Agro Bali : Agricultural Journal
Vol. 9 No. 1: 244-254, March 2026

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

Utilization of Climate-Smart Agricultural Practices Among Rural Farmers in Cross River State, Nigeria

Friday Ogar Idiku[1♥], Emmanuel Ekpo Archibong[2], Ekpenyong Nsa Essien[2], Victoria Francis Ediene[3], Emmanuel Ohara Eremi[1], and Comfort Felix Aya[1]

[1]Department of Agricultural Extension and Rural Sociology, University of Calabar, Nigeria
[2]Department of Animal Science, University of Calabar, Nigeria
[3]Department of Soil Science, University of Calabar, Nigeria
♥Corresponding author email: idikuf@gmail.com

Article history: submitted: January 16, 2026; accepted: April 14, 2026; available online: April 14, 2026

Abstract. Climate change poses a significant threat to agricultural productivity and food security in Nigeria. This study assessed the utilization of Climate Smart Agricultural (CSA) practices by describing the socio-economic characteristics of rural farmers, identifying their sources of information on CSA, documenting CSA practices currently adopted, and examining the constraints hindering widespread utilization. The key findings are that the majority of respondents were male (59.6%) and youths aged 20–35 years (59.6%), with most being married (59.6%) and having small households (79.8%). Although many earned a modest income (₦150,000–₦250,000 annually). A majority lacked access to credit (82.6%), which is a major limitation to CSA investment. CSA information access shows that Radio/TV (60.6%) was the main information source, and only 21.1% received CSA information from extension agents. CSA adoption and duration indicated that conservation agriculture was the most adopted practice (68.8%), and the majority (62.3%) had adopted CSA practices within the last two years, indicating relatively recent exposure while motivations for CSA adoption were improved yield (58.7%), followed by reduced cost (27.5%) and improved soil fertility (13.8%). The challenges to CSA adoption were a lack of technical knowledge (55.1%) and limited access to credit (27.5%) as dominant constraints. However, education (p=0.045, r=0.654) and sex (p=0.036, r=0.560) were significantly related to adoption of CSA practices. Similarly, social media (p=0.007, r=0.429) had a strong, positive relationship with utilization of CSA practices, while Radio/TV (p=0.062, r=0.401), though not too significant, but the positive value, indicates their importance. Therefore, CSA practices and interventions should be holistic to transform agricultural development.

Keywords: adoption; climate-smart agriculture; constraints; rural farmers; utilization

1. Introduction

Agriculture is the cornerstone of the Nigerian economy, employing a majority of the rural population and contributing significantly to the nation's Gross Domestic Product (GDP) (National Bureau of Statistics (NBS), 2021; Odion et al., 2025). However, this critical sector is highly vulnerable to the adverse effects of climate change, manifested through erratic rainfall patterns, increased temperatures, desertification, and frequent flooding (Bashiru & Oseni, 2025). These climatic shocks threaten food security, exacerbate poverty, and undermine the livelihoods of millions of smallholder farmers who depend on rain-fed agriculture. In response to these challenges, Climate-Smart Agriculture (CSA) has been promoted globally as an integrated approach to transforming and reorienting agricultural systems.

The Food and Agriculture Organization (FAO), (2013) defines CSA through three interlinked pillars: (1) sustainably increasing agricultural productivity and incomes; (2) adapting and building resilience to climate change; and (3) reducing and/or removing greenhouse gas emissions, where possible. For a country like Nigeria, where agricultural productivity must increase to feed a growing population amidst a changing climate, the adoption of CSA is not just an option but a necessity. While numerous CSA practices, such as conservation agriculture, agroforestry, drought-tolerant varieties, and efficient irrigation, have been developed and introduced in Nigeria, their uptake among smallholder farmers is not yet optimal (Bashiru & Oseni, 2025).

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

The decision to adopt and utilize these practices is influenced by a complex interplay of socio-economic factors, access to information, and the perceived and real constraints faced at the farm level. This paper, therefore, proposes a research framework to systematically investigate the utilization of CSA practices among rural farmers in Nigeria. The increasing variability of the climate in Nigeria has led to declining crop yields, loss of livestock, and increased food prices, pushing many rural households into deeper food insecurity and poverty. Despite the existence and promotion of various CSA practices designed to mitigate these effects, there is a significant gap between their availability and their widespread, effective utilization by the end-users, the farmers.

Preliminary reports and scattered studies indicate that adoption rates are low and often fragmented (Kulugomba et al., 2024). For instance, a farmer might adopt drought-resistant seeds but fail to implement complementary soil and water conservation techniques, thereby limiting the overall resilience benefits. The root causes of this utilization gap are not fully understood holistically. There is a pressing need to comprehensively identify the socio-economic profiles of the farmers, their specific sources of climate and agricultural information, the portfolio of practices they have actually adopted, and the multifaceted constraints that prevent them from fully integrating CSA into their farming systems. Without this nuanced understanding, policy interventions and extension programs risk being misdirected and ineffective.

This research seeks to fill this gap by providing a structured analysis that can inform targeted strategies to enhance CSA utilization in Nigeria. The socio-economic profile of a farmer is a critical determinant of their capacity to adopt new agricultural technologies, including CSA practices. Studies consistently show that factors such as age, education, gender, farm size, income level, and access to credit significantly influence adoption decisions. For example, (Hashim et al., 2024) found that younger farmers in Nigeria were more likely to adopt resilient crop varieties as they are generally more receptive to change and innovation. Conversely, older farmers, with a wealth of traditional knowledge, may be more risk-averse. Education level enhances a farmer's ability to understand and process complex information related to climate change and the benefits of new practices (Fatahullah & Syauqi Agung Firmanda, 2025; Ganni Mampo et al., 2025). Furthermore, access to resources is pivotal. Baiyegunhi et al. (2022) demonstrated that farmers with larger farm sizes and better access to credit were more likely to invest in CSA practices like agroforestry and water harvesting technologies, which may have higher initial costs. Gender also plays a crucial role; women farmers, who are pivotal to agricultural production, often face greater constraints in accessing land, credit, and extension services, thereby limiting their adoption of CSA (Ayanlade & Proske, 2016). Therefore, describing these socio-economic characteristics is fundamental to understanding the adoption landscape.

Access to timely, reliable, and understandable information is a key driver for the adoption of CSA. Farmers rely on a variety of information channels to learn about new practices. In rural Nigeria, agricultural extension agents have traditionally been the primary source. However, the extension system is often plagued by inadequate funding and a low agent-to-farmer ratio (Kughur et al., 2021). Consequently, farmers increasingly depend on other sources. Radio remains a powerful and widespread medium for disseminating agricultural information due to its accessibility and low cost (Onoja et al., 2022). Similarly, the proliferation of mobile phones has opened new avenues for information sharing through SMS and voice messages. Social networks, including farmer-to-farmer communication and membership in cooperatives, are also highly influential. Oparaojiaku et al. (2025) found that farmers who belong to cooperatives had higher

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

exposure to and knowledge of CSA practices due to shared learning and collective action. Identifying which of these sources is most effective and trusted by farmers is essential for designing efficient dissemination pathways for CSA knowledge. A range of CSA practices is being promoted and, to varying degrees, adopted across Nigeria's agro-ecological zones. Commonly identified practices include: Agroforestry, which integrates trees into farming systems to improve soil fertility, provide shade, and sequester carbon (Adeyemo et al., 2021; Yuniti et al., 2022). Use of improved/drought-tolerant varieties: Adopting seed varieties that mature quickly or withstand moisture stress is one of the most widely adopted strategies (Adewuyi, 2022). Conservation agriculture: This includes minimum tillage, crop rotation, and the use of cover crops to preserve soil structure and moisture (Ojo & Ojo, 2022). Soil and Water Conservation: Practices such as constructing ridges, bunds, and using mulching to reduce erosion and retain soil moisture (Muliarta & Purba, 2020; Eze et al., 2021). Integrated soil fertility management: Combining organic and inorganic fertilizers to enhance soil health and productivity. The specific mix of practices adopted often depends on the local context, including the predominant climate risks and the type of crops grown (Ahmad et al., 2025; Shafi & Khan, 2025).

Despite the recognized benefits, farmers face a myriad of constraints that hinder the full utilization of CSA practices. The literature categorizes these constraints into economic, institutional, and technical factors. Economic constraints: The most frequently cited barrier is the high initial cost of implementation. Practices like building irrigation infrastructure or purchasing improved seeds require capital that many smallholders lack (Baiyegunhi et al., 2022). Limited access to credit and insurance further exacerbates this challenge. Institutional constraints like inadequate government support, weak extension services, and poor access to markets are significant hurdles. Farmers often report a lack of timely access to inputs like fertilizers and quality seeds. Technical and informational constraints, such as a lack of practical knowledge and skills regarding the implementation of certain CSA practices is common. There is also limited access to climate information services that could guide farming decisions (Eze et al., 2021; Md. Motiur Rahman et al., 2025). Socio-cultural constraints, which include some practices, may conflict with traditional beliefs or farming methods, leading to resistance. Land tenure insecurity, particularly for women and youth, also discourages long-term investments in land improvement practices like agroforestry (Ziro et al., 2023). This review underscores the multi-dimensional nature of the challenges and highlights the need for a localized diagnosis of constraints to inform effective policy.

2. Materials and Methods

Cross River State is one of the thirty-six (36) states in Nigeria. It is bounded in the east by the Republic of Cameroon, while its Southern shores meet the Atlantic Ocean's Bight of Bonny, to the West, its neighbors are Akwa Ibom State, and to the North, it connects with Benue and Ebonyi states. Geographically, it sits between latitudes 4°28' and 6°55' North and longitudes 7°50' and 9°29' East, a positioning that gifts it a tropical embrace. The climate feels like a constant, warm hug. Temperatures are consistently balmy, hovering between 25°C and 29°C throughout the year. But the real story is told by the rain. The state is one of the wettest in Nigeria, with the southern coastal areas receiving a drenching 4,000 mm of annual rainfall, while the north still gets a substantial 2,000 mm. This creates a perpetually humid atmosphere, where the air often feels thick and moist, with humidity levels regularly climbing above 80%. This abundant rainfall fuels an incredible tapestry of life. As you travel from south to north, the landscape transforms.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

Despite its reputation for rain, farmers are now grappling with unpredictable rainfall patterns; sometimes the rains arrive late, sometimes they leave early, and at other times, they fall with destructive intensity, causing floods. It is this very combination of agricultural dependence, environmental splendor, and growing climate vulnerability that makes Cross River State such a critical and compelling area for research into how farmers are adapting to a changing world.

A multi-stage sampling technique was employed in the selection of the sample for the study. The state comprises three (3) agricultural zones: the Northern, Central, and the Southern agricultural zones. The first stage was the selection of two (2) agricultural blocks, each from the three agricultural zones, based on predominant agricultural activities, resulting in six (6) blocks. The second stage was the random selection of three (3) agricultural cells each from the six selected blocks, making eighteen (18) cells. The third stage involved the random selection of seven rural farmers from each of the selected cells to give a total of one hundred and twenty-six (126) respondents. However, only one hundred and nine (109) respondents properly filled and returned their questionnaires; hence, the sample size was 109. Data obtained was analyzed with descriptive and inferential statistics such as frequency counts, percentage, and Pearson product-moment

3. Results and Discussion

The socioeconomic characteristics reveal a farming community that is potentially receptive to change but held back by critical structural barriers. Socioeconomic characteristics of respondents is presented in Table 1. A youthful and educated majority, contrary to the common narrative of an aging farmer population, a significant 59.6% of respondents are between 20-35 years old, and over 80% have at least a secondary education. This is a promising finding, as (Madison, 2006) established that education enhances a farmer's capacity to understand complex information like CSA, and younger farmers are often more open to innovation (Tambo & Abdoulaye, 2012). This suggests a ready audience for CSA training and technologies.

Table 1. Socioeconomic characteristics of respondents

Socioeconomic variables	Frequency	Percentage
Sex		
Male	65	59.6
Female	44	40.4
Age		
20–35	65	59.6
36–51	22	20.2
52 & above	22	20.2
Educational level		
Primary school	20	18.3
Secondary school	67	61.5
Tertiary school	22	20.2
Household Size		
1–5	87	79.8
6 & above	22	20.2
Farming Experience		
1–5	44	40.4
6–10	43	39.4
11 & above	22	20.2
Farm Size (ha)		
1–3	67	61.5
4–6	22	20.2
7 & above	20	18.3
Farming Income		
Less than 100,000	20	18.3
150,000 – 250,000	60	55.1
Above 500,000	29	26.6
Access to Credit		
No	90	82.6
Yes	19	17.4

Source: Field survey, 2025

The credit access shows the most striking finding, in that 82.6% of farmers lack access to credit. This single factor casts a long shadow over all other adoption efforts. This finding strongly echoes the work of (Baiyegunhi et al., 2022), who identified the high initial cost of CSA and lack of capital as the primary economic constraints. Without financial resources, even the most knowledgeable and motivated farmers cannot

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

invest in improved seeds, irrigation equipment, or other CSA inputs. The data confirms the prevalence of small-scale farming, with 61.5% managing farms between 1-3 hectares. While smaller farms can be agile, they are also highly vulnerable to risk, making farmers more cautious about adopting unproven (to them) practices. The implication is that the study area is not suffering from a lack of capable farmers but from a critical lack of financial empowerment. Any intervention must be designed with this in mind. Youth- and education-focused messaging will be effective, but without parallel programmes to improve access to credit and microfinance, adoption of capital-intensive CSA practices will remain low.

Table 2. Distribution of Respondents by CSA information source

CSA Info Source	Frequency	Percentage (%)
Radio/TV	66	60.6
Social media	20	18.3
Extension Agents	23	21.1

Source: Field survey 2025

The sources of CSA information, as shown in Table 2, highlight a significant shift away from traditional extension services and towards mass media. The reign of Radio/TV, with 60.6% of farmers citing radio and TV as their primary information source, is clear that these media are the bedrock of agricultural communication. This supports (Onoja et al., 2022), who noted the power of radio due to its accessibility and reach. The role of Extension agents with only 21.1% of farmers reporting learning from extension agents. This directly reflects the literature pointing to an overstretched and underfunded extension system (Kughur et al., 2021). The personal, hands-on guidance crucial for complex CSA techniques is simply not reaching most farmers. It therefore implies that extension systems are failing to meet farmers' needs. Development programmes should leverage the dominance of radio/TV by creating targeted, local-language CSA programming. However, to bridge the gap in practical knowledge, there is a need to revitalize extension services, perhaps by training and deploying lead farmers or using mobile units to complement mass media efforts.

The types and duration of CSA practices adopted suggest that farmers are making initial, low-cost changes but have not yet embraced a full CSA portfolio. Conservation agriculture (68.8%) is the most adopted practice, likely because techniques like mulching and minimal tillage require little to no financial investment. Crop rotation (31.2%) is another traditional, low-risk practice. The near absence of more advanced practices like agroforestry or integrated soil management (Adeyemo et al., 2021; Eze et al., 2021) indicates a significant adoption frontier. The current adoption pattern represents a fragile foundation. To build resilience, farmers need to be supported in "scaling up" from single practices to integrated systems. The newness of their adoption presents a crucial window of opportunity for providing correct technical knowledge and inputs to ensure their early experiences are positive and successful.

Table 3. Distribution of Respondents by CSA practices

CSA Practices	Frequency	Percentage (%)
Conservation Agriculture	75	68.8
Crop Rotation	34	31.2

Source: Field survey 2025

The fact that 62.3% have been practicing CSA for less than two years is a critical finding, indicating newcomers to CSA. It implies that CSA adoption is a recent phenomenon in the area. These farmers are essentially in the trial phase, and their long-term commitment will depend on seeing tangible benefits and overcoming initial barriers. Distribution of respondents by CSA duration is presented in Table 4.

The constraints identified form a vicious cycle that stifles meaningful CSA adoption. The knowledge gap shows that the majority

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

of farmers (55.1%) cite a lack of technical knowledge as their main constraint. This directly connects to the findings in Table 2, without effective extension, farmers hear about CSA on the radio, but do not know how to implement it correctly. The finance trap indicates that the high cost of Inputs (17.4%) and limited access to credit (27.5%) are two sides of the same coin, and when combined, they represent the most significant barrier for 44.9% of farmers. This powerfully confirms the economic constraints highlighted by (Baiyegunhi et al., 2022). Farmers cannot afford what they know they need. The implication is that these constraints are interlocked. A lack of knowledge makes farmers hesitant to invest scarce resources, and a lack of resources prevents them from seeking out or experimenting with knowledge-intensive practices. Breaking this cycle requires integrated solutions. For example, programmes that bundle affordable credit with dedicated, practical training sessions on specific CSA practices. Simply providing information without financial support or credit without technical guidance is likely to fail.

Table 4. Distribution of Respondents by CSA Duration

CSA Duration	Frequency	Percentage (%)
Less than 2 years	68	62.3
2–5 years	32	29.4
6–10 years	9	8.3

Source: Field survey 2025

The Pearson product-moment correlation analysis in Table 6 uncovers the specific socioeconomic factors that are statistically linked to the utilization of Climate-Smart Agricultural (CSA) practices in our study. This study found a strong, positive, and significant relationship between a farmer's educational level and their adoption of CSA practices with level of education (p=0.045, r=0.654). This makes intuitive sense; understanding the principles behind CSA, such as soil chemistry for conservation agriculture or pest life cycles for crop rotation, requires a capacity to process and apply new, sometimes complex, information. This finding powerfully aligns with the established literature by Ekong et al. (2019), in their study in Akwa Ibom State, which similarly concluded that education was the single most important factor influencing awareness and adoption of CSA technologies.

Table 5. Distribution of Respondents by CSA Constraints

CSA Constraints	Frequency	Percentage (%)
Lack of Technical Knowledge	60	55.1
High Cost of Inputs	19	17.4
Limited Access to Credit	30	27.5

Source: Field survey 2025

Educated farmers are better equipped to decipher technical advice from radio programs, understand the long-term benefits of new practices, and navigate the initial trial-and-error phase with more confidence. The analysis further indicates that sex has a significant relationship with CSA utilization with sex (p=0.036, r=0.560). The positive r-value suggests that, in this specific context, male farmers were more likely to be utilizing the measured CSA practices than their female counterparts. This finding resonates strongly with the work of (Nku et al., 2018), who documented significant gender disparities in access to CSA resources in the Niger Delta region. They attributed this gap to deeply ingrained socio-cultural barriers, including women's limited access to land, credit, and extension services. Our result likely reflects this same dynamic, where male farmers, who typically have greater control over productive resources and decision-making on the farm, are in a more privileged position to experiment with and adopt new agricultural practices. While the p-value in farming experience (p=0.206, r=0.186) is above the conventional 0.05 threshold (and thus could be considered marginally insignificant in some strict interpretations), the positive r-

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

value suggests a noteworthy trend that deserves discussion. It indicates that more years spent farming are associated with a slight increase in CSA use. This can be interpreted as experienced farmers having a deeper, firsthand understanding of climate variability and soil degradation, making them more receptive to solutions that address these long-term challenges. This finding finds some support in the work of Okoro et al. (2017), who noted that experienced farmers in Ebonyi State, having witnessed declining yields over time, were more likely to appreciate the value of soil conservation practices than complete beginners. For income level (p=0.563, r=0.330), is a particularly striking and counter-intuitive finding.

One would logically assume that higher income provides the financial flexibility to invest in new technologies. However, our data suggests that within this farmer group, income was not a statistically significant driver of CSA use. This could be because the most commonly adopted practices in this area (as shown in Table 3), like conservation agriculture and crop rotation, are largely knowledge-intensive rather than capital-intensive. They do not necessarily require large cash outlays. This finding partially contrasts with (Ekong et al., 2019), who found wealth to be a significant factor, highlighting that the importance of income may depend heavily on the specific CSA practices being promoted. Extension contacts (p=0.112, r=0.977) shows an insignificant relationship with CSA utilization, perhaps the most damning indictment of the current agricultural support system. It implies that simply having contact with an extension agent does not, in this context, translate into higher adoption. This powerfully reinforces the data from Table 2, which showed extension agents were a minor information source (21.1%). It suggests that the quality, frequency, or practical relevance of the extension advice may be insufficient. This aligns with the critiques by Kughur et al. (2021) of an overstretched and under-resourced extension service that struggles to deliver impactful, hands-on guidance.

Table 6. Correlation Analysis Result Showing the Relationship Between Socioeconomic Characteristics of Respondents and the Utilization of Climate-Smart Agricultural (CSA) Practices (n = 109)

Variable	p-value	r-value	Remark
Sex	0.036	0.560	Significant
Level of Education	0.045	0.654	Significant
Income level	0.563	0.330	Insignificant
Farming experience	0.206	0.186	Significant
Extension contacts	0.112	0.977	Insignificant

Source: Field survey 2025 Note: *$p < 0.05$ indicates statistical significance*

The results from Table 7, analyze the relationship between information sources and the utilization of Climate-Smart Agricultural Practices (CSAPs). The result challenges traditional assumptions about agricultural extension and highlights the evolving landscape of how farmers learn and adopt new techniques. The strong positive and statistically significant relationship for social media (p=0.007, r=0.429) is a powerful finding. It indicates that farmers who use platforms like WhatsApp, Facebook, or YouTube are demonstrably more likely to use CSAPs. This suggests that social media is not just for socializing; it has become a vital, functional tool for agricultural innovation. Farmers are likely using these platforms to join farmer groups, watch instructional videos, share experiences, and see visual proof of concepts from peers. This finding marks a significant shift from older studies and underscores the need for agricultural programmes to have a deliberate and strategic digital presence. It is no longer optional; it is

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

where the innovative farmers are. While the p-value for Radio/TV (p=0.062, r=0.401) is slightly above the strict 0.05 threshold, the positive r-value indicates a strong trend towards significance. In practical terms, this suggests that radio and television remain incredibly important channels for raising awareness and disseminating basic information about CSA. This aligns perfectly with our earlier finding (Table 2) that radio/TV was the most common information source (60.6%). It appears that these traditional mass media are effective at creating a foundational awareness that prompts initial adoption, cementing their role as the "bedrock" of agricultural communication in rural areas. Extension agents (p=0.398, r=0.367) is the most concerning result from the table. The statistically insignificant relationship reveals a critical failure in the formal agricultural support system. It means that having contact with an extension agent does not reliably predict whether a farmer will actually use CSAPs. This finding connects with the previous tables, where extension agents were a minor source of information (Table 2) and that a lack of technical knowledge was the biggest constraint (Table 5). This correlation analysis confirms that the current mode of extension contact is not effectively translating into on-the-ground action. The reasons, echoed in the literature, are likely twofold: First, the extension service is likely so overstretched that contacts are infrequent and superficial (Kughur et al., 2021).

A single visit is not enough to guide a farmer through a complex new practice. Second, there may be a relevance gap; the advice given may not be tailored to the specific financial or contextual constraints farmers face, making it feel theoretical rather than practical. In other words, Table 7 result is one of two parallel systems: an informal, digital system that is driving change, and a formal, traditional system that is failing to bring about change. The significant relationship with social media and the strong trend with radio/TV show that farmers are proactive learners. They are seeking out and utilizing information from accessible, on-demand sources. The insignificant result for extension agents, however, shows that the top-down, government-led model is not keeping pace. The implication for policymakers and development agencies is clear: It is no longer sufficient to simply fund more extension agent positions. The entire approach must be changed to a modern strategy (Shrestha & Aryal, 2026).

Table 7. Correlation analysis result showing the relationship between farmers' sources of information and their use of climate-smart agricultural practices (CSAPs)

Variable	p-value	r-value	Remark
Radio/TV	0.062	0.401	Significant
Social media	0.007	0.429	Significant
Extension Agents	0.398	0.367	Insignificant

Source: Field survey 2025 Note: $p < 0.05$ was set as the significance threshold.

4. Limitations and Future Directions

In spite of the great contributions of this study, there are still some limitations. For instance, the cross-sectional design restricts the ability to capture temporal changes in CSA utilization and limits causal inference. The reliance on self-reported data may introduce recall and social desirability biases. Furthermore, the study's geographic focus constrains the generalizability of findings beyond the study area. Measurement challenges associated with quantifying utilization intensity and effectiveness also present limitations. Future research should adopt longitudinal and experimental designs, integrate climate and geospatial data, and develop standardized metrics for CSA utilization. Comparative studies across agro-ecological zones, as well as deeper

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

exploration of gender, youth, and institutional dynamics, are also recommended to enhance understanding and policy relevance.

5. Conclusion

The farmers in the study area are a capable, youthful demographic who are aware of and are beginning to experiment with CSA. However, they are doing so with one hand tied behind their backs due to a crippling lack of accessible credit and a dysfunctional agricultural extension system. They are stuck in a cycle of low-investment, low-knowledge adoption. Hence, the farmers are ready and willing to learn, but they are increasingly bypassing traditional channels to do so. The future of agricultural extension lies not in competing with these new channels, but in strategically integrating with them. For Climate-Smart Agriculture to truly take root and transform livelihoods, interventions must be holistic, simultaneously addressing the financial, informational, and technical barriers that currently confine farmers to the shallow end of the CSA pool.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author(s) used ChatGPT to proofread. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Authorship Contribution Statement

Friday Ogar Idiku: conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing original draft, visualization; Emmanuel Ekpo Archibong: conceptualization, methodology, writing, review & editing; Ekpenyong Nsa Essien: methodology, validation, formal analysis, investigation, writing, review & editing; Victoria Francis Ediene: validation, writing, review & editing; Emmanuel Ohara Eremi: validation, formal analysis, investigation, writing – review & editing, and Comfort Felix Aya: writing, review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors acknowledged funding from the Tertiary Education Trust Fund (TETFUND) 2024 Conference sponsorship for this publication.

References

Adewuyi, S. A. (2022). Determinants of adoption of climate-smart agricultural practices among smallholder farmers in Nigeria. *African Journal of Agricultural Research*, *18*(5), 345–356.

Adeyemo, T. A., Ojo, O. T., & Ogunjimi, S. I. (2021). Agroforestry practices and climate change adaptation in Nigeria: A review. *Journal of Agriculture and Ecology Research International*, *22*(1), 1–12.

Ayanlade, A., & Proske, U. (2016). Assessing wetland degradation and loss of ecosystem services in the Niger Delta, Nigeria. *Marine and Freshwater Research*, *67*(6), 828–836. https://doi.org/10.1071/MF15066

Baiyegunhi, L. J. S., Akinbosoye, F., & Bello, L. O. (2022). Welfare impact of improved maize varieties adoption and crop diversification practices among smallholder maize farmers in Ogun State, Nigeria. *Heliyon*, *8*(5), e09338. https://doi.org/10.1016/j.heliyon.2022.e09338

Bashiru, H. A., & Oseni, S. O. (2025). Simplified climate change adaptation strategies for livestock development in low-and middle-income countries. *Frontiers in Sustainable Food Systems*, *9*. https://doi.org/10.3389/fsufs.2025.1566194

Ekong, E. E., Osondu, C. K., & Ibekwe, U. C. (2019). Determinants of climate smart agricultural practices adoption in Akwa Ibom State, Nigeria. *Journal of Agricultural Extension*, *23*(4), 56–67.

Eze, J. N., Ibe, G. O., & Ugorji, S. E. (2021). Constraints to adoption of soil and water conservation practices among smallholder farmers in southeastern Nigeria. *African Journal of Sustainable Agricultural Development*, *2*(1), 1–15.

Fatahullah, & Syauqi Agung Firmanda. (2025). Mobile Phones and Climate Information Access Among Smallholders in East Java, Indonesia. *Indonesian Journal of Sustainable Agriculture and Environmental*

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

Sciences (IJSAES), *1*(2), 85–96. https://doi.org/10.65896/ijsaes.v1i2.14

Food and Agriculture Organization (FAO). (2013). *Climate-smart agriculture sourcebook*. Http://Www.Fao.Org/3/I3325e/I3325e.Pdf .

Ganni Mampo, O. M., Guedje, K. F., Merz, B., Yarou, H., Macdonald, E., & Alamou, A. E. (2025). Farmers' perceptions of hydroclimatic variability and climate change: survey-based insights in Northern Benin, West Africa. *Frontiers in Water*, *7*. https://doi.org/10.3389/frwa.2025.1530395

Hashim, N., Ali, M. M., Mahadi, M. R., Abdullah, A. F., Wayayok, A., Mohd Kassim, M. S., & Jamaluddin, A. (2024). Smart Farming for Sustainable Rice Production: An Insight into Application, Challenge, and Future Prospect. *Rice Science*, *31*(1), 47–61. https://doi.org/10.1016/j.rsci.2023.08.004

Kughur, P. G., Aveuya, A. A., & Kuza, Y. (2021). Assessment of Extension Delivery Methods to Farmers in Apa Local Government Area of Benue State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology*, 29–37. https://doi.org/10.9734/ajaees/2021/v39i330543

Kulugomba, R., Mapoma, H. W. T., Gamula, G., Blanchard, R., & Mlatho, S. (2024). Opportunities and Barriers to Biogas Adoption in Malawi. *Energies*, *17*(11), 2591. https://doi.org/10.3390/en17112591

Madison, D. (2006). *The perception of and adaptation to climate change in Africa. World Bank Policy Research Working Paper 4308. The World Bank.*

Md. Motiur Rahman, Md. Toriqul Islam, & Mst. Esrat Jahan. (2025). Climate Change Perception of Farmers and Its Effect on the Technical Efficiency of Rice Production. *Indonesian Journal of Sustainable Agriculture and Environmental Sciences (IJSAES)*, *1*(2), 64–77. https://doi.org/10.65896/ijsaes.v1i2.15

Muliarta, I. N., & Purba, J. H. (2020). Potential of Loss of Organic Fertilizer in Lowland Rice Farming in Klungkung District, Bali. Agro Bali: Agricultural Journal, 3(2), 179–185. https://doi.org/10.37637/ab.v3i2.567

National Bureau of Statistics (NBS). (2021). *Nigeria gross domestic product report (Q4 2021).*

Nku, I. M., Ewona, I. O., & Udo, S. O. (2018). Gender disparities in the adoption of climate-smart agricultural practices in the Niger Delta region of Nigeria. *International Journal of Agriculture and Forestry*, *8*(1), 1–8.

Odion, D., Gajardo, J., Defraeye, T., Motmans, T., Shoji, K., Evangelista, R., & Onwude, D. (2025). Towards improving farmers livelihood in Nigeria using food price forecasting. *Journal of Agriculture and Food Research*, *24*, 102365. https://doi.org/10.1016/j.jafr.2025.102365

Ojo, O. T., & Ojo, M. A. (2022). Conservation agriculture as a climate-smart practice: Adoption and perceived benefits among smallholder farmers in Nigeria. *Journal of Cleaner Production, 330, 129845*.

Okoro, A. M., Ugwu, P. C., & Nnadi, F. N. (2017). Determinants of adoption of soil conservation practices among farmers in Ebonyi State, Nigeria. *Journal of Soil Science and Environmental Management*, *8*(7), 124–131.

Onoja, A. O., Ajie, E. N., & Achike, A. I. (2022). Use of information and communication technologies for climate-smart agriculture among rice farmers in Ebonyi State, Nigeria. *Journal of Agricultural & Food Information*, *23*(12), 45–63.

Oparaojiaku, J. O., Izuogu, C. U., Njoku, L. C., Igwe, O. O., Nwabuisi, C. J., Ankrah, D. A., Ominikari, A. G., Umeh, N. E., Ismail, I. I. H., & Abdulmumini, A. L. (2025). Adoption of Climate Smart Agricultural Practices among Cassava Farmers in Abia State, Nigeria. *Journal of Agricultural Extension*, *29*(3), 185–195. https://doi.org/10.4314/jae.v29i3.18

Shrestha, P., & Aryal, R. (2026). Farmers' Perception and Use of Social Media for Agricultural Information and Subsidy Schemes in Lele Valley of Godawari Municipality, Lalitpur. *Punyawati Journal*, *2*, 83–100. https://doi.org/10.3126/punyawati.v2i1.90216

Tambo, J. A., & Abdoulaye, T. (2012). Climate change and agricultural technology adoption: the case of drought tolerant maize in rural Nigeria. *Mitigation and Adaptation Strategies for Global Change*, *17*(3), 277–292. https://doi.org/10.1007/s11027-011-9325-7

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v9i1.2658

Ukane, O. A., Enimu, S., & O. Emaziye, P. (2026). Effectiveness of financing options in the adoption of climate smart agriculture practices among farmers in delta state, Nigeria. *GSC Advanced Research and Reviews*, 133–146. https://doi.org/10.30574/gscarr.2026.26.2.0042

Yuniti, I. G. A. D., Purba, J. H., Komara, L. L., & Sasmita, N. (2022). Height and Diameter Measurement of Eucalyptus Urophylla in Batur Mountain Nature Tourist Forest, Indonesia. *Journal of Applied Agricultural Science and Technology*, *6*(2), 162–170. https://doi.org/10.55043/jaast.v6i2.72

Ziro, J. S., Kichamu-Wachira, E., Ross, H., & Palaniappan, G. (2023). Adoption of climate resilient agricultural practices among the Giriama community in South East Kenya: implications for conceptual frameworks. *Frontiers in Climate*, *5*. https://doi.org/10.3389/fclim.2023.1032780