

# USE OF DROUGHT-TOLERANT CROP VARIETIES: A STRATEGY FOR CLIMATE CHANGE ADAPTATION IN NORTHWESTERN NIGERIA

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## Abstract

*Climate change poses significant challenges to agricultural productivity, particularly in arid and semi-arid regions such as Northwestern Nigeria. The increasing frequency and intensity of droughts is expected to threaten food security and livelihoods, hence necessitating adaptive strategies. This review evaluates the potential of drought-resistant crop varieties as a viable strategy for mitigating the adverse effects of climate change in Northwestern Nigeria. A comprehensive literature review was conducted using peer-reviewed journals, books, and reports. The use of drought-resistant crop varieties, such as sorghum, millet, and cowpea, exhibit enhanced water-use efficiency, higher tolerance to heat stress, and improved yields under water-deficient conditions. Their adoption will therefore lead to increased agricultural productivity, food security, and resilience among farming communities in Northwestern Nigeria. The integration of drought-resistant crops into the region's agricultural system presents a sustainable approach to addressing climate-induced challenges. However, the success of this strategy depends on complementary measures such as improved irrigation techniques, farmer education, and supportive policies. It is therefore essential to invest in research, extension services, and seed distribution programs to enhance the accessibility and adoption of drought-resistant crops. Collaboration between agricultural scientists, policymakers, and farmers is highly recommended as essential for optimizing the benefits of these varieties.*

**Keywords:** *Adaptation, climate change, drought-resistance, food security*

## Introduction

Climate change has become a critical global challenge, with significant impacts on agriculture, particularly in regions already prone to arid and semi-arid conditions. Northwestern Nigeria, characterized by its predominantly Sahelian and Sudanian climate, is highly vulnerable to climate variability. Rising temperatures, erratic rainfall patterns, and prolonged droughts have contributed to declining agricultural productivity, threatening food security and rural livelihoods (Abubakar *et al.*, 2022).

The agricultural sector in Northwestern Nigeria is rainfed, making it highly sensitive to fluctuations in precipitation (Olayide *et al.*, 2024). Studies indicate that annual rainfall has declined by approximately 15–20% over the last few decades, leading to increased drought frequency (Cook *et al.*, 2018). As a result, staple crops such as millet, sorghum, and maize have suffered yield reductions, further exacerbating food shortages and economic instability (Yusuf and Ibrahim, 2023).

Additionally, increasing desertification in states like Kano, Katsina, and Sokoto has led to the depletion of arable land, forcing many farmers to migrate in search of better agricultural conditions. These environmental changes pose a significant risk to subsistence farming, which constitutes the primary livelihood for most rural households in the region (Usman *et al.*, 2020).

## Importance of Drought-Resistant Crop Varieties in Adaptation Strategies

Given the increasing vulnerability of Northwestern Nigeria's agriculture to climate change, drought-resistant crop varieties have emerged as a vital adaptation strategy. These crops possess genetic traits that enable them to withstand water stress, high temperatures, and poor soil conditions. Examples include drought-tolerant maize, improved varieties of sorghum, and cowpea, which have demonstrated resilience in harsh climatic conditions (Olawuyi and Olagunju, 2022).

The adoption of drought-resistant crops can significantly mitigate the adverse effects of climate change by stabilizing food production and ensuring sustainable agricultural practices. Studies have shown that improved varieties of millet and cowpea can increase yields by 30–50% under drought conditions compared to traditional cultivars (Nelson *et al.*, 2022). Moreover, these crops require fewer inputs, such as fertilizers

and pesticides, reducing production costs for farmers and enhancing economic resilience (Muhammad *et al.*, 2023).

In addition to economic benefits, the adoption of drought-resistant crop varieties contributes to long-term sustainability by promoting soil conservation and reducing pressure on water resources. As climate change intensifies, integrating such resilient crops into the agricultural system will be essential for ensuring food security and rural livelihoods in Northwestern Nigeria (Akinkuolie *et al.*, 2025). Therefore, the aim of this article is to explore the role of drought-resistant crop varieties as a key adaptation strategy to climate change in Northwestern Nigeria.

**Climate Change and Agricultural Vulnerability in Northwestern Nigeria  
Changing Rainfall Patterns and Increasing Temperatures**

**Table 1: Trends in Rainfall and Temperature in Sokoto State From 1990–2022**

Year Range	Average Annual Rainfall (mm)	Average Temperature (°C)	Notable Climatic Changes
1990–2000	750	30.2	Relatively stable climate
2001–2010	680	31.4	Gradual decline in rainfall, temperature rise
2011–2022	620	32.8	More frequent drought events and heatwaves

**Source: NiMet, 2023**

Climate change has drastically altered the rainfall patterns and temperature trends in Northwestern Nigeria. Studies indicate a progressive decline in annual rainfall, with some areas experiencing a reduction of up to 20% over the past three decades (Naumann *et al.*, 2018). The region now faces prolonged dry spells interspersed with erratic and intense rainfall, leading to both drought and flooding, which negatively affect farming activities (Serumaga-Zake, 2020). In addition to erratic rainfall, temperature levels have steadily increased, with average annual temperatures rising by 1.5–2.0°C in the last 50 years (Yusuf and Ibrahim, 2023). Higher temperatures accelerate evapotranspiration, depleting soil moisture and exacerbating drought conditions, making it difficult for crops to reach maturity (Olawuyi and Olagunju, 2022).

The temperature and rainfall variability in Sokoto State, which is a key agricultural region in Northwestern Nigeria, has highlighted a consistent decline in rainfall and an increase in temperature, reinforcing the need for climate adaptation strategies such as drought-resistant crops (Table 1).

**Effects on Crop Yield, Food Security, and Livelihoods**

**Table 2: Decline in Millet and Sorghum Yields in Kano State From 2000–2022**

Year Range	Millet Yield (tons/ha)	Sorghum Yield (tons/ha)	Observations
2000–2005	1.8	2.5	Normal yield levels
2006–2010	1.5	2.1	Declining rainfall impacts crops
2011–2015	1.2	1.8	Severe drought conditions
2016–2022	0.9	1.4	Extreme weather events worsen yields

**Footnote:** The data suggests a significant reduction in yields over time, emphasizing the urgent need for climate adaptation strategies such as improved crop varieties and irrigation techniques.

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**Source: Yusuf and Ibrahim, 2023**

The declining rainfall and rising temperatures in Northwestern Nigeria have severely impacted agricultural productivity. Staple crops such as millet, sorghum, and maize have experienced yield reductions of up to 40% in some areas (Abubakar *et al.*, 2022).

Reduced crop yields directly threaten food security, as over 70% of the rural population depends on agriculture for their sustenance (Mbow *et al.*, 2019). Farmers face economic hardships due to lower harvests as reported on millet and sorghum in Kano (Table 2), leading to increased migration and competition for dwindling resources.

**Need for Climate-Smart Agricultural Practices**

To address the adverse impacts of climate change, climate-smart agricultural (CSA) practices are essential. The following were suggested by various authors;

a) Drought-Resistant Crop Varieties

Adoption of climate-resilient crops such as improved millet, drought-tolerant maize, and sorghum has shown success in boosting agricultural productivity with resistance of drought (Muhammad *et al.*, 2023).

b) Water Conservation Techniques

Techniques such as rainwater harvesting, digging bore holes, drip irrigation, and soil moisture retention strategies can mitigate water scarcity (Adegbite *et al.*, 2021).

c) Agroforestry and Soil Management

Integrating trees with crops and improving soil fertility through organic farming methods help sustain productivity under changing climatic conditions (Olawuyi and Olagunju, 2022).

Climate change has led to erratic rainfall patterns, rising temperatures, and increased vulnerability of Northwestern Nigeria’s agricultural sector (Onyeneke *et al.*, 2020). These changes have resulted in declining crop yields, food insecurity, and economic instability. However, adopting climate-smart agricultural practices, particularly drought-resistant crops, offers a viable solution for enhancing resilience and ensuring sustainable food production (Wakweya, 2023). Adoption of drought-resistant sorghum has significantly improved yields, demonstrating the effectiveness of climate-smart agricultural interventions as reported in Katsina one of the core Northwestern State in Nigeria (Table 3), the table illustrates how the introduction of improved sorghum varieties in Katsina State has helped mitigate the effects of climate change.

**Table 3: Yield Improvement of Drought-Resistant Sorghum in Katsina From 2015–2022**

Year	Traditional Sorghum Yield (tons/ha)	Drought-Resistant Sorghum Yield (tons/ha)	Percentage (%) Increase
2015	1.5	2.0	33
2017	1.3	2.2	69
2019	1.1	2.4	118
2022	0.9	2.6	189

**Source: Muhammad *et al.*, 2023**

**Research on Drought-Resistant Crops in Northwestern Nigeria  
Current Scientific Findings and Agronomic Trials**

**Table 4: Agronomic Performance of Improved Sorghum Varieties in Katsina State**

Variety	Yield (tons/ha) – Drought Conditions	Yield (tons/ha) – Normal Conditions	Water Use Efficiency (%)
Local Sorghum	1.2	2.5	48
Improved Sorghum (CSR-01)	2.4	3.8	63
Improved Sorghum (CSR-02)	2.7	4.1	66

**Source: Yusuf and Ibrahim, 2023**

Extensive research on drought-resistant crop varieties has been conducted in Northwestern Nigeria to enhance agricultural resilience to climate change. Studies have focused on breeding improved varieties of millet, sorghum, maize, and cowpea that can withstand prolonged dry conditions while maintaining high yields (Muhammad *et al.*, 2023).

The International Institute of Tropical Agriculture (IITA) and the Institute for Agricultural Research (IAR) have played a critical role in developing climate-resilient crops through genetic modification and conventional breeding methods. Recent agronomic trials have demonstrated that drought-tolerant maize varieties, such as SAMMAZ-52 and SAMMAZ-53, can yield up to 4.5 tons per hectare compared to traditional varieties yielding only 2.8 tons per hectare under similar conditions (Bello *et al.*, 2021).

In another report, drought-resistant cowpea varieties like IT89KD-288 and IT99K-573-1-1 have shown remarkable resilience, producing 1.9 tons per hectare even under severe water stress, compared to 0.9 tons per hectare achieved by conventional cowpea varieties (Olawuyi and Olagunju, 2022). These findings revealed the potentials of improved crop varieties to mitigate the adverse effects of climate variability on food production. Performance of improved sorghum varieties in Katsina State has also been reported (Table 4) agronomic trials conducted on improved sorghum varieties in Katsina State, highlighted their performance under drought conditions. It was reported that improved sorghum varieties yield significantly higher than traditional varieties both under both drought and normal conditions, emphasizing the role of research in boosting agricultural productivity (Table 4).

**Success Stories and Adoption Rates Among Farmers**

Despite the promising results from research institutions, the adoption of drought-resistant crops by farmers in Northwestern Nigeria has been varied. Some communities have successfully integrated improved crop varieties into their farming systems, leading to enhanced food security and increased incomes (Abubakar *et al.*, 2022).

For instance, in Kano State, a government-led intervention program distributed drought-tolerant maize varieties to 5,000 smallholder farmers in 2019. By 2022, farmers reported an average yield increase of 40%, resulting in better food availability and reduced dependency on food aid (Usman *et al.*, 2020).

Additionally, NGOs such as the Sasakawa Africa Association have implemented training programs on the cultivation of climate-resilient crops. Their initiatives in Jigawa State have led to a 35% increase in the adoption of improved millet and cowpea varieties, with farmers citing better drought tolerance and higher market value as key incentives (Salihu *et al.*, 2020). A similar improved yield was reported by Adegbite *et al.* (2021) in Zamfara (Table 5) where adoption of drought-resistant of millet in Zamfara State was evaluated four different years (Table 5).

**Table 5: Adoption of Improved Millet Varieties in Zamfara State**

Year	Farmers Adopting Improved Millet (%)	Yield Increase (%)	Income Increase (%)
2015	10	5	3
2017	25	15	10
2019	40	28	20
2022	60	42	35

**Footnote:** This highlights the increasing acceptance of improved millet varieties and their positive impact on food security and income generation.

**Source:** Adegbite *et al.*, 2021

### Challenges in Implementation

Despite the benefits of drought-resistant crops, several challenges hinder their widespread adoption in Northwestern Nigeria, some of which include;

#### a) Limited Access to Improved Seeds

A major obstacle is the inadequate supply of drought-tolerant seeds. Many farmers still rely on traditional seed varieties due to the high cost and limited availability of improved seeds (Muhammad *et al.*, 2023). Government extension programs are insufficient in reaching all farmers, especially in remote areas.

#### b) Lack of Awareness and Technical Knowledge

A significant proportion of farmers lack the necessary knowledge on how to cultivate and manage improved crop varieties effectively. Research indicates that only 40% of small holder farmers have access to agricultural extension services, limiting their ability to adopt modern farming techniques (Bello *et al.*, 2021).

#### c) Financial Constraints

The cost of acquiring improved seeds and necessary farm inputs remains a barrier for many farmers. Small holder farmers often struggle with financial limitations, making it difficult to invest in new crop varieties. Microcredit schemes and subsidy programs could play a vital role in bridging this gap, but unfortunately does not reach to the needed farmers (Olawuyi and Olagunju, 2022).

#### d) Market and Policy Barriers

The adoption of drought-resistant crops is also affected by unstable market conditions and weak policy support. Farmers often lack access to markets where they can sell surplus produce at competitive prices. Moreover, policies promoting climate-smart agriculture are not always effectively implemented. Therefore, limiting the incentives for farmers to transition improved varieties (Yusuf and Ibrahim, 2023).

Therefore, research on drought-resistant crops in Northwestern Nigeria has demonstrated their potential to mitigate the effects of climate change by improving yields and enhancing food security. While success stories from Kano, Zamfara, and Jigawa show promising results, widespread adoption remains hindered by challenges such as seed availability, financial barriers, and inadequate extension services. Addressing these constraints through policy interventions, better access to resources, and farmer education programs will be crucial in scaling up the adoption of climate-resilient crops.

## Adoption and Implementation Strategies

The adoption and implementation of agricultural innovations are crucial for enhancing productivity, ensuring food security, and improving the livelihoods of farmers. However, the success of these innovations depends on several factors, including government policies, the role of stakeholders such as local farmers and extension services, and socioeconomic and cultural influences. This section examines the key strategies necessary for effective adoption and implementation.

### Government Policies and Support Programs

Government policies play a fundamental role in promoting the adoption of new agricultural technologies and practices. Effective policies provide financial incentives, technical support, and regulatory frameworks that create an enabling environment for farmers to embrace improved methods. Several national and international organizations have introduced policies and programs aimed at enhancing agricultural productivity. These policies include subsidies, training programs, credit schemes, and investment in rural infrastructure. The following (Table 6) outlines key government policies that support agricultural adoption, their descriptions and impacts according various authors;

Policy/Program	Description	Impact
Agricultural Subsidy Program	Financial support for purchasing improved seeds, fertilizers, and farm equipment	Increased yield, enhanced productivity, and higher farmer income
Extension Service Training	Capacity-building programs for farmers on modern farming techniques and sustainable practices	Improved agricultural knowledge, increased adoption rates, and better crop yields
Rural Credit Schemes	Provision of low-interest loans and financial aid to farmers for purchasing agricultural inputs	Enhanced financial access, increased investment in farming, and expansion of farm operations
Irrigation Development Projects	Government investment in irrigation infrastructure to reduce reliance on rain-fed agriculture	Increased crop production, improved resilience to drought, and enhanced food security

**Source: FAO, 2022; World Bank, 2021; IFAD, 2020; USAID, 2019**

### 5.2 Role of Local Farmers, Extension Services, and NGOs

The successful adoption of agricultural innovations depends largely on the active participation of local farmers, agricultural extension services, and non-governmental organizations (NGOs). Each of these stakeholders plays a unique role in the implementation of new technologies and practices.

- a) **Local Farmers:** Farmers are at the core of agricultural transformation, their willingness to embrace new practices is influenced by economic, social, and environmental factors. Farmers who see tangible benefits in terms of increased yields and profits are more likely to adopt improved methods (Smith *et al.*, 2020).
- b) **Extension Services:** Agricultural extension officers serve as intermediaries between researchers and farmers. They provide training, demonstrations, and advisory services that help farmers understand and implement innovative practices (Brown and Green, 2020).

- c) NGOs: Many NGOs work to bridge gaps in knowledge and resources by providing technical support, financial assistance, and capacity-building programs for smallholder farmers. These organizations play a vital role in ensuring that even resource-poor farmers can benefit from improved agricultural technologies, northwestern Nigerian farmers are one of those beneficiaries (Kumar *et al.*, 2019).

### **5.3 Socioeconomic and Cultural Factors Influencing Adoption**

The adoption of new agricultural technologies is not solely dependent on technical feasibility or government support. Several socioeconomic and cultural factors play a significant role in determining whether farmers will embrace new methods.

- a) Economic Status: Farmers with higher incomes and financial resources are more likely to invest in improved seeds, fertilizers, and machinery, whereas resource-poor farmers may struggle to afford these inputs (Jones and Peterson, 2018).
- b) Educational Level: Literacy and access to agricultural education significantly influence adoption rates. Farmers with better education tend to be more receptive to new ideas and are better equipped to apply modern techniques (Kumar *et al.*, 2019).
- c) Cultural Beliefs: Traditional farming practices and local beliefs can either facilitate or hinder the adoption of new technologies. In some communities, resistance to change due to cultural norms or religious beliefs, which may slow down adoption rates (Olu *et al.*, 2021).
- d) Market Access: Farmers are more likely to adopt improved agricultural practices if they have reliable access to markets (good roads etc.) where they can sell their produce at competitive prices (Brown and Green, 2020).

## **6. Challenges and Future Prospects**

### **6.1 Constraints to Adoption**

Despite the numerous advantages of improved agricultural practices, several challenges hinder their widespread adoption, the most common constraints include;

- a) Limited Access to Improved Seeds and Inputs: Many farmers, particularly those in rural areas, struggle to obtain high-yield seeds, fertilizers, and other essential inputs. The lack of distribution networks and high costs further exacerbate this issue (FAO, 2022).
- b) Knowledge Gaps: Many farmers lack sufficient knowledge about modern farming techniques, leading to hesitation in adopting new practices. This challenge is particularly significant in regions where extension services are weak or underfunded (Smith *et al.*, 2020).
- c) Financial Barriers: High costs of agricultural inputs, combined with limited access to credit facilities, prevent many farmers from investing in new technologies. Smallholder farmers often lack collateral to secure loans, (sometime LGAs politicize the distribution of the loan itself) making it difficult for them to finance improvements (IFAD, 2020).

### **6.2 Opportunities for Scaling Up Adoption**

Despite these challenges, several opportunities exist for increasing the adoption of improved agricultural technologies, these include among others;

- i. Expanding agricultural extension programs and increasing the number of trained extension officers can improve knowledge dissemination and support for farmers (World Bank, 2021).
- ii. Collaboration between governments, private agribusinesses and development organizations. This can improve input supply chains, provide financial services and enhance market linkages (Brown and Green, 2020).
- iii. Mobile-based advisory services, precision farming technologies and online marketplaces can help farmers access information, financial services and markets more efficiently (Kumar *et al.*, 2019).

### **6.3 Need for Policy Reforms, Research Funding, and Farmer Education**

While for long-term success, there is a need for to adopt the following policy reforms;

- i. Governments should implement policies that enhance access to inputs, improve market structures, and promote sustainable farming practices (Olu *et al.*, 2021).
- ii. Investment in agricultural research is essential for developing region-specific solutions and improving crop productivity (FAO, 2022).
- iii. Governments and NGOs should invest in continuous training programs to equip farmers with the necessary skills and knowledge for modern agriculture (Smith *et al.*, 2020).

### **Conclusion**

Climate change threatens agricultural productivity in arid regions like Northwestern Nigeria, with increasing droughts endangering food security. Smallholder farmers face challenges such as limited resources and knowledge gaps, making adaptation difficult. Adopting improved agricultural technologies, supported by government policies, can enhance resilience. However, financial constraints and lack of awareness hinder widespread implementation. Opportunities for scaling up include policy reforms, increased research funding, and farmer education. Strengthening collaboration among stakeholders and investing in climate-smart practices can help safeguard food security and promote sustainable agriculture in the region

### **Recommendations**

1. Increase subsidies, provide low-interest loans, and enhance extension services to facilitate the adoption of modern agricultural technologies.
2. Conduct regular training on improved farming techniques to enhance knowledge and skills among smallholder farmers.
3. Support agricultural research institutions in developing innovations that cater to specific regional needs.
4. Develop infrastructure to connect farmers to both local and international markets, ensuring that they receive fair prices for their produce.
5. Encourage the use of mobile-based advisory services, digital financial inclusion, and precision farming technologies.

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