

Farmer's Climate Change Adaptation Strategies and Perception of Their Effectiveness in Maradi State, Niger Republic

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Abstract

This study investigates the climate change adaptation strategies employed by farmers in Maradi State, Niger, and their perceptions of the strategies' effectiveness. A multistage random sampling procedure was used to select 400 respondents. Data were collected using questionnaire and interview schedules. The data were analyzed using mean scores, Likert-type rating scales, and Chi-Square Tests. The findings indicate that the most common adaptation measures among respondents include the use of fertilizer, crop rotation, and crop diversification. Farmers perceive these adopted strategies as positive, with crop rotation, fertilizer use, and changes in planting dates being considered very significant. Based on these findings, the study recommends that reliable weather information be effectively communicated to farmers through precise channels. Additionally, high-yielding and early-maturing crop varieties should be made available to farmers at subsidized rates and in a timely manner. The study also recommends that governmental and non-governmental organizations should provide easily accessible soft loans to farmers in the study areas.

Keywords: Climate change, Adaptation, Variability, Maradi, Farmer, and strategies

Introduction

Climate change impacts are becoming more intense and frequent on the sub-Saharan Africa (SSA). This is reinforcing poverty, affecting more than 40% of region's 360 million people (Trisos *et al.*, 2022). Several studies have reported severe consequences of climate change extreme events on the agriculture sector, which is the main source of livelihood for many people in sub-Saharan Africa (Ficchi *et al.*, 2021, Humphries *et al.*, 2020). The observed impacts of climate change on yields of most widely produced crops in sub-Saharan Africa (millet, maize, sorghum and rice) have been reported by many studies (Atiah *et al.*, 2022; Amouzou *et al.*, 2019, FAO, 2018). This is because the key livelihood depends on rainfall, as nearly 80% of agriculture land and crop production in this part of the world were rainfed (Gérardeaux *et al.*, 2018).

Niger has experienced an average of one flood per year and one drought every three years over the past two decades (Gao & Mills, 2021). Droughts and floods pose the most significant threat to agriculture in the country. In 2022, Floods and droughts disrupted agricultural production and resulted in the highest number of food-insecure people in the last eight years (Food and Agriculture Organization [FAO], 2022). Agriculture, primarily rainfed, is the most significant livelihood sector in Niger. The sector (including livestock and crop farming) employs about 80% of the population and contributes over 43% to the country's GDP (Ado *et al.*, 2019, 2020). Agriculture is primarily rainfed and subsistence, with less than one per cent of arable land irrigated (Potsdam Institute and GIZ 2021). Furthermore, socio-economic factors influence farmers' decisions for adopting particular strategies. For instance, farmers who have wider land are able to adopt more strategies and have more opportunities to improve their income (Belay *et al.*, 2017). In addition, farmers' cohesion is a key factor related to the social and cultural dimensions (Adger *et al.*, 2013). Similar

experiences in dealing with the local phenomena (Turasih & Kolopaking, 2016) contribute to the efforts of improving their prosperity and quality of life (Adger et al., 2013).

On one hand, increasing flooding due to climate change destroys and inundates crops and kills livestock. In 2020, Niger faced one of the largest floods in its history which submerged over 3,082 hectares of irrigated land (World Bank, 2022). Again in 2021, similar flooding following torrential rains submerged as much as 6000 hectares of cultivated land and killed over space 10,000 livestock (UN Office for the Coordination of Humanitarian Affairs [OCHA], 2021) additionally, in the global perspectives the united nation and global community have jointly work over issues of sustainability this also a contributions from the effort to recognize public services' innovation in achieving the Sustainable Development Goals through the Department of Economic and Social Affairs (UN DESA, 2017).

Flooding is mainly a challenge in the southern part of the country (World Bank, 2021). Thus, the importance of adaptation strategies for farmers who depend largely on agriculture as means of livelihood becomes an absolute priority.

In order to reduce the negative effects of climate change and variability on agriculture-food system, farmers must adapt economic viable strategies that have positive effects on their farming operations. Adaptation to climate change and variability is a process that initially demands farmers to think that the climate has changed and then identify the possible adaptation measure to be implemented.

Description of Study Area

The study was carried out in Maradi State, Niger¹. Maradi State is located in the south-central Niger Republic, specifically within the department of Madarumfa, between 13° and 15° 26' north latitude and 6° 16' and 8° 36' east longitude². It lies approximately 650km east of the capital, Niamey, along National Highway No.1, and is about 45km from the Republic of Nigeria³. The town of Maradi is bordered to the north by the urban municipality of Tibiri, to the west by the rural municipalities of Sarkin Yamma and Safo, and to the east by the rural municipality of Djiratawa (Arma, 2012).

The region's topography is primarily a flat, sandy plain with elevations ranging from 300 to 500 meters (1,000 to 1,650 feet), characterized by isolated sandstone bluffs. This relief significantly impacts agricultural practices and the area's susceptibility to flooding. The Goulbi river, a seasonal watercourse originating from Nigeria, is vital for irrigation but also contributes to flooding during

the rainy season, causing substantial damage to infrastructure and agriculture (Babaye et al, 2023).

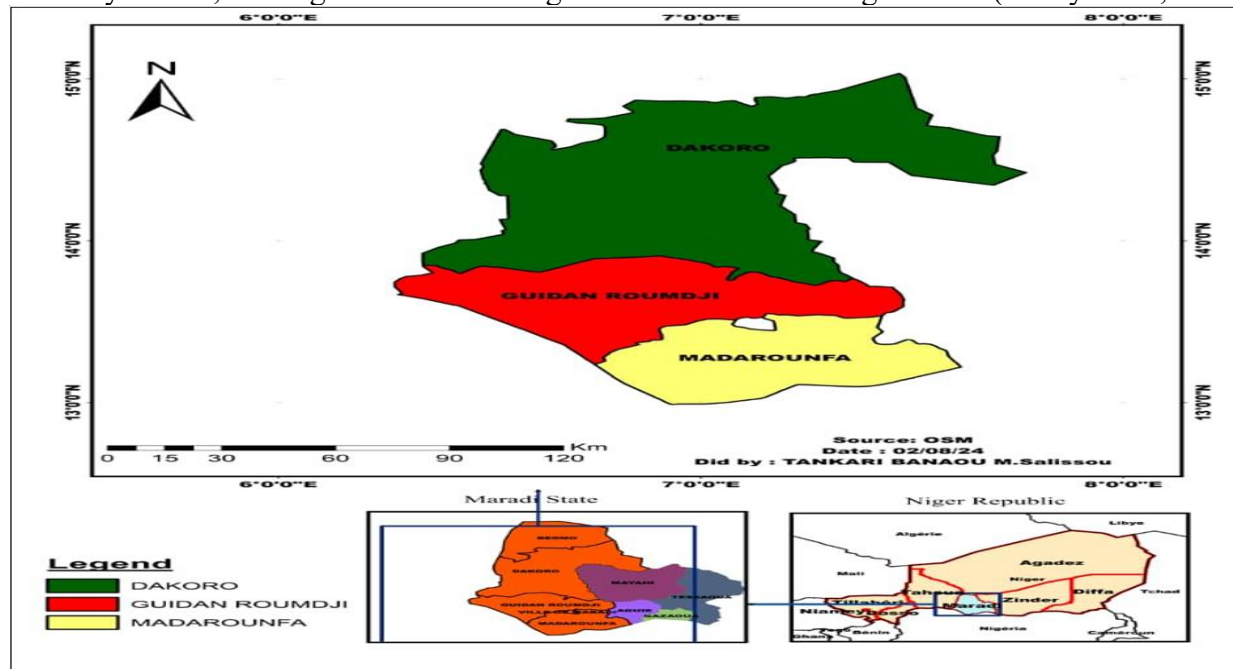


Figure 1: Map of the study area

Source: An Extract from technical services solutions

Northern Maradi experiences annual rainfall of less than 300 mm (12 inches), marking the limit for non-irrigated cultivation. The more fertile southern parts support crops like peanuts and cotton, while the drier northern areas focus on millet and sorghum (Diouldé, 2014). Flooding is a persistent problem, with significant events in recent years leading to widespread agricultural damage and affecting thousands of households (Babaye *et al*, 2023). After floods in 1945, the city's design was altered from traditional layouts to a grid system to mitigate future risks.

Maradi experiences a north-south rainfall gradient, ranging from 200 mm to 750 mm. In the extreme southern part, normal annual rainfall is between 600–700 mm, and the rainy season lasts 3 to 4 months. Mean temperatures fluctuate from 23.5 °C to 32.7 °C in April/May. Relative humidity peaks at nearly 100% in August, which is also the rainiest month, and drops to below 10% between December and March when atmospheric temperatures are lowest (Moussa, 2011). The soils in Maradi are predominantly sandy and vary in fertility. Northern Saharan soils are generally infertile, except in oases. The southern part, with better rainfall (200-400 mm annually), has more fertile soils suitable for agriculture, where crops such as peanuts, cassava, and cotton are grown. Drier northern areas, in contrast, focus on less lucrative crops like millet and sorghum, alongside livestock farming (Ibrahim Musa Abdelsam, Xu Shinwei & Yu Wen, 2013).

Like the rest of Niger, Maradi's economy heavily relies on the primary sector, mainly agriculture and livestock, which engage over 90% of the industry's assets. However, trade is a prominent activity in Maradi town, employing about 79.5% of the working population. Among women, trade accounts for 92.1% of their modern activities. Dynamic activities like crafts and rural exodus (for men) also contribute significantly to the local economy, particularly in tanning, despite these sectors being informal and unorganized (Trading Company of Niger, 2009).

Methodology

The study used both qualitative and quantitative research designs with data being collected through interview and questionnaires. The study randomly selected three Local Government Areas (LGAs) in Maradi State based on their agriculture output. The LGAs selected were Madarunfa, Dakoro and Gidan Roundji. To determine the sample size, which also determine the number of questionnaires to be administered, the Yamane formular (1967) was adopted. Therefore, a sample size of 400 was derived from the study's population of 12000 at 95% confidence level and 5% sampling error assumption.

Table 1: Sample size table in the study are

S/No	LGAs	No of Farmers	Sample size (%)
1	Madarunfa	5000	$(5000 \times 400 / 12000) = 167$
2	Dakora	4000	$(4000 \times 400 / 12000) = 133$
3	Gidan Roundii	3000	$(3000 \times 400 / 12000) = 100$
Total		12000	400

A structured and close-ended questionnaire were used in the field to obtain information for the study.

The assessment of the socio-economic characteristics of farmers in the study area was achieved using descriptive statistics like frequency distribution, percentages and mean.

The examination of the level of knowledge of farmers on climate change was achieved by using descriptive statistics: 3-point Likert scale being used in this regard. These points were:

- Highly Knowledgeable (HK) = 3
- Moderately Knowledgeable (MK) = 2
- Less Knowledgeable (LK) = 1

The decision rule was based on bench mean score obtained by adding $3+2+1 = 6/3$ to get 2.0

Any value above ≥ 2.0 implies that the respondent is highly knowledgeable to climate change and variability. any value that is less than < 2.0 will be classify Not knowledgeable.

The adaptation strategies their perception on the effectiveness of the strategies were assessed through descriptive statistic to determine numbers and types of adaptation strategies adopted by respondents using four-point Likert scale as can be shown below:

- Very effective (VE) = 4
- Effective (E) = 3
- Fairly effective (FE) = 2
- Not effective (NE) = 1

Statement whose means score is ≥ 3.0 will be classify as significant while statement with less than < 3.0 is consider not significant. The decision rule was based on bench mark mean score of adding $4+3+2+1=10/4$ to get 3, any value equal to or above 3.0 implies that the adaptation strategies is effective while value less than 3.0 implies that the adaptation strategies is not effective.

Results of the Findings

Perception of Climate Change

Table 2 illustrates farmers' perceptions of climate change in Maradi State, Niger Republic.

Table 2: Perception of Climate Change

	Perception of Climate Variability	Agree	Neutral	Disagree	Average Score
1	Rainfall patterns in my area have become less predictable.	287	53	41	2.646
2	Temperature has increased in recent years.	262	86	33	2.601
3	Droughts and floods are more frequent now than before.	224	116	41	2.480
4	Climate variability has made it harder for me to plan my farming activities.	269	66	46	2.585
5	I am worried about the long-term effects of climate change on farming.	311	39	31	2.735

An average score of 2.646 for "Rainfall patterns in my area have become less predictable" indicates that most farmers acknowledge the reduced predictability of rainfall, making farming activity planning difficult. For "Temperature has increased in recent years," the average score was 2.601, suggesting farmers perceive a rise in temperatures, which could negatively affect crop yields and the farming environment.

"Droughts and floods are more frequent now than before" received an average score of 2.480, implying that many farmers believe extreme weather events have become more common, disrupting farming by damaging crops, reducing water availability, and causing soil degradation. The statement "Climate variability has made it harder for me to plan my farming activities" scored 2.585, highlighting that farmers feel climate variability impacts their planning ability, making farming less predictable and riskier. The highest average score of 2.735 was for "I am worried about the long-term effects of climate change on farming," reflecting significant concern among farmers about future climate change impacts on their livelihoods.

Climate Change Adaptation Strategies

Table 3 presents the climate change adaptation strategies adopted by farmers in Maradi State, Niger Republic.

Table 3: Climate Change Adaptation Strategies

Adaptation Measures	Frequency	Percentage (%)
Crop diversification	153	40.16
Use of pesticides	95	24.93
Half-moon	57	14.96
Crop rotation	191	50.13
Agroforestry	133	34.91
Use of fertilizer	210	55.12
Changing planting dates	172	45.14
Irrigation with motor pump	95	24.93
Other	19	4.99

The most common adaptation measure is the use of fertilizer, adopted by 55.12% of farmers, indicating a priority for enhancing soil fertility to maintain or increase crop productivity amidst climate change challenges. Crop rotation is also widely used by 50.13% of farmers, reflecting efforts to improve soil health and prevent pest infestations. Changing planting dates (45.14%) and crop diversification (40.16%) are significant strategies, showing farmers' adjustments to unpredictable rainfall patterns and extreme weather events.

Agroforestry, adopted by 34.91%, highlights efforts to enhance resilience through sustainable land management. However, the lower adoption rates for half-moon techniques (14.96%) and irrigation with motor pumps (24.93%) suggest potential barriers such as limited access to resources, knowledge, or labor. Pesticide use, adopted by 24.93%, emphasizes the need for pest and disease control, often exacerbated by climate change. A small percentage (4.99%) reported using other methods, indicating that innovative or less common practices are not widely adopted.

Farmers in Maradi State primarily rely on strategies that improve soil fertility and agricultural productivity, such as fertilizer use, crop rotation, and crop diversification, as these are relatively easy to implement and provide immediate benefits. Adjustments to planting dates also show awareness of changing climatic patterns. However, the lower adoption of techniques like half-moon and motor pump irrigation points to challenges in scaling these practices due to knowledge, tools, or investment requirements. Moderate adoption of agroforestry indicates an understanding of its long-term benefits, but further promotion of this sustainable practice is needed.

Effectiveness of Climate Change Adaptation Strategies

Table 4 presents farmers' perceptions of the effectiveness of different climate change adaptation strategies in Maradi State, Niger Republic.

Table 4: Effectiveness of Climate Change Adaptation Strategies

Adaptation Measures	Very effective	Fairly effective	Not effective	Average Score
Crop diversification	174	121	86	2.231
Use of pesticides	107	69	205	1.743
Half-moon	98	104	179	1.787
Crop rotation	192	144	45	2.386
Agroforestry	142	131	108	2.089
Use of fertilizer	261	73	47	2.562
Changing planting dates	283	67	31	2.661
Irrigation with motor pump	309	53	19	2.761

Irrigation with motor pumps is considered the most effective strategy, with an average score of 2.761, indicating its perceived effectiveness in addressing water shortages due to unpredictable rainfall. Changing planting dates (2.661) and the use of fertilizer (2.562) also scored highly, suggesting their effectiveness in adapting to changing weather and improving soil quality and crop yields, respectively.

Strategies rated as fairly effective include crop rotation (2.386) and crop diversification (2.231). Crop rotation helps maintain soil fertility and control pests, while crop diversification spreads risks across multiple crops. Strategies considered less effective include the use of pesticides (1.743) and half-moon techniques (1.787). Pesticides may be less effective due to pest resistance or improper use, and half-moon techniques might not meet expectations for improving crop performance.

Farmers predominantly rely on strategies that offer immediate and visible benefits, such as irrigation, fertilizer use, and adjusting planting dates. While crop rotation offers long-term benefits, it may require additional support to boost adoption. Less effective strategies like pesticides and half-moon techniques may need further education, training, or improvements to become more beneficial for farmers. Promoting highly effective strategies while addressing challenges of less

effective ones can help farmers in Maradi State better adapt to climate change and enhance agricultural productivity.

This study on adaptation strategies to climate change by farmers and the perception of their effectiveness in Maradi State, Niger has shown a vital requirement for adaptation strategies by the farmers particularly on climate change. The results indicate crop diversification, crop rotation, use of fertilizer, changing planting dates and use of pesticides as the major adaptation strategies in the study area. These results can be applicable in the entire regions for better productivity and wellbeing of the people.

Conclusion

This study concerned about the adaptation strategies to climate change, highlights the critical need for farmers in Maradi State, Niger, to adopt effective measures in order to cope with climate change. The findings align with existing knowledge, emphasizing the importance of specific strategies in mitigating the impacts of climate change on agricultural practices. The results presented clearly outline actionable measures for extension workers and farmers, and serve as an important tool for guiding policy makers in their decision-making processes.

Recommendations

Based on the study's findings, the following recommendations are made to foster improved atmospheric conditions and agricultural resilience:

- i. **Reliable Weather Information:** Weather information should be effectively and precisely communicated to farmers through appropriate channels to enable timely and informed decisions.
- ii. **Availability of Improved Crop Varieties:** High-yielding and early-maturing crop varieties should be made available to farmers at subsidized rates and in a timely manner.
- iii. **Access to Soft Loans:** Government and non-governmental organizations should facilitate easy access to soft loans for farmers in the study areas, providing crucial financial support for adaptation initiatives.

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