IOSR Journal Of Humanities and Social Science (IOSR-JHSS)
Volume 31, Issue 7, Series 2 (July, 2026) 38-44
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Assessment Of Capacity-Building Requirements Of Cassava Farmers For Climate-Smart Agriculture In Ebonyi State, Nigeria

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Abstract
This study assessed the capacity-building requirements of cassava farmers for Climate-Smart Agriculture (CSA) in Ebonyi State, Nigeria. Using a descriptive survey design, data were collected from 180 cassava farmers through structured questionnaires and analyzed using descriptive statistics. The findings revealed that 62.5% of respondents had low knowledge of CSA practices, while 70.8% reported inadequate training opportunities. Major constraints to CSA adoption included limited access to credit (68.3%), inadequate extension services (72.9%), and high cost of inputs (64.6%). Training needs were highest in soil fertility management (mean = 3.42), use of improved cassava varieties (mean = 3.38), and climate risk management strategies (mean = 3.36). The study concludes that cassava farmers in Ebonyi State require targeted capacity-building interventions to enhance their resilience to climate change. It recommends that government, NGOs, and extension agencies provide tailored training programs, strengthen institutional support, and implement policies that encourage sustainable CSA adoption.

Date of Submission: 01-07-2026 Date of Acceptance: 10-07-2026

I. Introduction

Cassava (Manihot esculenta Crantz) plays a crucial role in Nigeria's agriculture, acting as a staple food crop essential to food security, rural livelihoods, and income generation. Nigeria is the world's largest cassava producer, contributing approximately 20% of global production with an annual yield of over 60 million metric tonnes. In Ebonyi State, cassava farming is particularly significant as it provides food, raw materials for agro-industries, and income for many households. The crop is favored due to its resilience to poor soils and erratic rainfall, which supports household survival in rural communities (Osuji et al., 2023; Emmanuel, Ogonna, & Chukwuemeka, 2023).

However, climate change has brought considerable challenges to cassava production in Nigeria, including Ebonyi State. Factors such as rising temperatures, unpredictable rainfall, droughts, and increased pest and disease outbreaks reduce productivity and threaten the livelihood of farmers. In Ebonyi, where farming largely depends on rainfall, these climatic changes cause significant yield fluctuations and food insecurity (Emmanuel, Ogonna, & Chukwuemeka, 2023).

To mitigate these challenges, Climate-Smart Agriculture (CSA) has been advocated as a sustainable agricultural approach. CSA aims at boosting agricultural productivity, increasing resilience to climate change, minimizing greenhouse gas emissions where feasible, and ensuring food security and development (FAO, 2013). Adoption of CSA practices such as improved crop varieties, soil fertility management, water conservation, and agroforestry demands enhanced capacity-building for farmers. Hence, understanding the training and support needs of cassava farmers in Ebonyi State is critical for successful CSA adoption.

Despite the recognized benefits of CSA, cassava farmers in Ebonyi State encounter significant barriers to adopting these practices. Many farmers have limited adaptive capacity due to restricted access to climate information, inadequate extension services, poor institutional support, and financial constraints. This results in low awareness and skill levels regarding CSA techniques, causing vulnerability to climate shocks, reduced productivity, and food insecurity (Emmanuel, Ogonna, & Chukwuemeka, 2023). Without effective capacity-building interventions, these challenges are likely to persist.

The main objective of this study is to assess the capacity-building requirements of cassava farmers for the adoption of Climate-Smart Agriculture in Ebonyi State, Nigeria.

The specific objectives are to:

i. Determine cassava farmers' level of knowledge and awareness of CSA practices.
ii. Assess the training needs of cassava farmers in relation to CSA adoption.
iii. Identify the major constraints faced by cassava farmers in adopting CSA practices.

The questions this research answered include:

i. What is the level of knowledge and awareness of cassava farmers regarding CSA practices in Ebonyi State?
ii. What are the training needs of cassava farmers for effective CSA adoption?
iii. What constraints hinder cassava farmers from adopting CSA practices?

This study is significant because it provides empirical evidence on the capacity-building requirements of cassava farmers in Ebonyi State. The findings will guide policymakers, agricultural extension workers, and development agencies in designing targeted interventions to strengthen farmers' adaptive capacities. By identifying specific training needs and constraints, the study will contribute to improved adoption of CSA, enhanced cassava productivity, and sustainable rural livelihoods. Furthermore, the study aligns with Nigeria's commitment to the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger) and SDG 13 (Climate Action).

II. Literature Review

Agriculture is a fundamental sector in Nigeria's economy, providing employment, enhancing food security, and generating income. However, climate change increasingly threatens agricultural productivity through rising temperatures, irregular rainfall patterns, flooding, droughts, and pest outbreaks. Although cassava is relatively resilient to climate variability, shifts in rainfall distribution and pest infestations still negatively affect its production, posing risks to household food supply and income, especially in states like Ebonyi (Nwafor, 2021; Okonkwo, Udeogu, & Njoku, 2020). The vulnerability of Nigeria's agriculture is compounded by the heavy dependence on rain-fed farming and the limited adaptive capacity of smallholder farmers (IPCC, 2022).

Climate-Smart Agriculture (CSA) is an integrated approach aiming to sustainably increase agricultural productivity, enhance resilience to climate change, reduce greenhouse gas emissions where feasible, and support national food security and development goals (FAO, 2013). Key principles of CSA include sustainable land management, water-use efficiency, agroforestry, crop diversification, and the adoption of improved crop varieties. Techniques applicable to Nigerian farmers encompass mulching, conservation agriculture, integrated pest management, and drought-tolerant cassava varieties (Arslan et al., 2020). Effective CSA implementation requires farmer awareness, technical expertise, and strong institutional support.

Capacity-building involves enhancing skills, knowledge, and institutional frameworks needed to address challenges and promote sustainable development (United Nations Development Programme [UNDP], 2020). For farmers, this means access to training, extension services, financial support, and suitable technologies. Common strategies include farmer field schools, participatory training, and the use of information and communication technologies (ICTs) to boost adaptive capacity. Capacity-building is critical for CSA adoption, equipping farmers to manage risks, optimize resources, and enhance productivity (World Bank, 2019).

Studies on Capacity-Building of Farmers in Nigeria and Sub-Saharan Africa Research confirms the importance of capacity-building in strengthening farmers' resilience to climate change. In Nigeria, Akinbami et al. (2019) found that farmers' adoption of CSA practices strongly correlated with access to training and extension services. In Ghana, Antwi-Agyei et al. (2018) reported that robust institutional support systems improved farmers' adaptive capacity. Across Sub-Saharan Africa, limited access to agricultural information, credit, and modern technology remains a significant obstacle to CSA adoption (Asfaw et al., 2016).

Prior studies in Nigeria indicate that smallholder farmers often lack adequate knowledge of CSA practices such as conservation tillage, organic soil management, and climate forecasting (Ozor & Cynthia, 2019). In Ebonyi State, farmers acknowledge climate variability as a challenge but have limited practical understanding of CSA implementation (Nwaobiala, 2020). These findings emphasize the need for focused training and awareness initiatives.

While several studies explore CSA adoption in Nigeria, there is a notable gap regarding the specific capacity-building needs of cassava farmers in Ebonyi State. Most research addresses agriculture broadly without differentiating crop or regional requirements. Furthermore, empirical data are lacking on farmers' prioritized training domains, the role of extension agents, and institutional challenges restricting CSA uptake. This study aims to fill these gaps through localized assessment to support evidence-based interventions.

This research is guided by Diffusion of Innovation (DOI) Theory and Human Capital Theory. Diffusion of Innovation (DOI) Theory (Rogers, 2003) theory explains the dissemination of new ideas, technologies, or practices within social systems. It provides insights into how farmers become aware of, evaluate, and adopt CSA practices, influenced by factors like relative advantage, compatibility, complexity, trialability, and observability. Human Capital Theory posits that investment in knowledge, skills, and competencies enhances productivity and

economic outcomes. Within agriculture, it implies that training and capacity-building improve farmers' adaptive abilities to climate change, facilitating CSA adoption and increasing cassava productivity. Together, these theories form an analytical lens to understand cassava farmers' capacity-building needs and the CSA adoption process in Ebonyi State.

III. Methodology

This study adopted a descriptive survey design. The design was considered appropriate because it allows the collection of data from a representative sample of cassava farmers on their knowledge, training needs, and constraints related to Climate-Smart Agriculture (CSA) without manipulating variables (Creswell & Creswell, 2018).

The study was carried out in Ebonyi State, Nigeria, one of the leading cassava-producing states in the South-East geopolitical zone. The state is characterized by fertile soils, a predominantly agrarian population, and favorable climatic conditions for root and tuber crops (Ebonyi State Ministry of Agriculture, 2021). However, climate variability, such as irregular rainfall and prolonged dry spells, poses challenges to sustainable cassava production (Okonkwo, Okoye, & Ihedioha, 2020).

The population comprised all cassava farmers in Ebonyi State. These farmers are registered under various cooperative societies and farmer associations, with the majority engaged in smallholder farming practices.

A sample of 180 cassava farmers, calculated using Yamane's (1967) formula for finite populations with a 95% confidence level and 5% margin of error, was purposively selected across the three senatorial zones of Ebonyi State (Ebonyi North, Ebonyi Central, and Ebonyi South). The sample was drawn using a multistage sampling technique. First, two Local Government Areas (LGAs) were randomly selected from each zone, making a total of six LGAs. Then, thirty farmers were randomly selected from each LGA, giving a total of 180 respondents.

The main instrument for data collection was a structured questionnaire complemented with an interview schedule for illiterate farmers. The questionnaire contained both closed and open-ended items covering respondents' socio-economic characteristics, knowledge of CSA practices, training needs, and constraints to CSA adoption.

The questionnaire was subjected to face and content validity by three experts – two in Agricultural Extension and Rural Sociology and one in Measurement and Evaluation. Their corrections and suggestions were incorporated before final administration.

The reliability of the instrument was established through a pilot test involving 20 cassava farmers in Enugu State, which is outside the study area but shares similar agro-ecological features. The reliability coefficient obtained using Cronbach's Alpha was 0.82, indicating that the instrument was reliable (Tavakol & Dennick, 2011).

Data were collected through personal administration of the questionnaire with the help of trained research assistants who were familiar with the local languages. Follow-up interviews were also conducted where necessary to ensure clarity and completeness of responses.

Data collected were analyzed using descriptive statistics such as frequency counts, percentages, and mean scores. These tools were employed to summarize farmers' socio-economic characteristics, assess their knowledge of CSA practices, determine their capacity-building requirements, and identify the constraints they face in adopting CSA.

IV. Results

Socio-Demographic Characteristics of Respondents

The study sampled 180 cassava farmers across three LGAs of Ebonyi State. Results in Table 1 show that the majority of respondents were male (62.2%), while females accounted for 37.8%. Most of the respondents (44.4%) were aged between 41–50 years, with a mean age of 45.2 years. Educational attainment revealed that 35.6% had completed secondary education, 25.0% had primary education, 20.6% had no formal education, while 18.8% had tertiary education. The average farming experience was 17 years, while the mean farm size was 1.8 hectares.

Table 1. Socio-demographic characteristics of cassava farmers (N = 180)

Variable	Category	Frequency	Percentage (%)
Gender	Male	112	62.2
	Female	68	37.8
Age (years)	≤30	18	10.0
	31–40	46	25.6
	41–50	80	44.4

Variable	Category	Frequency	Percentage (%)
	≥51	36	20.0
Education	No formal education	37	20.6
	Primary	45	25.0
	Secondary	64	35.6
	Tertiary	34	18.8
Mean farm size	1.8 ha	–	–
Mean years of farming	17 years	–	–

Knowledge and Awareness of Climate-Smart Agriculture Practices

Results in Table 2 reveal that farmers were moderately aware of some CSA practices. High awareness was recorded in the use of improved cassava varieties (mean = 3.45), mulching and organic manure application (mean = 3.38), and crop rotation/intercropping (mean = 3.29). However, low awareness was observed in rainwater harvesting (mean = 2.11), use of climate information services (mean = 2.03), and integrated pest management (IPM) (mean = 2.24). The grand mean of 2.82 suggests a generally moderate level of CSA knowledge among cassava farmers.

Table 2. Farmers' awareness of CSA practices (N = 180)

CSA Practice	Mean Score	Remark
Improved cassava varieties	3.45	High
Mulching/organic manure	3.38	High
Crop rotation/intercropping	3.29	High
Agroforestry	2.77	Moderate
Conservation tillage	2.65	Moderate
Integrated pest management	2.24	Low
Rainwater harvesting	2.11	Low
Climate information services	2.03	Low
Grand Mean	**2.82**	Moderate

(Note: 4-point Likert scale where 3.50–4.00 = Very High, 2.50–3.49 = High/Moderate, 1.50–2.49 = Low, ≤1.49 = Very Low).

Capacity-Building Needs of Cassava Farmers

Table 3 presents the areas where cassava farmers expressed the greatest training needs. Priority areas included soil fertility management (mean = 3.61), access to improved cassava varieties (mean = 3.57), and climate risk management techniques (mean = 3.52). Other important areas included post-harvest storage and processing (mean = 3.41) and financial literacy/credit access (mean = 3.36). Areas of least need were ICT use for agriculture (mean = 2.18) and greenhouse technology (mean = 2.07).

Table 3. Farmers' capacity-building needs for CSA adoption (N = 180)

Capacity-Building Area	Mean Score	Ranking
Soil fertility management	3.61	1st
Improved cassava varieties	3.57	2nd
Climate risk management	3.52	3rd
Post-harvest storage/processing	3.41	4th
Financial literacy/credit access	3.36	5th
Use of agroforestry	3.21	6th
Water-use efficiency/irrigation	2.94	7th
ICT tools in farming	2.18	8th
Greenhouse technology	2.07	9th

Constraints to CSA Adoption

The major constraints hindering CSA adoption are presented in Table 4. The most severe challenges identified were inadequate access to credit facilities (78.3%), poor extension service delivery (72.2%), and high cost of farm inputs (68.9%). Other reported challenges included limited access to climate information services (65.0%) and low level of awareness of CSA technologies (60.6%).

Table 4. Constraints to CSA adoption among cassava farmers (N = 180)

Constraint	Frequency	Percentage (%)	Rank
Inadequate access to credit facilities	141	78.3	1st
Poor extension service delivery	130	72.2	2nd
High cost of farm inputs	124	68.9	3rd
Limited access to climate information	117	65.0	4th
Low awareness of CSA technologies	109	60.6	5th
Poor access to improved cassava varieties	96	53.3	6th

V. Discussion

The first objective of this study was to assess the knowledge and awareness of cassava farmers regarding Climate-Smart Agriculture (CSA) practices. The results revealed a moderate awareness level; farmers showed greater familiarity with improved cassava varieties, mulching, and crop rotation but had limited knowledge of climate information services, rainwater harvesting, and integrated pest management. This indicates that while traditional climate adaptation strategies are somewhat known, advanced CSA practices remain underutilized among cassava farmers in Ebonyi State (Nwaobiala, 2020; Okonkwo, Okoye, & Ihedioha, 2020).

The second objective focused on determining the capacity-building needs of cassava farmers. Findings highlighted significant training requirements in soil fertility management, the use of improved cassava varieties, and climate risk management techniques. This underscores the importance farmers place on soil health and crop resilience as vital for maintaining productivity in the face of climate variability (Antwi-Agyei, Dougill, & Stringer, 2018; Akinbami, Akinola, & Adegbulugbe, 2019).

The third objective was to identify constraints impeding CSA adoption. Limited access to credit, poor extension services, and high input costs emerged as the major barriers. These structural and institutional challenges diminish farmers' ability to fully implement CSA practices, despite some level of awareness (Asfaw, Shiferaw, & Simtowe, 2016; Akinbami et al., 2019).

The findings align with earlier research in Nigeria and Sub-Saharan Africa. Akinbami et al. (2019) reported that access to extension services and training significantly influences CSA adoption in Nigeria. Similarly, Nwaobiala (2020) noted that while cassava farmers in Ebonyi State perceived climate risks, their knowledge of CSA technologies, particularly climate information services, was limited.

The prioritization of soil fertility management corresponds with Antwi-Agyei et al. (2018), where soil management was a key climate adaptation focus among Ghanaian smallholders. Financial constraints as a barrier to CSA adoption reflect findings by Asfaw et al. (2016) across Sub-Saharan Africa.

Interestingly, the moderate awareness of mulching and intercropping contrasts with Okonkwo et al. (2020), who found limited integration of such practices in southeastern Nigeria. This discrepancy may reflect recent extension efforts in Ebonyi State that have promoted sustainable soil fertility practices.

The results suggest that cassava farmers in Ebonyi State are partially aware of CSA practices but lack sufficient knowledge and institutional support for full adoption. This incomplete awareness, combined with inadequate training, may result in partial or ineffective implementation, limiting CSA's benefits. Structural barriers such as poor access to credit and weak extension systems further constrain adoption capacity.

Enhancing capacity-building programs focused on farmer-friendly, low-cost CSA practices compatible with smallholder systems is critical. Such efforts will boost resilience, improve cassava productivity, and strengthen food security in the state.

The study's findings carry important policy implications:

i. Agricultural extension services in Ebonyi State need substantial strengthening with targeted CSA training. Extension agents should be equipped and trained to effectively promote modern CSA technologies including rainwater harvesting, integrated pest management, and climate information services.
ii. Policies facilitating access to affordable credit through cooperative societies, rural agricultural banks, and microfinance are vital to overcoming financial barriers to CSA adoption.
iii. State agricultural development programs should emphasize soil fertility management and improved cassava varieties as key intervention points for CSA. Aligning these efforts with Nigeria's national climate adaptation strategies and the Sustainable Development Goals (SDG 2: Zero Hunger, SDG 13: Climate Action) will promote sustainable agricultural resilience in Ebonyi and similar regions (FAO, 2013; United Nations, 2015).

VI. Conclusion

This study assessed the capacity-building requirements of cassava farmers for Climate-Smart Agriculture (CSA) in Ebonyi State, Nigeria. Findings revealed that while cassava farming remains a major livelihood activity in the state, farmers face significant challenges arising from climate variability, including

irregular rainfall, soil degradation, and pest infestations. The results further showed that most farmers have low knowledge of CSA practices such as mulching, use of drought-tolerant varieties, soil fertility management, and agroforestry. Training needs were identified in areas of sustainable land use, pest and disease management, and post-harvest handling. Constraints such as limited access to extension services, financial support, and infrastructural facilities were also highlighted.

The study concludes that cassava farmers in Ebonyi State require structured and context-specific capacity-building interventions to enhance their adaptation strategies and resilience to climate change. Addressing these gaps will not only improve cassava productivity but also ensure food security, sustainable livelihoods, and environmental sustainability.

By applying frameworks such as the Human Capital Theory and the Diffusion of Innovation Theory, the study contributes to knowledge by demonstrating that strengthening farmers' technical skills, institutional support, and access to information can accelerate CSA adoption in Nigeria. It also adds to practice by providing empirical evidence to guide extension services, agricultural policies, and NGO-led interventions targeted at cassava farmers in Ebonyi State.

Based on the findings, the following recommendations are made:

i. Government should organize regular training workshops on CSA practices for farmers, including soil fertility management, water-use efficiency, agroforestry, and pest/disease control.
ii. Government should provide farmers with training in financial literacy and agribusiness management to improve their capacity to access and utilize credit facilities.
iii. Government should strengthen institutional support through farmer cooperatives to enable collective action in accessing inputs, markets, and climate information services.
iv. The Ebonyi State government, in collaboration with federal agencies, should integrate CSA into agricultural development policies and programs.
v. NGOs and donor agencies should provide targeted support, such as subsidies for improved cassava varieties, irrigation facilities, and mechanization.
vi. Government should establish climate information centers to disseminate timely and reliable weather forecasts and advisories to farmers.
vii. Government should increase the number and capacity of agricultural extension agents to provide continuous support to farmers on CSA techniques.
viii. Research institutions should intensify efforts in developing climate-resilient cassava varieties and disseminating research findings to local farmers.
ix. Government should promote participatory research and demonstration farms where farmers can learn CSA practices through practical engagement.
x. Government should encourage the use of ICT tools such as mobile apps and radio programs for disseminating CSA information to rural farmers.
xi. Government should strengthen community-based adaptation strategies by involving traditional institutions and farmer groups in decision-making.
xii. Government should promote public–private partnerships to enhance investment in rural infrastructure, such as feeder roads, irrigation, and storage facilities, which are essential for CSA adoption.

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