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ASSESSMENT OF CLIMATE CHANGE ADAPTIVE CAPACITIES OF GRAIN CROP FARMERS IN SOBA LOCAL GOVERNMENT AREA, KADUNA STATE, NIGERIA

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ABSTRACT

This research aimed to assess the climate change adaptive capacities of grain crop farmers in Soba Local Government Area of Kaduna State. A total of 375 copies of a questionnaire were administered to maize and rice farmers in eleven selected communities (one in each of the 11 wards) of the area. Descriptive statistics was used to analyze the respondents' socioeconomic characteristics, while a five-point Likert scale was used to analyze the respondents' adaptive capacities. The results revealed that most respondents (78%) were male and married (82.5%). Of the 11 communities sampled, only 27% have high adaptive capacities. Maigana has the highest rank in terms of adaptive capacity, with a mean score of 3.68, whereas Ung. Gamagira has the lowest, with a mean of 2.32. A climate change policy on poverty reduction is recommended to enhance rural adaptive capacities. Such policies should streamline roles and responsibilities, strategies for adaptation and mitigation of climate change, and stakeholders' involvement systematically, and awareness programs should be intensified to educate people on the recent changes in climate as a process of enhancing people's adaptive capacities.

Keywords: adaptive capacities, climate change, Communities, Crop production, impact

1 Introduction

Climate change, particularly its influence on temperature, rainfall patterns, and extreme weather events, poses significant challenges to agriculture. Nigeria's climate has been notably variable since the late 1960s, with recurrent floods, droughts, and ocean surges affecting agricultural output (NiMet, 2017). This variability is especially concerning for grain crop farming in northern Nigeria, where crops like wheat, corn, and millet, central to food security and income, are susceptible to these climatic changes.

In Kaduna State, specifically Soba LGA, grain farming is a cornerstone of the local economy, providing sustenance, employment, and income for the rural population. However, the increasing frequency and intensity of climate-related events threaten the sustainability of grain production. Although several studies have examined the impacts of climate change on agriculture in northern Nigeria (Abaje and Giwa, 2010), there is limited research focused on the adaptive capacities of grain farmers in Soba LGA. Understanding the specific adaptation strategies available to these farmers and their effectiveness in mitigating climate risks is crucial for enhancing food security and sustaining livelihoods in the region.

This study aims to assess the adaptive capacities of grain crop farmers in selected communities within Soba LGA. By identifying the challenges and opportunities for adaptation, this research seeks to provide insights into how farmers can better cope with the effects of climate change, thereby contributing to ongoing efforts to strengthen climate resilience in northern Nigeria.

2 Lıterature Revıew

Climate change is often characterized by long-term shifts in weather patterns that significantly impact ecosystems and societies (Akpodiogaga & Odjugo, 2010). However, public perception and societal judgments also influence how climate change is understood and addressed, as these factors shape communication strategies and community adaptation efforts (Rahmstorf et al., 2009). Effective climate adaptation hinges on the concept of adaptive capacity**,** which refers to the ability of a system—whether a community, sector, or region—to adjust to climate variability, mitigate damages, and exploit opportunities (Pelling & High, 2005). Determinants of adaptive capacity include access to economic resources, technology, skills, infrastructure, and the ability to mobilize information (Smit & Wandel, 2006). In regions with limited resources, such as rural areas of Nigeria, enhancing adaptive capacity is critical for reducing vulnerability to climate impacts (Abaje et al., 2015).

Numerous studies have examined adaptive capacities in Nigerian agricultural contexts, particularly in Kaduna State. For instance, Murtala and Abaje (2018) explored how climate variability affects cowpea yields, while Atiyong, Abaje, and Abdulkarim (2018) focused on rainfall variability and ginger production in Jaba Local Government Area. Both studies highlight how crop yields in the region are closely linked to climate patterns, reinforcing the importance of adaptive strategies in agricultural production.

In a broader context, Abaje et al. (2015) assessed the adaptive capacities of rural communities across six Local Government Areas (LGAs) in Kaduna State, including Soba. The findings indicate a north-south gradient in adaptive capacity, with communities in the northern part of the state, where rainfall is more erratic, showing lower adaptive capacities than those in the southern areas. This is particularly relevant for grain farming in Soba LGA, where rain-fed agriculture is predominant and more susceptible to climate-induced changes in rainfall and temperature.

Building on these studies, this research seeks to assess the adaptive capacities of grain farmers in Soba LGA. Unlike earlier work on cowpea and ginger, this study specifically addresses the challenges grain farmers face, whose crops (such as rice and maize) are susceptible to climatic changes. By focusing on this key agricultural sector, the study will contribute to a more comprehensive understanding of adaptation in Kaduna State.

3 Materıals and Methods

3.1 Description of Study Area

Soba Local Government Area (Fig. 1) was created in 1989 by the Former Military Administration headed by General Ibrahim Babangida (Rtd). It was carved out of Zaria L.G.A. By 1991, however, Soba L.G.A. was reduced in size with the creation of Sabon Gari LGA. Presently, Soba L.G.A comprises of two districts, Soba and Maigana districts, with Maigana as the administrative headquarters (Ibrahim, 2004). The Local Government covers approximately 2,955sq km and is located on Latitude 10°58'52.79"N and Longitude 8° 03' 26.96" E. It is bounded by Makarfi L.G.A to the North, Sabon Gari and Zaria L.G.As to the North-West, Igabi LGA to the South-West, Kauru LGA to the South, Kubau LGA to the East and Ikara LGA to the North-East respectively (Ibrahim, 2004).

The area is designated as Koppen’s Aw climate, with two distinct seasons: a wet season in summer and a dry season in winter. Rainfall occurs between April and October, peaking in August (Abaje and Oladipo, 2019). The natural vegetation of the study area is the northern Guinea savanna, which consists of a vast expanse of short grasses and scattered strands of shrubby plants about 1.2m in height (Abaje, 2007).

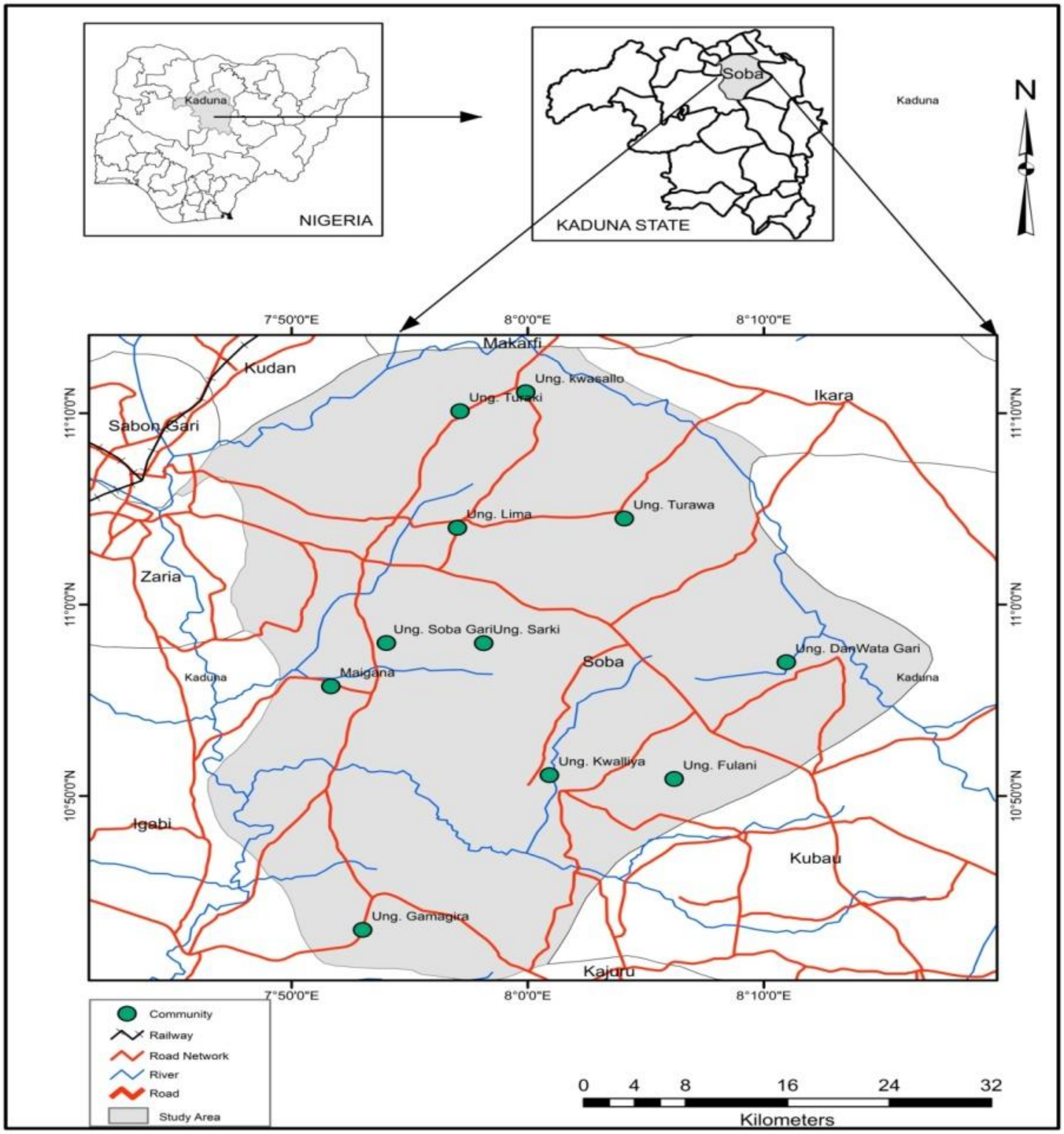

Figure 1: Study Area
Source: Adapted from Kaduna State Ministry of Lands and Survey (2022)

3.2 Data Collection

The population of grain crop (maize and rice) farmers was obtained from the Kaduna State Agricultural Development Agency (KADA). The data shows that the estimated numbers of maize and rice farmers are 180,000 and 105,000, respectively, with the total being 285,000. This information was used to arrive at proportional estimates of the farmers' population in various localities using the 1991 Census. According to the 1991 Census, the population of Soba LGA was 174,217 (with 11 wards and 211 communities), with an annual growth rate of 2.8% (NPC, 1991). The basis for using the 1991 population instead of the 2006 population [(291,173) (NPC, 2009)] is because the 2006 census had no locality population. To project this population to 2020, Mehta's (2004) method of population projection was employed. This method is calculated as:

$$P_n = P_o\,(1+R/100)^n \quad \ldots\ldots \text{(Eq. 1)}$$

Where: R = annual rate of growth

P_n = population in the current year

P_0 = population in the base year

n = number of intermediary years

Hence, the population of Soba LGA was projected to be approximately 398,957 as of 2020. The total population of the sampled communities was calculated to be 5.4% of the entire population. This value was used to estimate the number of grain crop farmers in the selected communities from the population data obtained from KADA, as shown in Table 1. The communities were chosen randomly.

Table 1: Population of the Sampled Communities

S/NO	Community	1991 population	Projected Population (2020)	Estimated number of farmers
1	Ung. Danwata Gari	2,233	5,133	3,680
2	Ung. Gamagira	2,100	4,809	3,462
3	Ung. Turawa	607	1,390	1,001
4	Ung. Kwasallo	341	781	562
5	Ung. Turaki	125	286	206
6	Ung. Sarki	402	921	663
7	Ung. Soba Gari	863	1,976	1,422
8	Ung. Liman	875	2,004	1,442
9	Ung. Kwalliya	895	2,049	1,475
10	Ung. Fulani	550	1,260	908
11	Maigana	345	790	569
	TOTAL	9,336	21,379	15,390

Source: NPC, 1991.

To determine the sample size required for the questionnaire survey, the Krejcie and Morgan (1970) method was adopted. The formula is given as:

$$s = X^2 NP(1-P) \div d^2 (N-1) + X^2 P(1-P) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Eq. 2)}$$

where: s = sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size.

P = the population proportion (assumed to be .50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

Based on this method, the recommended sample size for a population of 15,390, at 95% confidence level and a margin of error of 5%, would be 375. A sample size of 375 persons was used, and a proportional distribution of respondents, as shown in Table 2, was adopted for the communities.

Table 2: Sampled Communities and Proportion of Respondents

S/NO	Selected Communities	Estimated number of farmers	Proportional Distribution of Respondents	Proportion of Maize Farmers	Proportion of Rice Farmers
1.	Ung. Danwata Gari	3,680	90	57	33
2	Ung. Gamagira	3,462	84	53	31
3.	Ung. Turawa	1,001	24	15	9
4.	Ung. Kwasallo	562	14	9	5
5.	Ung. Turaki	206	5	3	2
6.	Ung. Sarki	663	16	10	6
7.	Ung. Soba Gari	1,422	35	22	13
8.	Ung. Liman	1,442	35	22	13
9.	Ung. Kwalliya	1,475	36	22	14
10.	Ung. Fulani	908	22	14	8
11.	Maigana	569	14	9	5
	TOTAL	15,390	375	236	139

Source: Field survey (2023)

Data and information for this research were obtained from a field study based on 375 questionnaires administered to grain farmers in 11 communities of Soba LGA of Kaduna State. A snowball approach was adopted for the research. The snowball sampling approach helped reach a representative sample of grain farmers by leveraging local networks where initial participants recommend others involved in farming, ensuring the inclusion of those who may not be easily accessible through random sampling. To minimize biases, care was taken to diversify the initial contacts and ensure they represent different community segments, such as farm size, gender, or geographic location. Eleven research assistants (each representing a community) were trained to conduct the interviews. The questionnaires were purposively administered to grain crop farmers aged 41 years and above to ensure that the respondents had sufficient long-term farming experience. This age group was selected because they are more likely to have witnessed and adapted to climate variability over time, making them better positioned to provide insights into the impacts of climate change on grain crop production and the adaptive strategies employed. Their knowledge and awareness of changes in farming conditions make their perspectives particularly valuable for assessing adaptive capacities. Only respondents who were willing and interested on the subject matter were purposively administered questionnaires. The respondents were selected based on their experience and participation in grain crop production. In addition, a Focus Group Discussion (FGD) of eleven people (one representative from each of the 11 communities) was also held to obtain in-depth information on recent environmental changes, changes in grain crop production, and and communities' adaptive capacity. A Key Informant Interview was also conducted to get relevant information from key informants.

3.3 Data Analysis

To assess the adaptive capacity of the farmers, the major indices influencing rural peoples' adaptive capacity were considered as employed by Deressa, Hassan, and Ringler (2008) and Gbetibouo, Ringler and Hassan (2010) that climate change adaptive capacity depends on five livelihood assets: wealth, farm inputs, availability of infrastructures and institutions, irrigation potentials, and literacy level. These five indices were selected because they are significant indicators of the adaptive capacity of the communities to climate change in the study area, on which data can be obtained using a questionnaire. In the same vein, these indicators are the most cited in several studies (for example, Moss, Brenkert and Malone, (2001); Cutter, Boruff and Shirley, (2003); Fothergill and Peek, (2004); O'Brien et al, (2004); Adger et al, (2004); Deressa et al, (2008); Cutter et al, (2009); Gbetibouo et al, (2010) as well as Abaje et al, (2015) of rural communities' adaptive capacity to climate change. A five-point Likert Scale was then used (5=strongly agree, 4=agree, 3=undecided, 2=disagree, and 1=strongly disagree) to assess the adaptive capacity of the grain crop farmers. This is found in section E of the questionnaire. The adaptive capacity (AC) of each community was therefore calculated as:

$$AC = \frac{W+FI+AII+IP+LL}{5} \qquad \text{(Eq. 3)}$$

where: W = wealth
FI = farm inputs
AII = availability of infrastructure and institutions
IP = irrigation potentials
LL = literacy level

Using the interval scale of 0.50, the upper cut-off point was determined as 3.00 + 0.50 = 3.50; the lower limit was 3.00 – 0.50 = 2.50. Table 3 shows the modified classification of the adaptive capacity.

Table 3: Classification of Adaptive Capacity

Mean Score	Level of Adaptive Capacity
0.00 – 2.49	Low adaptive capacity
2.50 – 3.49	Moderate adaptive capacity
3.50 – 5.00	High adaptive capacity

Source: Adopted from Abaje *et al. (*2015).

Explanation of Indices

1. Wealth (W): Wealth refers to the economic resources available to the farmers, which influence their ability to adapt to climate change. Data was gathered on factors such as the size of landholdings, ownership of livestock, access to credit, and the types of assets owned (e.g., machinery, vehicles). Wealthier farmers generally have more resources to invest in adaptive measures such as improved seeds, irrigation systems, or fertilizers. *Example*: Farmers were asked if they had access to agricultural credit facilities. Responses were rated using the Likert scale, with "strongly agree" indicating high access to credit (higher adaptive capacity) and "strongly disagree" indicating no access (lower adaptive capacity).
2. Farm Inputs (FI): Farm inputs include access to seeds, fertilizers, pesticides, and other agricultural materials needed for farming. This index measures how readily farmers can obtain these essential resources, which are crucial for productivity and resilience in the face of climate variability. *Example*: Farmers were asked to rate their access to high-quality seeds and fertilizers. A "strongly agree" response indicates easy access to these inputs, whereas "strongly disagree" indicates limited or no access.
3. Availability of Infrastructures and Institutions (AII): This index assesses the presence of essential infrastructure (e.g., roads, markets, storage facilities) and supportive institutions (e.g., agricultural extension services, cooperative societies). Well-developed infrastructure and substantial institutional support help farmers adapt to climate change by improving market access and providing information and resources. *Example*: Questions included whether farmers could access good roads to transport their produce to markets. A response of "agree" or "strongly agree" indicates good infrastructure and, thus, a higher adaptive capacity.
4. Irrigation Potentials (IP): Irrigation potentials refer to the availability and use of irrigation facilities. This is particularly important in areas where rainfall patterns have become unpredictable, and irrigation can be a key adaptive strategy to cope with droughts or variable rainfall. *Example*: Farmers were asked if they had access to irrigation facilities or water sources. A "strongly agree" response would suggest that the farmer can irrigate their crops during dry spells, reflecting higher adaptive capacity.
5. Literacy Level (LL): Literacy level measures farmers' educational backgrounds. Higher levels of literacy often correlate with better access to climate information, more effective use of technology, and an increased ability to adopt innovative practices. *Example*: Farmers were asked about their educational attainment. A "strongly agree" response might indicate that the respondent completed secondary or tertiary education, showing a higher adaptive capacity due to their ability to process and use new information.

To assess adaptive capacity, a five-point Likert scale was used:

- **5** = Strongly Agree
- **4** = Agree
- **3** = Undecided
- **2** = Disagree
- **1** = Strongly Disagree

Each farmer's response was tallied for the five indices (Wealth, Farm Inputs, Availability of Infrastructure and Institutions, Irrigation

Potentials, and Literacy Level). The final adaptive capacity for each farmer and community was calculated using Equation 3 above. For example, if a farmer gave the following responses:

- Wealth: 4 (Agree)
- Farm Inputs: 3 (Undecided)
- Infrastructure/Institutions: 5 (Strongly Agree)
- Irrigation Potentials: 2 (Disagree)
- Literacy Level: 4 (Agree)

The adaptive capacity would be calculated as:

$$AC = \frac{4+3+5+2+4}{5} = \frac{18}{5} = 3.6$$

Since the value 3.6 is above 3.5, this would indicate a high adaptive capacity. The calculated result of the people's adaptive capacity to changing climatic conditions was used to rank the studied communities in the LGA based on their adaptive capacities.

4 Results and Discussion

4.1 Socioeconomic Characteristics of the Respondents

Out of the 384 questionnaires administered, 78% of the respondents were male, while 22% were female. This gender distribution aligns with previous studies, such as those by Ishaya and Abaje (2008) and Abaje, Sawa, and Ati (2014), which found that men in rural Nigeria predominantly carry out agricultural work and adaptation activities. The age distribution shows that 45.3% of the respondents were between 40-45 years old, making this the most represented age group, followed by 35.2% who were between 46-50 years. These age groups are likely to be actively engaged in farming, suggesting that the participants are predominantly in their prime working years. 11.3% were between 51 and 60, while the remaining 8.2% were 61 and above.

Regarding marital status, 82.5% were married, which could indicate that household responsibilities, including farming, are shared between spouses. Educational attainment data reveals that 55% of respondents had only Islamic education, and 4.9% had no formal education. This could suggest limited access to formal agricultural knowledge, affecting their ability to access climate change information. Most respondents (47.4%) earned an annual income of ₦10,000 or less, which places them within the low-income category, further limiting their ability to adapt to climate-related challenges.

Table 4: Socio-Demographic Characteristics of the Respondents

Parameters	Options	Percentages (%)
Gender	Males	78
	Females	22
Age	40-45 years	45.3
	46-50 years	35.2
	51-60 years	11.3
	61 years and above	8.2
Marital Status	Married	82.5
	Single	9.0
	Divorced	3.0
	Widowed	5.5

Source: Data Analysis (2023)

4.2 Adaptive Capacity of the Respondents

Table 4 presents the adaptive capacities of the respondents across various communities. The adaptive capacity was assessed based on five key indices: wealth, farm inputs, availability of infrastructure and institutions, irrigation potential, and literacy level. Communities were ranked accordingly.

4.2.1 Wealth as an Index of Adaptive Capacity

Maigana recorded the highest wealth-related adaptive capacity with a score of **3.98**, followed by Ung. Turawa (**3.92**) and Ung. Kwalliya (**3.90**). Wealthier communities have greater access to resources, which improves their resilience against climate shocks. As wealth provides access to better assets, insurance, and savings, these communities can recover more quickly from climate impacts, which aligns with Cutter et al. (2003) and Abaje et al. (2015) findings. In contrast, Ung. Gamagira, with a wealth score of **2.48**, displayed low adaptive capacity. Factors contributing to this disparity may include lower income levels, less access to assets such as livestock and farming machinery, and fewer opportunities to diversify income streams, all exacerbating vulnerability to climate impacts. The high adaptive capacity in wealth observed in Maigana may also be due to better market access and stronger local economies.

4.2.2 Farm Inputs as an Index of Adaptive Capacity

Maigana again ranked highest regarding access to farm inputs, with a score of **4.01**, followed by Ung. Turawa (**3.83**) and Ung. Kwalliya (**3.70**). These communities have better access to essential farming materials, such as seeds, fertilizers, and pesticides. Proximity to suppliers and stronger farming networks likely contribute to these high scores, as Deressa et al. (2008) noted. In contrast, communities like Ung. Soba Gari (**2.32**) and Ung. Gamagira (**2.23**) recorded the lowest scores. These areas may face challenges in accessing farm inputs, possibly due to poor road networks, higher costs, or less developed agricultural markets, which limits their ability to adapt to climate variability.

4.2.3 Infrastructures and Institutions as Indices of Adaptive Capacity

None of the communities recorded a high adaptive capacity regarding infrastructural and institutional availability. Maigana (**3.19**), Ung. Turawa (**3.16**), and Ung. Sarki (**3.02**) displayed moderate adaptive capacity, likely due to better road networks, access to agricultural extension services, and local credit institutions. However, communities like Ung. Liman (**2.36**), Ung. Kwasallo (**2.34**), and Ung. Gamagira (**2.30**) displayed low adaptive capacity, which could be attributed to inadequate infrastructure such as poor road networks and limited access to financial services. As highlighted by Deressa et al. (2008), the availability of infrastructure significantly influences adaptation methods, and communities with better institutional support are more capable of responding to climate challenges.

4.2.4 Irrigation Potentials as an Index of Adaptive Capacity

Irrigation potential is critical in determining how well communities can cope with droughts or unpredictable rainfall. Maigana (**3.54**) and Ung. Turawa (**3.51**) ranked the highest in this regard, possibly due to proximity to water sources or better-developed irrigation systems. Communities such as Ung. Liman (**2.32**) and Ung. Gamagira (**2.24**) recorded low adaptive capacity, indicating limited access to irrigation facilities, which increases their vulnerability during dry seasons. O'Brien et al. (2004) noted that communities with more irrigable land have a higher capacity to adapt to climate change, which is corroborated by this study.

4.2.5 Literacy Level as an Index of Adaptive Capacity

Literacy levels were highest in Maigana (**3.66**), Ung. Turawa (**3.62**), and Ung. Kwalliya (**3.52**), where a greater proportion of the population had formal education, which improves their access to climate information and adoption of modern agricultural techniques. In contrast, Ung. Soba Gari (**2.47**) and Ung. Gamagira (**2.34**) displayed the lowest literacy levels. As highlighted by Deressa et al. (2008), communities with higher literacy levels have greater adaptive capacity due to their ability to access and interpret climate information, enabling them to make informed decisions.

The overall results show that Maigana consistently ranks highest across all adaptive capacity indices, with a mean score of **3.68**. This is likely due to this community's relatively better wealth, farm inputs, infrastructure, and literacy levels, which all contribute to their ability to adapt to climate change. In contrast, Ung. Gamagira, with a mean score of **2.32**, ranked the lowest in adaptive capacity. The community's limited wealth, low access to farm inputs, poor infrastructure, and low literacy levels contribute to its high vulnerability to climate change impacts.

The findings of this study are consistent with those of Abaje et al. (2015), who found that areas with better wealth, access to farm inputs, infrastructure, and higher literacy levels exhibited higher adaptive capacities. The results also align with the work of Marlin et al. (2007), which found that wealthier communities, such as those in Canada, had higher adaptive capacities due to their greater access to resources.

Table 5: Adaptive Capacity of the Respondents

	Adaptive Capacity Variables	Communities										
		Ung. Danwata Gari	Ung. Gamagira	Ung. Turawa	Ung. Kwasallo	Ung. Turaki	Ung. Sarki	Ung. Soba Gari	Ung. Liman	Ung. Kwalliya	Ung. Fulani	Maigana
a	Wealth consideration as indices of adaptive capacity to climate change	2.60	2.48	3.92	2.62	3.22	3.18	2.81	2.65	3.90	2.83	3.98
b	Farm inputs consideration as indices of adaptive capacity to climate change	2.25	2.23	3.83	2.26	3.45	3.33	2.32	2.28	3.70	3.23	4.01
c	Infrastructural and institutional availability as indices of adaptive capacity to climate change	2.31	2.30	3.16	2.34	2.82	3.02	2.55	2.36	2.97	2.60	3.19
d	Irrigation potentials as indices of adaptive capacity to climate change	2.29	2.24	3.51	2.30	2.98	3.16	2.14	2.32	3.41	3.16	3.54
e	Literacy level consideration as indices of adaptive capacity to climate change	2.35	2.34	3.62	2.37	3.00	3.27	2.47	2.39	3.52	3.24	3.66
Mean		**2.36**	**2.32**	**3.61**	**2.39**	**3.09**	**3.19**	**2.46**	**2.40**	**3.50**	**3.01**	**3.68**
Rank		**10**	**11**	**2**	**9**	**5**	**4**	**7**	**8**	**3**	**6**	**1**

Note: 0.00 – 2.49 = Low adaptive capacity
2.50 – 3.49 = Moderate adaptive capacity
3.50 – 5.00 = High adaptive capacity

Source: Data Analysis (2023)

5 Conclusion and Recommendations

5.1 Conclusion

Based on the findings of this research, it is concluded that farmers in the study area, Soba LGA of Kaduna State, are significantly vulnerable to the impacts of climate change. Their adaptive capacity across various livelihood assets—such as wealth, farm inputs, availability of infrastructure, irrigation potentials, and literacy levels—is generally low, especially in communities like Ung. Gamagira. This lack of adaptive capacity means farmers are ill-equipped to cope with increasing temperatures, erratic rainfall, and other climate-related challenges. Consequently, these vulnerabilities will persist without intervention, further exacerbating the negative impacts of climate change on agriculture and rural livelihoods in the area.

5.2 Recommendations

1. Strengthen Research on Climate Change and Adaptation Strategies: The government and academic institutions should intensify efforts to conduct targeted research on the specific challenges farmers face in adapting to climate change. This research should explore current conditions, project future climate scenarios, and assess their impacts on farming systems. Particular attention should be given to how grain crop farming, which dominates this region, will be affected by ongoing climatic changes.

2. Improve Infrastructure in Rural Communities: One of the key findings is the lack of adequate infrastructure, which hampers the adaptive capacity of communities. The government should prioritize the development of rural infrastructure, such as:

i. Improved road networks: Enhancing access to markets and agricultural input suppliers would improve farm productivity and reduce post-harvest losses.

ii. Reliable electricity and water supply: Providing rural areas with a consistent power supply and access to irrigation water would significantly enhance the resilience of farming systems, especially in drought-prone regions.

iii. Healthcare and veterinary services: Strengthening healthcare and animal husbandry support will reduce vulnerabilities in the agricultural sector by ensuring that humans and livestock remain healthy, even in challenging climatic conditions.

3. Enhance Climate Awareness Programs: Awareness campaigns should be rolled out, educating farmers about climate change, emerging climate patterns, and appropriate adaptation techniques. Specific institutions that should take the lead include:

i. Agricultural Extension services can directly support farmers, share knowledge about climate-smart agricultural practices, and facilitate access to improved technologies.

ii. Local Government Authorities (LGAs): Local government should coordinate with national climate agencies to disseminate timely and accurate weather forecasts, ensuring that farmers are well-prepared for changing conditions.

iii. Non-Governmental Organizations (NGOs): NGOs working in rural development and agricultural sustainability can also raise awareness and train communities in climate adaptation strategies.

4. Promote Access to Climate-Resilient Farm Inputs: The availability of farm inputs such as drought-resistant seeds, fertilisers, and pesticides was critical in determining adaptive capacity. Programs should be developed to make these inputs affordable and accessible, particularly in low-capacity communities like Ung. Gamagira. This could involve subsidising climate-resilient crop

varieties or establishing community-based input supply centres.

5. Future Research Opportunities: This study has limitations, including its focus on grain crops and a limited sample size restricted to Soba LGA. Future research could:

i. Expand the sample size to include other LGAs and examine variations in adaptive capacity across a broader region.

ii. Explore other types of crops in addition to grains, such as legumes or root crops, which may have different adaptive requirements.

iii. Investigate gender dynamics more deeply, as male dominance in farming activities may mask the essential contributions of women, especially in post-harvest and small-scale adaptation efforts.

By addressing these areas, future research can offer deeper insights into the complex factors influencing farmers' adaptive capacities, ultimately contributing to more effective climate change adaptation strategies.

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