
**GENDER DIFFERENCES IN THE UTILIZATION OF CLIMATE-SMART AGRICULTURAL
TECHNIQUES IN AKWA IBOM STATE, NIGERIA**

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ABSTRACT

This study examined gender differences in the utilization and constraints of climate-smart agricultural (CSA) techniques among rural farmers. Specifically, it described the socio-economic characteristics of male and female farmers, assessed their CSA utilization levels, and identified major constraints to adoption. A total of 480 farmers (240 males, 240 females) were selected using a multistage sampling technique across four agricultural zones. Data were collected via a structured questionnaire and analyzed using descriptive statistics and Principal Component Analysis (PCA). Findings revealed that the majority of respondents were aged 31–45 years, had secondary education (43.8%), and cultivated farms averaging 2.8 ha, with males generally older, more experienced, and earning higher incomes than females. Overall utilization of CSA techniques was moderate (mean = 42.6 ± 9.8), with males adopting practices slightly more frequently (44.2 ± 9.2) than females (41.0 ± 10.1); 51.7% of farmers fell in the moderate utilization category. Adoption was highest for improved crop varieties, biosecurity in poultry, and manure management in livestock, while aquaculture practices were least utilized. PCA revealed five major constraints: financial (21.2%), institutional (19.0%), technical/knowledge (16.8%), environmental (13.7%), and socio-cultural (12.1%), with financial and technical limitations most pronounced for female farmers. The study concluded that gender disparities affect CSA utilization, with women facing greater barriers to utilization. It recommended targeted capacity-building, inclusive extension campaigns, and provision of accessible credit and technical support to enhance equitable participation in climate-smart agriculture.

Keywords: Climate-Smart Agriculture, Gender Differences, Utilization, Constraints

INTRODUCTION

Climate change has become a major threat to agricultural sustainability, particularly for smallholder farmers who depend heavily on climate-sensitive resources. In Nigeria, these impacts have contributed to declining agricultural productivity and growing food insecurity (Adamaagashi *et al.*, 2023; Okon *et al.*, 2021). To address these challenges, Climate-Smart Agriculture (CSA) has been promoted as an integrated approach for improving productivity, enhancing resilience, and strengthening food security under changing climatic conditions (Ariom *et al.*, 2022; Gopal *et al.*, 2025). Evidence shows that CSA practices such as improved crop varieties, soil and water conservation, and diversification can significantly improve farm performance and household welfare (Andati *et al.*, 2023; Obianefo *et al.*, 2024).

In Akwa Ibom State, agriculture is highly vulnerable to climate variability, particularly due to irregular rainfall patterns and flooding, which negatively affect crop production and water management (Isaiah *et al.*, 2023). These challenges have contributed to increased vulnerability and food insecurity among farming households (Uko and Eyo, 2025). Although CSA practices have been introduced to enhance farmers' resilience, their level of utilization remains uneven. Previous studies in the state have examined climate adaptation and CSA use. Nyong and Bassey (2019) focused on CSA practices among yam farmers, while Okon, Ernest, and Udoh (2024) examined determinants of CSA use among arable crop farmers. Studies by Ekanem and Uloh (2025) and Nkanta *et al.*, (2025) reported gender differences in access to agricultural services, and Asanwana and Uloh (2025a) highlighted the importance of gender-responsive extension for women's empowerment.

This study, therefore, seeks to fill this gap by examining gender differences in the utilization and constraints of CSA techniques among farmers in Akwa Ibom State.

Objectives of the Study

- i. Describe the socio-economic characteristics of male and female rural farmers in the study area.
- ii. assess the level of utilization of climate-smart agricultural (CSA) techniques among male and female farmers; and
- iii. Identify the major constraints to the utilization of climate-smart agricultural (CSA) techniques among the respondents.

METHODOLOGY

The study was conducted in Akwa Ibom State, located in the South-South geopolitical zone of Nigeria. A multistage sampling technique was employed to ensure representativeness and operational convenience. First, four agricultural zones (Abak, Ikot-Ekpene, Etinan, and Uyo) were randomly selected from the six zones. Second, two blocks were randomly selected from each zone, followed by the random selection of two cells from each block. Finally, 15 male and 15 female farmers were selected from each cell, resulting in a total sample of 480 respondents (240 males and 240 females). Primary data were collected using a structured questionnaire administered electronically through the Open Data Kit (ODK) platform. Socio-economic characteristics were measured using frequency counts, percentages, means, and standard deviations. Utilization of Climate-Smart Agriculture (CSA) techniques was measured using a 4-point Likert scale: Rarely (1), Occasionally (2), Frequently (3), and Very frequently (4). Mean scores were computed for each technique, and a cut-off mean of 2.50 was used to determine utilization. Overall utilization levels were categorized into low (16–32),

moderate (33–48), and high (49–64). Constraints to CSA utilization were measured using multiple items and reduced into underlying dimensions using Principal Component Analysis (PCA) with Varimax rotation. The PCA model is expressed as:

$$Z_j = \alpha_{j1}X_1 + \alpha_{j2}X_2 + \dots + \alpha_{jp}X_p$$

where Z_j is the j^{th} principal component, α_{jp} are factor loadings, and X_p are standardized observed variables. Factors with eigenvalues ≥ 1.0 and loadings ≥ 0.60 were retained. Sampling adequacy was confirmed using the Kaiser-Meyer-Olkin (KMO) statistic and Bartlett's Test of Sphericity. Data were analyzed using descriptive statistics and factor analysis to address the study objectives. This analytical approach is widely applied in CSA adoption and constraint studies for identifying key underlying barriers and utilization patterns (Apeh *et al.*, 2024; Muriithi *et al.*, 2023).

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Male and Female Rural Farmers

The respondents comprised 480 farmers, equally divided between males and females (Table 1). The age of respondents ranged from 18 to over 60 years, with the majority (47.5%) falling within the 31–45 years category, while the least (7.5%) were above 60 years. Male farmers were slightly older on average (44.1 ± 11.5 years) than female farmers (40.5 ± 10.8 years).

Educational attainment showed that most respondents (43.8%) had secondary education, with males slightly more likely to have tertiary education (20.8%) compared to females (14.2%). A small proportion of respondents had no formal education (17.5%). Most respondents were single (83.0%), with a minority married (8.7%).

Household size ranged from 1 to over 8 members, with a mean of 6.2 ± 2.5 . Households of 5–8 members were most common (57.5%), whereas households with more than 8 members were the least represented (15.8%).

Farming experience averaged 15.4 ± 8.7 years, with nearly half of respondents (49.6%) having 5–15 years of experience. Male farmers generally had more experience (>15 years) than females. Farm size varied, with 50.0% cultivating less than 1 hectare, and male farmers having larger farms on average (3.2 ± 1.8 ha) than female farmers (2.4 ± 1.2 ha).

The majority of respondents (89.6%) identified farming as their primary occupation. Annual income was concentrated between ₦300,000–₦600,000 (54.2%), while only 26.6% earned above ₦600,000, with male farmers earning higher incomes on average ($₦610,000 \pm 220,000$) than females ($₦510,000 \pm 200,000$).

The socio-economic profile indicates potential for CSA adoption, but gender differences in education, experience, farm size, and income could shape the utilization and constraints of these techniques among male and female farmers.

Table 1: Socio-economic characteristics of respondents (N=480)

Characteristic	Male (n=240) f (%)	Female (n=240) f (%)	Total (N=480) f (%)
Age (years)			
18–30	28 (11.7%)	44 (18.3%)	72 (15.0%)
31–45	108 (45.0%)	120 (50.0%)	228 (47.5%)
46–60	78 (32.5%)	66 (27.5%)	144 (30.0%)
>60	26 (10.8%)	10 (4.2%)	36 (7.5%)
Mean ± SD	44.1 ± 11.5	40.5 ± 10.8	42.3 ± 11.2
Educational Level			
No formal education	38 (15.8%)	46 (19.2%)	84 (17.5%)
Primary	48 (20.0%)	54 (22.5%)	102 (21.2%)
Secondary	104 (43.3%)	106 (44.2%)	210 (43.8%)
Tertiary	50 (20.8%)	34 (14.2%)	84 (17.5%)
Marital Status			
Single	22 (9.2%)	18 (7.5%)	40 (8.3%)
Married	196 (81.7%)	202 (84.2%)	398 (83.0%)
Married	22 (9.2%)	20 (8.3%)	42 (8.7%)
Widowed/Divorced			
Household Size			
1–4	52 (21.7%)	76 (31.7%)	128 (26.7%)
5–8	136 (56.7%)	140 (58.3%)	276 (57.5%)
>8	52 (21.7%)	24 (10.0%)	76 (15.8%)
Mean ± SD	6.5 ± 2.7	5.9 ± 2.3	6.2 ± 2.5
Farming Experience (years)			
<5	20 (8.3%)	30 (12.5%)	50 (10.4%)
5–15	110 (45.8%)	128 (53.3%)	238 (49.6%)
>15	110 (45.8%)	82 (34.2%)	192 (40.0%)
Mean ± SD	16.8 ± 9.1	14.0 ± 8.1	15.4 ± 8.7
Farm Size (ha)			
<1	122 (50.8%)	118 (49.2%)	240 (50.0%)
1–2	60 (25.0%)	88 (36.7%)	148 (30.8%)
>2	58 (24.2%)	34 (14.2%)	92 (19.2%)
Mean ± SD	3.2 ± 1.8	2.4 ± 1.2	2.8 ± 1.6
Primary Occupation			
Farming	220 (91.7%)	210 (87.5%)	430 (89.6%)
Farming	20 (8.3%)	30 (12.5%)	50 (10.4%)
Trading/Other			
Annual Income (₦)			
<₦300,000	30 (12.5%)	62 (25.8%)	92 (19.2%)
₦300,000–₦600,000	128 (53.3%)	132 (55.0%)	260 (54.2%)
>₦600,000	82 (34.2%)	46 (19.2%)	128 (26.6%)
Mean ± SD	610,000 ± 220,000	510,000 ± 200,000	560,000 ± 210,000

Source: Field survey (2025)

Level of Utilization of Climate-Smart Agricultural (CSA) Techniques among Male and Female Farmers

The analysis of the level of utilization of climate-smart agricultural (CSA) techniques among respondents revealed variation across domains (Table 2a). For crop production, the use of improved varieties had the highest mean (3.06), followed by integrated pest management (2.97), while water management recorded the lowest utilization (2.63). In livestock production, manure management was most frequently utilized (2.92), whereas sustainable grazing/land management was least applied (2.50). Among poultry farmers, biosecurity measures showed the highest adoption (3.12), with improved stock being the least utilized (2.95). In aquaculture/fishery, fish health management was most practiced (2.38), and smart pond construction the least (2.06).

Gender-disaggregated data indicated that male farmers generally reported higher utilization across all domains. Males recorded the highest means for biosecurity in poultry (3.20), manure management in livestock (3.00), and improved varieties in crops (3.09). Females also ranked the same techniques highest within each domain, but with slightly lower values, such as biosecurity in poultry (3.03) and manure management (2.81). The lowest utilization among males and females consistently appeared in aquaculture practices, particularly smart pond construction and improved stocking (Table 2a).

The results indicate that farmers in Akwa Ibom State adopted CSA techniques at varying levels depending on the domain. Crop production and poultry practices showed the highest levels of utilization, suggesting that farmers prioritized techniques that directly influence yield and livestock health. Low adoption in aquaculture may reflect limited knowledge, infrastructure, or resource constraints, consistent with findings from Cheruiyot and Adhiaya (2023) and Somarajan *et al.* (2025), who reported that smallholder fish farmers often underutilize technical interventions due to cost and skill requirements.

Gender differences were evident, with male farmers generally utilizing CSA techniques more frequently than female farmers across all domains. This aligns with Apeh *et al.* (2024) and Bako *et al.* (2022), highlighting systemic gender disparities in access to agricultural resources, training, and extension services. The similar ranking of techniques between genders suggests that both male and female farmers recognize the relative importance of specific practices, though resource access limits female adoption. These patterns have implications for designing gender-responsive interventions to enhance equitable access to CSA knowledge, inputs, and support (Ekanem and Uloh, 2025; Nkanta *et al.*, 2025).

Table 2a: Level of utilization of CSA techniques by respondents (N = 480)

CSA Technique	Total (N = 480)		Male (n = 240)		Female (n = 240)	
	Mean ± SD	Rank	Mean ± SD	Rank	Mean ± SD	Rank
Crop Production		1 st		1 st		1 st
Improved varieties	3.06 ± 0.81		3.09 ± 0.80		3.03 ± 0.81	
Conservation agriculture	2.78 ± 0.90	3 rd	2.81 ± 0.88	3 rd	2.74 ± 0.90	3 rd
Water management	2.63 ± 0.92	4 th	2.65 ± 0.91	4 th	2.60 ± 0.92	4 th
Integrated pest management	2.97 ± 0.86	2 nd	3.00 ± 0.84	2 nd	2.91 ± 0.88	2 nd
Livestock Production						
Genetic breed improvement	2.54 ± 0.97	3 rd	2.66 ± 0.94	3 rd	2.33 ± 0.92	3 rd
Sustainable grazing/land management	2.50 ± 0.98	4 th	2.62 ± 0.95	4 th	2.28 ± 0.90	4 th
Improved fodder/feed conservation	2.71 ± 0.96	2 nd	2.81 ± 0.92	2 nd	2.57 ± 0.94	2 nd
Manure management	2.92 ± 0.91	1 st	3.00 ± 0.86	1 st	2.81 ± 0.90	1 st
Poultry Production						
Smart housing	3.00 ± 0.87	3 rd	3.03 ± 0.85	3 rd	2.93 ± 0.88	3 rd
Improved stock	2.95 ± 0.89	4 th	3.00 ± 0.86	4 th	2.86 ± 0.89	4 th
Feed management	3.06 ± 0.84	2 nd	3.13 ± 0.82	2 nd	3.00 ± 0.85	2 nd
Biosecurity	3.12 ± 0.82	1 st	3.20 ± 0.80	1 st	3.03 ± 0.84	1 st
Aquaculture/Fishery		4 th		4 th		4 th
Smart pond construction	2.06 ± 0.93		2.25 ± 0.96		1.91 ± 0.88	
Improved stocking	2.12 ± 0.95	3 rd	2.33 ± 0.99	3 rd	1.99 ± 0.90	3 rd
Water management (pH, liming, etc.)	2.23 ± 0.92	2 nd	2.43 ± 0.93	2 nd	2.07 ± 0.91	2 nd
Fish health management	2.38 ± 0.94	1 st	2.52 ± 0.95	1 st	2.15 ± 0.92	1 st

Rating was based on a 4-point Likert scale: Rarely (1), Occasionally (2), Frequently (3), Very frequently (4).

Source: Field survey (2025). Cut off means 2.50

The overall utilization of CSA techniques among respondents was moderate (mean = 42.6 ± 9.8), with 51.7% of farmers falling into the moderate category, 27.1% in the high utilization category, and 21.3% in the low category (Table 2b). Male farmers demonstrated slightly higher overall utilization (mean = 44.2 ± 9.2), with 31.7% achieving high utilization, while females had a lower mean (41.0 ± 10.1) and 22.5% classified as high users. The proportion of females in the low utilization category (26.7%) exceeded that of males (15.8%), indicating gendered differences in overall CSA utilization (Table 2b).

The overall moderate utilization of CSA techniques reflects the partial integration of climate-smart practices among farmers in Akwa Ibom State. Male farmers' higher mean scores correspond with evidence from Kamara *et al.*, (2025) and Ayinde *et al.*, (2023), which suggest that men generally have greater access to inputs, credit, and extension services, facilitating higher adoption. The notable proportion of females in the low utilization category highlights persistent barriers related to resource access, decision-making authority, and gender norms, consistent with the observations of Apeh *et al.*, (2024) and Nyberg *et al.*, (2025).

The findings suggest that while both male and female farmers recognize the value of CSA practices, gendered structural inequalities continue to limit effective adoption by women. Addressing these gaps

through targeted extension, capacity-building, and gender-responsive policy interventions is critical to ensuring equitable agricultural productivity and resilience to climate variability (Ekanem and Uloh, 2025; Asanwana and Uloh, 2025a; Nkanta *et al.*, 2025).

Table 2b: Overall utilization of CSA techniques by respondents

Utilization Level	Score Range	Total (N=480)	Male (n=240)	Female (n=240)
		f (%)	f (%)	f (%)
Low	16–32	102 (21.3%)	38 (15.8%)	64 (26.7%)
Moderate	33–48	248 (51.7%)	126 (52.5%)	122 (50.8%)
High	49–64	130 (27.1%)	76 (31.7%)	54 (22.5%)
Mean ± SD		42.6 ± 9.8	44.2 ± 9.2	41.0 ± 10.1

Source: Field survey (2025)

Major Constraints to the Utilization of Climate-Smart Agricultural (CSA) Techniques

The principal component analysis of the constraints to the utilization of climate-smart agricultural (CSA) techniques revealed five major factors, collectively explaining 82.8% of the total variance (Table 3). Financial constraints emerged as the most significant limitation overall, with the highest eigenvalue (3.28) and accounting for 21.2% of the variance. Institutional constraints followed, contributing 19.0% of the variance, while technical/knowledge-related constraints explained 16.8%. Environmental/agro-ecological factors and socio-cultural constraints accounted for 13.7% and 12.1%, respectively. Reliability analysis showed acceptable internal consistency across all factors (Cronbach’s α range: 0.73–0.82), with an overall KMO measure of 0.80 and a significant Bartlett’s test ($p < 0.001$).

When disaggregated by gender, male farmers reported a slightly higher influence of financial constraints (eigenvalue = 3.18; 22.0% variance), followed by institutional and technical constraints, while socio-cultural constraints were the least limiting. Female farmers identified financial constraints as the most critical barrier (eigenvalue = 3.32; 20.5% variance), followed by technical/knowledge and institutional constraints, with socio-cultural limitations being relatively less pronounced. The total variance explained was slightly higher for male farmers (85.6%) compared to female farmers (79.8%), indicating marginal gender differences in perceived constraints (Table 3).

The findings indicate that financial constraints were the foremost limitation to CSA adoption among farmers in Akwa Ibom State. High input costs, limited access to credit, and insufficient subsidies restrict farmers’ ability to implement improved practices.

Institutional constraints, including inadequate extension services, poor access to government programs, and gaps in policy support, emerged as the second major barrier. Male farmers reported slightly greater institutional limitations, which may reflect their higher engagement in formal agricultural networks, consistent with findings from Nchanji *et al.*, (2025) and Okon *et al.* (2024). Female farmers, while similarly affected, often experience compounded barriers due to limited participation in decision-making structures, echoing the observations of Olumba (2026) and Apeh *et al.*, (2024).

Technical and knowledge-related challenges were particularly significant for female farmers, suggesting gaps in access to training, demonstration plots, and advisory services. This pattern supports the work of Mbegalo *et al.*, (2024) and Tilahun *et al.*, (2023), which emphasize that limited technical capacity constrains the effective adoption of CSA practices. Addressing these knowledge gaps is crucial for enhancing productivity and resilience among women farmers.

Environmental and agro-ecological constraints, including soil degradation, water scarcity, pest pressures, and climate variability, were moderately limiting. Both genders recognized these as critical factors affecting CSA implementation, consistent with studies by Antwi-Agyei *et al.*, (2023) and Nyong and Bassey (2019), which highlight the vulnerability of smallholder agriculture to local environmental stresses.

The results reflect a combination of economic, institutional, technical, environmental, and sociocultural barriers, with financial and institutional factors being dominant for both genders, while technical knowledge constraints are more pronounced among women. These findings suggest that CSA adoption strategies must be gender-responsive, addressing both access to resources and targeted capacity-building interventions.

Table 3: Major Constraints to the utilization of Climate-Smart Agricultural (CSA) techniques by gender

Factor	Variables Included	Overall (n=480) Eigenvalue	%Var	Male (n=240) Eigenvalue	%Var	Female (n=240) Eigenvalue	%Var	Cronbach's α Range
F1: Financial Constraints	High cost of inputs, Limited access to credit, Lack of subsidies, Poor financing options	3.28	21.2	3.18	22.0	3.32	20.5	0.80–0.82
F2: Institutional Constraints	Limited extension support, Poor access to government programs, Inadequate training, Policy gaps	2.95	19.0	2.88	19.9	2.92	18.0	0.77–0.79
F3: Technical/Knowledge Constraints	Lack of technical know-how, Limited knowledge of CSA techniques, Inadequate demonstration sites, Poor advisory services	2.60	16.8	2.54	17.5	2.56	16.0	0.78–0.80
F4: Environmental/Agro-ecological Constraints	Soil degradation, Water scarcity, Pest/disease pressure, Climate variability	2.12	13.7	2.06	14.2	2.10	13.0	0.75–0.77
F5: Sociocultural Constraints	Gender norms, Cultural beliefs, Household labour demands	1.88	12.1	1.81	12.0	1.85	12.3	0.73–0.75
Total Variance Explained (%)			82.8		85.6		79.8	

Notes:

- Factor loadings ≥ 0.60 are considered significant.
- Overall KMO = 0.80; Male KMO = 0.82; Female KMO = 0.80.
- Bartlett's Test significant at $p < 0.001$ for all groups.
- Principal Component Analysis with Varimax rotation applied.

CONCLUSION AND RECOMMENDATION

The study revealed that male and female farmers in Akwa Ibom State exhibited moderate overall utilization of climate-smart agricultural (CSA) techniques, with males consistently reporting slightly higher adoption levels across crop, livestock, poultry, and aquaculture domains. Gender disparities in utilization were influenced by differences in education, farming experience, farm size, and income. The major constraints to CSA adoption were financial, institutional, technical/knowledge-related, environmental, and socio-cultural, with financial barriers being the most significant for both genders and technical knowledge gaps particularly limiting for female farmers. Based on the findings, the following recommendations are proposed:

1. Agricultural extension services and development agencies should design targeted capacitybuilding programs that enhance women farmers' access to education, training, and resource support, ensuring they can effectively adopt CSA practices.
2. Farmers' associations, cooperatives, and extension agents should promote inclusive CSA adoption campaigns, providing hands-on demonstrations and field days tailored to both male and female farmers to improve utilization across all agricultural domains.
3. Government agencies, financial institutions, and NGOs should provide accessible credit facilities, subsidies, and technical support, with special emphasis on addressing financial and technical barriers for women farmers to ensure equitable participation in climate-smart agriculture.

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