Current Innovation in Agriculture Science
Vol. 2, Issue 1, pp. 405-414
Research Article
ISSN (E): 3048-6009

Gender participation in climate-resilient agriculture: A study of food security outcomes in Kebbi state, Nigeria

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Received: 21 July 2024 | Accepted: 28 December 2024

DOI: doi.org/cias/312ersredf

ABSTRACT

The study examines gender participation in climate-resilient agriculture (CRA) practices and its implications for food security in Kebbi State, Nigeria. Data were collected through surveys and interviews with 220 farmers, focusing on understanding the participation rates of male and female farmers in various CRA practices, the constraints they face, and the factors influencing food security outcomes. Results show that male farmers had higher participation rates in most CRA practices, including drought-resistant crops, water harvesting, and agroforestry, with an average participation rate of 59% for males and 54% for females. The study also identifies several constraints that hinder participation, with female farmers facing more significant challenges than their male counterparts. These include land ownership, access to credit, cultural restrictions, and domestic workload. Logistic regression analysis reveals that factors such as gender, access to CRA inputs, extension contact, land ownership, education level, household size, access to credit, and experience with climate shocks significantly influence food security. Male-headed households, households with access to CRA inputs, and those with regular extension contact were more likely to be food secure. The study concludes that gender disparities in participation in climate-resilient agriculture practices contribute to unequal food security outcomes. Although both male and female farmers participate in CRA practices, women face more barriers that limit their full participation and ability to enhance their food security. It is essential to recognize the role of gender in agricultural decision-making processes and to address the socio-economic factors that limit women's access to resources. Recommendations include the need for targeted interventions that reduce the gender gap in CRA practices by providing women with better access to land, credit, and extension services. Empowering female farmers through training, promoting gender-inclusive policies in agricultural development, and improving women's access to climate-resilient agricultural inputs are critical steps. Additionally, addressing cultural and social barriers that restrict women's mobility and participation in decision-making will be crucial in enhancing their contribution to climate-resilient agriculture and improving overall food security in the region.

KEY WORDS: *Gender participation*; *Climate-resilient agriculture*; *Food security*; *Agricultural practices*

1. Introduction

Climate change represents a formidable threat to agricultural sustainability and food security globally, particularly in Sub-Saharan Africa, where agriculture is predominantly rain-fed and highly climate-sensitive. Rising temperatures, erratic rainfall, prolonged droughts,

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desertification, and flooding are among the major climate-related stressors that have significantly disrupted agricultural livelihoods and rural economies across the continent. Nigeria, like many other African countries, is grappling with these adverse impacts, which are projected to intensify in both frequency and severity. Kebbi State, located in the northwestern region of Nigeria, is notably vulnerable due to its reliance on smallholder, subsistence agriculture that depends on predictable climatic patterns. The state's agro-ecological zones have been experiencing increasing variability in rainfall patterns, shortened growing seasons, declining crop yields, and frequent pest and disease outbreaks—all of which undermine food availability and rural livelihoods. In response to these mounting pressures, the adoption of Climate-Resilient Agriculture (CRA) practices has emerged as a promising pathway to enhance adaptive capacity, safeguard food systems, and foster environmental sustainability.

CRA encompasses a variety of practices and technologies, including agroforestry, drought-tolerant crop varieties, water conservation techniques, integrated pest management, organic composting, and improved livestock management. These innovations not only buffer against climate shocks but also contribute to long-term productivity and ecological balance. However, the effectiveness of CRA interventions is closely tied to social factors such as access to resources, decision-making power, and institutional support - elements that are often shaped by gender dynamics. Gender plays a pivotal role in shaping agricultural adaptation strategies, as men and women experience different vulnerabilities and possess distinct capacities to respond to climate-induced challenges. Although both male and female farmers contribute significantly to agricultural production in Kebbi State, prevailing gender disparities in access to land, agricultural inputs, extension services, and climate information hinder women's full participation in CRA. These disparities are often rooted in traditional norms, legal constraints, and institutional biases that marginalize women in rural development processes.

Thus, understanding gender differences in participation in CRA is critical to designing inclusive policies and interventions that effectively enhance food security. This study seeks to empirically examine the relationship between gender participation in CRA and food security outcomes in Kebbi State. By highlighting the structural barriers that limit women's engagement in CRA and analyzing their implications on household food security, the study aims to inform gender-sensitive climate adaptation strategies and contribute to the broader discourse on sustainable development in Nigeria.

Climate-resilient agriculture (CRA) has emerged as a vital strategy to mitigate the adverse effects of climate change on agricultural productivity and food systems. With climate shocks becoming increasingly frequent and severe - particularly in vulnerable regions such as Kebbi State - the adoption of adaptive agricultural practices is crucial for safeguarding rural livelihoods and ensuring long-term food security. Despite growing awareness and institutional backing for CRA initiatives in Nigeria, gender disparities remain a significant barrier to the full realization of their benefits. In many rural communities of Kebbi State, women comprise a substantial share of the agricultural workforce. However, they continue to face marginalization in terms of access to essential

resources such as land, credit, extension services, and climate-related information.

Structural obstacles, including patriarchal land tenure systems, gender-based financial schemes, and the underrepresentation of women in decision-making bodies, hinder their ability to actively and effectively participate in climate adaptation initiatives.

These gender-based constraints not only weaken the impact of CRA interventions but also heighten household vulnerability to food insecurity. Moreover, the formulation and execution of agricultural policies and programs in Nigeria have often been gender-blind, overlooking the distinct needs, responsibilities, and adaptive capacities of men and women. Empirical evidence examining the influence of gender participation on CRA outcomes and household food security - especially in the specific context of Kebbi State - is limited. The absence of gender-disaggregated data impedes the development of inclusive, evidence-based strategies for climate adaptation and resilience-building within the food system.

In light of these challenges, this study seeks to explore the extent and determinants of male and female participation in climate-resilient agricultural practices, identify gender-specific constraints, and assess how such participation impacts household food security outcomes. Addressing this research gap is essential for informing the development of gender-responsive agricultural policies that promote equity, resilience, and sustainable development in climate-vulnerable regions.

The general objective of the study is to examine the impact of gender participation in climate-resilient agriculture on household food security outcomes in Kebbi State, Nigeria. Specifically, the study aims to: (1) assess the level of male and female participation in climate-resilient agricultural practices; (2) identify the key constraints affecting gender participation in CRA; and (3) evaluate how gender participation in CRA influences household food security outcomes.

2. Material and Methods

2.1 Description of the study area

Kebbi State is situated in North-western Nigeria, located approximately between latitudes 10°05'N and 13°45'N and longitudes 3°30'E and 6°02'E. It shares international boundaries with the Republic of Niger to the north and Benin Republic to the west, and borders domestically with Sokoto State to the northwest, Zamfara State to the east, and Niger State to the south. The state covers a land area of about 36,800 square kilometers and has a projected population of approximately 5 million people as of the 2023 estimate (National Population Commission, 2023).

Administratively, the state comprises four major agricultural zones: Argungu, Zuru, Yauri, and Birnin Kebbi. The economy of Kebbi State is predominantly agrarian, with major economic activities including rice, millet, sorghum, and maize farming, as well as livestock rearing and artisanal fishing.

Kebbi is recognized as one of Nigeria's leading rice-producing states and hosts several irrigation schemes to support dry season farming. The region experiences a tropical climate characterized by a distinct wet season (May to October) and dry season (November to April), with annual rainfall ranging between 800 mm and 1,000 mm. The state's ecological diversity and dependence on

rain-fed agriculture make it highly vulnerable to climate-induced hazards such as drought, floods, and soil degradation.

2.2 Population of the study

The target population for this study includes all male and female smallholder farmers engaged in crop and livestock production across the four agricultural zones of Kebbi State.

2.3 Research design

This study employs a descriptive survey research design complemented by inferential statistical analysis to assess gender participation in CRA and its effects on food security outcomes.

2.4 Sampling procedure and sample size

A multistage sampling technique was adopted to ensure representativeness and gender balance: In Stage 1,One Local Government Area (LGA) was purposively selected from each of the four agricultural zones in Kebbi State: Argungu (Central), Zuru (South), Yauri (East), and Birnin Kebbi (Northwest). These LGAs were selected based on the prominence of farming activities and the presence of CRA-related interventions. In Stage 2, two farming communities were randomly selected from each selected LGA to capture intra-LGA diversity. In Stage 3**,** within each community, farmers were stratified by gender. From each stratum, simple random sampling was used to select an equal number of male and female farmers. A total of 220 respondents were selected, comprising 110 male and 110 female farmers, ensuring gender parity across the sample (Table 1).

2.5 Data collection procedures

Primary data were collected using a structured questionnaire. The questionnaire was designed to capture quantitative data on socio-demographic characteristics, CRA practices, access to resources, and household food security status, measured using the Household Food Insecurity Access Scale (HFIAS). The instrument was pre-tested for reliability and administered by trained enumerators across all selected communities. Responses were recorded and coded for statistical analysis.

2.6 Data analysis procedure and model specification

Data analysis will be conducted in two main phases: descriptive and inferential analysis.Descriptive statistics such as frequencies, percentages, means, and standard deviations will be used to summarize and present the socio-demographic characteristics of respondents, their participation in climate-resilient agriculture (CRA) practices, and household food security status. This will help provide an overview of the

Table 1: Distribution of Sampled Respondents by LGA and Gender

Agricultural Zone	LGA	Communities Sampled	Male Farmers	Female Farmers	Total
Central	Argungu	2	28	28	56
South	Zuru	2	27	27	54
East	Yauri	2	28	28	56
Northwest	Birnin Kebbi	2	27	27	54
Total		8	110	110	220

data before applying any inferential techniques.To examine the relationship between gender participation in CRA and household food security, a Binary Logistic Regression model will be used. This is appropriate since the dependent variable (household food security) is binary, coded as 1 (food secure) and 0 (food insecure).The binary logistic regression model will allow us to estimate the probability of a household being food secure based on various independent variables, including gender participation in CRA and other relevant socio-economic factors.

2.7 Model specification

The Logit model can be expressed as follows: The dependent variable (household food security) is binary, coded as 1 (food secure) and 0 (food insecure). The binary logistic regression model will allow us to estimate the probability of a household being food secure based on various independent variables, including gender participation in CRA and other relevant socio-economic factors.

$$\text{Logit}(P) = \ln(P1-P)=\beta 0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\epsilon$$

Where:
P = Probability of a household being food secure
$\beta 0$ = Constant term
ϵ = Error term
β_1- β_8- Coefficients estimated

Parameter measured:
X_1 Gender of the Respondent (Male = 1, Female = 0):
X_2 - Access to Climate-Resilient Agriculture Inputs (Scale 1-5)
X_3 -Frequency of Contact with Extension Services (Scale 1-5)
X_4- Land Ownership (1 = Owned, 0 = Rented/Sharecropped)
X_5 - Household Income (Log of Monthly Income in Naira)
X_6- Availability of Water Resources (Scale 1-5)
X_7 - Education Level of Household Head (Years of Formal Education):
X_8- Social Capital (Scale 1-5)

3. Results and Discussion

Table 2 presents gender-disaggregated participation rates in nine climate-resilient agricultural (CRA) practices. The data reveals significant variation across practices and between genders. Male farmers demonstrated higher participation in drought-resistant crops (78%), water harvesting (69%), and crop diversification (70%), suggesting better access to climate adaptation inputs, which aligns with findings by Nhemachena and Hassan (2007) who noted that men tend to dominate practices that require capital and technological knowledge. Conversely, female farmers slightly outpaced males in organic composting (60% vs. 55%), indicating their stronger engagement in low-cost sustainable soil fertility management. This is consistent with studies such as those by Jost *et al.* (2016), who observed that women tend to adopt low-input and labor-intensive practices due to their limited access to productive resources.

The mean participation rates range from 52% (zero/reduced tillage) to 66% (drought-resistant crops), with an overall average of approximately 59%. The highest gender disparity is observed in drought-resistant crops (SD = 16.97%), suggesting a gender gap in access to improved seed varieties and information. This supports the argument of Doss (2001) that unequal access to extension

Table 2: Level of participation in CRA practices by gender (N = 220)

CRA Practice	Male (%)	Female (%)	Mean	Std. Dev. (%)
Drought-resistant crops	78	54	66.0	16.97
Water harvesting	69	42	55.5	19.09
Organic composting	55	60	57.5	3.54
Agroforestry	64	51	57.5	9.19
Crop diversification	70	58	64.0	8.49
Mulching	62	50	56.0	8.49
Integrated pest management	59	47	53.0	8.49
Use of cover crops	66	52	59.0	9.90
Zero/reduced tillage	61	43	52.0	12.73

Source: Field survey, 2025

services and inputs contributes to lower adoption rates among women. On the other hand, practices like organic composting (SD = 3.54%) show minimal disparity, suggesting these may serve as viable entry points for promoting inclusive CRA adoption. Similarly, practices such as agroforestry, mulching, and integrated pest management show moderate gender gaps and can be enhanced through targeted capacity-building programs. These findings underline the importance of gender-responsive approaches in the design and implementation of CRA interventions in Kebbi State. Policies must address structural barriers, including unequal land tenure, access to credit, and technical training. As Meinzen-Dick *et al.* (2011) argue, enhancing women's participation in agricultural innovation is crucial for climate resilience and food security.

The data in Table 3 clearly indicate that female farmers experience significantly greater constraints than their male counterparts in engaging with Climate-Resilient Agriculture (CRA) practices. These findings are consistent with prior studies in sub-Saharan Africa that document gender-based disparities in agricultural access and productivity (FAO, 2011; Peterman *et al*., 2014). Land ownership is one of the most pressing challenges for women, with 74% of female respondents citing it as a constraint compared to only 32% of males**.** This reflects entrenched patriarchal land tenure systems that restrict women's legal rights to land a key resource for agricultural innovation and resilience (Agarwal, 1994).

Limited access to credit also disproportionately affects women (65%) compared to men (48%). This limits women's ability to invest in improved seeds, irrigation tools, and other climate-smart technologies, reinforcing a cycle of low productivity and vulnerability (World Bank, 2009). A poor extension contact rate among females (68%) underscores their exclusion from critical information channels needed for adopting CRA. Men's better access (39%) still indicates a gap, but one that is significantly narrower. Women often miss out on extension services due to time constraints and societal norms (Meinzen-Dick *et al*., 2011). Cultural restrictions, such as mobility limitations and gender-based roles, were cited by 61% of women, compared to 22% of men. These barriers significantly restrict women's ability to attend training, join cooperatives, or market their produce.

Educational attainment also influences participation, with 56% of females identifying low educational levels as a constraint, compared to 27% of males. Literacy and basic education are essential for understanding climate information and technology usage. Input access, another critical area, affects 63% of women as opposed to 41% of men, aligning with evidence that women often receive lower quantities and poorer-quality agricultural inputs (Doss, 2015). The domestic workload or time burden is especially pronounced among women (70%) compared to men (18%). This reflects traditional gender roles that assign household and care giving duties primarily to women, limiting their time for farm and climate adaptation activities (Quisumbing *et al*., 2014). Market access constraints were reported by 59% of women and 36% of men, showing the challenges women face in transporting and selling produce due to mobility, financial, and infrastructural issues.

Table 3: Constraints to Gender Participation in CRA

Constraint	Male (%)	Female (%)
Lack of land ownership	32	74
Limited access to credit	48	65
Poor extension contact	39	68
Cultural restrictions	22	61
Low educational attainment	27	56
Inadequate access to inputs	41	63
Time burden (domestic workload)	18	70
Poor market access	36	59
Lack of participation in cooperatives	29	62

Source: Field survey, 2025

Finally, lack of participation in cooperatives was significantly higher among women (62%) than men (29%). Participation in such groups is crucial for accessing shared knowledge, credit facilities, and policy advocacy (Njuki *et al*., 2013). In sum, these findings affirm that gender-specific constraints must be addressed to ensure equitable participation in climate-resilient agriculture. Policies must focus on land reforms, inclusive extension services, access to finance and inputs, and reducing women's time poverty to enhance overall climate resilience in rural areas.

The logistic regression analysis presented in Table 4 assesses the determinants of household food security among 220 respondents using a binary outcome model (1 = food secure, 0 = food insecure). The results demonstrate that eight explanatory variables significantly influence the likelihood of a household being food secure, with good model fit indicators including a Nagelkerke Pseudo R^2 of 0.421 and an adjusted value of 0.396. The model chi-square statistic ($\chi^2 = 68.35$, $p < 0.001$) confirms the joint significance of the predictors, while the Hosmer Lemeshow goodness-of-fit test ($\chi^2 = 6.87$, $p = 0.55$) suggests a good fit to the data. The coefficient for gender ($\beta = 0.58$, $p < 0.01$) indicates that male-headed households have a statistically higher probability of being food secure. This finding is consistent with previous studies (e.g., Ogundari, 2017), which observed that male household heads tend to have greater access to productive assets and extension services, which may enhance their adaptive capacity in food production.

Access to climate-resilient agriculture (CRA) inputs is positively and significantly associated with food security status ($\beta = 0.74$, $p < 0.001$). This corroborates the findings of Asfaw *et al*. (2016), who documented that CRA practices such as improved seed varieties, organic inputs, and conservation agriculture enhance productivity and food availability. Similarly, extension contact ($\beta =$

0.49, $p< 0.01$) emerges as a key determinant, suggesting that farmers who receive regular technical advice are more likely to adopt best practices and mitigate risks. This aligns with the conclusions of Anderson and Feder (2007), who emphasized the instrumental role of agricultural extension in technology dissemination and capacity building. Land ownership ($\beta = 0.62$, $p< 0.01$) significantly increases the odds of being food secure, reflecting the economic security and productive advantage associated with having secure tenure. This is in agreement with Fenske (2011), who posited that land rights incentivize investment in long-term soil fertility and resource conservation.

Table 4: Logistic Regression Results on Food Security (n = 220)

Variable	Coefficient (β)	Std. Error	p-value
Gender (1 = Male)	0.58**	0.21	0.007
CRA input access	0.74***	0.19	0.000
Extension contact	0.49***	0.17	0.003
Land ownership (1=Yes)	0.62***	0.18	0.001
Education level (years)	0.35**	0.14	0.011
Household size	-0.27**	0.12	0.028
Access to credit	0.41***	0.15	0.006
Climate shock experience	-0.53***	0.16	0.001
Pseudo R^2	0.421		
Adjusted Pseudo R^2	0.396		
Model Chi-square	68.35		
2 Log Likelihood	184.26		

The coefficient for education level ($\beta = 0.35$, $p< 0.05$) suggests that formal education enhances food security through improved access to information, innovation uptake, and decision-making capacity. Similar outcomes have been reported by Abdulai and Huffman (2005), who found that higher educational attainment positively affects both agricultural efficiency and household welfare. Conversely, household size has a negative effect on food security ($\beta = -0.27$, $p< 0.05$), implying that larger households may experience greater consumption burdens relative to available food resources. This is consistent with the findings of Ogunniyi *et al*. (2020), who reported that larger household sizes often translate to increased dependency ratios and reduced per capita food availability.

The availability of credit ($\beta = 0.41$, $p< 0.01$) significantly improves food security outcomes, highlighting the importance of financial access in enabling input acquisition, market participation, and income diversification. This is supported by the work of Ali and Erenstein (2017), who noted that credit serves as a buffer against production shocks and seasonal food shortages. Finally, experience of climate shocks negatively influences food security ($\beta = -0.53$, $p< 0.01$), indicating that households recently exposed to climatic disruptions such as droughts or floods are more vulnerable to food insecurity. This result is in line with Deressa *et al*. (2009), who emphasized that climate-induced risks have direct consequences on agricultural outputs and food access. Collectively, these findings underscore the multifaceted nature of food security and the need for integrated interventions targeting gender equity, education, land access, extension service delivery, and climate resilience strategies. Strengthening these dimensions can enhance rural households' capacity to attain sustainable food security in the face of environmental and economic challenges.

4. Conclusion

The study concludes that gender disparities significantly influence participation in climate-resilient agricultural practices and subsequently affect food security outcomes in Kebbi State.

Female farmers encounter systemic barriers that limit their access to resources and reduce their adaptive capacity. Promoting gender equity in agricultural adaptation strategies is essential for achieving sustainable food security and rural development.

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