferred foods (3.52 vs. 2.70), and going to sleep hungry (2.59 vs. 1.87), all significant at $p < 0.01$. These findings indicate that CBRCB project participation improved food access and dietary stability by supporting collective grain storage systems, enhancing household buffer stocks, and reducing vulnerability during lean seasons. The reliable differences across all indicators reflect how community cereal banks and capacity-building interventions mitigate food insecurity among participants. This aligns with the Food and Agriculture Organization (FAO, 2023) and World Bank (2022) findings that community-based grain reserves and collective action significantly reduce hunger and enhance rural food security. Similarly, Adebayo *et al.* (2022) and Olaniyan *et al.* (2023) reported that local food storage and cooperative marketing initiatives improve food availability and smooth consumption patterns among smallholder farmers in Nigeria.

Table 3: Farmers' Food Insecurity Experiences (n = 836)

Food Insecurity Experience	Mean Score (1–5)	Participants (Mean)	SD	Non-Participants (Mean)	SD	χ^2 -value
Worry about not having enough food	2.89 ± 1.12	2.45	1.06	3.32	1.08	-2.76
Ate limited preferred foods	3.11 ± 1.09	2.70	1.01	3.52	1.02	-4.11
Ate a smaller meal portion	2.78 ± 1.02	2.34	0.98	3.22	0.95	-2.54
Ate fewer meals per day	2.63 ± 1.07	2.28	1.00	2.98	1.02	-3.83
No food at all in the household	1.91 ± 0.98	1.61	0.89	2.21	0.96	-2.97
Went to sleep hungry	2.23 ± 1.04	1.87	0.95	2.59	1.00	-3.33
Whole day without eating	1.83 ± 0.89	1.51	0.80	2.15	0.88	-2.64



Food Access and Availability

Concerning food access and availability, table 4 shows 32% of participants testified that adults skipping meals compared to 57.8% of non-participants. Similarly, 23.8% of participants experienced hunger without eating versus 52.1% of non-participants. Participants adopted fewer severe coping strategies: 39.4% skipped meals compared to 65.8% of non-participants, and 54.1 reduced food portions compared to 73.2% among non-participants. The results indicate that the CBRCB project has significantly improved food accessibility and availability and reduced hunger among participating households. This is consistent with findings by FAO (2023) and the World Bank (2022), which highlight that community-based cereal banks and cooperative food storage systems enhance local food availability and reduce seasonal hunger among smallholder farmers.

Table 4: Distribution of Farmers based on Food Access and Availability (n = 836)

Indicator	Participants (%)	Non-participants (%)	χ^2 -value
Adults skipped meals	32	57.8	36.42
Ate less than felt needed	45.2	64	27.12
Hungry but didn't eat	23.8	52.1	41.83
Lost weight due to hunger	17.5	40.9	35.64

Household Dietary Diversity (Past 7 Days)

Table 5 indicates consistent dietary advantage for CBRCB participants. Primary food consumption was almost universal (mean = 6.4 among participants vs. 6.0 among non-participants; $p = 0.043$), indicating general food availability across both groups but slightly higher adequacy among participants. The differences become more evident for nutrient-dense foods. Protein foods (mean = 4.2 vs. 3.2, $p < 0.001$), fruits/vegetables (3.8 vs. 2.8, $p < 0.001$), dairy products (2.9 vs. 2.1, $p < 0.001$), and legumes/nuts (3.9 vs. 2.9, $p < 0.001$) all show significantly higher consumption frequencies among participants. These findings infer that participation in the CBRCB project enhanced dietary quality and diversity, improved access to varied foods and possibly better income and nutrition awareness. According to FAO (2023) and Herforth *et al.* (2022), dietary diversity is one of the most reliable indicators of household food security and nutritional adequacy.

Table 5: Household Dietary Diversity (Past 7 Days)

Food Group	Participants	Non-Participants	t-value	p-value
Staples	6.4	6	2.03	0.043
Protein foods	4.2	3.2	6.12	0.000
Fruits/Vegetables	3.8	2.8	5.88	0.000
Dairy products	2.9	2.1	6.01	0.000
Legumes/Nuts	3.9	2.9	5.23	0.000

Mechanism through which CBRB Impacts Food Security

The high mean score in Table 6 indicates that participants perceive the factors that are important and impacting Community-Based Rural Bank on household food availability, income, and standard of living. The impact of Community-Based Rural Cereal Banks is determined by several factors, including community participation and ownership, access to credit, effective management, transparency and accountability, farmer groups, extension services, and secure storage facilities. Previous studies have shown that these factors significantly influence the success of CBRCBs in improving household food security, income, and livelihoods Awotide & Awoyemi, 2020; Kangalawe *et al.*, 2019).

Table 6: Mechanism through which CBRB Impacts Food Security

Determinant	Mean	Rank	Decision
Improved food availability	4.42	1st	Significant
Reduced post-harvest losses	4.31	2nd	Significant
Increased household income	4.25	3rd	Significant
Access to credit	4.18	4th	Significant
Effective management	4.10	5th	Significant
Extension services	3.95	6th	Significant
Community participation	3.90	7th	Significant
Training and capacity building	3.82	8th	Significant
Farmer group membership	3.75	9th	Significant
Transparency and accountability	3.68	10th	Significant

Impact Assessment Using Propensity Score Matching

The propensity score estimation achieved excellent covariate balance (Table 7), with standardized reduction of biases to below 10% for all variables after matching. The greatest substantial improvements occurred for extension contract (96.3% reduction), education (90.8%), asset index (92.6%), and distance to market (91%). This confirms that the matched comparison groups were statistically comparable, satisfying the conditional independence assumption required for valid causal inference.

Table 7: Covariate Balance Before and After PSM

Covariate	% Bias (Unmatched)	% Bias (Matched)	Bias Reduction (%)
Age (years)	7	1.4	80
Education (years)	39.2	3.6	90.8
Household size	6	2.1	65
Farm size (ha)	46.3	6.5	85.9
Extension contacts (%)	76.6	2.8	96.3
Asset index (0-1)	44.8	3.3	92.6
Distance to market (km)	-50.2	-4.5	91

The PSM results (Table8) demonstrate that CBRCB participation generated statistically significant positive impacts across all three welfare dimensions at $p < 0.01$. The Average Treatment Effect on the Treated (ATT) indicates that:

Food Availability: Participants experienced a 34.1% improvement in the Food Availability Index (ATT = 0.145, $t = 6.30$). This extensive gain reflects the effectiveness of collective storage in reducing seasonal shortages and stabilizing household food access during slim periods. The result aligns with FAO (2023) and Adebayo *et al.* (2022), who documented that community-managed grain reserves enhance local food systems by smoothing consumption cycles.

Household Income: Participation in CBRCB increased annual income by 31.6% (ATT = 0.275, $t = 5.12$). This income result operates through multiple channels: higher crop yields supported by input credit, good price realization through collective marketing, and reduced post-harvest losses through improved storage. The finding corroborates Barrett and Carter (2022) and AGRA (2021), who emphasized that structured cooperative programs generate income gains through improved market organization and collective bargaining power.

Living Standards: The Living Standard Index improved by 21.6% (ATT = 8.9, $t = 5.09$), reflects broader welfare improvements beyond income, including improved asset accumulation, good access to credit and social support networks, and higher household resilience. This multidimensional improvement validates the Sustainable Livelihoods Framework, which speculates that institutional participation strengthens multiple asset categories simultaneously (Natarajan *et al* 2022).



Table 8: Impact Estimates (ATT and ATE) of CBRCB Participation

Outcome Indicator	Estimate	Std. Error	t-value	95% CI	% Change
Food Availability Index (0-1 scale)					
ATT	0.145	0.023	6.3	0.100 - 0.190	34.1
ATE	0.13	0.019	6.84	0.092 - 0.168	30.6
Household Annual Income (Naira)					
ATT	0.275	0.055	5.12	0.168 - 0.382	31.6
ATE	0.24	0.048	5.31	0.146 - 0.334	27.1
Living Standard Index (0-100)					
ATT	8.9	1.75	5.09	5.45 - 12.35	21.6
ATE	7.6	1.45	5.24	4.72 - 10.48	18.4

The FGD responses corroborated these quantitative findings. Community members reported that approximately 20-30% of households now maintain year-round food availability since joining CBRCBs, compared to pre-participation conditions where more than half faced seasonal shortages. Participants emphasized that CBRCBs instilled a “spirit of giving” and collective responsibility toward vulnerable households during slim periods.

CONCLUSION AND RECOMMENDATION

This study gives strong evidence that Community-Based Rural Cereal Banks (CBRCBs) significantly improve household food security, income, and living standards among rural farming households in Kaduna and Katsina States, Nigeria. Propensity Score Matching results showed that participation increased food availability by 34.1%, household income by 31.6%, and living standards by 21.6%, validating the effectiveness of CBRCBs as an integrated method for food storage, credit access, collective marketing, and social capital development. Participation was significantly influenced by education, cooperative membership, access to credit, extension services, and program awareness. However, low female participation, distance to cereal bank facilities, governance deficiencies, and external challenges such as insecurity and rising production costs remain major constraints to sustainability. Overall, the findings confirm that CBRCBs are an effective rural food security intervention but require stronger institutional support to sustain their impacts.

Government and developmental agencies should prioritize gender-inclusive participation and strengthen institutional governance through capacity building.

- Government should extend the CBRCB model to other food-insecure areas, improve access to financial services, and invest in rural infrastructure and security.
- Strengthen market linkages with commodity buyers and agribusiness firms.

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