Research Article

Assessing Climate Change Adaptation Strategies and Challenges in Maize Farming: A Study of Giwa LGA, Kaduna State, Nigeria

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Abstract— This paper assessed adaptation strategies employed by maize farmers and the challenges encountered in implementing adaptation strategies in Giwa Local Government Area (LGA) of   Kaduna State, Nigeria. Purposive sampling was used to select 383 respondents. The instruments used for data collection were self-structured questionnaire titled; Maize Farmers' Perception Questionnaire (MFPQ) and interview guide titled; Maize Farmers' Perception Interview Guide (MFPIG). The instruments were validated for face and content validity by the lead researcher and two other experts in the field of Geography. The reliability of the instruments was determined using the Cronbach Alpha reliability coefficient and the values for MFPQ = 0.76 and MFPIG = 0.82 respectively. The data generated for the study were analysed using frequency counts and simple percentages. The result show that the farmers used multiple adaptation strategies to cope with the effect of climate change. Mixed cropping was ranked 1st, use of chemical fertilizers was ranked 2nd and early planting was ranked 3rd. However, these measures are constrained by inadequate access to water resources for irrigation farming (35%), inadequate knowledge on climate change adaptation strategies (28%) and financial constraint (13%). The study recommended targeted interventions such as improved irrigation systems, enhanced extension services, and access to climate-resilient maize varieties to strengthen farmers' adaptive capacity.

Keywords— Adaptation Strategies; Barriers; Climate Change; Maize farming; Mixed cropping and Constraint

1. Introduction

Climate change poses one of the greatest threats to global agriculture, particularly in sub-Saharan Africa, where livelihoods are predominantly rain-fed [1]. Variability in rainfall patterns, increasing temperatures and prolonged droughts makes smallholder farmers vulnerable to the effect of climate change [2]. Climate change involves many dimensions – science, economics, society, politics, moral and ethical questions – and is a global problem, felt on local scales, that will be around for thousands of years [3]. [1] reported that climate change is affecting nature, people's lives and infrastructure everywhere. Its dangerous and pervasive impacts are increasingly evident in every region of our world. These impacts are hindering efforts to meet basic human needs and they threaten sustainable development across the globe.

Climate change affects the rain-fed agriculture in which many of the population depend. Crop loses their viability, and the farmers lose their income source. The reason for crop yield decline may be due to inter-annual variation. The annual variation of weather parameters, particularly in northern Nigeria, is large, often resulting in climate hazards, especially

floods and droughts with devastating effects on food production and associated calamities and sufferings [4]. Despite the great potential of Nigeria in crop production, the frequent occurrence of drought occasioned by erratic rainfall distribution and cessation of rain during the growing season is the greatest hindrance to increasing production and this is more serious in the northern part of the country where most of the grains are produced [5].

Climate change adaptation is the process of adjusting to the effects of climate change. These can be both current and expected impact [1]. Adaptation aims to moderate or avoid harm for people, and is usually done alongside climate change mitigation. It also aims to exploit opportunities. Humans may also intervene to help adjust for natural systems. There are many adaptation strategies or options in the agricultural sector [3]. They can help manage impacts and risks to people and nature. The four types of adaptation actions are infrastructural, institutional, behavioural and nature-based options. The goal of adaptation is to reduce our risks from the harmful effects of climate change (like sea-level rise, more intense extreme weather events, or food insecurity). It also includes making the most of any potential beneficial opportunities associated with climate change (for example, longer growing seasons or increased yields in some regions).

The need for adaptation varies from place to place. Different regions must adapt differently because they each face particular sets of climate risks [6]. For instance, arid areas could focus on water scarcity solutions, land restoration and heat management. The needs for adaptation will also depend on how much the climate changes or is expected to change, which is different from place to place. Adaptation is important in developing countries because they are most vulnerable to climate change [7]. Adaptation needs are high for food, water and other sectors important for economic output, jobs and incomes. One of the challenges is to prioritize the needs of communities, including the poorest, to help ensure they are not disproportionately affected by climate change. While maize farmers adopt viable strategies in coping with the numerous effects of climate change, the farmers are faced with challenges in implementing the strategies [2].

Maize is a staple crop in Nigeria. It is highly susceptible to climatic changes. Giwa Local Government Area (LGA), a major maize-producing area in Kaduna State, experiences erratic rainfall and prolonged dry seasons, threatening food security and farmer livelihoods [8]. The need for effective adaptation strategies is critical to sustain maize farming amidst such challenges. This study evaluates the adaptation strategies adopted by maize farmers in Giwa LGA and examines the challenges to their implementation. By understanding these dynamics, the study seeks to contribute to policy and practice aimed at improving agricultural resilience in the area.

Maize production in Nigeria mainly depends on climatic conditions and its yield depends on rainfall availability in terms of amount and distribution [4]. Maize is grown under divergent physical condition. The variability of rainfall pattern in Nigeria is responsible for the gradual changing of the planting date of maize. According to International Institute for Tropical Agriculture [9], maize requires considerable amount of moisture of about 500-750 mm of well-distributed rainfall conducive for proper growth. Maize requires more moisture during reproductive period and less moisture when developing towards maturity [2]. Its area of cultivation has extended into the drier zones of Nigeria because of the introduction of drought resistant early maturing varieties [10].

Maize is one of the important grains in Nigeria. It is a multipurpose crop in which every part of it has great economic value. The grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food products. Studies by [11] on maize production in different parts of Nigeria has shown an increasing importance of the crop amidst growing utilization by food processing industries and livestock feed mills in Nigeria. The demand for maize is increasing daily, because it is a major staple food for human and animals. Despite the economic importance of maize, it has not been produced in such quantity that could meet food and industrial needs of the country, and this could be attributed to low productivity due to lack of improved technologies for maize production [12]. One of the major limitations to maize production in Nigeria is the rainfall variability which is exacerbated by climate change [4]. In view of the demand for maize, Nigeria and international bodies such as Food and Agriculture Organization [13] have developed interest in promoting maize production for households food security and poverty alleviation.

1.1 Objectives of the Study

This study attempts to assess the adaptation strategies adopted by maize farmers and the challenges encountered in implementing these strategies in Giwa LGA of Kaduna State.

1.2 Research Questions

Based on the objectives of the study, the following research questions were formulated.
1. What are the socio-economic characteristics of maize farmers in the area?
2. What are the adaptation strategies adopted by the maize farmers?
3. What are the barriers to climate change adaptation in the area?

2. Related Work

[2] researched on the effect of climate change on the yield of selected crops and farmers adaptation strategies in Sokoto, Nigeria. Maize is an important source of carbohydrate, protein, iron, vitamin B and minerals. It is a staple food for the masses and provides dry season feed for farm animals. The result showed a positive relationship between total annual rainfall and the yield of maize. Adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including volatile short-term changes in local and large-scale markets. The result further showed that as a way of coping with the effect of climate change, the farmers used several adaptation strategies such as organic manure, chemical fertilizer and use of improved seed varieties.

[14] worked on the relationship between rainfall variability and maize yield in Benue State, Nigeria. The result showed that rainfall variability affects the yield of maize in the area. Maize yield increases as rainfall amount increases. Adaptation strategies is necessary to enable the farmers to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages; and to take advantage of new opportunities.

[15] in their study, the impact of rainfall variability on maize yield in Gusau station, Zamfara State, Nigeria showed that rainfall variability showed a positive relationship with the yield of maize. the study recommended the use of high and early maturing cultivars, fertilizer and organic manure management, crop rotation to reduce pests attack which will play a major role in improving the productivity of maize in the study area.

3. Theory

Study Area

Giwa LGA is located between Latitudes 10° 50' 00" N and 11° 30' 00" N of the Equator and Longitude 7° 05' 00" E and 7° 40' 00"E of the Greenwich Meridian (see Figure 1). The LGA

is found in Kaduna State, north-western Nigeria. It is bounded in the North by Funtua and Malumfashi LGAs of Katsina State and on the west and south by Birnin Gwari and Igabi LGAs of Kaduna State respectively [16]. The climate of the area is generally tropical continental (tropical wet and dry) represented by Aw based on Koppen's classification. The general pattern of rain is mainly affected by two principal air masses which are Tropical Continental (cT) and Tropical Maritime (mT) air masses. The mean annual rainfall is about 1,100mm. The area records maximum temperature of up to 30°C. The lowest mean temperature (18°C – 23°C). The major source of economic activity in this area is agriculture where crop production and animal rearing are undertaken by small farmers and Fulani herdsmen respectively [17].
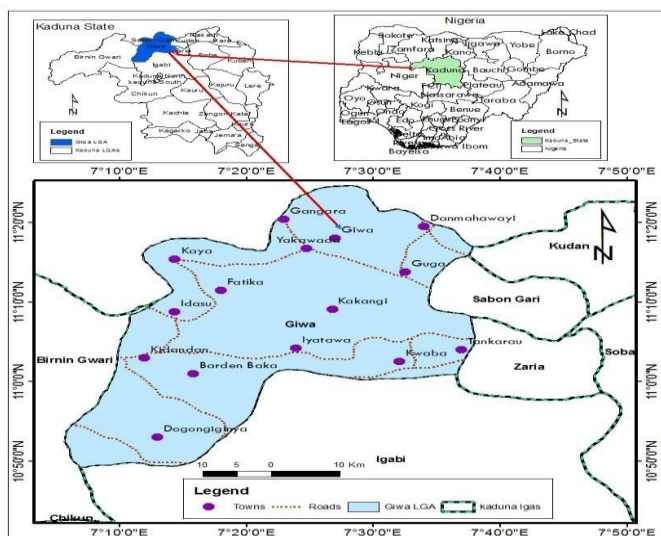

Figure 1: The Study Area
Source: Modified from Administrative Map of Kaduna State 2024

4. Methodology

Purposive sampling was used to select 383 respondents. Maize farmers above twenty (20) years of age and who must have lived in the study area for at least ten (10) years were identified through the "Sarkin Noma" (Head of the Farmers) and the village Heads. The reason for this decision was that those within the age bracket had the information needed about climate change in the area. The instruments used for data collection were self-structured questionnaire titled; Maize Farmers' Perception Questionnaire (MFPQ) and interview guide titled; Maize Farmers' Perception Interview Guide (MFPIG). The instruments were validated for face and content validity by the lead researcher and two other experts in the field of Geography. The reliability of the instruments was determined using the Crombatch Alpha reliability coefficient and the values for MFPQ = 0.76 and MFPIG = 0.82 respectively. The data generated for the study were analysed using frequency counts, simple percentages and charts.

5. Results and Discussion

The gender distribution of the respondents is presented in Table 1. The results show that 299 respondents (78%) are male, while 84 (22%) are female. The percentages indicate the

proportion of each gender within the total sample. Males represent a significantly larger portion of the respondents compared to females, with a difference of 56%. Farmers above 20 years were purposively selected for the study. The result on the age of the farmers show that 30% of the farmers are within the ages of 20 – 29 years; 28% 30 – 39; 20% 40 – 49 years and 14% are between 50 – 59 years, only 3% are above the age of 70.

Table 1: Socio-demographic of the maize farmers

Variables	Respondents	Percentage
Gender of the Farmers		
Male	299	78
Female	84	22
Total	**383**	**100**
Age of the Farmers		
20 – 29 years	114	30
30 – 39 years	109	28
40 – 49 years	78	20
50 – 59 years	50	14
60 – 69 years	19	5
70 >	13	3
Total	**383**	**100**
Duration of Residency in the Area		
Less than 10 years	50	13
11 – 20	144	38
21 – 30	101	49
31 >	88	
Total	**383**	**100**
Level of Awareness of Climate Change		
Yes	367	96
No	16	4
Total	383	100
Sources of Information on Climate Change		
Radio	108	28
Personal observation	137	36
Interaction with other farmers	61	16
All of the above	77	20
Total	**383**	**100**

Source: Author's Field Survey, June 2024

The results show that 13% of the respondents have lived in the study area for less than 20 years; 38% have lived between 21-30 years, and 49% have lived in the study area for over 31 years and above. This distribution indicates that a significant portion of respondents have lived in the study area for more than 30 years comprising nearly half (49%) of the sample. Those residing for 21-30 years represent a substantial portion (38%), while those with less than 20 years of residency are the smallest group (13%). The high percentage of respondents with 31 years or more of residency that most of the respondents have dwelled within the study area for a longer time and thus have noticed the change in Climate over the years. The result of the farmer's level of awareness of climate change shows that the majority of the farmers (95.8%) are aware of climate change; 4.2% are not aware of the existence of climate change in the study area. The high level of awareness among the respondents suggests that they are likely to be more informed about climate change and its consequences in the study area.
The sources of information on climate change in the study

area are presented in Table 4.4. The results reveal that the respondents' primary sources of information about climate change are a combination of personal observation, media (radio and news), and interactions among farmers.

The results show that 28% (108 respondents) got their information about climate change from the radio; 36% got their information from personal observation; 16% got their information from interacting with friends and 20% got their information from all of the above sources (radio, personal observation and interacting with friends and researchers. [18] noted that suggested adaptation strategies may be completely new to a community or they may simply be an improvement on what the community is already familiar with. Essentially, adaptation strategies are procedures that can engender or enhance socio-economic wellbeing of societies. There are several adaptation strategies that can be adopted in addressing crop failures in the semi-arid region of Nigeria. Farmers in Giwa LGA use different adaptation strategies such as the use of organic manure, chemical fertilizer, early planting of seeds, crop rotation among others.

Table 2: Adaptation Strategies among maize farmers

Adaptation Strategies	Frequency	Percentage	Ranking
Use of organic manure	27	7	4
Use of chemical fertilizer	101	26	2
Early Planting of seeds	37	10	3
Irrigation and fadama farming	12	3	5
Crop Rotation System	8	2	6
Mixed Cropping	198	52	1
Total	**383**	**100**	

Source: Author's Field Survey, June 2024

Based on the data presented in Table 2, mixed cropping as reported by 52% of the respondents. The second most effective adaptation strategy is the use of chemical fertilizers as reported by 26% of the respondents. Early planting is the third most effective adaptation strategy used by 10% of the respondents. Other adaptation strategies, such as organic manure (7%); irrigation and Fadama system of farming (3%) and crop rotation system (2%) are used by smaller proportions of the respondents. The predominance of mixed cropping as the most effective adaptation strategy suggests that diversifying crop production is a key approach used by farmers to build resilience and adapt to the impacts of climate change in the study area. That mixed cropping adaptation strategies ranked first agree with the study of [2] which stated that majority of the farmers in Goronyo LGA of Sokoto State, Nigeria adapt to climate change through mixed cropping system. The result also agrees with the finding of [19] which noted that mixed cropping, crop diversification and different planting dates are main farm-level adaptation strategies in Southern Africa. Results from the interview agrees with the analysed ranking of the adaptation strategies where farmers of the study area emphasized that mixed cropping is farmers' friendly because of its numerous benefits of multiple harvest, crop security and the extra sources of income it provides to the farmers.

The challenges of climate change adaptation strategies in the study area are presented in Table 3. The results show that lack of access to water for irrigation is a major challenge to climate change adaptation strategies in the area (35%); inadequate knowledge on climate change adaptation strategies was ranked 2nd (28%); Lack of information on adaptation strategies (14%); inadequate access to improved seed varieties was ranked 5th (9%). This suggests that the availability of suitable maize varieties for adaptation may not be a significant constraint compared to other factors. Financial constraints (13%) was ranked 4th as the most pressing challenges to climate change adaptation strategies to farmers. The high cost of fertilizers, seeds, and other inputs prevents farmers from adopting more effective strategies. Limited access to credit further exacerbates this issue. That inadequate access to water for irrigation is the major challenges to adaptation strategies corroborated with the findings of [20] which reported that lack of access to water for irrigation is a challenge to farmers in Sokoto State.

Table 3: Challenge of Climate Change Adaptation Strategies

Challenges	Frequency	Percentage	Ranking
Inadequate knowledge on adaptations	108	28	2
Inadequate access to improved seed varieties	36	9	5
Inadequate access to water for irrigation	135	35	1
Inadequate access to information on climate change adaptation strategies	53	14	3
Financial Constraint	51	13	4
Total	**383**	**100**	

Source: Author's Field Survey, June 2024

6. Conclusion and Future Scope

This study has assessed climate change adaptation strategies and challenges in maize farming among farmers in Giwa LGA. The reviewed literature confirmed that climate change affect maize yield. The study has established that farmers in the area have shown remarkable adaptability to climate change by employing strategies like mixed cropping and the use of chemical fertilizer. However, the effectiveness of these measures is constrained by inadequate access to water for irrigation, knowledge gaps and financial limitations. Strengthening institutional support and providing access to resources are critical for sustaining maize farming in the area.

Based on the findings of the study, the following recommendations are made:
i.   Improve irrigation infrastructure: Investments in small-scale irrigation systems and water conservation techniques are essential to reduce reliance on rainfall.
ii. Enhance agricultural extension services: provide tailored training programmes to educate farmers on advanced farming practices and climate-resilient technologies.
iii. Promote access to financial support: establish credit schemes and subsidies to facilitate the purchase of fertilizers, improved seeds, and farming tools.
iv. Develop and distribute climate-resilient maize varieties: research institutions should focus on drought-tolerant and

heat-resistant seeds to ensure consistent yields amidst climatic variability.

There is need to embark on further research in the following areas: analysis of rainfall trend and its relationship with sorghum yield and farmers' adaptation strategies. Adaptation is very important in a study that shows the vulnerability of agriculture to the impact of climate variability.

Data Availability
The data collected from the maize farmers via the administration of questionnaire and interview were succinctly analysed and discussed in the paper and related works were properly acknowledged and referenced. The work was limited to maize farmers in Giwa LGA.

Conflict of Interest
The authors have not declared any conflict of interests.

Authors' Contributions
1. Samuel Isaac: Researched literature and conceived the study
2. Ikpe Elisha: Data analysis and drafting of the article

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