

Women Farmers' Empowerment and the Adoption of Sustainable Agricultural Practices in Jema'a Local Government Area, Kaduna State, Nigeria

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Publication Date: 2026/10/13

Abstract: This article investigates the extent to which women farmers in Jema'a Local Government Area, Kaduna State, report using sustainable agricultural practices and whether their level of empowerment predicts that engagement. The study used a descriptive cross-sectional survey of registered and unregistered women farmers. Of 350 questionnaires distributed, 347 were returned, and 298 were retained after screening. We used means, standard deviations, and simple linear regression for analysis at the 0.05 significance level. Overall engagement in sustainable practices was high ($M = 3.12$, $SD = 0.77$), especially for soil conservation, improved seed use and environmentally responsible pest and disease control. Respondents nevertheless reported difficulties due to limited training, inputs, and extension support. Empowerment showed a strong positive association with sustainable-practice adoption ($R = .895$, $R^2 = .801$, $p < .001$). The findings indicate that extension programmes should combine technical support with improved access to productive resources and greater decision-making agency for women farmers.

Keywords: Agricultural Empowerment; Sustainable Agricultural Practices; Women Farmers.

How to Cite: Ezekiel Joyce; Maichiki, Isaac Peter; Stephen, Victor Dutse (2026) Women Farmers' Empowerment and the Adoption of Sustainable Agricultural Practices in Jema'a Local Government Area, Kaduna State, Nigeria.

International Journal of Innovative Science and Research Technology, 11(10), 341-346.

<https://doi.org/10.38124/ijisrt/26oct380>

I. INTRODUCTION

Women contribute substantially to agrifood production, processing, and marketing, but participation alone does not ensure equal access to the assets and decisions that shape farm outcomes. FAO (2023) identifies gender equality and women's empowerment as important conditions for productive, resilient and sustainable agrifood systems. Quisumbing et al. (2023) likewise treat agricultural empowerment as multidimensional, encompassing agency, resource access, income control and meaningful participation in production decisions. These issues remain relevant in Nigeria, where many women farm actively yet still face

limitations in land, finance, technology, and institutional support.

Climate variability, declining natural resources and food-security pressures have increased interest in farming practices that protect the production base while sustaining output. Examples include crop rotation and diversification, organic nutrient management, soil and water conservation, improved seed use, agroforestry and integrated pest management. Pretty et al. (2018) link sustainable intensification to redesigning agricultural systems so that productivity gains do not depend on greater environmental damage. In North Central and Northwest Nigeria, Gabriel et al. (2023) reported substantial awareness and use of climate-

smart practices, but also uneven uptake of soil testing, agroforestry, terracing and conservation tillage, with extension agents remaining an important source of information.

For women farmers, the decision to adopt sustainable practices is constrained not only by knowledge but also by the means and authority to act. Nigerian studies have linked empowerment and gender differences with climate-smart agriculture adoption (Oyawole et al., 2021), while credit, cooperative membership, climate information and related institutional conditions have been associated with adoption decisions (Ojo et al., 2023). Edewor et al. (2023) further showed that gendered land ownership remains relevant to the adoption environment. More recent evidence indicates that extension contact, credit, and access to productive resources continue to shape adoption patterns across genders in Nigeria (Daudu et al., 2025).

Institutional arrangements are also important. Onah et al. (2026), drawing on women farmers and agricultural institutions across Nigeria's six geopolitical zones, reported that gender-inclusive climate policies were associated with better access to agricultural inputs and sustainable adaptation, whereas institutional and gender barriers reduced access. Their findings support an understanding of empowerment that goes beyond participation in farming to include effective access to resources, services and decision-making opportunities.

Evidence from other African settings supports this argument. Hailemariam et al. (2024) identified gender gaps in the adoption of climate-smart practices in sub-Saharan Africa and linked them partly to differences in land, information, and decision-making power. Boudalia et al. (2024) highlighted financial, sociocultural, policy and information barriers affecting female farmers, while Nadeem et al. (2025) reported in Pakistan that stronger control of assets, decisions, legal rights, skills and information technology was associated with greater sustainable-practice adoption. Adoption, therefore, reflects both technical choices and the resources and agency available to farmers.

It is less clear how these dimensions operate together among women farmers in Jema'a Local Government Area. Much Nigerian research focuses on specific technologies, crops, regions, or single dimensions of empowerment. This study addresses this local gap by examining a broader measure of empowerment alongside a set of sustainable agricultural practices. Jema'a therefore serves as a case study through which the interaction of resource access, agency, and extension support can be examined, with implications for gender-responsive extension and rural-development policy beyond the sampled communities.

➤ *Objective and Hypothesis*

This article aims to assess the extent to which women farmers adopt sustainable agricultural practices in Jema'a LGA and to determine whether women farmers' empowerment significantly predicts adoption of sustainable agricultural practices.

- **H₀:** Women farmers' empowerment does not significantly predict the adoption of sustainable agricultural practices in Jema'a LGA.

II. LITERATURE AND THEORETICAL PERSPECTIVE

Agricultural empowerment is broader than simply taking part in farm work. Kabeer's (1999) resources-agency-achievements formulation provides a useful lens because it links what people can draw upon, their capacity to make and act on choices, and the outcomes that follow. Alkire et al. (2013) translated related ideas into the Women's Empowerment in Agriculture Index, which considers production decisions, productive resources, income, leadership and time. Quisumbing et al. (2023) further underscore the value of multidimensional measurement and the central place of agency in agricultural and food-system research.

In this study, the resource dimension covers farmland, credit, inputs, agricultural knowledge and extension support. Agency refers to meaningful involvement in farm decisions and control over agricultural choices. These dimensions are linked because knowledge of a beneficial practice does not guarantee its use when a farmer lacks secure land access, finance, inputs, information or decision-making authority. FAO (2023) similarly notes that structural gender inequalities shape women's access to agrifood assets, services, opportunities and benefits.

The Sustainable Livelihood Framework adds an asset-based perspective. Knowledge and skills represent human capital; farmer organisations and networks provide social capital; land and water form natural capital; equipment and infrastructure represent physical capital; and credit, savings and income constitute financial capital. Sustainable-practice adoption becomes more feasible when women can mobilise these assets together with decision-making agency. For instance, Valerio et al. (2024) found that targeted credit and extension services were associated with women's empowerment in a semi-arid agricultural setting.

Nigerian empirical studies support this resource-and-agency connection from different angles. Oyawole et al. (2021) linked differences in empowerment to climate-smart agriculture adoption, Gabriel et al. (2023) identified extension agents as an important source of climate-smart agriculture awareness, and Ojo et al. (2023) showed the importance of credit and institutional support among rice farmers. Edewor et al. (2023) demonstrated the relevance of gender-sensitive land analysis, while Daudu et al. (2025) linked adoption decisions to education, farm size, climate-smart agriculture awareness, extension access, credit, and association membership.

The literature also shows that no single resource explains women's agricultural constraints. Adeyeye and Fischer (2024) reported continuing inequalities across empowerment domains among cassava producers in Southwest Nigeria. Omeje et al. (2024) identified high technology costs and weak access to credit and subsidies as barriers among smallholder

women farmers. Hailemariam et al. (2024) found that women were less likely than men to adopt several high-return climate-smart practices, with information, farm characteristics, values and norms helping to explain the gap. Boudalia et al. (2024) and Onah et al. (2026) similarly highlight the combined importance of finance, policy, sociocultural conditions, climate information, and gender-responsive institutions.

Taken together, these studies support a framework in which sustainable-practice adoption depends on both access to livelihood resources and the agency to use them. The present article therefore combines Kabeeer's empowerment perspective with the Sustainable Livelihood Framework. It expects women farmers with stronger access to productive assets, knowledge, finance, institutional support and decision-making power to be better positioned to adopt sustainable practices.

III. MATERIALS AND METHODS

The study used a descriptive cross-sectional survey design. The parent study estimated a population of about 2,500 registered and unregistered women farmers in selected communities in Jema'a Local Government Area, Kaduna State. The Taro Yamane procedure yielded a target sample of 345, and we distributed 350 questionnaires to allow for non-response or unusable returns. Of the 347 returned questionnaires, we removed 49 during screening, leaving 298 valid cases, equivalent to 85.1% of those distributed. The regression reported for Hypothesis One used 292 complete cases, consistent with the residual degrees of freedom reported as $F(1, 290)$.

Sampling proceeded in stages. Farming communities were first selected purposively. We then grouped women farmers by farming activity and selected respondents proportionately using simple random sampling within the resulting strata. The questionnaire captured socio-demographic information, empowerment indicators and sustainable agricultural-practice items, together with other outcome domains examined in the parent study.

The sustainable agricultural-practice/food-production scale showed high internal consistency (Cronbach's $\alpha = .964$). The inferential model used Q11–Q16 as the empowerment measure and Q1–Q9 as the sustainable-practice adoption measure. Q10, a negatively worded constraint item, was retained for descriptive interpretation but excluded from the adoption composite used in regression. The six-item empowerment measure produced Cronbach's $\alpha = .940$.

Means and standard deviations summarised the practice items. Responses were recorded on a four-point scale from 1 = Strongly Disagree to 4 = Strongly Agree, with 2.50 used as the criterion mean. We tested the null hypothesis using simple linear regression at $\alpha = .05$. Because the design was observational and cross-sectional, we interpret the regression as evidence of association and prediction within the sample, not proof of a causal effect.

We obtained ethical approval from Kaduna State College of Education, Gidan Waya, before data collection; the institution did not issue an approval/reference number. Participants gave informed consent; participation was voluntary, withdrawal without penalty was permitted, and confidentiality and anonymity procedures protected identifying information.

IV. RESULTS

➤ Extent of Adoption of Sustainable Agricultural Practices

Table 1 Women Farmers' Responses on Sustainable Agricultural Practices

Q1 Crop diversification: M = 3.01, SD = .85
Q2 Crop rotation: M = 3.15, SD = 1.01
Q3 Organic manure/compost: M = 3.13, SD = 1.04
Q4 Soil conservation methods: M = 3.30, SD = .88
Q5 Water management: M = 3.05, SD = .95
Q6 Improved seeds/varieties: M = 3.27, SD = .89
Q7 Environmentally responsible pest/disease control: M = 3.26, SD = .80
Q8 Training/extension advice improved practices: M = 3.15, SD = .74
Q9 Practices increased quantity/quality: M = 2.97, SD = .83
Q10 Limited training/inputs/extension makes adoption difficult: M = 2.89, SD = .98

Across the practice items, the overall mean was 3.12 (SD = .77), above the 2.50 decision point. Soil conservation had the highest mean (M = 3.30), followed by improved seeds or varieties (M = 3.27) and environmentally responsible pest and disease control (M = 3.26). Crop rotation and perceived improvement following training or extension advice each had a mean of 3.15. Q10 recorded the lowest mean (M = 2.89); because it was negatively worded, this still reflects agreement that inadequate training, inputs and extension support hinder adoption.

➤ Test of Hypothesis

Table 2 Simple Linear Regression of Empowerment on Sustainable Agricultural-Practice Adoption

R = .895 R ² = .801 Adj. R ² = .801 F = 1170.093 df = 1, 290 B = .902 SE = .026 β = .895 t = 34.207 p = < .001
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The regression for Hypothesis One used 292 complete observations and was statistically significant, $F(1, 290) = 1170.093$, $p < .001$. The model produced $R = .895$ and $R^2 = .801$. Thus, within the regression sample, the empowerment score explained 80.1% of the observed variance in the measured adoption score. Empowerment had a positive regression coefficient ($B = .902$, $SE = .026$, $\beta = .895$, $t = 34.207$, $p < .001$, 95% CI [.850, .953]). We rejected the null hypothesis; higher empowerment scores were associated with higher sustainable-practice adoption scores.

V. DISCUSSION

Women farmers in the sampled Jema'a communities reported broad use of sustainable agricultural practices. Soil conservation, improved seed or variety use and environmentally responsible pest and disease control were the most strongly endorsed, with additional evidence of crop rotation, organic manure or compost use, water management and benefits from training or extension advice. This pattern resembles Gabriel et al. (2023), who reported substantial but uneven use of climate-smart practices in North Central and Northwest Nigeria.

The most notable result is the strong association between empowerment and adoption. This aligns with Nigerian evidence that gender and empowerment matter for climate-smart agriculture decisions (Oyawole et al., 2021) and with Nadeem et al. (2025), who linked asset control, decision-making, legal rights, skills, and information technology to sustainable-practice adoption among women farmers. The Jema'a findings therefore add local evidence to a broader literature linking agency and resource access to farming behaviour.

One possible mechanism is improved access to finance and productive assets. Ojo et al. (2023) linked credit and cooperative participation to climate-smart agriculture adoption among Nigerian rice farmers, while Omeje et al. (2024) identified technology costs and limited access to credit and subsidies as constraints for women farmers. Daudu et al. (2025) similarly linked access to credit and extension services to climate-smart agriculture adoption. Together, these findings suggest that empowerment can make adoption more feasible by improving women's capacity to obtain inputs, invest in technology and manage production risks.

A second mechanism concerns information and institutional support. Respondents agreed that shortages of training, inputs and extension services make adoption more difficult. Gabriel et al. (2023) identified extension agents as an important channel for climate-smart agriculture awareness, Valerio et al. (2024) linked extension and targeted credit with women's empowerment, and Onah et al. (2026) associated gender-inclusive climate policies with women's access to agricultural inputs. Extension support may therefore strengthen both technical knowledge and women's practical capacity to act on that knowledge.

The result should also be read against persistent differences in control over resources and farm decisions. Adeyeye and Fischer (2024) found that substantial participation by women in cassava value chains did not remove structural inequalities in empowerment. Boudalia et al. (2024) similarly identified financial constraints, sociocultural norms, policy conditions and information access as drivers of gendered adoption gaps across Africa. Therefore, participation in farming should not be treated as equivalent to empowerment when women still lack authority over production choices or resources.

The theoretical interpretation follows the same logic. In Kabeer's (1999) framework, resources enlarge the range of choices available, agency concerns the ability to act on those choices, and achievements reflect realised outcomes. Alkire et al. (2013) and Quisumbing et al. (2023) likewise present agricultural empowerment as multidimensional. From a livelihood perspective, land, finance, knowledge, social networks and productive assets are forms of capital that can support sustainable strategies. The Jema'a result is therefore consistent with the proposition that livelihood assets and agency shape adoption.

The magnitude of R^2 (.801) warrants caution. Empowerment and adoption were self-reported by the same respondents in a single survey, so shared measurement conditions and conceptual overlap may have inflated the observed relationship. The model therefore indicates a strong predictive association within this sample; it does not establish that changes in empowerment caused 80.1% of subsequent changes in adoption. Longitudinal or intervention studies would be better suited to causal inference.

VI. CONCLUSION

The study found a strong positive association between women farmers' empowerment and their reported use of sustainable agricultural practices in Jema'a LGA. Women widely reported soil conservation, improved seed varieties, environmentally responsible pest and disease control, crop rotation, organic manure, and water-management practices. At the same time, limited training, inputs and extension support remained important constraints.

The practical implication is that sustainable agriculture programmes should not treat technical training as sufficient on its own. Women also need workable access to productive resources, institutional support and decision-making authority. Although the evidence comes from one local government area, it illustrates a wider extension challenge in Nigeria: adoption is more likely when information, resources and agency are addressed together.

RECOMMENDATIONS

- Kaduna State agricultural authorities and Jema'a Local Government should strengthen women-focused extension programmes with practical instruction in soil conservation, crop rotation, organic manure, water management, improved seed use and environmentally responsible pest management.
- Support programmes should improve women farmers' access to affordable credit, quality seed, suitable farm inputs, small-scale irrigation and labour-saving equipment.
- Agricultural and community institutions should pursue arrangements that improve women's secure and practical access to farmland and other productive assets.
- Extension scheduling, training locations and communication methods should take account of women's combined farming and household responsibilities.

- Cooperatives and farmer groups should be used more deliberately as channels for information, inputs, credit, training, market access and collective negotiation.
- Programme design should treat empowerment as a combination of resource access, participation and decision-making authority rather than assuming that training by itself will produce adoption.

LIMITATIONS AND FURTHER RESEARCH

The evidence is based on cross-sectional self-reports from selected communities in one LGA, so the regression should not be interpreted causally or automatically generalised to other settings. Future work could follow farmers over time or evaluate specific interventions that alter access to land, credit, inputs, extension contact or decision-making power. Comparative studies across several LGAs would also help determine whether the observed relationship is particular to Jema'a.

DECLARATIONS

- Data Availability Statement: Anonymised data underlying the analysis may be requested from the corresponding author, subject to confidentiality and ethical restrictions.
- AI Use Declaration: OpenAI ChatGPT was used to assist with language editing, restructuring and manuscript formatting. It was not used to generate the original research data or conduct the original statistical analysis. The authors reviewed and verified the revised manuscript and accept responsibility for its accuracy, references, analysis and conclusions.
- Ethical Compliance: The authors obtained ethical approval from Kaduna State College of Education, Gidan Waya, before data collection. The institution did not issue an approval/reference number.
- Informed Consent: Participants gave informed consent before taking part. Participation was voluntary, withdrawal without penalty was permitted, and confidentiality and anonymity were maintained.
- Competing Interests: The authors declare no competing interests.
- Funding: The Tertiary Education Trust Fund (TETFund), Nigeria, funded this research.

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