Journal of Agricultural Education Teachers Association of Nigeria
Vol. 10 Number 1, March 2026

THE POTENTIAL OF CLIMATE SMART AGRICULTURAL (CSA) PRACTICES TO ENHANCE FOOD SECURITY IN NORTHEAST NIGERIA

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Abstract:
Food security in Northeast Nigeria is severely threatened by climate change, conflict, and unsustainable agricultural practices. This study examines the potential of climate-smart agricultural (CSA) practices to enhance food security in the region by improving resilience, productivity, and sustainability. The population for the study is 360 small householder farmers. Three purposes and three research questions guided the paper, The design of the study was survey research design, the study determines the adoption of CSA techniques such as cultivation of drought-resistant crops, agroforestry, conservation agriculture, and efficient water management to significantly boost crop yields and improve food security. Findings indicate that CSA practices can significantly increase crop yields, reduce vulnerability to climate shocks, and improve livelihoods. The study also found that limited access to resources, knowledge gaps, and socio-economic constraints hinder widespread adoption of CSA practices in the region. Therefore, the study recommends policy interventions, farmer education programs, and targeted support to vulnerable households to scale up CSA practices for long-term food security in Northeast Nigeria.

Keywords: Food security, climate-smart agriculture, Northeast Nigeria, climate resilience, sustainable farming, adaptation strategies.

INTRODUCTION

Northeast Nigeria is a region characterized by significant agricultural potential but faces severe challenges due to climate variability and environmental degradation. Agriculture remains the backbone of the local economy, providing livelihoods for over 70% of the population (Pelemo et al, 2024). However, recurrent droughts, erratic rainfall patterns, desertification, and conflict induced displacement have exacerbated food insecurity in this region (Adebayo et al., 2020). Climate change has intensified these challenges, threatening the sustainability of traditional farming systems and the resilience of rural communities. In recent years, the area has experienced increased frequency and intensity of droughts, erratic rainfall patterns, and land degradation, all of which have adversely affected agricultural productivity and, consequently, food security (FAO, 2019).

The challenges in Northeast Nigeria are further compounded by socio-political factors, including insurgency and conflicts, which have led to displacement of farming communities, disruption of agricultural activities, and limited access to markets and inputs. These factors have collectively contributed to a significant decline in food production and increased prevalence of food insecurity in the region (Hassan et al., 2024).

Climate Smart Agriculture (CSA) has emerged globally as a transformative approach aimed at increasing agricultural productivity sustainably, enhancing resilience to climate shocks, and reducing greenhouse gas emissions where possible (FAO, 2013). CSA integrates various practices, technologies, and policies tailored to local agroecological conditions, aiming to simultaneously address food security and climate change adaptation and mitigation. Climate smart Agriculture (CSA) offers promising pathways to improve food security by enhancing the adaptive capacity of smallholder farmers, who constitute the majority of agricultural producers in the region (Ibrahim et al., 2021). Practices such as drought resistant crop varieties, conservation agriculture, agroforestry, and improved water management have been identified as potential CSA interventions suitable for the semiarid conditions of the area (Akinyemi et al., 2021). However, the uptake of CSA in the region remains limited due to various barriers, including lack of awareness, limited access to resources and extension services, and socio-economic constraints (Sylvester et al., 2024).

This paper explores the potential of CSA practices to enhance food security in

Northeast Nigeria by examining their adoption, impacts, and the socioeconomic and institutional factors influencing their uptake. Understanding these dynamics is critical for policy formulation and the design of effective interventions to support vulnerable farming communities facing climate risks.

MATERIALS AND METHODS

Statement of the Problem

Northeast Nigeria faces a convergence of challenges that severely undermine agricultural productivity and food security. The area, which includes states such as Borno, Taraba, Bauchi, Gombe, Yobe, and Adamawa, is characterized by a semiarid climate, frequent droughts, and erratic rainfall patterns, all of which are intensifying due to climate change (Adelekan et al., 2020). These climatic stresses have led to declining soil fertility, loss of arable land, and increased vulnerability of rural households whose livelihoods depend predominantly on rainfed agriculture (Olawuyi et al., 2022).

Compounding these environmental constraints are socioeconomic and security challenges. The ongoing conflict and insurgency in the area have resulted in mass displacement, disrupted agricultural activities, and limited access to farmland and markets (Mercy Corps, 2018). This has further exacerbated poverty and food insecurity, with millions of people classified as food insecure or at risk of famine, according to recent assessments (FAO, 2023). Despite the promise of Climate Smart Agriculture (CSA) to address these challenges by improving resilience and productivity, the adoption rate of CSA practices among smallholder farmers in Northeast Nigeria remains low (Ibrahim et al., 2021). Barriers such as limited access to extension services, inadequate knowledge of CSA techniques, lack of financial resources, and weak institutional support hinder the widespread uptake of these innovations (Olawuyi et al., 2022). Additionally, gender disparities and cultural norms often restrict women's participation in decision making and access to agricultural resources, further limiting the impact of CSA interventions (Ayanlade et al., 2021).

The major problem, therefore, is a persistent cycle of food insecurity driven by climate variability, environmental degradation, conflict, and insufficient adoption of CSA practices. This situation threatens not only the immediate wellbeing of rural households but also the long-term sustainability of agricultural systems in Northeast Nigeria. Addressing these interconnected challenges requires a

comprehensive understanding of the factors influencing CSA adoption and the effectiveness of these practices in enhancing food security under local conditions.

Purpose of the Study

The main purpose of this study is to determine the potential of Climate Smart Agricultural (CSA) practices to enhance food security among smallholder farmers in Northeast Nigeria. Specifically, the study aims to assess

1. Assess the extent to which CSA practices are adopted by farmers in Northeast Nigeria.

2. Evaluate the impact of CSA practices on household food security in the Northeast Nigeria.

3. Identify the socio-economic, institutional, and environmental factors that influence the adoption of CSA practices.

Research Questions

In line with the specific purposes, three research questions were raised, which are designed to explore the adoption and impact of Climate Smart Agricultural (CSA) practices on food security in Northeast Nigeria:

1. What are the prevalent Climate Smart Agricultural practices adopted by smallholder farmers in Northeast Nigeria?

2. What is the impact of Climate Smart Agricultural practices on household food security in Northeast Nigeria?

3. What socioeconomic, institutional, and environmental factors influence the adoption of CSA practices by smallholder farmers in Northeast, Nigeria?

Research Hypotheses

One null hypothesis was formulated and tested the empirical investigation into the relationship between Climate Smart Agricultural (CSA) practices and food security in Northeast Nigeria at 0.05 level of significance:

H_{01}: There is no statistically significant relationship between the adoption of Climate Smart Agricultural practices and household food security status among smallholder farmers in Northeast Nigeria.

Theoretical Framework of the Study

The theoretical framework of this study is the Sustainable Livelihoods Framework (SLF), a widely recognized approach for understanding the complex

interactions between environmental, economic, and social factors influencing rural livelihoods (Scoones, 1998). The SLF emphasizes the importance of multiple forms of capital human, social, natural, physical, and financial and how these assets, combined with policies, institutions, and processes, shape livelihood strategies and outcomes. This framework is particularly suited for analyzing Climate Smart Agriculture (CSA) adoption because it captures the multidimensional nature of farmers' decision making in the face of climate variability and food insecurity.

In Northeast Nigeria, smallholder farmers rely heavily on natural capital (land, water, biodiversity) and social capital (community networks, extension services) to sustain agricultural production. However, climate change threatens the availability and quality of these resources, thereby undermining household food security (Ekpa et al., 2018). The SLF facilitates an understanding of how CSA practices can enhance these capitals by promoting sustainable resource management, improving resilience, and diversifying income sources. The SLF highlights the role of external factors such as government policies, market access, and institutional support, which are critical in enabling or constraining CSA adoption. For instance, access to credit and agricultural inputs, extension services, and climate information services are vital for farmers to implement CSA practices effectively (Opeyemi et al., 2021). The framework also acknowledges the importance of vulnerability context shocks, trends, and seasonality that influences livelihood outcomes, which aligns well with the climatic challenges faced in Northeast Nigeria.

By applying the SLF, this paper examines how CSA practices interact with various livelihood assets and institutional contexts to impact food security outcomes. It also provides a lens to analyze barriers to adoption and the potential for scaling up CSA interventions. The framework's holistic perspective enables a comprehensive assessment of CSA's potential to contribute to sustainable agricultural development and resilience building in the region.

Area of the study

This study focuses on Northeast Nigeria, an area comprising states such as Borno, Yobe, Adamawa, Bauchi, Gombe, and Taraba. The area is characterized by a semiarid climate with highly variable rainfall, frequent droughts, and significant vulnerability to climate change impacts (Ekpa et al., 2021). Agriculture is

predominantly rainfed and practiced mainly by smallholder farmers who rely on subsistence farming. The area has also experienced socio-political instability due to insurgency, which has affected agricultural activities and food security (Mercy Corps, 2018).

Population and Sampling Techniques

The target population includes smallholder farming households in selected LGAs (Local Government Areas) across three representative states: Borno (conflict-affected), Bauchi (moderate climate risk), and Taraba (diverse agro-ecological zones). A multistage sampling technique is employed where a purposeful selection of three states based on security, climate vulnerability, and farming activity, two LGAs per state is randomly selected. Random sampling of 50–70 farming households per LGA. Finally, smallholder farming households will be randomly sampled from community lists obtained from local agricultural offices. This yields a total sample size of 360 respondents, which is statistically adequate for regression and hypothesis testing. The sample size of approximately 360 households is used to ensure statistical robustness and representativeness (Krejcie & Morgan, 1970).

Data Collection Methods

A structured questionnaires administered to selected smallholder farmers. The questionnaire captured information on socioeconomic characteristics, CSA practice adoption, access to extension services, credit, and climate information, as well as household food security indicators.

Analysis Methods

Quantitative data will be analyzed using descriptive statistics to summarize demographic characteristics and CSA adoption rates. The Household Food Insecurity Access Scale (HFIAS) will be employed to measure household food security status, providing a standardized assessment of food access and insecurity levels (Coates et al., 2007). Inferential statistics, including logistic regression analysis, was used to examine factors influencing CSA adoption and its impact on food security outcomes. The regression models were used to test the formulated hypotheses by assessing the significance of socioeconomic and institutional variables on CSA uptake and food security indicators.

RESULTS AND DISCUSSION

Common CSA Practices in Northeast Nigeria

The paper found that smallholder farmers in Northeast Nigeria have adopted a range of Climate Smart Agricultural (CSA) practices the survey revealed that 72.5% of the respondents had adopted at least one Climate-Smart Agricultural (CSA) practice. The most frequently adopted practices include:

Drought-tolerant crop varieties (45.3%), Water harvesting techniques (e.g., zai pits, bunds) (38.1%), Agroforestry (planting trees within or around farmland) (26.7%), Minimum tillage/conservation agriculture (22.5%), Composting and organic manure (17.8%. Agroforestry, involving the integration of trees with crops, was particularly noted for its benefits in soil fertility restoration and microclimate regulation. These findings align with earlier reports from the CGIAR Climate Change Program, which noted similar CSA adoption trends in semi-arid regions of Nigeria (CGIAR, 2021).

Impact on Household Food Security

Analysis using the Household Food Insecurity Access Scale (HFIAS) indicated that households practicing CSA demonstrated significantly better food security outcomes compared to nonadopters. This was evident in:

Mean HFIAS score:

Adopters: 8.2 and Non-adopters: 14.9

(Lower scores indicate greater food security)

Household Dietary Diversity Score (HDDS):

Adopters: 6.8 and Non-adopters: 4.1

Factors Influencing Adoption

Several socioeconomic and institutional factors were found to influence CSA adoption. Access to extension services emerged as a critical determinant, with farmers receiving regular agricultural advice being 2.5 times more likely to adopt CSA practices (Ibrahim et al., 2021). Education level, farm size, and access to credit also positively correlated with adoption rates.

Logistic regression revealed the following factors as significant predictors of CSA adoption:

Access to agricultural extension services (Odds Ratio [OR] = 3.82, p = 0.001)

Education level (OR = 2.17, p = 0.015), Farm size (OR = 1.92, p = 0.028)

Access to climate information (OR = 3.21, p = 0.004)

Membership in farmer cooperatives (OR = 2.48, p = 0.007)

These findings are consistent with Kassie et al. (2015), who demonstrated the role of knowledge, information flow, and institutional support in the adoption of climate-smart innovations in sub-Saharan Africa.

A t-test confirmed that these differences were statistically significant at $p < 0.01$.

While, regression analysis showed a positive and significant association between CSA adoption and food security outcomes ($\beta = 0.541$, $p = 0.003$), even after controlling for socio-economic variables such as household size, income, and education. These findings support similar studies such as Ali et al. (2020), who found CSA adoption improved food access and resilience in Northern Ghana. supporting the hypothesis that CSA practices enhance resilience to climate shocks and improve food access (Olawuyi et al., 2022). CSA adopters reported significantly higher food security levels than non-adopters.

CONCLUSION AND RECOMMENDATION

The study concludes that there are ample evidences of CSA activities among small holder farmers in the Northeast, since most of them practice one or more CSA practices, but the effects of climate change are hitting hard, due to the over dependence on agriculture and poor coping capacities. Agriculture in the northeast is rain fed and weather dependent which leaves the farmers at the mercy of climatic conditions. Climate smart Agriculture is not new to farmers in the study area as most farmers practiced CSA. The study recommends policy interventions, farmer education programs, and targeted support to vulnerable households to scale up CSA practices for long-term food security in Northeast Nigeria. Increased sensitization campaign on reality of climate change and the need to adopt

climate smart practices towards reduction of adverse effect of climate change should also

be intensified;

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