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SMALLHOLDER FARMERS' ADAPTATION TO DROUGHT IN NORTHERN KATSINA STATE, NIGERIA: A QUALITATIVE APPROACH

*Jabiru Magaji and I.B. Abaje

Department of Geography, Federal University Dutsin-Ma, Katsina State, Nigeria.

*Corresponding Author: j.magaji@fudutsinma.edu.ng, Tel.: 09039732906
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ABSTRACT

The study aimed to assess smallholder farmers' adaptation strategies to drought in the northern part of Katsina. The study used qualitative data obtained from farmers in four Local Government Areas. The objectives of the study are to examine the effects of drought and the adaptation strategies, as well as the constraints to adaptation. Data for the study were collected through Focus Group Discussion (n=28) and Key Informants Interview (n=10). The effects identified by the smallholder farmers were reduced crop yields, total crop failure, hunger, drying of surface and subsurface water, loss of animals, and vegetation. Furthermore, the results showed that smallholder farmers adapt to drought by planting drought-tolerant crops, planting early-maturing crops, practicing multiple cropping, applying manure, engaging in mixed farming, and using insecticides. Others were adjusting the farming calendar, planting economic trees, and switching to other businesses. Constraints to adaptation include limited access to improved crop varieties, credit, extension services, and irrigation water sources. It also consists of a lack of capital, high fertilizer and other farm input costs, and poor governance. It is recommended that smallholder farmers work together to develop sustainable community-based adaptation strategies and to plant economic trees as a livelihood activity. Governmental and nongovernmental organizations should empower farmers to adopt robust methods, such as irrigation, and incorporate their adaptation knowledge into the national drought plan.

Keywords: Adaptation Strategies, Constraints, Crops, Drought, Impacts, Rainfall

INTRODUCTION

Globally, droughts have occurred in the past and will continue to occur in the future since they are a normal part of the climate (Wilhite, 2011). This is true in all regions, but the arid and semi-arid regions of the world are the most vulnerable. Drought has been a recurring event in Africa since the 1960s. Gautam (2006) reported that drought accounts for 8% of natural disasters globally. It accounts for 25% of the natural disasters that occurred in Africa between 1960 and 2006. This makes Africa the region with the highest drought frequency between 1960 and 2006, with 382 reported events (Gautam, 2006). In recent years, drought frequency has fluctuated in West Africa since 2002 (Henchiri et al., 2020).

Furthermore, climate change is expected to increase the frequency, duration, and severity of droughts worldwide (Asadi, Zarch, Sivakumar, and Sharma, 2014). Ajayi and Ilori (2020) warned that areas north of 12°N in West Africa will be a hotspot for mildly and moderately dry events, while the southern part of West Africa will experience pronounced severe and extreme dry events. Nigeria, like other countries of the West African Sahel region, is threatened by drought events. Although drought occurs over the whole country, the northern part is more vulnerable to threats of drought (Federal Republic of Nigeria (FRN), 2018). The northern regions, especially north of latitude 12°N, have been affected by droughts in a continuum since the scourge of the 1970s (Oladipo, 1993b). Areas severely affected by these drought events include those adjacent to the Niger Republic (Abubakar & Yamusa, 2013) and around Sokoto, Zamfara, Katsina, Kano, Jigawa, Yobe, and Borno States (FRN, 2018).

Drought affects a substantial portion of the global population, with approximately 630 million people living in arid and semi-arid areas (Ngaira, 2004) and who rely on rain-fed smallholder farming for their livelihoods (Ribot, 1996). About one-third of people in Africa live in drought-prone areas and are vulnerable to drought impacts (Bates, Kundzewicz, Wu, and Palutikof, 2008). Over the past four decades, droughts have affected about 326 million people in Africa (Gautam, 2006). About 60% of the population in Sub-Saharan Africa is vulnerable to drought, whilst another 30% is regarded as highly vulnerable (Ngaka, 2012). In 1986, approximately 185 million people living in the dryland areas of Africa were at risk, and 30 million were immediately threatened (Dinar & Keck, 2000).

Agriculture is usually the first economic sector to be affected by drought because soil moisture supplies are often quickly depleted (Wilhite, 2000). Rain-fed agriculture is particularly at risk from drought. However, irrigated agriculture also experiences significant impacts when drought conditions persist over a long period, reducing available water supplies from both surface and groundwater sources (Sivakumar, Wilhite, Svoboda, Hayes, and Motha 2011). During periods of drought and beyond, smallholder farmers often lose their livelihood and investment in agriculture (Muthelo, Owusu-Sekyere and Ogundeji, 2019). Nigeria is highly exposed to drought because the agricultural sector employs about 70% of the total population, and more than 80% of farmers are smallholders (Mgbenka & Mbah, 2016), who are mainly rain-fed (FRN, 2021). During drought years, significant losses occur, including low yields, total crop failure, and animal mortality. Drought conditions are typically severe in the northern regions, particularly those north of latitude 11°N (primarily Sokoto, Zamfara, Katsina, Kano, Jigawa, Yobe, and Borno States) (FRN, 2018; Ati, Aremu, Olatunde, Abaje & Oladipo, 2022). For example, during the 1972/73 drought that affected most of Nigeria, particularly in the northern states, farmers recorded only 10% of the expected yield. 105,876 cattle, 168,918 sheep and goats, 543 donkeys, and 4,422 died, resulting in a 400% increase in food prices (FRN, 2018). It also reduced the agricultural sector's contribution to GDP, especially crop production, from 18% before the 1970s drought to 7.5% after the event (Abubakar & Yamusa, 2013). At the end of the 1987 growing season, a considerable loss was also recorded in parts of northern Nigeria, with about 5 million tonnes of grain valued at over 4 billion Naira lost to drought. In Kano State alone, farmers harvested 56-75 % of the 1986 total harvest (Motimore, 1989).

People living in drought-prone zones employ different adaptation measures to minimise the impact of drought in their areas (Abdulrashid & Yaro, 2020). Several climate-smart solutions (e.g., climate information services, soil-water conservation practices, and rainwater harvesting, among others) are being adopted in West Africa to adapt to and mitigate drought-related risks to natural resources, food, water, and livelihoods (Partey, Zougmore and Ramasamy, 2021).

Several studies were conducted to assess farmers' adaptation to drought in the region. However, these studies mainly focused on farmers in general (Suleiman 2014; Muhammed & Umar 2014; Abubakar et al 2018; Abaje & Magaji, 2022) rather than smallholder farmers who are more vulnerable to the adverse effects of drought due to their socioeconomic characteristics.

Further, while quantitative research is important and has its strengths, there are limited qualitative studies, even though they effectively allow a researcher to deeply evaluate people’s perceptions by analysing stories and narratives rather than numbers (Quandt, 2022; Michael, 2024a and b). Most of the previous studies on farmers’ adaptation to climate change and weather extremes, including drought in the arid and semiarid regions of Sub-Saharan Africa, are highly quantitative (see Muhammed and Umar 2014; Abubakar et al 2018; Abaje and Magaji 2022; Gidey et al., 2023; Abaje, 2023). The limited qualitative studies focus on policy makers rather than the farmers (Gana 2019; Gana, 2022), or focus on gender, hence only a handful of studies consider the voices of smallholder farmers (Dayour et al., 2014; Birhanu et al., 2017; Kamara, Agho and Renzaho, 2019; Chipatu & Kumbwa, 2021; Hawkins et al., 2022; Michael 2024a and b; Mzimela & Moyo, 2025; Bwalya & Mwanza, 2025). Against this background, this paper assesses the effects and adaptation strategies of drought, as well as the constraints to adaptation, through qualitative interviews with smallholder farmers and experts on agricultural adaptation to climate change extremes.

MATERIALS AND METHODS

Study Area

The study area (Figure 1) is located between Latitudes 12°25'00" and 13°20'32" N and Longitudes 6°59'20" to 9°02'50" E. It shares a border with the Republic of Niger to the North, Kano and Jigawa States to the East, Zamfara State to the West, and the central part of the state (Matazu and Danmusa Local Government Areas) to the South (See Figure 1). This area covers the North and Central Senatorial Districts of Katsina State, except for Danmusa Local Government Area, which is excluded due to its climatic characteristics, making 22 Local Government Areas in the zone (James *et al.,* 2018). Case study areas were four LGAs: Charanchi, Kaita, Kusada, and Zango.

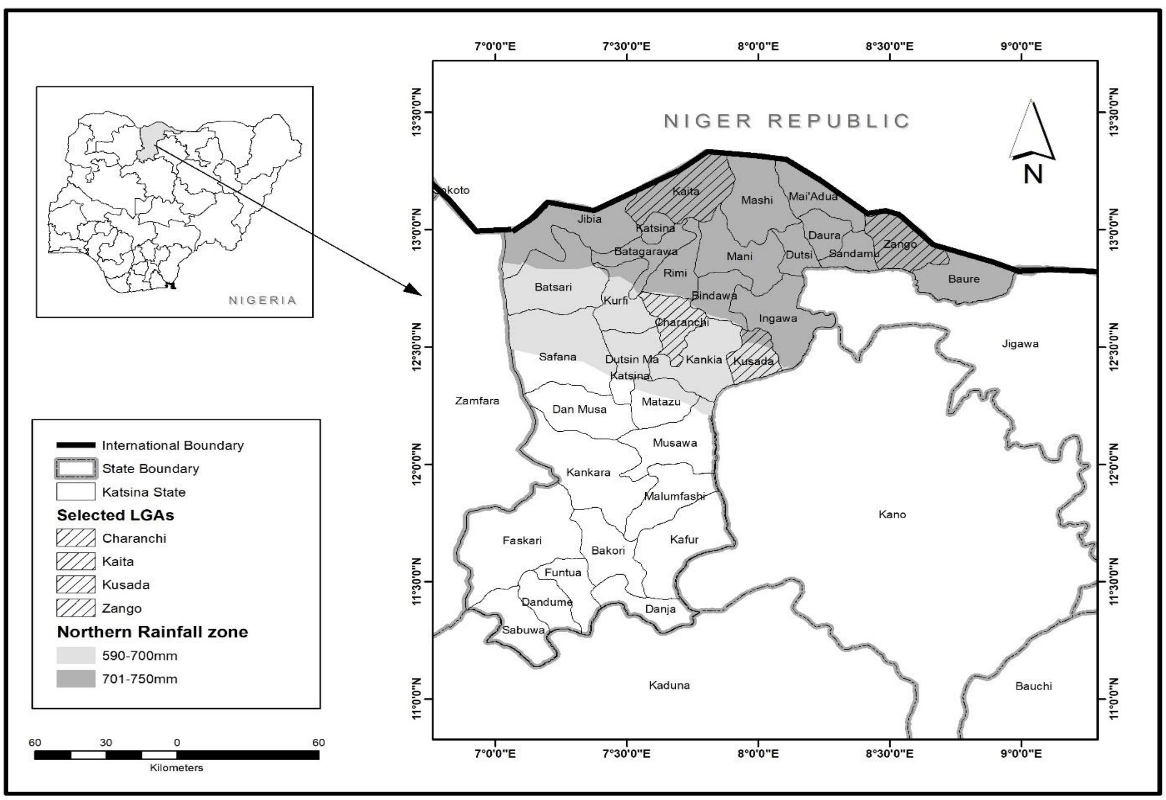

Figure 1: Map of Katsina State showing the Study Area
Source: Adopted from the office of the Surveyor General, Katsina State

The area has a Tropical Continental wet-and-dry climate (Aw) as classified by the Köppen climate classification. It is characterized by a longer dry season and a short rainy season. It receives a mean annual rainfall total of 590–750 mm (James et al., 2018), which falls between June and September, reaching its peak in August. The area has four distinct seasons: a cold and dry season (*Rani*), a hot and dry season (*Bazara*), a wet and warm season (*Damina*), and a warm and dry season (*Kaka*) (Abaje et al., 2012; Magaji, Abaje & Ati, 2025). The temperature is high, with an average annual temperature of about 27°C. Evapotranspiration is high (James et al, 2018). The area is characterized by savannah vegetation, with the extreme northern part of the state having Sahel savannah, while the southern part has Sudan savannah vegetation (Tukur et al., 2013).

Over 70% of people in Katsina State are farmers, especially those in rural areas. They are predominantly subsistence farmers who practice rainfed farming and are therefore more vulnerable to drought. Agriculture in the area constitutes both crop and animal production (Katsina State Government, KTSG, 2016). Crop farming is largely rain-fed and produces both cash and food crops. The cash crops are sesame and groundnut, while the major food crops produced in the area are sorghum, millet, and cowpea. Irrigation farming is also practiced on several irrigation sites distributed all over the area to complement rain-fed agriculture. However, according to their tradition, farmers in the state concentrate on the production of horticultural crops, especially tomatoes, peppers, onions, cabbage, lettuce, and various kinds of melons (KTSG, 2016).

Animal production plays a significant role in the life of the people of Katsina State as it is a secondary source of income for peasant farmers. This involves both extensive and intensive livestock farming. The livestock includes cattle, goats, sheep, and camels. Modern animal production, such as poultry, fisheries, and aquaculture, is also practiced by a few people. However, very few people are engaged in other occupations such as carpentry, blacksmithing, and trading.

Data Collection

Study Design

The study used a qualitative research design to collect data from smallholder farmers through Focus Group Discussions (FGD) and Key Informant Interviews (KII) to understand their perceptions of drought's effects, their adaptation to its impacts, and the constraints to that adaptation.

Sampling Techniques

Multistage sampling was used to collect the study sample. The area spans 22 local government areas in the state. Firstly, the LGAs were clustered into two zones based on average annual rainfall, as identified by James *et al.* (2018). Each of the two identified rainfall zones was further clustered into two based on longitude. In accordance with this, the study area was divided into four (4) clusters. Secondly, random sampling was used to select one (1) LGA from each cluster. Thus, four (4) LGAs, Kusada, Charanchi, Zango, and Kaita, were selected. The basis for this is that the area cut across two different rainfall zones and therefore drought is spatially variable; both the occurrence of and adaptation to meteorological drought also vary.

Finally, purposive sampling was used to choose the target respondents. This is because not all farmers in the area are smallholders. This was achieved by following the official definition of Nigerian smallholders' production capacity, which falls between 0.1 and 4.99 hectares of land holding (National Agriculture and Food Security Strategy (NAFSS), 2010). Based on Anderson, Marita, Musiime and Thiam (2017), two key criteria – landholding size and livestock count— were used as the starting point for identifying the target group for sample selection. Self-identifying perception questions were asked to ensure that each smallholder household selected for the study viewed agriculture as a meaningful part of the household's livelihood, income, and/or consumption.

Focus Group Discussions

FGDs were conducted to gather information on the impacts of and adaptation strategies to drought, as well as the constraints to the adaptation. Four FGDs were held, one in each of the selected LGAs. Each FGD had seven (7) participants who were chosen purposively based on their knowledge, experience, and leadership role. Participants were selected from the qualified population using random sampling in each LGA. The FGD took the form of an unstructured interview guided by a checklist of a few open-ended questions on the subject matter. During the interview, the participants were given the freedom to express and exchange their opinions and views on the subject matter. Table 1 shows the number of FGD participants and the venues of the interview.

Table 1: Focus Group Discussion Participants

S/NO	LGA	Number of participants	Venues
1	Charanchi	7	Ward head residence, Farin Ruwa
2	Kaita	7	Village head palace, Abdallawa
3	Kusada	7	Village head palace, Kofa
4	Zango	7	Village head palace, Makiyawa
Total		**28**	**4 Sessions**

Source: Field Survey, 2024

Key informant interview

Key Informant Interview (KII) is a qualitative data collection method that involves in-depth interviews with selected stakeholders to obtain the necessary knowledge, opinions, perspectives, and ideas on a specific topic. The informants were selected based on their profession, age, experience, and leadership role. The informants may be ordinary people with the required knowledge or professionals with expertise. The objective of selecting these people as informants was to obtain in-depth knowledge of drought occurrences and adaptation in the area. The interview was conducted as an informal, semi-structured interview with a guide that included open-ended questions. Table 2 presents the composition of the KII.

Table 2: Key Informant Interview Participants

S/NO	Participants	Numbers
1	Elderly people	3
2	Traditional rulers	3
3	Experienced farmers	3
4	Extension workers (KTARDA)	3
5	Climate change (IFAD)	3
Total		15

Source: Field Survey, 2024

Data Analysis

The KII and FGD were analysed using a qualitative data analysis method. The audio recordings of the interviews were listened to and replayed several times, and transcribed into text. Subsequently, the transcribed responses were coded according to the study's themes. Then the responses from each theme were interpreted, narrated, and discussed.

RESULTS AND DISCUSSION

This section presents the results of the data collected and analysed, and discusses the major findings of the study.

Effects of Drought

Drought is a devastating climatic hazard with non-structural impacts. Its negative impacts on rainfed farming in developing countries are unequivocal. The results revealed that smallholder farmers in the northern part of Katsina State perceived negative impacts of drought, including reduced crop yields, total crop failure, animal deaths, and vegetation loss. FGDs indicate that, although the frequency and severity of the negative impacts on them, then and now, are undisputable. Reduced crop yield is one of the recognised effects of drought in the study area. A Key Informant from Kaita LGA revealed that:

> *The severity of drought has drastically reduced, and its impacts on our farming have lessened recently compared to years ago. I could remember decades before (not precise, but about 40 years ago) when the negative impacts of drought were very high. There was a time of about 40 days without rain. A field where 40 bundles (dami) of millet is harvested had an output of 1 bundle or less.*

Smallholder farmers identified crop failure as a devastating effect of drought. Another Key Informant from Kaita LGA disclosed that:

> *We had severe and frequent drought years ago, but we thank Almighty Allah that dry years are not experienced these days because of our consistent prayers, which He (Almighty Allah) answered. In the past, 50 to 60 days could pass without any effective rain. The soil would dry, plants would die, and when a fire was set on the farm, it could immediately burn out to ash due to the lack of moisture in the plants. This led to the total crop failure; you could see several farms where nothing was harvested, and the field crops were totally damaged by drought.*

When the yield was reduced or the crops failed, hunger set in. FGDs revealed that farmers in the villages have no food to eat, let alone sale it to the market due to drought-induced low yield.

Surface and subsurface water for irrigation, domestic use, and rearing animals is heavily affected by drought. FGDs and field observation show that during drought years, most of our rivers, ponds, and earth dams dry out. We had to walk a long distance to reach a water body in the area. In the extreme northern part of the study area, where rainfall is very low, groundwater is the primary source of domestic water. Water is generated from a well, and most of these wells dry up in the drought years; only deep wells have water. As a result, people and animals travel several kilometers to obtain a well with water for domestic use and animal drinking.

Plant species suffer during drought because soil moisture is insufficient to support their growth and development. "Not only do crops die during drought, but grasses and shrubs also die. Only some particular tree species can withstand severe droughts, and even some of them cannot grow effectively. As a result, animals suffer from a shortage of food and water and therefore, competition for survival. A participant of the FGD added that:

> *Drought leads to food scarcity and, therefore, a hike in food prices, which in turn leads to hunger. To overcome hunger caused by drought, we eat the leaves of plants such as yadiya, dinkin, and kanya, that is, Leptadenia lancifolia (twining shrub), Diospyros mespiliformis (African ebony), and Celtis integrifolia (African nettle-tree), respectively, and the fruits of wild plants, as they are readily available. We also engage in hunting and eating wild animals, especially birds.*

A FGD participant from Fiwuni community, Zango LGA, said that "the frequency of occurrence of drought has greatly reduced in recent years because of prayers, repentance, and forgiveness that people do". This is consistent with the studies of Abaje et al. (2013), Abaje and Magaji (2022), and Abaje (2023), which show that drought frequency has decreased in recent years. The impacts of drought vary spatially, with less severity in the southern part of the study area, around Kusada, than in the extreme northern part, around Kaita. This may be because the area is in the southern part of the study area and therefore receives more rainfall than other areas, as rainfall decreases northward due to the movement of the ITD. Consequently, the southern part of the study area is less vulnerable to drought. This is supported by the FGD and KII results, which indicate that drought is more severe in the northern part than in the southern part of the study area. A key informant from Kusada said:

> *This place (Kusada) is a transition zone between the northern and southern parts of the state. The drought is more severe in the northern part of the State; it is moderate here and low in the southern part. This is because the incidence begins in the extreme north around Maiadua and continues southward. The frequency of the event is higher in the north and decreases toward the south.*

Adaptation Strategies to Drought

Among the several adaptation strategies, the most widely used in the area are planting drought-resistant crops, planting early-maturing crops, multiple cropping, and application of manure. This agrees with the study of Abaje et al. (2012), Abaje et al. (2013), Abaje and Magaji (2022), and Abaje (2023). In contrast, water harvesting, asset sales, the use of improved storage facilities, and irrigation are rarely used adaptation strategies in the area. Findings also revealed that the majority of crops cultivated in the area are drought-tolerant and can withstand severe dryness. These include millet, sorghum, hibiscus, and sesame beans, among others. A FGD participant said, "If we plant maize here, we are always scared of the drought because it requires high rainfall. Alternatively, we plant crops that tolerate drought, such as millet, sorghum, and groundnut." Similarly, a Key Informant said that:

> *Farmers in Charanchi LGA predominantly plant millet and sorghum. Although maize is a major food crop that they usually consume, it is rarely cultivated here. It is usually brought from the southern part, where rainfall is suitable for its production. Farmers will not stop planting millet here because it resists drought. A millet can withstand a 50-day dry spell in the rainy season. It easily regenerates when the rain resumes normal conditions.*

Smallholder farmers' adoption of these crops may be influenced by their experience of recurrent drought in the area. The findings agree with Abaje et al. (2013), Abubakar *et al*. (2018), Abaje and Magaji (2022), and Abaje (2023). Additionally, it aligns with the fact that drought-tolerant crops are among the major strategies for coping with drought in different parts of the world (Quandt, 2021; Mavhura *et al.,* 2015; Muthelo *et al.,* 2018; Mardy *et al.,* 2018). It was reported that the major crops grown in the area are millet, sorghum, cowpea, and groundnut, among other drought-tolerant crops (Abubakar & Yamusa, 2013).

Planting of early-maturing crops is also common in the area. The adoption of these crops by smallholder farmers in the area may be due to observed erratic and unreliable rainfall and recurrent drought. This strategy will allow them to escape the effects of the short growing season associated with drought (Abubakar & Yamusa, 2013). The participants of the FGD and KII revealed that the crops planted in the area are early-maturing due to frequent drought and the early cessation of rainfall. A key informant from Dambuna Charanchi reported that:

> *The varieties of all crops produced in this area were changed to suit the changing climatic conditions. People are aware that the amount of rainfall and length of the growing season have changed, and therefore, the crop varieties have to change. If the former varieties are planted now, they will fail due to the change in climatic conditions. In fact, we changed all the seed varieties to early-maturing ones suitable for the local climate and soil.*

FGD and KII showed that cowpea (beans) (*wake maifitila*), an early-maturing variety that matures in 40 to 50 days, is planted in Zango LGA. For groundnut, an early maturing variety brought from Tsanyawa, Kano State, called "*Yar Dakar*", replaced the former varieties in Kusada LGA. The early maturing variety of millet, which is short in size (*Danborno)* and matures in about 70 days, replaced the late maturing variety of millet, which is long in size (*Zangoo*) and matures in about 100 days, in Zango LGA. A key informant disclosed that:

> *Even early-maturing varieties of drought-sensitive crops, such as maize, can be cultivated in drought-prone areas. For example, a maize variety that matures in 60 days was introduced by the Kusada LGA. Many farmers are planting it, and the yield is higher than that of the previous variety.*

The maturity duration of such crops varies with latitude, decreasing from south to north. A participant from Burtu in Charanchi LGA said:

> *The maturity of the varieties varies by location due to differences in rainfall. The sorghum variety planted in Kankara cannot be grown in this area because, before it gets mature, the rain will stop. Similarly, our sorghum variety cannot be grown in areas around Mani and Daura in the northern part.*

This may be one of the reasons planting early-maturing crops is less common in Kusada LGA. The result agrees with the study of Abaje and Magaji (2022) and Ibrahim and Abdullahi (2022). It also agrees with the findings of Mavhura et al. (2015), Muthelo et al. (2018), and Quandt (2021) in Zimbabwe, South Africa, and Kenya, respectively.

Multiple cropping is also adopted in the area. Farmers in the area cultivate different varieties to mitigate the risks of low yield or total crop failure caused by drought. This may be in the form of intercropping different types of crops on the same farmland, or different varieties of the same crop on the same or different farmland. The strategy increases soil fertility. A FGD participant from the Rogogo community, Zango LGA, said, "We plant multiple crops on the same or different farms because if we lose one type of crop, we will get the other." Similarly, a key informant in Kaita said that "farmers engage multiple cropping to share risk and exploit opportunities. They often intercrop cereal with legumes, for example, millet with groundnuts or beans. Now, cash crops are intercropped with food crops, for example, hibiscus and millet." The results concur with the previous studies such as Mondal *et al.* (2014), Mavhura *et al.* (2015), Abubakar *et al.* (2018), Quandt (2021), and Abaje and Magaji (2022).

The respondents adopt mixed farming, which involves integrating crop production with animal production. This is a coping strategy that helps share risk, as during drought, farmers respond to crop failure by selling livestock to buy food (Motimore, 1989). A Key Informant said that:

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> *Farmers here mix crop production with animal production and other side businesses. The three activities are interdependent for people in this area; those who combine them are less vulnerable to the uncertainties of rainfed farming. People who leave any of these activities are more vulnerable because, when drought sets in and causes crop failure, they would not have alternative means of livelihood.*

The findings agree with Abaje and Magaji (2022). Animal dung is similarly utilized as organic manure to improve soil fertility and therefore maximize crop yields even amid dryness. The application of manure is also a significant adaptation strategy for drought, which respondents adopted. Smallholder farmers mostly use manure to improve soil fertility. This may be due to the farmers' availability and financial condition, since manure, sometimes freely obtained from animal dung, is used in a mixed farming strategy, as is domestic waste. Additionally, organic fertilizer is too expensive, and most of the smallholder farmers in the area cannot afford it. A participant from the Kabobi community of Kaita LGA said, "*Whoever gets the chance will mix cultivation with the rearing of animals. In addition, our soil is infertile and needs adequate support from farmers. Therefore, we can benefit from mixed farming by getting manure since fertilizer is not affordable*".

The use of insecticides is also a common adaptation strategy to drought among smallholder farmers in northern Katsina. This may be because recurrent dry spells in the area (Umar *et al.,* 2019) provide insects with breeding grounds, as the absence of a moist environment to feed on forces them to feed on plants. However, it may be due to the susceptibility of the genetically modified varieties to pests and diseases. The results agree with Gana *et al.* (2021), who state that insect/pest control is one of the main measures for mitigating the effects of drought.

Planting economic trees, adjusting planting days, and switching to other businesses are relatively important adaptation strategies for drought in the area, whereas cutting off trees, selling assets, and using improved storage facilities and irrigation are not significant adaptation strategies. These strategies were widely used among smallholder farmers across different parts of the world to cope with drought. Tree planting is not widely adopted in the area. A Key Informant from Abdallawa, Kaita LGA, disclosed that:

> *Planting economic trees, such as orchards, is not common here, despite their crucial role in augmenting the loss of income from drought-induced crop failure. People are not aware of the importance of orchard farming, so more effort should be made to educate them. However, pests are seriously affecting the seedlings at their nursery. Farmers do not plant mostly because they occupy arable land, and thus they assume that reducing their land size will reduce the amount of crop they produce. These economic trees are very productive, and much money is generated from orchard farming. In fact, if you plant 100 trees, their output will outnumber that of crops cultivated on that plot.*

This is likely due to smallholder farmers' knowledge of deforestation's contribution to soil erosion and the resultant desertification in the area. A FGD respondent from Kabobi community of Kaita LGA said that "we do not cut trees here; we only trim them. In fact, we take whoever cuts trees as nonsense because it greatly contributed to soil erosion and desert encroachment."

The sale of assets is also a rarely used strategy among smallholder farmers. This may be because it is a responsive strategy adopted during drought to mitigate the severity of its adverse impacts (Mavhura *et al.,* 2015). It is regarded as a regressive strategy (Motimore, 1989). In addition, farmers in the area now engage in tree planting to mitigate desertification and, at the same time, generate a reasonable income from the sale of fruit and wood.

Only 15% of the respondents use improved storage facilities to preserve farm products as a strategy to cope with drought. The least adopted strategy is water harvesting, adopted by only 3.5% of the respondents. This is not unconnected with the fact that smallholder farmers have little knowledge and few resources to acquire water-harvesting facilities. The FGD and KII results showed that farmers store farm produce in traditional sailors, containers, and in their husks.

Constraints to Farmers' Adaptation Strategies to Drought

Although adaptation strategies are crucial for reducing the negative impacts of drought, some constraints hinder their adoption. The study uncovered several constraints to farmers' adaptation to drought, which include a lack of government support, limited access to improved varieties, credit, and extension services. FGDs revealed that a lack of government support is a significant barrier to smallholder farmers' adaptation to drought. Government intervention is not reliable; that is, we do not care more about aid. The aid may not reach us, and even if it comes, it may be late due to bureaucracy. The government is not helping the matter. They do not subsidize farm inputs; fertilizer, insecticides, and improved varieties are expensive. This is in agreement with the findings of Samoura *et al* (2022).

Financial factors are essential in implementing effective drought adaptation strategies. However, smallholder farmers have limited resources to adapt. This could be covered by getting credit or loans from the government and other financial organisations. Unfortunately, smallholder farmers have limited access to credit. FGD participants testify that obtaining a loan for farming from a financial institution is difficult due to strict conditions. At the same time, the government is reluctant to empower the masses, not only farmers. This concurs with Samoura et al (2022) and Yakubu *et al*. (2021).

Extension services play a vital role in guiding farmers on adaptation strategies to reduce the negative impacts of drought on farming practices. However, extension services are limited in developing countries. FGD revealed that extension services are not available, especially in remote areas, as there are no nearby offices and workers rarely visit village communities to provide their services. A key informant disclosed that "the Ministry of Agriculture is short of manpower to offer extension services due to the rapidly growing population of farmers and the stagnant number of extension workers." This is in line with Samoura *et al* (2022) and Yakubu *et al.* (2021), who state that the lack of access to improved varieties is a major constraint to farmers' adaptation to drought.

Planting genetically modified seeds is a widely adopted strategy to increase farmers' resilience to climate change and extreme weather, including drought. FGD participants said that improved, drought-tolerant varieties are not readily available in the area, but are brought in from other areas, such as Kano and Funtua. This also agrees with Yakubu *et al.* (2021) and Samoura *et al.* (2022)

CONCLUSION AND RECOMMENDATIONS

To reduce the effects of drought, smallholder farmers have many adaptation strategies. Smallholder farmers adapt to drought by using drought-tolerant crops, early-maturing crops, multiple cropping, and manure, among other methods. The decrease in drought occurrence has made reactive strategies, such as selling assets, adjusting eating habits, water harvesting, and cutting trees, go unrecognized. Similarly, technical strategies that require finance and technology, such as irrigation and improved storage facilities, are uncommon adaptation strategies in the area.

It is recommended that smallholder farmers work together to develop sustainable community-based adaptation strategies and to plant economic trees as a livelihood activity. Governmental and nongovernmental organizations should empower farmers to adopt robust methods, such as irrigation, and incorporate their adaptation knowledge into the national drought plan.

REFERENCES

Abaje, I. B. & Magaji, J. (2022). Farmers' Perceptions of Drought and Adaptation Strategies in Mashi Local Government Area, Katsina State, Nigeria. *Journal of Meteorology and Climate Science*, 21(1): 54–82.

Abaje, I. B., Ati, O.F. & Iguisi, E.O. (2012). Changing Climatic Scenarios and Strategies for Drought Adaptation and Mitigation in the Sudano- Sahelian Ecological Zone of Nigeria. In: M.A. Iliya and I.M. Dankani, eds. *Climate Change and Sustainable Development in Nigeria.* Ibadan: Crown F. Publishers. Ch.5.

Abaje, I. B., Ati, O.F., Iguisi, E.O. & Jidauna, G.G. (2013). Droughts in the Sudano-Sahelian Ecological Zone of Nigeria: Implications for Agriculture and Water Resources Development. *Global Journal of Human Social Science Geography, Geo-Sciences* & Environmental, 8(2): 1 – 11.

Abaje, I.B. (2023). Geo-Statistical Analysis of Meteorological Drought and Recurrence Intervals in the Context of Climate Change Over Extreme Northeastern Region of Nigeria. *Tanzania Journal of Science,* 49 (1), 152–166. DOI: https://dx.doi.org/10.4314/tjs.v49i1.14

Abdulrashid, A. & Yaro, A. (2020). Coping With Drought: The Role of Wild Food Plants In SemiArid Areas of Katsina State. IIARD *International Journal of Geography and Environmental Management*, 6(1): 1 - 12. Available at www.iiardpub.org

Abubakar, A., Maigari, A. I., Danhassan, S. S., Umar, S. I., Usman, M. K., & Gambo, J. (2018). Smallholder farmers' adaptation strategies to drought in the Sahelian Zone of Jigawa State, Nigeria. *International Journal of Advanced Academic Research*, 4(10), 130-146.

Abubakar, I. U. &. Yamusa, M. A. (2013). Recurrence of Drought in Nigeria: Causes, Effects and Mitigation. *International Journal of Agriculture and Food Science Technology*, 4(3): 169-180. Retrieved from http://www.ripublication.com/ ijafst.html

Ajayi, V.O. and Ilori, O.W., (2020) Projected Drought Events over West Africa Using RCA4 Regional Climate Model. Earth *Systems and Environment*, pp.1-20. https://doi.org/10.1007/s41748-020-00153-x

Alam, K. (2015). Farmers' adaptation to water scarcity in drought-prone environments: A case study of Rajshahi District, Bangladesh. *Agricultural water management*, 148, 196-206.

Asadi Zarch, M. A., Sivakumar B. & Sharma, A. (2014). Droughts in a warming climate: A global assessment of Standardized precipitation index (SPI) and Reconnaissance drought index (RDI). *Journal of Hydrology* 526: 183–195

Ati, O.F., Aremu, K., Olatunde, A.F., Abaje, I.B. & Oladipo, E.O. (2022). Meteorological Drought and Temperature in Sudano-Sahelian Region of Nigeria under Increasing Global Warming. In S.A. Harris (Ed.), *The Nature, Causes, Effects and Mitigation of Climate Change on the Environment*. London: Intechopen Limited. https://doi.org/10.5772/intechopen.94777.

Bates, B. C., Kundzewicz, Z. W., Wu, S. & Palutikof, J.P. (2008).*Climate Change and Water*. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva. https:// www.ipcc.ch/ meetings/session28/doc 13.pdf

Birhanu, Z., Ambelu, A., Berhanu, N., Tesfaye, A. & Woldemichael, K. (2017). Understanding Resilience Dimensions and Adaptive Strategies to the Impact of Recurrent Droughts in Borana Zone, Oromia Region, Ethiopia: A Grounded Theory Approach. International Journal of Environmental Research and Public Health, 2017, 14, 118.

Bwalya, B. & Mwanza, K. (2025). Co-production of knowledge on climate change, its effects, and adaptation measures: A gender-responsive qualitative study of smallholder farmers. PLOS Clim 4(8): e0000531. https://doi.org/10.1371/journal.pclm.0000531.

Caldwell, K. & Boyd, C. P. (2009). Coping and resilience in farming families Affected by drought. The International Journal of Rural and Remote Health and Research, Education and Policy. ISSN 1445-6354.

Chipatu, L., & Kumbwa, M. N. (2021). Drought Coping among the Small-Scale Farmers of Luangwa District in Zambia. *Multidisciplinary Journal of Language and Social Sciences Education (2664-083X, Online ISSN: Print ISSN: 2616-4736)*, *4*(2), 68-75.

Dayour, F., Yendaw, E. and Jasaw, G.S. (2014), "Local residents' perception and adaptation/coping strategies to climate-induced disasters in Bankpama, Wa West District, Ghana", International Journal of Development and Sustainability, Vol. 3 No. 12, pp. 2186-2205.

Dinar, A. & Keck, A., (2000). Water supply variability and drought impact and mitigation in subSaharan Africa. In: Wilhite, D. A. (Ed.), *Drought: A Global Assessment*. Routledge, London.

Federal Republic of Nigeria [FRN] (2018). National Drought Plan (NDP) for Nigeria. Federal Ministry of Environment in partnership with

Federal Republic of Nigeria [FRN] (2021). Nigeria's Adaptation Communication to the United Nations Framework Convention on Climate Change. Federal Ministry of Environment

Gana, A. H., Fullen, M. A., & Oloke, D. (2021). Effects of drought and their mitigation strategies in Yobe State, Nigeria. Sustinere: *Journal of Environment and Sustainability*, 5(3): 184-200.

Gautam, M. (2006). Managing Drought in Sub-Saharan Africa: Policy Perspectives. Paper prepared for an Invited Panel Session on Drought: Economic Consequences and Policies for Mitigation, at the IAAE Conference, Gold Coast, Queensland, Australia, August 12-18, 2006.

Gidey, E., Mhangara, P., Gebregergs, T., Zeweld, W., Gebretsadik, H., Dikinya, O., ... & Birhane, E. (2023). Analysis of drought coping strategies in northern Ethiopian highlands. *SN Applied Sciences*, *5*(7), 195.

Hawkins, P., Geza, W., Mabhaudhi, T., Sutherland, C., Queenan, K., Dangour, A., & Scheelbeek, P. (2022). Dietary and agricultural adaptations to drought among smallholder farmers in South Africa: A qualitative study. *Weather and climate extremes*, *35*, 100413.

Henchiri, M.; Liu, Q., Essifi, B., Javed, T., Zhang, S., Bai, Y. & Zhang, J. (2020). Spatio-Temporal Patterns of Drought and Impact on Vegetation in North and West Africa Based on Multi-Satellite Data. *Remote Sensing*, 13: 4730.

James, G. K., Jega, I. M., Olojo, O. O., Oyewumi, A. S., Salami, V. TT., Adedeji, O. I. & Idris, S. (2018). Geospatial Assessment of Climatic Variability and Aridity in Katsina State, Nigeria. *International Journal of Innovative Science and Research Technology*, 3(12): 615 – 625.

Kamara, J. K. Agho, K. & Renzaho, A. M. N. (2019). Understanding disaster resilience in communities affected by recurrent drought in Lesotho and Swaziland—A qualitative study. PLoSONE 14(3): e0212994. https://doi.org/10.1371/journal.pone.0212994

Katsina State Government, KTSG (2016). *Katsina State Investor's Handbook*. Katsina State Government Printing Press, Katsina.

Lütkemeier, R. & Lieh, S. (2015). Impact of drought on the inhabitants of the Cuvelai watershed: A qualitative exploration. In Andreu et al. (Eds). Drought: Research and Science-Policy Interfacing.

Magaji Jabiru, Abaje, I.B. & Ati, O.F. (2025). Spatio-Temporal Analysis of Rainfall Distribution in the Northern Part of Katsina State, Nigeria. ***Science World Journal***, 20 (1), 89–101. Available online at https://scienceworldjournal.org/index

Mardy, T., Uddin, M. N., Sarker, M. A., Roy, D., & Dunn, E. S. (2018). Assessing coping strategies in response to drought: A micro level study in the north-west region of Bangladesh. *Climate*, *6*(2), 23.

Mavhura, E., Manatsa, D., & Mushore, T. (2015). Adaptation to drought in arid and semi-arid environments: Case of the Zambezi Valley, Zimbabwe. Jàmbá: *Journal of Disaster Risk Studies,* 7(1), 1-7.

Michael TO (2024). Adapting to climate change-induced flooding: insights from women traders in the riverine areas of Nigeria—a qualitative study. Front. Sustain. 5:1385513. doi: 10.3389/frsus.2024.1385513

Michael, T.O. (2024). A Qualitative Exploration of the Influence of Climate Change on Migration of Women in the Riverine Area of Bayelsa State, Nigeria. Social Sciences 13: 89. https://doi.org/10.3390/socsci13020089.

Mitter, H., Obermeier, K. & Schmi, E. (2024). Exploring smallholder farmers' climate change adaptation intentions in Tiruchirappalli District, South India. Agriculture and Human Values (2024) 41:1019–1035.

Mondal, B., Loganandhan, N., & Raizada, A. (2014). Meteorological drought and coping strategies by small and marginal farmers in semi-arid Karnataka. *Indian Journal of Soil Conservation,* 42(1): 54–61.

Mortimore, M. (1989). *Adapting to drought: Farmers, famines and desertification in West Africa*. Cambridge University Press.

Muhammed, S. & Umar, A. (2013). Analysis of Periodic Drought and Adaptive Strategies of Smallholder Farming Communities in Dawakin Tofa and Rimi Drylands of Northwestern Nigeria. *Proceedings of the 1st International Conference on Drylands Bayero University Kano.*

Muthelo, D., Owusu-Sekyere, E. & Ogundeji, A. A. (2019). Smallholder Farmers' Adaptation to Drought: Identifying Effective Adaptive Strategies and Measures. *Water*, 11, 2069.

Mzimela, J. H. & Moyo, I. (2025). An intersectional analysis of the collective efficacy-drought adaptation nexus among small-scale farmers in uMkhanyakude District Municipality, South Africa, Environmental Sociology, DOI:10.1080/23251042.2025.2484480

Ngaira, J. (2004). *Basic facts in contemporary climatology.* Lake publishers and enterprises, Kisumu.

Ngaka, M.J., (2012). 'Drought preparedness, impact and response: A case of the Eastern Cape and Free State provinces of South Africa', Jàmbá: *Journal of Disaster Risk Studies*, 4(1), 1–10, viewed 01 December 2013, from http://jamba.org.za/index.php/jamba/article/view/

Oladipo, E. O. (1993). Some aspects of the spatial characteristics of drought in Northern Nigeria. *Natural Hazards, Netherlands.* 8:171-188

Partey, S. T., Zougmoré, R. B. & Ramasamy, J. (2021). Drought in West Africa. Specal Drought Report: a case study. Global Assessement Report on Disaster Risk Reduction.

Quandt, A. (2021). Coping with drought: Narratives from smallholder farmers in semi-arid Kenya. *International Journal of Disaster Risk Reduction*, 57, 102168.

Quenum, G. M. L. D., Klutse, N. A. B., Dieng, D., Laux, P., Arnault, J., Kodja, J. D. & Oguntunde P. G. (2019). "Identification of potential drought areas in West Africa under climate change and variability." *Earth Systems and Environment* 3 (2019): 429-444.

Ribot, J. (1996). Climate Variability, Climate Change and Vulnerability: Moving Forward by Looking Back. In: Ribot, J.C., Magalhães, A.R. and Panagides, S.S. (eds.) *Climate Variability, Climate Change and Social Vulnerability in the Semi-arid Tropics*. Cambridge: Cambridge University Press.

Samoura, D. A., Wahab, B., Taiwo, O. J., & Bishoge, O. K. (2023). Small-scale farmers' coping strategies to extreme weather events in Upper Guinea. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS),* 124(1), 13-21.

Sivakumar, M. V., Wilhite, D. A., Svoboda, M. D., Hayes, M., & Motha, R. (2011). Drought risk and meteorological droughts. Background paper prepared for the (2011) Global Assessment Report on Disaster Risk Reduction.

Suleiman, U. B. (2014). Farmers' Adaptation Strategies to Drought in Katsina and its Environs. Unpublished M.Sc. Thesis Submitted to the Post Graduate School, Ahmadu Bello University, Zaria, Nigeria.

Tukur, R., Adamu, G. K., Abdulrahid, I., & Rabi'u, M. (2013). Indigenous trees inventory and their multipurpose uses in Dutsin-Ma area, Katsina State. *European Scientific Journal,* 9(11), 288–300.

Usman, S. U., Abdulhamid, S. I., Sawa, B. A., Kibon, A. U., & Yusuf, Y. O. (2014b). An Assessment of Temporal Variability of Drought in Katsina Using Standardized Precipitation Index. BEST: *International Journal of Humanities, Arts, Medicine and Sciences*, 2(7): 33–40.

Wilhite, D. A. (2000). Drought as a Natural Hazard: Concepts and Definitions. In Wilhite, D. A. (Eds). *Drought: A Global Assessment*, 1(1): 3–18 London: Routledge

Wilhite, D. A. (2011). Quantification of Agricultural Drought for Effective Drought Mitigation and Preparedness: Key Issues and Challenges. In Sivakumar, M. B. K., Motha, T. P., Wilhite, D. A. & Wood, D. A. (Eds). *Quantification of Agricultural Drought*. World Meteorological Organization, *Geneva.*