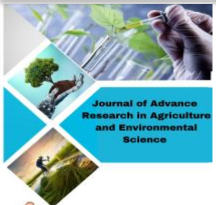

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DEVELOPMENT AND EVALUATION OF CLIMATE-SMART AGRICULTURAL EXTENSION SERVICES FOR SMALLHOLDER FARMERS IN SOUTHERN TARABA STATE, NIGERIA: A COMMUNITY-BASED APPROACH

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ABSTRACT:

This study developed and evaluated climate-smart agricultural (CSA) extension services for smallholder farmers in Southern Taraba State, Nigeria, using a community-based approach. The study specifically examined farmers' socioeconomic characteristics, developed a participatory extension framework and evaluated its effectiveness. Primary data were obtained through structured questionnaires and key informant interviews using a multi-stage sampling technique to sampled 138 respondents across the five Local Government Areas. Data were analyzed using descriptive statistics (frequency, percentage, mean and standard deviation) and thematic analysis. The results revealed that 55.8% of farmers were within the economically active age group of 21–40 years, with a mean age of 38 years, while 63% were male. About 76.1% cultivated not less than one hectare, and 79.7% earned between ₦100 and ₦100,000 monthly, indicating limited financial capacity. Evaluation results indicated that 81.9% of farmers reported improved adaptive capacity, with observed benefits including yield improvement (29.7%) and reduced losses (24.6%). Farmers perception for developing community-based climate smart practices showed indigenous soil management, mulching, use of organic manure, traditional crop varieties and local weather predication should be incorporated. The study concludes that while smallholder farmers in Southern Taraba show promising levels of awareness and adoption of climate-smart agricultural (CSA) practices, their capacity to fully benefit from these innovations is constrained by socioeconomic limitations such as low income, restricted access to credit, small landholdings, and gender disparities. It is therefore recommended that extension programs adopt inclusive, community-based approaches that integrate indigenous knowledge, strengthen farmer participation, and improve access to affordable inputs and climate information to enhance sustainable adoption of CSA practices.

Keywords: Climate-Smart, Agricultural Extension Services, Smallholder Farmers, Community-Based

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INTRODUCTION

Agriculture remains the backbone of Nigeria's economy, contributing significantly to employment, food security, and rural development. Over 70% of Nigeria's population is engaged in agriculture, with smallholder farmers constituting approximately 88.4% of the sector (Chiaka *et al.,* 2022). These farmers are predominantly located in rural areas and rely heavily on rain-fed agriculture, making them highly vulnerable to climate variability and change (Cohn *et al.,* 2017). Southern Taraba is situated in the North-East geopolitical zone, agriculture is the primary livelihood for most rural communities. However, the region faces increasing threats from erratic rainfall, flooding, soil degradation, and other climate-induced challenges (Adedugbe, 2023). Agriculture in Nigeria, particularly in regions like Southern Taraba , remains highly vulnerable to the adverse impacts of climate change, including erratic rainfall patterns, prolonged droughts, flooding, and declining soil fertility. These environmental stressors disproportionately affect smallholder farmers who rely on rain-fed agriculture and have limited adaptive capacities (Ntuli, 2023). Climate-smart agriculture (CSA) has emerged as a viable framework for addressing these challenges by promoting sustainable agricultural practices that enhance productivity, increase resilience to climate variability, and reduce greenhouse gas emissions (Tilahun 2025).

Climate change has emerged as a critical global issue, with profound implications for agricultural productivity, food systems, and rural livelihoods. The Intergovernmental Panel on Climate Change (IPCC) warns that without adequate adaptation strategies, climate change will exacerbate food insecurity and poverty, particularly in developing countries (Tirado *et al.,* 2022). In Nigeria, the effects of climate change are already evident in reduced crop yields, increased pest infestations, and heightened vulnerability of farming communities (Prince *et al.,* 2023). These challenges necessitate a transformative approach to agricultural extension services one that integrates climate-smart principles and community-based strategies. Climate-Smart Agriculture (CSA) is an innovative approach developed by the Food and Agriculture Organization (FAO) to address the intertwined challenges of food security and climate change. CSA aims to sustainably increase agricultural productivity, enhance resilience to climate shocks, and reduce greenhouse gas emissions (Lipper *et al.,* 2022). Practices such as agroforestry, conservation agriculture, intercropping, and integrated pest management have shown promise in improving farm-level resilience and productivity (Arshad *et al.,* 2024). However, the adoption of CSA practices among smallholder farmers in Nigeria remains limited due to inadequate extension support, poor access to information, and lack of enabling policies (Ojo *et al.,* 2024). Agricultural extension services play a pivotal role in disseminating innovations, building farmer capacity, and facilitating behavioral change. Yet, traditional extension models in Nigeria often suffer from top-down approaches, limited reach, and insufficient integration of climate-related information (Adedugbe, 2023). A community-based extension approach, which emphasizes participatory learning, local knowledge, and farmer-led innovation, offers a promising alternative. Such models foster ownership, trust, and contextual relevance key ingredients for sustainable adoption of CSA practices (Tofu *et al.,* 2022).

Community involvement not only enhances the sustainability of interventions but also builds resilience by aligning extension services with real-time climate information and local adaptive practices (Prajapati *et al.,* 2025). This study seeks to bridge the gap between climate-smart agricultural innovations and their practical uptake among smallholder farmers. By leveraging participatory methodologies and community engagement, the research aims to design, implement, and assess extension strategies that are contextually grounded, socially inclusive, and environmentally sustainable. The findings contribute to policy discourse, extension reform, and the broader goal of climate-resilient agriculture in Nigeria. Hence the research to Develop and Evaluate Climate-Smart Agricultural Extension Services for Smallholder Farmers in Southern Taraba, Nigeria: A Community-Based Approach.
The specific objectives are to:

i. describe the socio economic characteristics of small holder farmers in Southern Taraba
ii. develop a community-based framework for delivering climate-smart agricultural extension services tailored to the needs of local farmers.
iii. evaluate the effectiveness of the developed climate-smart extension services in enhancing farmers' adaptive capacity and resilience to climate change.

Materials and Method

The Study Area

The Study was conducted in Southern Taraba, Taraba State, Nigeria. Southern Taraba is made up of five Local Governments areas (Wukari, Takum, Donga, Ussa and Ibbi). It lies between latitudes $8^0 30^0$N and $9^0 3^0$E of the Equator and between longitudes $8^0 30^0$N and $10^0 30^0$E of the Greenwich Meridian (Danladi *et al.,* 2024). It covers an area 14,099Km^2 land mass with a population of about 687,077 people as at 2006 (NPC, 2006). The National

Population Commission had projected an annual growth rate of 3.5% which brought the population figure to 1,233,080.294 people as at 2023 (Danladi *et al.*, 2024). The area shares boundaries with Gassol, Bali, Kurmi, Gashaka and Karim-lamido Local Government areas in the North, Nasarawa State and Plateau State to the North -West, Benue State in the South-West and Republic of Cameroun in the South-East. The area has mean annual rainfall of 1800mm (Rukwe *et al.,* 2020).

Majority of the population consists of peasants farmers cultivating food and cash crop such as sorghum, yam, maize, cassava, sesame, rice etc. at a small-scale level, fresh water fishing and forestry. Livestock keeping is a minor occupation of the population of the area dealing on goats, sheep, poultry, rabbit and fish farming. Other activities include trading and civil service. The people lived mostly in an organized settlements, town and villages. The indigenous ethnic group found in the area is Jukun (Wapan, Kuteb, Wanu, kpanzun, Yukuben, Ichen and Chamba) and others are Tiv, Igbo Yoruba and Hausa.

Sampling Techniques:

A multi-stage sampling technique was used for obtaining sample size for this research work in Southern Taraba based on the availability of smallholder farmers. Stage one, all the five (5) local government areas that made up Southern Taraba were used. They include; Donga, Takum, Ussa, Wukari and Ibi. Stage two, three (3) wards were purposively selected from each of the local government areas based on the presence of smallholder farmers, which are: Asibiti, Akate, Mararraba, Dutse, Rogo, Manya, Lissam I, Lissam II, Kwesati, Puje, Hospital, Rafin kada, Rimi uku I, Rimi uku II and Nwonyo I. The last stage, random sampling was employed to select 138 smallholder farmers from the selected wards. Ten (10) smallholder farmers were interviewed and also ten (10) stakeholders were interviewed. The stakeholders interviewed were selected two (2) from each wards.

Table 1: Sampled size of the smallholder farmers in the study area

Selected LGAs	Wards	Population	Sample Size
Donga	Asibiti	96	12
	Akate	80	8
	Mararraba	90	11
Takum	Dutse	90	11
	Rogo	87	9
	Manya	83	8
Ussa	Lissam I	89	10
	Lissam II	76	7
	Kwesati	87	9
Wukari	Puje	89	10
	Hospital	87	9
	Rafin kada	83	8
Ibi	Rimi uku I	89	10
	Rimi uku II	83	8
	Nwonyo I	83	8
Total		**1292**	**138**

Source: Field survey, 2026

Sources of Data /Data Collection

Primary data was used for this research work. The primary data was collected using a well-structured questionnaire.

Analytical techniques

Data for the research was analyzed using descriptive statistic such as frequency, percentage, mean and standard deviation and thematic analysis. Specifically, objective i and iii were analyzed using descriptive statistics such involving frequency, percentage, mean, standard deviation and ranking. Objectives ii was achieved using thematic analysis.

Likert type scale rating technique

The Likert scale was developed in 1932 by Rensis Likert. It uses the principle of measuring attitude or opinion by asking people to respond to a series of statements about a topic, in terms of the extent/level of their agreement/disagreement with the statement. In the social sciences, common example of the Likert scale is the 1-5 ratings scales in which a respondent selects the number which is considered to be true reflection of the perceived quality or opinion of the respondent on an item statement. Likert scale of a 5-point rating was used in this study to measure the extent of the constraints. The grading was in this order: Strongly agree =5, Agree =4, Undecided = 3, Disagree =2 and Strongly disagree =1. The values of the Likert scale was added to get 15, which was divided by 5 to get a mean score of 3 (i.e. 5+4+3+2+1=15/5=3) cut off point. The respondents mean score was obtained from each response item such that anyone higher or equal to 3 was categorized as agree while anyone less than 3 was categorized as disagree.

Thematic analysis

Objectives ii which is to develop a community-based framework for delivering climate-smart agricultural extension services tailored to the needs of local farmers was achieved using thematic analysis. The interview was group into two section which is interview for smallholder farmers and key stakeholder's perceptives on climate smart agricultural extension services in the study area.

Interview schedule for Smallholder farmers which incorporate the following questions: Main Farming Enterprise, Observed Climate Changes, Effects on Farming, Perception of CSA Practices, Type of Extension Services Received, Frequency of Extension Contact, Relevance of Extension Messages, Information Learning Needs, Preferred Communication Channels, Community Group Activity, Willingness for Group, Role of Women & Youth, Barriers to CSA Adoption, Barriers to Extension Participation, Suggested Improvements, Preferred Extension Structure, Stakeholder Roles and Local Knowledge Integration

Key Stakeholders' Perspectives on Climate-Smart Agricultural Extension Services in Southern Taraba which involves the following questions: Definition of CSA, CSA Practices Promoted, Institutional Capacity, Training / Support Needed, Information Dissemination, Community Involvement, Existing Community Platforms, Institutional Constraints, Socio-cultural Barriers, Stakeholder Collaboration, Integration of Local Knowledge, Suggested Structures / Strategies, Tailoring to Southern Taraba and Monitoring & Evaluation.

The information collected from the respondents were then analyze using descriptive statistics such as frequency and percentage.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Smallholder Farmers in Southern Taraba

The socioeconomic characteristics of smallholder farmers in Southern Taraba, as presented in Table 2, provide critical insights into the demographic and livelihood factors that influence the adoption of climate-smart agricultural (CSA) practices. The result revealed that majority of respondents (55.8%) were between 21–40 years, followed by 37.7% in the 41–60 age bracket, with a mean age of approximately 38 years. This indicates a relatively young and economically active farming population in the study area. Studies suggest that younger farmers are generally more receptive to adopting innovative agricultural practices, including CSA techniques, due to their higher risk tolerance and exposure to new knowledge (Sanogo *et al.*, 2023). The small proportion of respondents above 60 years (2.9%) highlights potential challenges in engaging older farmers who may have lower adaptive capacity.

The result further revealed that Male farmers constituted 63% of respondents, while females made up 37%, reflecting the predominance of men in decision-making roles within agricultural households. This gender distribution is consistent with patterns in Nigeria, where men typically control productive resources, although women play critical roles in farm labor and household food security (Fasakin *et al.*, 2023). Regarding marital status, 66.7% were married, 28.3% single, and 5.1% widowed or divorced. This implies that married farmers dominated farming activities in the study area because farming activities requires family labour. Married farmers often have larger household labor availability, which can positively influence farm productivity and the adoption of CSA practices (Onyenekwe *et al.*, 2026). Education levels among respondents were relatively high, with 36.2% attaining secondary education and 39.1% tertiary education. Only 11.6% had no formal education. This implies that most of the farmers in the study area were educated having one form of education or the other. Higher educational attainment is positively associated with the adoption of innovative agricultural practices, as educated farmers are more likely to understand the benefits of CSA techniques and apply technical advice effectively (Saadu *et al.*, 2024).

Furthermore, the average household size was 5, with 50% of respondents having 4–6 members. This implies that farming household in the study area have access to family labour with a mean of 5 farmers in a household. Larger households provide additional labor, which can facilitate the adoption of labor-intensive CSA practices such as mulching, intercropping, and soil conservation measures (Phiri *et al.*, 2022). Conversely, small households (1–3 members) may face labor constraints, limiting their ability to implement certain practices. Primary Occupation of the respondents revealed that Farming was the primary occupation for 65.2% of respondents, followed by trading (26.1%) and artisan work (8.7%). Most farmers (76.1%) cultivated only one hectare, with 16.7% cultivating two hectares. This implies that farming is the major occupation of the respondents in the study area. This pattern of small farm sizes reflects the prevalence of smallholder agriculture in Southern Taraba, which often constrains mechanization and adoption of resource-intensive CSA interventions (Olabanji and Chitakira, 2025). In terms of type of farming, 56.5% engaged in crop farming, 28.3% in livestock, and 15.2% in mixed farming. This implies that crop farming is the major types of farming activities engaged by the farmers. Crop-focused farming aligns with the dominant agricultural systems in the region, but the presence of mixed systems suggests opportunities for integrated CSA practices.

Sources of Income and Monthly Earnings of the respondents showed that Farming was the primary source of income for 56.5% of respondents, followed by civil service (23.9%), trading (11.6%), and artisan work (8.0%) which implies that farming is the major source of income to the farmers in the study area. Monthly income data reveal that 79.7% earned between 100–100,000 Naira, reflecting limited financial capacity. Low income can restrict access to inputs and technologies necessary for CSA adoption (Hanson *et al.*, 2024). Only 33.3% of respondents had access to credit, highlighting the importance of financial support mechanisms in enabling climate-smart interventions. Membership in Farmer Groups and Training Attendance revealed that approximately 52.2% of respondents were members of farmers' groups or cooperatives, while 47.8% were not. This implies that majority of the farmers are members of farmers organization. Membership in farmer organizations is often positively correlated with knowledge sharing, resource pooling, and collective adoption of innovations (Ogunleye *et al.*, 2021). Despite this, only 30.4% of farmers had attended formal agricultural training programs, suggesting limited capacity-building opportunities in the region. Enhancing training coverage is crucial for improving understanding and uptake of CSA practices.

Table 2: Socioeconomic characteristics of the respondents

Socioeconomic characteristics	*Frequency*	*Percentage*	*Mean (Standard Deviation)*
Age			
1-20	5	3.6	
21-40	77	55.8	
41-60	52	37.7	
61-80	4	2.9	37.9783 (12.59966)
Gender			
Female	51	37.0	
Male	87	63.0	
Marital status			
Single	39	28.3	
Married	92	66.7	
Widowed	3	2.2	
Divorced	4	2.9	
Educational level			
No formal education	16	11.6	
Primary education	18	13.0	
Secondary education	50	36.2	
Tertiary education	54	39.1	
Household size			
1-3	35	25.4	
4-6	69	50.0	
7-9	27	19.6	
10-12	7	5.0	4.9710 (2.30500)

Primary occupation			
Farming	90	65.2	
Trading	36	26.1	
Artisan	12	8.7	
Farm size			
1	105	76.1	
2	23	16.7	
3	5	3.6	
4	4	2.9	2.4159 (2.32728)
Type of farming			
Crop	78	56.5	
Livestock	39	28.3	
Mixed	21	15.2	
Source of income			
Farming	78	56.5	
Civil service	33	23.9	
Trading	16	11.6	
Artisan	11	8.0	
Monthly income			
100-100000	110	79.7	
100001-200000	5	3.6	
200001-300000	15	10.9	
300001-400000	2	1.4	
400001-500000	5	3.6	
500001-600000	1	0.7	6.7293E4 (1.17974E5)
Access to credit			
No	92	66.7	
Yes	46	33.3	
Membership in farmers group / cooperative			
No	66	47.8	
Yes	72	52.2	
Training attendance			
No	96	69.6	
Yes	42	30.4	
Total	**138**	**100.0**	

Source: Field survey, 2026 Multiple response

A community-based framework for delivering climate-smart agricultural extension services tailored to the needs of local farmers, Interview schedule for Smallholder farmers.

The results presented in Table 3 provide a detailed understanding of smallholder farmers' socio-economic context, their experiences with climate variability, perceptions of climate-smart agricultural (CSA) practices, and expectations for agricultural extension services in Southern Taraba. These findings are critical for designing a community-based CSA extension framework tailored to local realities. The majority of farmers (60%) were engaged primarily in crop farming, while 30% practiced mixed farming (crop and livestock), and 10% focused solely on livestock. This distribution reflects the diverse livelihood strategies in Southern Taraba, where crop cultivation remains dominant. Farmers reported notable changes in weather patterns over the past five to ten years, with irregular rainfall (50%), increased temperatures (30%), and delayed onset of rains (20%) being the most commonly observed phenomena. The farmers' observations also revealed that climate variability has significantly impacted agricultural outcomes. Reduced yields (60%), crop failure (20%), and increased pest and disease incidences (20%) were frequently reported. These impacts highlight the vulnerability of smallholder farmers to climate-induced stresses and emphasize the urgency of implementing adaptive strategies through climate-smart agricultural practices.

Perceptions and Adoption of Climate-Smart Agricultural Practices revealed that Most farmers (70%) perceived CSA practices as highly useful, with the remaining 30% considering them moderately useful. This suggests a generally positive attitude toward climate-smart interventions, indicating a fertile ground for adoption if extension services are appropriately designed and delivered. However, perceptions alone do not guarantee uptake, and adoption is often influenced by access to knowledge, resources, and technical support. Access to extension services remains limited. Only 40% of farmers received regular information from government extension agents, 30% from NGOs, 20% via radio programs, and 10% had no access. Frequency of extension contact was low, with 60% of respondents reporting rare visits (1–2 times per year), 30% occasional visits (3–5 times per year), and only 10% receiving regular contact. Similarly, only 40% of farmers considered extension messages fully relevant to their climate challenges. These findings highlight gaps in the delivery, frequency, and contextual relevance of agricultural extension services in the study area.

Farmers indicated a strong need for targeted agricultural information to cope with climate-related risks. The most critical needs included drought-resistant varieties (40%), soil conservation techniques (30%), water management strategies (20%), and pest control measures (10%). These priorities suggest that extension services should focus on locally relevant, practical interventions that directly address observed climate impacts. Farmers also expressed preferences for receiving agricultural information through radio (40%), mobile phones (30%), farmer group meetings (20%), and demonstration plots (10%). This indicates the potential for combining traditional (radio, community meetings) and modern (mobile/ICT) channels to enhance the reach and effectiveness of CSA extension services. Community Structures and Participation revealed that half of the respondents (50%) described community groups as active in agricultural decision-making, 30% as moderately active, and 20% as inactive. A majority of farmers (60%) expressed high willingness to participate in group-based learning initiatives such as Farmer Field Schools or demonstration activities. However, participation of women and youth was limited, with only 20% actively involved. These findings suggest that existing community structures can serve as platforms for CSA interventions but require strategies to enhance inclusivity and equitable participation (Huyer et al., 2021)

Barriers to Adoption and Extension Participation revealed that financial constraints (40%), lack of knowledge (30%), cultural beliefs (20%), and poor access to inputs (10%) were identified as the primary barriers to adopting CSA practices. Similar factors financial limitations, knowledge gaps, cultural norms, and logistical challenges also constrained participation in extension programs. These barriers highlight the need for targeted support mechanisms, including capacity building, affordable inputs, and culturally sensitive approaches (Kim and Bang, 2025). Farmers suggested that extension services could be improved through more frequent visits (40%), provision of locally relevant content (30%), use of local languages (20%), and practical demonstrations (10%). Regarding the structure of extension services, 50% preferred community-based groups, 30% favored ICT-supported delivery, and 20% endorsed government-led approaches. Stakeholders emphasized collaboration among farmers, community leaders, and local organizations in designing and implementing CSA programs (Andrieu *et al.*, 2019). Finally, the respondent suggested local knowledge integration such as indigenous soil management, mulching use of organic manure, traditional crop varieties and local weather prediction in the study area.

Table 3: Farmers' Perspectives for Developing a Community-Based Climate-Smart Extension Framework (n = 10)

Variable	*Response Category*	*Frequency (f)*	*Percentage (%)*
Main Farming Enterprise	Crop farming (maize, yam, cassava)	6	60.0
	Mixed farming (crop + livestock)	3	30.0
	Livestock only	1	10.0
Observed Climate Changes	Irregular rainfall	5	50.0
	Increased temperature	3	30.0
	Delayed onset of rains	2	20.0
Effects on Farming	Reduced yields	6	60.0
	Crop failure	2	20.0
	Increased pest/disease	2	20.0
Perception of CSA Practices	Highly useful	7	70.0
	Moderately useful	3	30.0
Type of Extension Services Received	Government extension agents	4	40.0
	NGOs	3	30.0
	Radio programs	2	20.0
	None	1	10.0
Frequency of Extension Contact	Rare (1–2 times/year)	6	60.0
	Occasional (3–5 times/year)	3	30.0
	Regular (>5 times/year)	1	10.0
Relevance of Extension Messages	Relevant	4	40.0

	Partially relevant	4	40.0
	Not relevant	2	20.0
Information Needs	Drought-resistant varieties	4	40.0
	Soil conservation	3	30.0
	Water management	2	20.0
	Pest control	1	10.0
Preferred Communication Channels	Radio	4	40.0
	Mobile phone	3	30.0
	Farmer groups/meetings	2	20.0
	Demonstration plots	1	10.0
Community Group Activity	Active	5	50.0
	Moderately active	3	30.0
	Inactive	2	20.0
Willingness for Group Learning	Highly willing	6	60.0
	Moderately willing	3	30.0
	Not willing	1	10.0
Role of Women & Youth	Limited participation	5	50.0
	Moderate participation	3	30.0
	Active participation	2	20.0
Barriers to CSA Adoption	Financial constraints	4	40.0
	Lack of knowledge	3	30.0
	Cultural beliefs	2	20.0
	Poor access to inputs	1	10.0
Barriers to Extension Participation	Financial	4	40.0
	Knowledge gap	3	30.0
	Cultural factors	2	20.0
	Distance/logistics	1	10.0
Suggested Improvements	More frequent visits	4	40.0
	Locally relevant content	3	30.0
	Use of local language	2	20.0
	Practical demonstrations	1	10.0
Preferred Extension Structure	Community-based groups	5	50.0
	ICT-supported services	3	30.0
	Government-led	2	20.0
Stakeholder Roles	Farmers & leaders collaboration	6	60.0
	NGO support	2	20.0
	Government only	2	20.0
Local Knowledge Integration	Indigenous soil management, mulching, use of organic manure	4	40.0
	Traditional crop varieties	3	30.0
	Local weather prediction	3	30.0

Source: Field survey, 2026 Multiple response

Key Stakeholders' Perspectives on Climate-Smart Agricultural Extension Services in Southern Taraba

The results in Table 4 provide valuable insights into the perceptions, capacities, constraints, and recommendations of key stakeholders including extension agents, community leaders, NGOs, ADP officials, and local government officers on delivering climate-smart agricultural (CSA) extension services in Southern Taraba. These findings are critical in informing the development of a community-based CSA extension framework tailored to the local context. The result showed that Stakeholders demonstrated a clear understanding of CSA, with 60% defining it as sustainable agricultural practices that adapt to local climatic variability, while 40% highlighted its role in reducing greenhouse gas emissions and improving productivity. This demonstrates that stakeholders possess foundational knowledge of CSA principles, which is essential for the successful planning and delivery of context-specific extension services. Their understanding aligns with international definitions emphasizing adaptation, mitigation, and productivity enhancement (Rosenzweig and Tubiello, 2007).

Stakeholders suggested that promoting drought-resistant crop varieties (50%) and soil and water conservation practices (40%), while integrated pest management (30%) and agroforestry (20%) were less emphasized. This suggests that extension programs have prioritized practices addressing the most immediate climate-related challenges, such as erratic rainfall and soil degradation, which are widely observed by farmers in Southern Taraba. The lower emphasis on agroforestry and integrated pest management indicates potential areas for expansion to enhance resilience and environmental sustainability. Institutional Capacity and Training Needs revealed that the majority of stakeholders (60%) indicated that their organizations have moderate capacity to deliver CSA services, primarily due to limited staffing, funding, and logistical constraints. Stakeholders also emphasized the need for CSA-specific training (70%) and ICT skills (50%) to improve the efficiency and reach of extension programs. These findings reflect broader challenges in rural extension systems in developing countries, where knowledge exists but institutional limitations impede effective service delivery (Becerra-Encinales et al., 2024). The study further revealed that information is currently disseminated through farmer meetings and workshops (60%), radio and mobile messaging (50%), and demonstration plots (40%).

However, only 30% of stakeholders reported active community involvement in program design or evaluation, while 50% noted limited consultation. Existing community platforms such as cooperatives (60%), religious groups (40%), and youth groups (30%) offer opportunities for enhancing participation. Constraints in CSA Service Delivery revealed that Stakeholders identified several constraints affecting CSA delivery. Institutional challenges include inadequate funding (70%), insufficient staffing (60%), and poor logistics (50%). Socio-cultural barriers include resistance to new practices (50%), gender norms limiting participation (40%), and low literacy or awareness (30%). These constraints are consistent with literature indicating that financial, human resource, and cultural limitations significantly hinder the adoption of CSA practices among smallholder farmers (Muriithi et al., 2023).

Collaboration and Integration of Local Knowledge revealed that Stakeholders reported collaboration with NGOs (60%), research institutions (40%), and meteorological agencies (30%), indicating a multi-stakeholder approach to CSA extension. Integration of local knowledge including indigenous crop varieties, traditional planting calendars, and soil and water management practices was highlighted as essential for designing locally relevant interventions. This aligns with community-based adaptation principles, which emphasize the integration of indigenous knowledge to enhance resilience and adoption (Motsumi and Nemakonde, 2024). Framework Recommendations revealed that Stakeholders suggested that CSA extension programs should be community-based (70%), supported by ICT-enabled advisory services (50%) and farmer-led demonstration plots (40%). Tailoring programs to local conditions, promoting gender inclusivity (50%), and using local languages (40%) were identified as key strategies for enhancing effectiveness. Monitoring and evaluation should adopt participatory approaches (60%) and include performance indicators such as yield improvement and adoption rates (40%) to ensure accountability and continuous improvement.

Table 4: Key Stakeholders' Perspectives on Climate-Smart Extension Services (n = 10)

S/N	*Variables*	*Response Category*	*Frequency (f)*	*Percentage (%)*
1	Definition of CSA	Sustainable practices adapting to local climate	6	60.0
		Practices that reduce emissions and improve productivity	4	40.0
2	CSA Practices Promoted	Drought-resistant crops	5	50.0
		Soil and water conservation	4	40.0
		Integrated pest management	3	30.0
		Agroforestry	2	20.0
3	Institutional Capacity	Moderate (limited staff & resources)	6	60.0
		High capacity (trained staff, funded programs)	4	40.0
4	Training / Support Needed	CSA-specific training	7	70.0
		ICT & mobile advisory skills	5	50.0
		Improved transport/logistics	3	30.0
5	Information Dissemination	Farmer meetings / workshops	6	60.0
		Radio & mobile messaging	5	50.0
		Demonstration plots	4	40.0
6	Community Involvement	Limited consultation	5	50.0
		Active participation in program design	3	30.0
		Community evaluation of programs	2	20.0
7	Existing Community Platforms	Cooperatives	6	60.0

		Religious groups	4	40.0
		Youth groups	3	30.0
8	Institutional Constraints	Funding	7	70.0
		Staffing shortage	6	60.0
		Transport / logistics	5	50.0
9	Socio-cultural Barriers	Resistance to new practices	5	50.0
		Gender norms limiting participation	4	40.0
		Low literacy / awareness	3	30.0
10	Stakeholder Collaboration	NGOs	6	60.0
		Research institutions	4	40.0
		Meteorological agencies	3	30.0
11	Integration of Local Knowledge	Crop varieties & planting dates	5	50.0
		Soil & water conservation methods	4	40.0
		Pest management	3	30.0
12	Suggested Structures / Strategies	Community-based groups	7	70.0
		ICT-supported delivery	5	50.0
		Farmer-led demonstration plots	4	40.0
13	Tailoring to Southern Taraba	Context-specific CSA practices	8	80.0
		Gender-inclusive programs	5	50.0
		Local language communication	4	40.0
14	Monitoring & Evaluation	Participatory M&E with farmers	6	60.0
		Periodic reporting & feedback	5	50.0
		Use of indicators (yield, adoption)	4	40.0

Source: Field survey, 2026 Multiple response

Effectiveness of Climate-Smart Extension Services

The findings in Table 5 indicate that climate-smart extension programs are widely accessed and positively perceived among smallholder farmers in Southern Taraba. A significant majority of respondents (76.1%) reported participation in climate-smart extension programs, suggesting that extension services are increasingly engaging farmers in climate adaptation initiatives. This is consistent with evidence from Sub-Saharan Africa, where participatory extension programs have enhanced smallholder awareness and adoption of climate-smart agricultural (CSA) practices (Alhassan and Haruna, 2024). The study further revealed that farmers gained practical skills across a range of CSA practices. High adoption rates were reported for climate-resilient crop varieties (84.1%), soil and water conservation methods (82.6%), improved planting techniques (80.4%), and climate risk assessment and planning (80.4%). Other notable practices adopted included efficient irrigation methods (77.5%), pest and disease management strategies (79.7%), agroforestry and tree planting (72.5%), post-harvest handling and storage (71.0%), and farm record keeping and decision-making (78.3%). These results demonstrate that extension programs are effectively transmitting diverse CSA practices, which aligns with findings that practical, hands-on training increases the likelihood of adoption (Ojo *et al.*, 2025).

Regarding the impact on farmers' adaptive capacity, 81.9% of respondents reported that participation improved their ability to cope with climate-related risks, indicating that CSA extension programs are enhancing resilience to climate variability. Farmers rated the overall effectiveness of the programs as very effective (44.2%), moderately effective (33.3%), and not effective (22.5%), highlighting that while most farmers perceive substantial benefits, a notable proportion still face limitations that constrain effectiveness. In terms of observed outcomes, respondents reported improvements in yield (29.7%), reduced losses (24.6%), better planning (25.4%), and improved soil health (20.3%). These outcomes suggest that CSA extension programs not only enhance knowledge but translate into measurable productivity and risk mitigation benefits, consistent with evidence that targeted extension services improve farm-level adaptive outcomes (Kamruzzaman *et al.*, 2021). Despite these positive impacts, farmers identified remaining challenges that could limit the full effectiveness of the programs. The most cited barriers were inadequate follow-up support (35.5%), low market access (24.6%), climate unpredictability (17.4%), poor infrastructure (11.6%), and limited access to inputs (10.9%). These findings underscore the need for complementary interventions that address structural, institutional, and logistical constraints, which are critical for sustaining CSA adoption and maximizing benefits (Muriithi *et al.*, 2023).

Table 5: Effectiveness of Climate-Smart Extension Services

Effectiveness of Climate-Smart Extension Services	***Frequency***	***Percentage***
Have you participated in any climate-smart extension programs		
No	33	23.9
Yes	105	76.1
If yes, what practices did you learn or adopt		
Improved planting techniques		
No	27	19.6
Yes	111	80.4
Soil and water conservation methods		
No	24	17.4
Yes	114	82.6
Climate risk assessment and planning		
No	27	19.6
Yes	111	80.4
Use of climate-resilient crop varieties		
No	22	15.9
Yes	116	84.1
Agroforestry and tree planting		
No	38	27.5
Yes	100	72.5
Efficient irrigation methods		
No	31	22.5
Yes	107	77.5
Pest and disease management strategies		
No	28	20.3
Yes	110	79.7
Post-harvest handling and storage		
No	40	29.0
Yes	98	71.0
Farm record keeping and decision-making		
No	30	21.7
Yes	108	78.3
Did the program improve your ability to cope with climate-related risks		
No	25	18.1
Yes	113	81.9
How would you rate the effectiveness of the program		
Very effective	61	44.2
Moderately effective	46	33.3
Not effective	31	22.5
What changes have you observed in your farming outcomes since participating		
Increased yield	41	29.7
Reduced losses	34	24.6
Improved soil health	28	20.3
Better planning	35	25.4
What challenges remain despite the intervention		
Limited access to inputs	15	10.9
A poor infrastructure	16	11.6
Climate unpredictability	24	17.4
Low market access	34	24.6
Inadequate follow up support	49	35.5
Total	**138**	**100.0**

Source: Field survey, 2026 Multiple response

Conclusion

This study concludes that while smallholder farmers in Southern Taraba show promising levels of awareness and adoption of climate-smart agricultural (CSA) practices, their capacity to fully benefit from these innovations is constrained by socioeconomic limitations such as low income, restricted access to credit, small landholdings, and gender disparities. Extension services have contributed to improved knowledge and resilience, but their limited coverage and weak participatory approaches reduce effectiveness. The findings highlight that community-based, inclusive, and participatory extension frameworks integrating indigenous knowledge and local engagement are essential for strengthening adaptive capacity and ensuring sustainable adoption of CSA practices. Ultimately, the study demonstrates that CSA interventions can enhance resilience to climate change, but their success depends on addressing structural barriers and embedding farmers' voices in design and implementation.

Recommendations

Based on the findings from the research, the following recommendations were proffered:

i. Climate Smart Agricultural messages using local languages, visual aids, and practical demonstrations to ensure comprehension across varying educational backgrounds and improve adoption.
ii. Smallholders should be provided with low-cost, scalable CSA technologies, while larger farmers can adopt more capital-intensive practices.
iii. Improve extension effectiveness by focusing on content relevance, participatory methods, and CSA-focused training for agents, rather than only increasing visit frequency.
iv. Leverage existing farmer groups, cooperatives, and community institutions for knowledge sharing, collective action, and participatory program design, integrating indigenous knowledge with scientific CSA practices.
v. Traditional farming methods such as intercropping, mulching, and use of organic manure should be incorporated into Climate Smart Agriculture frameworks. This ensures CSA builds on familiar, trusted practices while enhancing sustainability.

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