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Climate Resilient Crop Adoption in Kaduna State as a Strategy for Food Security and Improved Nutrition in Kaduna State

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Abstract

Variations in weather patterns, temperatures, and erratic rainfall threaten food and nutrition security as well as agricultural sustainability globally. Kaduna State with 88.8% of its population in poverty is also facing this variation which is affecting the poor more than other sections of the population. To address these challenges, the adoption of climate-resilient crops which doubles as biofortified crops becomes essential. This study investigates the level of awareness and adoption of climate-resilient crops in kaduna State as a strategy for curbing food insecurity and malnutrition in the State. The study used questionnaire to assess the level of awareness and willingness to adopt climate-smart crops and the findings revealed a low level of awareness among farmers majority of indicate high level willingness to cultivate and consume biofortified crops, recognizing their health benefits and resilience to climate-induced stresses. Age, gender, and educational background play significant roles in shaping farmers' awareness and willingness to adopt these crops. The high levels of unawareness regarding biofortified crops/climate-resilient crops is augmented by limited knowledge about specific varieties such as Vitamin A maize. The study highlights a notable interest among farmers to embrace these crops if they were made available and accessible, with 100% of respondents indicating their willingness to cultivate or consume them. The policy implications underscore the need for targeted efforts in raising awareness, capacity building, and providing access to improved seeds and technologies. Furthermore, fostering collaboration between governments, research institutions, NGOs, and farmers will enhance the effectiveness of these interventions. By promoting the adoption of biofortified crops, Kaduna State can strengthen food security, improve nutrition, and build resilience to climate change, ensuring a sustainable and productive agricultural sector.

Keywords: *Resilient, Climate, Crops, Food, Nutrition*

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Background to the Study

Climate change, which is defined by rising temperatures, altering rainfall patterns, and enhanced extreme weather events, is posing a significant danger to agricultural systems around the world. The Intergovernmental Panel on Climate Change (IPCC, 2021) says that global average temperatures have already risen by around 1.1°Cover pre-industrial levels, with major regional differences. These changes are especially severe in Sub-Saharan Africa, where rain-fed agriculture provides the majority of livelihoods and food security. For example, in Nigeria, forecasts show that temperatures could rise by 1.5°C to 2.5°C by mid-century, accompanied by more frequent and severe droughts and floods (Nigerian Meteorological Agency, 2018). Malnutrition is a secret catastrophe that impacts millions, impeding physical and cognitive development and perpetuating poverty cycles. According to the Global Alliance for Improved Nutrition (GAIN, 2023), over 828 million people worldwide are hungry, and approximately 3 billion do not have access to a good food, resulting in various kinds of malnutrition such as micronutrient deficiencies and child stunting. GAIN specifically states that approximately 149 million children under the age of five are stunted, with 45 million wasted, indicating acute nutritional inadequacies. According to the 2018 Nigeria Demographic and Health Survey (NDHS), roughly 38.5% of children under the age of five in Kaduna State are stunted, indicating chronic malnutrition, while 23.4% are underweight. These statistics reflect the urgent need for interventions that address both food availability and nutritional quality. Thornton et al. (2021) found that climate change is increasing malnutrition through a variety of mechanisms, including decreasing agricultural production and disturbed food networks. In this context, the adoption of climate-resilient biofortified crops appears to be a potential solution for addressing both climate vulnerability and nutritional deficiencies. These crops, which have been bred to withstand harsh climatic conditions and are fortified with essential micronutrients such as Vitamin A, iron, and zinc, have the potential to forge an ideal relationship: a sustainable agricultural system that ensures both food availability and nutritional adequacy in the face of environmental challenges.

However, the reality on the ground frequently deviates dramatically from the ideal. Climate change is already having an impact in locations such as Kaduna State, Nigeria, with decreased crop yields and greater food price volatility, compounding current food poverty. According to data from the Kaduna State Agricultural Development Project (KADP), maize yields have decreased by 10-20% in recent years as a result of irregular rainfall. Furthermore, the National Bureau of Statistics (NBS, 2020) reports that agricultural output in Kaduna State has fluctuated in line with documented shifts in rainfall patterns.

The adoption of climate-resilient crops, while theoretically advantageous, faces numerous practical barriers, including limited access to improved seeds (only an estimated 15% of farmers use improved seeds in Kaduna State, according to a 2020 agricultural survey conducted by the Kaduna State Ministry of Agriculture), inadequate extension services (with a farmer-extension ratio far exceeding recommended levels, estimated to be around 1 extension worker per 1,500 farmers in some areas), and socio-economic constraints (over 70% of farmers in the state are smallholders with limited financial resources, as indicated by the Federal Ministry of Agriculture and Rural Development, 2019). The consequences of this

gap between potential and reality are dire: increased vulnerability to food shortages, heightened malnutrition rates, and a diminished capacity for communities to adapt to future climate shocks. Children, pregnant women, and other vulnerable populations are particularly at risk, facing long-term health and developmental setbacks, leading to reduced human capital and economic productivity.

Despite the growing recognition of the importance of climate-resilient agriculture, a significant study gap remains. There is a dearth of context-specific research that thoroughly examines kaduna state's farmers knowledge/understanding or awareness of the existence of climate resilient crops and their adoption in the State. This study is motivated by the urgent need to bridge this gap, providing evidence-based insights that can inform targeted interventions and policies. By investigating the adoption of climate-resilient crops as a strategy for food security and improved nutrition, this research aims to contribute to the development of more resilient and sustainable food systems in Kaduna State, where over 60% of the population relies on agriculture for their livelihoods, and where climate change impacts are increasingly felt.
This paper has five sections which are introduction, literature review, methodology, results and discussions, conclusion and Recommendation

Literature Review
This section delves into the existing body of knowledge relevant to climate-resilient crop adoption, food security, and nutrition in the context of Kaduna State, Nigeria. It encompasses a comprehensive review of conceptual frameworks, theoretical underpinnings, and empirical findings, culminating in the identification of critical research gaps.

Conceptual Review
The core concepts guiding this study include climate-resilient agriculture (CRA), food security, and nutrition. CRA, as defined by the Food and Agriculture Organization of the United Nations (FAO, 2013), aims to achieve three interconnected objectives: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing greenhouse gas emissions. In the context of this study, the focus is on the adoption of climate-resilient crops, which are varieties specifically bred or selected for their ability to withstand adverse climatic conditions such as drought, heat stress, and flooding, while maintaining or improving yield potential. These crops often include biofortified varieties, which are enriched with essential micronutrients to address nutritional deficiencies.

Table 1: Biofortified Crops: Climate-smart Traits and Productivity Advantages

Biofortified crop	Nutrition trait	Climate-smart traits	Sample Varieties	Yield, tons per hectare (maturity time)
Rice	High zinc	Extra early maturity	BRRI Dhan 62	4 t/ha (Extra early: 100 days)
Wheat	High zinc	Stem rust resistance Drought tolerance	Akhbar-2019	4.47 t/ha (Intermediate: 140 – 145 days)
Maize	High vitamin A	Drought tolerance Early maturity	SAMMAZ 60	5 t/ha (Early to medium: 110 – 120 days)
Pearl Millet	High iron	Downy mildew resistance High temperature and drought tolerance Extra early maturity	Dhanshakti	2.5 t/ha (Extra early: 70 – 75 days)
			HHB299	3.3 t/ha (Intermediate: 80 – 85 days)
Beans	High iron	High temperature tolerance (up to 4°C higher than the range normally tolerated by bean varieties grown in drought conditions in Latin America and the Caribbean)	ICTA Peten ACM	4.2 t/ha
			CENTA Ferromas	2.3 t/ha
			ICTA Superchiva	4.2 t/ha
			Corpoica Rojo 43	1.2 t/ha

Source: Harvest Plus' website and article titled: "Biofortification and Climate Change"

Food security, as defined by the World Food Summit (1996), is achieved when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. This concept encompasses four dimensions: availability, access, utilization, and stability. In Kaduna State, climate change impacts are primarily affecting the availability and stability dimensions, through reduced crop yields and increased vulnerability to weather extremes. Nutrition, on the other hand, refers to the intake of food, considered in relation to the body's dietary needs. It encompasses the processes by which the human body utilizes nutrients for growth, development, maintenance, and overall health. Malnutrition, in all its forms, including undernutrition (stunting, wasting, underweight) and micronutrient deficiencies, poses a significant threat to human capital development and economic productivity.

Theoretical Review

To understand the factors influencing the adoption of climate-resilient crops, this study draws upon relevant behavioral and innovation theories. The theory of planned behavior (TPB)

(Ajzen, 1991) provides a framework for understanding how attitudes, subjective norms, and perceived behavioral control influence farmers' intentions to adopt new agricultural practices. In the context of climate-resilient crop adoption, farmers' attitudes towards the perceived benefits of these crops, social pressure from peers and community members, and their perceived ability to implement the practices (e.g., access to resources, knowledge) play crucial roles.

Diffusion of innovation theory (Rogers, 2003) offers insights into the process by which new technologies and practices are adopted over time. This theory emphasizes the importance of factors such as relative advantage (the degree to which an innovation is perceived as better than the idea it supersedes), compatibility (the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters), complexity (the degree to which an innovation is perceived as difficult to understand and use), trialability (the degree to which an innovation can be experimented with on a limited basis), and observability (the degree to which the results of an innovation are visible to others). These factors influence the rate and extent of climate-resilient crop adoption in Kaduna State. Additionally, the sustainable livelihoods framework provides a structured way to analyze the assets, strategies, and outcomes of rural households in the face of climate change. It highlights the importance of understanding the context within which farmers operate, including their access to natural, physical, financial, human, and social capital.

Empirical Review

Numerous empirical studies have examined the adoption of climate-resilient crops and their impacts on food security and nutrition. Research in various regions of sub-Saharan Africa has demonstrated the positive effects of drought-tolerant maize varieties on household food security (Fisher et al., 2015). Similarly, studies on cassava varieties resistant to drought and diseases have shown improvements in food availability and income in Nigeria (Manyong et al., 2011). Studies have also highlighted the importance of access to information and extension services in promoting the adoption of climate-resilient crops. For example, Kassie et al. (2013) found that access to extension services and farmer training significantly influenced the adoption of improved chickpea varieties in Ethiopia. Furthermore, research has shown that social networks and farmer groups play a crucial role in disseminating information and facilitating the adoption of new agricultural practices.

However, barriers to adoption, such as limited access to seeds, financial resources, and market linkages, have been identified in various studies. For instance, research by Lobell et al. (2011) has highlighted the significant yield gaps that exist in many parts of Africa due to limited access to inputs and technology.

Recent studies have explored the impact of biofortified crops on nutritional outcomes.[1] For example, research on vitamin A-biofortified maize has shown improvements in vitamin A status among children in Zambia (Zulu et al., 2019). Studies in other regions have explored the impact of iron-biofortified crops on anemia prevalence. There is no study that assessed the

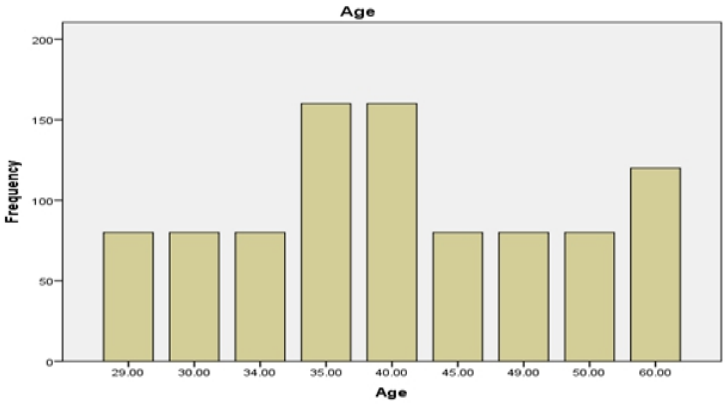
level of awareness and adoption of climate resilient crops in Kaduna State and their potential to improve food and nutrition security in the State. Hence, this study is set to cover these gaps.

Methodology

This study employed a mixed-methods approach to examine the adoption of climate-resilient crops in Kaduna State. A structured questionnaire was used to collect quantitative data from 920 respondents across various Local Government Areas (LGAs). The sampling framework ensured representation from diverse demographic groups, including age, gender, education level, and occupation. Data collection focused on respondents' awareness, perceptions, and willingness to adopt biofortified crops, as well as their understanding of the health and economic benefits associated with these crops. Descriptive statistics and charts were used to analyze the demographic and perceptual data.

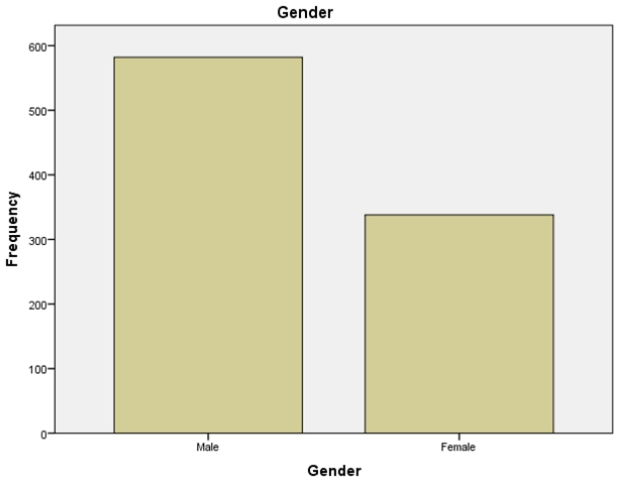
Results and Findings

Fig. 1: Age distribution



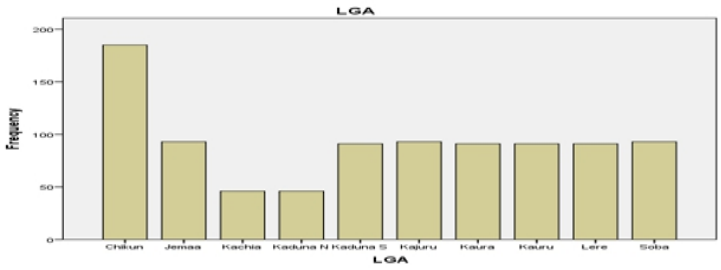
Respondents are distributed across various age groups, with the highest representation in the 35-40 age brackets (34.8% combined). This suggests that the study primarily involves middle-aged individuals.

Fig. 2: Gender Distribution of Respondents



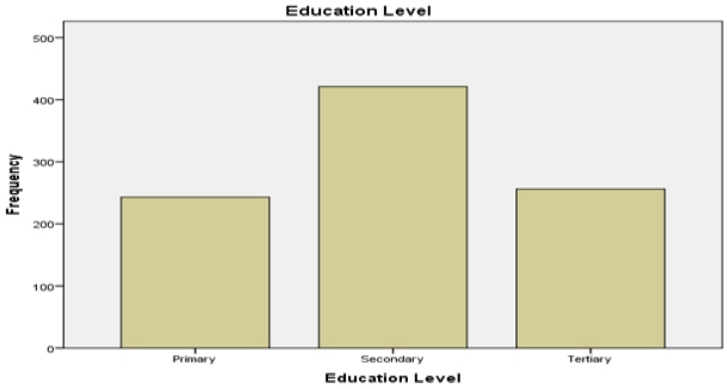
Male respondents make up the majority (63.3%), while females account for 36.7%. This indicates a gender imbalance among participants.

Fig. 2



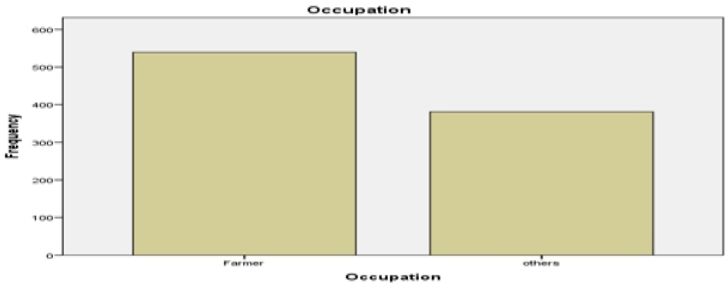
Most of the respondents are from Chikun LGA with almost equal distribution of respondents across the other LGAs

Fig. 3



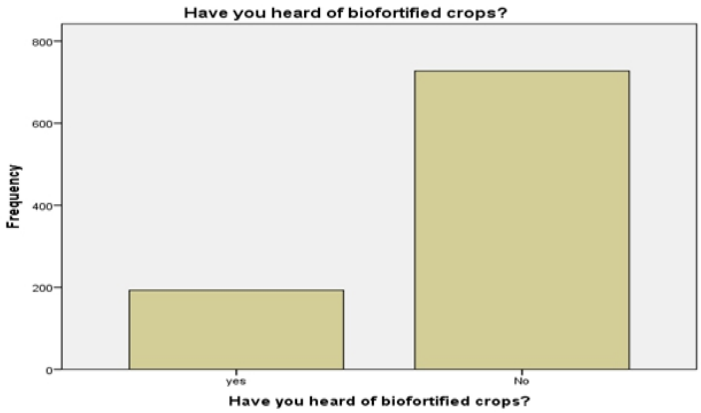
The educational levels chart above shows that all the respondents are literate with a minimum of a primary certificate. The majority have secondary school certificates.

Fig. 4



The occupation charts showed that most of the respondents are farmers while the rest combine other jobs with farming.

Fig. 5

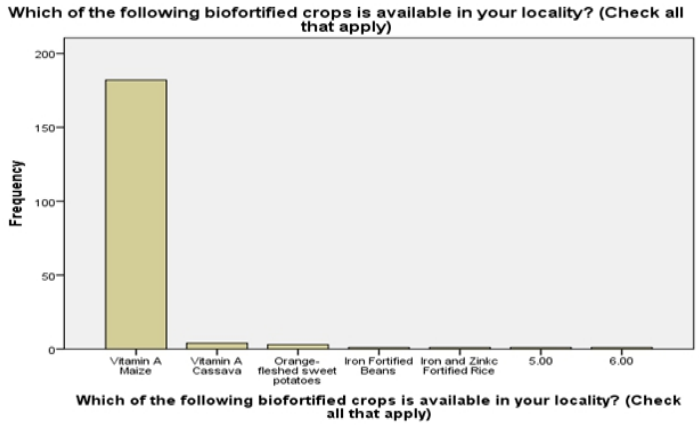


The chart above shows that most of them have not heard of biofortified crops

Fig. 6

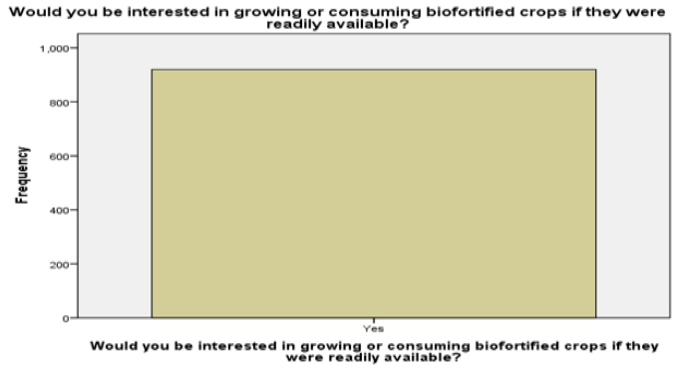
Most of them agreed that biofortified crops have health benefits

Fig. 7



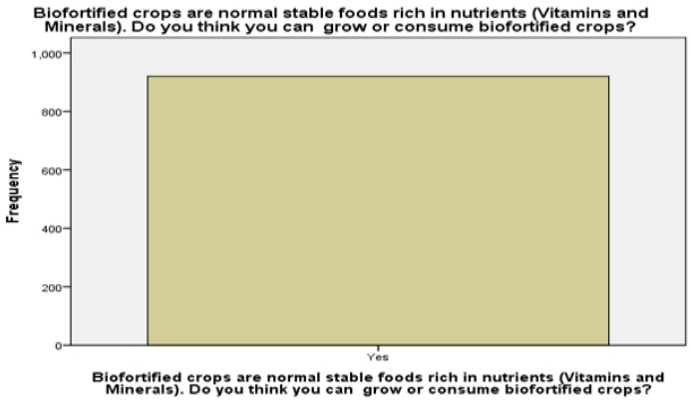
Almost all the respondents who know biofortified crops identified Vitamin A maize as the crop that they know

Fig. 8



On the interest and willingness to cultivate or consume these crops, all the respondents showed interest and willingness.

Fig. 9



100% of the respondents agreed to grow or consume the crops.

Table 2: Would you be interested in growing or consuming biofortified crops if they were readily available?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	920	100.0	100.0	100.0

Table 3: Biofortified crops are normal stable foods rich in nutrients (Vitamins and Minerals). Do you think you can grow or consume biofortified crops?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Yes	920	100.0	100.0	100.0

Conclusion

This study has demonstrated the potential of climate-resilient and biofortified crops to address the twin challenges of food security and climate change in Kaduna State. Findings revealed a high level of interest and willingness among respondents to adopt biofortified crops, with 100% of respondents expressing readiness to grow or consume these nutrient-rich, climate-smart crops if made readily available. Despite this, awareness of biofortified crops remains low, as most respondents had not previously heard of these varieties. However, those familiar with biofortified crops primarily recognized Vitamin A maize as a key example.

The demographic analysis indicated that the majority of respondents were middle-aged (35–40 years, 34.8%), literate, and primarily engaged in farming activities. Gender distribution showed that male respondents dominated (63.3%), while Chikun Local Government Area (LGA) had the highest representation among participants. These findings underscore the need for targeted interventions to enhance awareness, accessibility, and adoption of climate-resilient crops within the state.

With appropriate support and interventions, the adoption of climate-resilient crops can significantly enhance agricultural productivity, improve nutrition, and build resilience to the adverse effects of climate change in Kaduna State.

Policy Implications

The findings of this study highlight the urgent need for comprehensive policy interventions to promote the adoption of climate-resilient and biofortified crops in Kaduna State. One critical area of focus is raising awareness about these crops. Governments and development agencies must launch extensive campaigns to educate farmers on the nutritional, economic, and environmental benefits of biofortified crops. These campaigns should be tailored to local communities and use accessible communication channels such as radio programs, community gatherings, and agricultural extension services.

Capacity building is another essential policy area. Farmers need practical training on sustainable farming techniques, including integrated crop management, crop rotation, and the use of smart agricultural technologies. By equipping farmers with these skills, policymakers can ensure that they maximize yields and maintain soil health while adapting to climate variability. Agricultural extension officers should play a pivotal role in disseminating this knowledge and providing ongoing technical support. Access to quality seeds is a significant barrier to the widespread adoption of climate-resilient crops. To address this, policymakers must prioritize the development of efficient seed distribution systems. Establishing community seed banks and partnering with private seed producers can help make biofortified seeds more accessible and affordable. Subsidizing the cost of seeds or providing them at no cost to smallholder farmers can further encourage uptake, especially among economically disadvantaged farmers.

Financial incentives are also necessary to support farmers in transitioning to climate-resilient agriculture. Subsidies for farm inputs, low-interest credit facilities, and grants for adopting

new technologies can lower the financial burden associated with cultivating biofortified crops. Incentives for early adopters can serve as motivation for others to follow suit, creating a ripple effect across farming communities. Improving rural infrastructure is another crucial policy implication. Investments in irrigation systems, storage facilities, and rural roads will enhance the efficiency of farming activities and reduce post-harvest losses. These investments will not only benefit farmers cultivating biofortified crops but also strengthen the entire agricultural value chain.

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