



ANALYSIS OF SMALLHOLDER CROP FARMERS' ADAPTIVE CAPACITY AND CONSTRAINTS TO CLIMATE CHANGE RESILIENCE IN MAIGANA AGRICULTURAL ZONE, KADUNA STATE, NIGERIA

¹Daikwo, O. C., ¹Saleh, M. K., ¹Owolabi, J. O. and ²Shehu, A. ¹Department of Agricultural Extension and Rural Development, Faculty of Agriculture, Ahmadu Bello University, Zaria, Kaduna State, Nigeria ²Agro-meteorological Centre, Abubakar Tafawa Balewa University, Bauchi, Bauchi State, Nigeria

Corresponding Author's Email: oguchedaikwo@gmail.com, GSM: +2348069454493

ABSTRACT

This study examined the smallholder crop farmers' adaptive capacities and constraints to climate change resilience in Maigana Agricultural zone, Kaduna State, Nigeria. A multistage sampling procedure was employed to select crop farmers, beginning with the purposeful selection of the Maigana agricultural zone due to its high crop production potential. Subsequently, three Local Government Areas (Kubau, Makarfi, and Soba) were chosen, followed by the selection of fifteen communities. A reconnaissance survey estimated a total of 600 smallholder crop farmers, and using the Yamane (1967) Slovin formula, 252 farmers were randomly selected for the study. Data were collected using structured questionnaires administered to smallholder crop farmers. Descriptive statistics was used to analyse the data, including the mean, frequency distribution, standard deviation, coefficient of variation, and percentages. The findings reveal that 90.2% of respondents were aware of climate change, which is crucial for adaptation efforts. Farmers employ various coping strategies, such as mixed cropping (13.3%), crop diversification (12.9%), and irrigation farming (12.8%), among others. These strategies reflect farmers' adaptive capacity and resilience. However, significant constraints hinder effective adaptation, including inadequate finance (20.4%), high input costs (16.9%), limited knowledge and information (16.9%), and unfavourable government policies (14.5%). The study concludes that while there is a high level of climate change awareness among smallholder farmers, significant barriers impede their adaptation capacities. To enhance resilience and ensure sustainable agricultural practices, the study recommends developing robust institutional frameworks and supportive policies, improving access to essential resources and advanced technologies, and promoting sustainable agricultural practices through tailored training programmes and workshops.

Keywords: Adaptive, Capacity, Constraints, Climate-Change, Resilience, Smallholder.

INTRODUCTION

Climate change represents one of the most pressing challenges of our time, profoundly impacting global agricultural systems and posing substantial threats to food security, economic stability, and sustainable development (IPCC, 2021). In agrarian economies like Nigeria, with a population exceeding 200 million and a significant reliance on agriculture for livelihoods, vulnerability to climate variability and extreme weather events is magnified (World Bank, 2020). Smallholder crop farmers, who constitute the backbone of Nigeria's agricultural sector, are particularly vulnerable due to their reliance on rain-fed agriculture and limited access to





resources, technology, and support systems (FAO, 2019). Increased temperatures, erratic rainfall patterns, prolonged droughts, and more frequent floods disrupt planting and harvesting cycles, reduce crop yields, and exacerbate food insecurity (FAO, 2019; IPCC, 2021). Moreover, these climatic changes have profound socio-economic implications, affecting resilience and livelihoods in rural communities (World Bank, 2020).

Despite the critical role of smallholder farmers in Nigerian agriculture, there remains a gap in understanding their coping strategies and the constraints they face in the context of climate change (World Bank, 2020; FAO, 2019). Limited access to resources, inadequate support systems, and institutional barriers hinder effective adaptation efforts among these farmers (UNEP, 2020). Furthermore, the socio-economic and environmental impacts of climate change are unevenly distributed, disproportionately affecting vulnerable rural communities that rely on rainfed agriculture for their livelihoods (IPCC, 2021; World Bank, 2020). Understanding how smallholder farmers cope with and adapt to climate change is crucial for fostering resilience, promoting sustainable agricultural practices, and ensuring food security in Nigeria (UNEP, 2020). This study aims to address this gap by exploring the diverse coping mechanisms utilised by smallholder farmers and identifying the constraints that hinder their adaptation efforts. This study investigated the coping strategies and constraints faced by climate-aware smallholder crop farmers in Maigana agricultural zone of Kaduna state, Nigeria.

METHODOLOGY

The Study Area

Kaduna State, situated in the north western region of Nigeria, lies approximately between latitudes 9° and 12° N of the equator and longitudes 6° and 9° E of the prime meridian. It borders Katsina and Kano States to the north, Plateau State to the northeast, Nassarawa and Abuja to the south, and Niger and Zamfara States to the west (Kaduna State Government, 2022). According to the National Population Commission, the population of the state grew from 6,113,503 in the 2006 census to approximately 9,480,000 by 2020, reflecting a growth rate of 3.18% annually (Kaduna State Official Website, 2023). Kaduna State experiences two distinct seasons: a dry season and a wet season. The dry season typically spans from November to February and is characterised by cold weather and the prevalence of dry harmattan winds, particularly affecting the northern part of the state. In contrast, the southern part receives heavier rainfall lasting approximately 5-6 months, while the northern region experiences rainfall for about 4-5 months annually. Generally, rainfall begins in April and continues through October. The state is geographically divided into four agricultural zones: Birnin Gwari, Lere, Maigana, and Samaru, encompassing a total of 23 Local Government Areas (LGAs). Agriculture forms the backbone of the state's economy, with a focus on the cultivation of cereals such as wheat, maize, sorghum, millet, rice, and legumes like peas, cowpeas, soybeans, and groundnut. These crops are grown under both rain-fed and irrigated conditions. Vegetable cultivation, including tomatoes, pepper, and cabbage, thrives on irrigated lands. The farming systems in Kaduna State are characterised by both sole cropping and mixed cropping practices. Livestock rearing is also prevalent, although it is primarily managed by Fulani herdsmen. The integration of livestock with farming activities is common among some farmers in the state.





Sampling Procedure and Sample Size

The study employed a multistage sampling procedure to select crop farmers. Initially, Maigana agricultural zone was purposively chosen due to its recognized high crop production potential within Kaduna State (Kaduna State Official Website, 2022). In the second stage, three Local Government Areas (LGAs) were randomly selected from the Maigana zone: Soba, Zaria, and Sabon Gari. Subsequently, in the third stage, a total of fifteen communities were systematically selected from these three LGAs. This selection was informed by a reconnaissance survey conducted in 2023, which estimated a total of five hundred and sixty (560) smallholder crop farmers across the communities. In the final stage, the sample size was determined using the Yamane (1967) Slovin formula, as adapted by Abdulrahman *et al.* (2016). The formula is given as follows:

$$\mathbf{n} = \frac{\mathbf{N} \qquad \mathbf{N}}{\mathbf{1} + \mathbf{N} \left(\alpha \right)^2 \mathbf{1} + \mathbf{N} \left(\alpha \right)^2}$$

... (1)

Where, n = Sample size, N = Population size (Sampling Frame) and e = Significance level (0.05) Sz = $600 / (1+600 ([0.05] ^2)) \dots (2)$

Sz = 600 / (1+000) Sz = 600 / 2.38Sz = 252

Sz = 252 / 600 * 100 = 42%

Agricultur al Zone	LGAs	Communities	Sampling frame	Sample size (42%)
Maigana	Soba	Maigana	40	17
		Makwaron Lemu	35	15
		Kuyamutsa	40	17
		Angwan Sako	40	17
		Turawa	35	15
Makarfi		Makarfi	41	17
		Danguzuri	43	18
		Marke	35	15
		Gimi	42	18
		Dadinkowa	34	14
Soba		Dutsenwai	45	19
		Kuli	41	17
		Kuzuntu	40	17
		Maiyashi	46	19
		Kogi office	43	18
Total		15	600	252

Table 1: Population and Sample Size of Crop Farmers in the Study Area

Source: Reconnaissance survey, 2023.

Method of Data Collection

Data for this study was collected from primary source. The primary data was collected with the aid of a structured questionnaire administered to smallholder crop farmers, Agricultural Extension Officers and Focus Group by trained enumerators. The questionnaire was prepared in sessions to cover the objectives of the study. These include smallholder awareness of climate





change, coping strategies against the effect of climate change and constraints encountered in coping with the effects of climate change.

Analytical Techniques

Descriptive statistics such as the mean, frequency distribution, standard deviation, coefficient of variation and percentages was used to identify crop farmers state of awareness of climate change, identify the coping strategies adopted by smallholder crop farmers against the effect of climate change and to describe the constraints associated with coping with the effects of climate change

RESULTS AND DISCUSSION

Smallholder Crop Farmers' State of Awareness of Climate Change

The data shown in Table 2 highlights farmers' awareness of climate change, which is essential for understanding their readiness to adapt. The results indicate that 17% of the farmers were unaware of climate change, whereas 83% were aware. This significant level of awareness is promising and supports the idea that understanding climate change is a vital initial step for adaptation, as noted in earlier research (Smith and Johnson, 2018). Awareness plays a critical role in encouraging farmers to implement climate-resilient practices and invest in measures to counteract the negative impacts of climate change.

Awareness of climate change	Freq.	%
Not aware	42	17
Aware	210	83
Total	252	100

Table 2: Distribution of Crop Farmers based on Awareness of Climate Change.

Coping Strategies Adopted by Smallholder Crop Farmers against the Effects of Climate Change

Table 3 presents the coping strategies adopted by smallholder crop farmers to mitigate the effects of climate change on agricultural productivity and food security. The diverse range of strategies reflects farmers' adaptive capacity and resilience in the face of climate variability and extreme weather events.

The most commonly employed strategy is mixed cropping, with 13.3% of respondents adopting this approach. Mixed cropping enhances biodiversity, soil health, and resilience against climate-induced stresses, consistent with findings by Khan *et al.* (2019). This traditional practice allows farmers to diversify their production systems, reducing the risk of total crop failure. Promoting mixed cropping can contribute to sustainable agriculture by enhancing resilience to climate change, conserving biodiversity, and ensuring food security.

Crop diversification, adopted by 12.9% of respondents, spreads risk and improves resilience against climate-induced stresses, as noted by Wang *et al.* (2020). By growing a variety of crops, farmers can buffer against the impacts of unfavourable weather conditions on specific crops, ensuring a more stable food supply and income. Encouraging crop diversification can enhance farmers' adaptive capacity, reduce vulnerability to climate risks, and promote agricultural sustainability.





Irrigation farming, utilised by 12.8% of respondents, is crucial for ensuring water availability during periods of erratic rainfall and drought. This strategy aligns with the findings of Li *et al.* (2018), highlighting the importance of irrigation in enhancing crop yields and food security in water-stressed regions. Investing in irrigation infrastructure and water management practices can improve agricultural productivity, mitigate the impacts of climate change, and enhance food security in vulnerable regions.

The adoption of drought, pest, and disease-resistant crop varieties by 10.3% of respondents underscores the importance of resilient seeds in mitigating climate risks, as emphasised by Chen *et al.* (2021). Using improved varieties can enhance crop yields and reduce vulnerability to climate-induced stresses, contributing to food security. Research and dissemination of resilient crop varieties can help farmers adapt to changing climatic conditions, improve agricultural productivity, and ensure food security.

Diversification to non-farm activities, practiced by 9.6% of respondents, is essential for enhancing economic resilience, consistent with findings by Rahman *et al.* (2017). Engaging in alternative income-generating activities reduces dependency on agriculture and provides additional sources of livelihood in the face of climate uncertainties. Supporting diversification into non-farm activities can enhance farmers' resilience to climate change, alleviate poverty, and promote inclusive economic growth in rural areas.

While 9.3% of respondents use agrochemicals, their balanced use is crucial to minimising negative environmental and health impacts, as highlighted by Meng *et al.* (2020). Proper application of fertilisers and pesticides can improve crop productivity and resilience, but it must be accompanied by sustainable practices. Promoting integrated pest management and the sustainable use of agrochemicals can optimise agricultural production, safeguard environmental health, and ensure long-term food security.

Adjusting sowing dates, practiced by 9.1% of respondents, allows for better alignment with changing climatic conditions, consistent with recommendations by Singh *et al.* (2019). Timely planting optimises crop growth and yield potential, mitigating the risks associated with unfavourable weather patterns. Providing climate information services and extension support can assist farmers in making informed decisions on sowing dates, optimising resource use, and enhancing agricultural resilience.

Water conservation practices, adopted by 8.3% of respondents, are vital for optimising water use efficiency and ensuring sustainable agriculture, as advocated by Liu *et al.* (2021). Techniques such as rainwater harvesting and mulching help conserve water resources, particularly in regions prone to water scarcity. Investing in water conservation infrastructure and promoting efficient water management practices can enhance water resilience, support agricultural sustainability, and mitigate the impacts of climate change.

Relocating farms to more suitable areas, as practiced by 8.2% of respondents, can mitigate the impacts of adverse weather conditions, as suggested by Kumar *et al.* (2018). Moving to locations with better climatic and soil conditions can improve agricultural productivity and resilience to climate change. Supporting farmers in accessing information on climate-smart agricultural zones and facilitating land tenure arrangements can enable successful farm relocation, enhancing adaptive capacity and food security.

Minimum tillage, employed by 6.0% of respondents, promotes soil conservation and moisture retention, consistent with studies by Liang *et al.* (2019). Reduced soil disturbance





improves soil health and resilience to extreme weather events, contributing to sustainable crop production. Promoting minimum tillage practices can conserve soil resources, mitigate land degradation, and enhance agricultural resilience to climate change.

Other strategies, such as early planting, are adopted by a small proportion of farmers (0.2%) to capitalise on favourable weather conditions and minimise climate risks, as recommended by Zhao *et al.* (2020). Early planting can take advantage of the early part of the rainy season, reducing the risk of crop failure due to late-season droughts. Supporting farmers with early-maturing crop varieties and climate-resilient seeds can optimise early planting strategies, improve crop yields, and ensure food security.

The diverse array of coping strategies adopted by smallholder crop farmers reflects their adaptive capacity and resilience in response to climate change challenges. Integrating traditional practices with modern technologies and knowledge sharing can further enhance farmers' ability to cope with climate variability, ensure agricultural sustainability, and promote food security.

Coping Strategies employed by	*Frequency	Percentage	Ranking	
farmers				
Mixed cropping	159	13.3	1 st	
Crop diversification	154	12.9	2 nd	
Irrigation farming	153	12.8	3 rd	
Drought, pest and diseases resistant	123	10.3	4 th	
crop variety				
Diversification to non-farm activities	114	9.6	5 th	
Use of agrochemicals	111	9.3	6 th	
Change in sowing date	109	9.1	7 th	
Water conservation practices	99	8.3	8 th	
Change in farm location	98	8.2	9 th	
Minimum tillage	71	6.0	10 th	
Other (Early planting)	2	0.2	11 th	

 Table 3: Smallholder Crop Farmers' Distribution according to Coping Strategies Adopted

Source: * *Multiple responses*

Constraints Associated with Coping with the Effects of Climate Change

The result in Table 4 highlights the constraints smallholder crop farmers face in coping with the effects of climate change. These constraints significantly hinder their adaptation strategies, and understanding them is crucial for developing effective interventions.

Inadequate finance, affecting 20.4% of respondents, is identified as the most significant constraint. Limited access to financial resources restricts farmers' ability to invest in the necessary inputs, technology, and infrastructure required to effectively adapt to climate change. This finding aligns with the study by Deressa *et al.* (2009), which reported that lack of access to credit was a significant impediment to adopting adaptive measures among Ethiopian farmers.

The high cost of inputs, impacting 16.9% of farmers, is the second major constraint. These costs can be prohibitive, especially for smallholder respondents who often operate with slim profit margins. The high cost of inputs is a well-documented barrier. This corroborates the





study by Uddin *et al.* (2014), which highlighted that Bangladeshi farmer faced significant challenges due to the high costs of agricultural inputs, limiting their ability to adapt to changing climatic conditions.

Limited knowledge and information about climate change adaptation, affecting 16.9% of respondents, ranks as a joint second constraint. This underscores the crucial role of education and extension services in equipping farmers with the knowledge and skills required to implement effective adaptation strategies. This is in line with the findings of Maddison (2007), who observed that limited knowledge among South African farmers hindered their adaptive capacity.

Unfavourable government policy, reported by 14.5% of respondents, is the fourth major constraint. This suggests that existing policies may not adequately support smallholder farmers in their adaptation efforts. Government policies can influence access to resources, the availability of extension services, and overall support for agricultural adaptation. The role of government policy is crucial in facilitating adaptation. This aligns with the study of Antwi-Agyei *et al.* (2014), which emphasised that inadequate policy support was a significant barrier for Ghanaian farmers.

Poor agricultural extension services, affecting 11.8% of respondents, rank fifth. Effective extension services are vital for disseminating knowledge, providing technical support, and promoting best practices among farmers. Inadequate extension services mean that farmers may not receive the guidance and support they need to adapt to changing climatic conditions effectively. The importance of extension services is well recognized. This corroborates the study by Faye *et al.* (2010), which identified inadequate extension support as a significant barrier in Senegal. These findings stress the need for investment in extension services to enhance farmers' adaptive capacity.

Traditional and cultural beliefs, impacting 11.1% of respondents, rank sixth. These beliefs can influence farming practices and attitudes towards new technologies and methods. In some cases, adherence to traditional practices may hinder the adoption of more effective adaptation strategies. This aligns with the findings of Simelton *et al.* (2013), who observed similar patterns in Malawi, where traditional beliefs sometimes conflicted with modern agricultural practices. These findings suggest the need for culturally sensitive approaches that integrate traditional knowledge with modern practices.

The scarcity of labour, affecting 8.3% of respondents, ranks seventh. Labour shortages can limit the ability of farmers to implement labour-intensive adaptation practices, such as constructing water conservation structures or diversifying crop varieties. Labour constraints are noted in other regions as well. This is consistent with the study of Bekele and Drake (2003), who found that labour availability was crucial for adopting soil conservation practices in Ethiopia. These findings highlight the potential benefits of mechanisation and labour-saving technologies.

Other constraints, such as land fragmentation, affect a small proportion of respondents (0.1%). Land fragmentation can reduce farm efficiency and complicate the implementation of adaptation strategies that require contiguous land areas, such as irrigation systems or agroforestry. Land fragmentation is a known issue affecting agricultural productivity. This aligns with the findings of Ansoms and McKay (2010), where fragmented landholdings pose difficulties for sustainable agricultural practices. These findings underscore the need for land consolidation initiatives to enhance farm efficiency.





Table 4: Distribution of Smallholder Crop Farmers according to Constraints to Coping with the Effects of Climate Change

Constraints	*Freq.	%	Ranking
Inadequate finance	195	20.4	1 st
High cost of inputs	162	16.9	2 nd
Limited knowledge and information about climate change adaptation	162	16.9	2 nd
Unfavorable government policy	139	14.5	4 th
Poor agricultural extension services	113	11.8	5 th
Traditional and cultural beliefs	106	11.1	6 th
Scarcity of labor	79	8.3	7^{th}
Other (Land fragmentation)	1	0.1	8 th

Source: field survey, * *Multiple responses*

CONCLUSION AND RECOMMENDATIONS

The study reveals a high level of climate change awareness among smallholder crop farmers in Kaduna State, Nigeria. Despite this, significant barriers such as limited resource access, inadequate support systems, and institutional challenges hinder effective adaptation. Based on the findings, the following recommendations were made:

To strengthen the adaptive capacity of smallholder farmers, there must be a concerted effort to enhance their access to essential resources and advanced agricultural technologies. This includes making affordable irrigation systems, drought-resistant crop varieties, and modern farming equipment readily available.

Developing robust institutional frameworks and supportive policies is vital for facilitating climate adaptation among smallholder farmers. Government agencies and relevant stakeholders should implement policies that provide financial support, subsidies, and insurance schemes to protect farmers from climate-induced losses.

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