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Bridging The Adaptation Gap: Barriers And Opportunities For Climate-Resilient Irrigation Farming In Dutse LGA, Jigawa, Nigeria

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Abstract: This research explores the challenges and prospects for climate-resilient irrigation farming in Dutse Local Government Area (LGA), Jigawa State, Nigeria. Employing a mixed-methods strategy, the study combines survey questionnaires (N = 200), focus group discussions (FGDs), and key informant interviews (KIIs) to assess the adaptive capacity of smallholder irrigation farmers. The findings reveal substantial obstacles, including the high cost of irrigation resources, ineffective extension services, limited access to climate information, restricted credit opportunities, and gender disparities in land ownership. Logistic regression analysis revealed that factors such as education level, contact with extension services, and access to credit are statistically significant determinants of adopting climate-resilient practices. Despite these obstacles, the study also identifies opportunities, including traditional water conservation techniques, community-led adaptation initiatives, and the development of solar-powered irrigation systems. The research asserts that closing the adaptation gap necessitates targeted policy interventions, inclusive financial support mechanisms, gender-sensitive land reform, and enhanced institutional capabilities. Implementing these measures is crucial for enhancing rural livelihoods, ensuring food security, and achieving the Sustainable Development Goals (SDGs) in Nigeria's most vulnerable regions.

Keywords: Climate change adaptation, irrigation agriculture, obstacles, resilience, Dutse, Jigawa, smallholder farmers, agricultural extension, rural development, and sustainable agriculture.

1. Introduction

Climate change poses a significant threat to global agricultural sustainability, with its effects being particularly severe in arid and semi-arid regions, such as Northern Nigeria. Dutse Local Government Area (LGA), located in Jigawa State within the Sudan-Sahel ecological zone, exemplifies this dilemma. In recent years, the area has experienced unpredictable rainfall, extended droughts, rising

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temperatures, and desertification elements that have increasingly threatened smallholder irrigation farming, which is vital to local food systems and rural livelihoods (NIMET, 2023).

Jigawa State is among Nigeria's most vulnerable states to climate change due to its location and dependency on both rain-fed and irrigated farming. According to the Federal Ministry of Agriculture and Food Security (2024), over 75% of the state's workforce is involved in agriculture, accounting for about 38% of household income in rural communities. However, this sector remains vulnerable to climate-induced shocks, with smallholder farmers experiencing the most severe impacts from declining water supplies, increased pest outbreaks, and deteriorating soil fertility (Jafaru, Aliyu, & Sule, 2025). These environmental challenges intensify rural poverty (Aluko & Magaji, 2020), jeopardise food security, and contribute to rural-urban migration (Magaji & Musa, 2024).

In Dutse LGA, irrigation practices utilising Fadama lands, tube wells, and small-scale canals have historically been employed as a strategy to adapt to inconsistent rainfall patterns. Nevertheless, the escalating cost of diesel, inconsistent access to electricity, and limited availability of solar-powered solutions have curtailed the expansion of this adaptive tactic. These limitations have significant repercussions for realising the United Nations Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 15 (Life on Land). The capacity of communities, such as those in Dutse LGA, to sustainably manage their land and water resources while upholding productivity is crucial for both national and global sustainability objectives (UNDP, 2023).

Additionally, Nigeria's National Adaptation Plan (Federal Ministry of Environment, 2021) emphasises the need for localised approaches to climate adaptation, particularly in frontline states. Despite various policy measures, significant adaptation gaps persist due to systemic issues, including limited access to climate information, inadequate financial support, ineffective extension services, and insufficient institutional capacity for supporting local adaptation planning (Magaji et al., 2024). Understanding the specific obstacles faced in regions like Dutse is crucial for developing effective and inclusive strategies that address these challenges.

Moreover, rural communities are not only ecologically at risk but are also economically disadvantaged (Magaji & Adamu, 2011). Farming households commonly experience income instability, food insecurity, and inadequate infrastructure (Magaji, Musa, & Ismail, 2025). Climate-related shocks often lead to decreased yields and income losses, thereby hindering households' ability to invest in adaptation or recover from disasters (Tanko, Magaji, & Musa, 2025). This situation creates poverty (Magaji & Musa, 2015) and results in a vulnerability trap, where the most impoverished households face the highest exposure to climate impacts yet have the least capacity to respond effectively (Adger et al., 2014).

In this framework, irrigation farming offers both a means of coping and a strategic opportunity to enhance climate resilience. When sufficiently supported, small-scale irrigation can boost crop yields, prolong the growing season, and stabilise household incomes. However, this potential is often unrealised in many communities due to institutional and financial barriers (Magaji, 2008). Identifying these obstacles—and the associated opportunities to overcome them is an essential step in facilitating rural adaptation.

The objective of this study is to explore the challenges to effective climate change adaptation among irrigation farmers in Dutse LGA and to pinpoint avenues for fostering more climate-resilient farming systems. By utilising a mixed-methods approach that encompasses both the experiences of farmers and insights from experts, the research aims to provide evidence-based recommendations for closing the adaptation gap. This is crucial not only for the sustainability of local livelihoods but also for enhancing the wider climate resilience of Nigeria's agricultural sector.

2. Literature Review

2.1 Conceptual Definition Climate change adaptation in agriculture pertains to the process through which individuals, communities, and systems make adjustments to actual or anticipated climate impacts to mitigate harm or take advantage of beneficial opportunities. In this regard, the Sustainable Livelihoods Framework (DFID, 1999) offers a helpful structure for examining how rural households leverage various assets (natural, human, financial, social, and physical capital) to manage climatic challenges. The framework highlights the importance of enhancing these livelihood assets, minimising vulnerability, and fostering resilience through supportive policies and institutions (Sabiu & Magaji, 2024). It positions farmers not merely as passive victims but as proactive agents in managing risks and generating innovations amidst uncertainty (Ellis, 2000).

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2.2 Theoretical Framework Supporting this is the Social-Ecological Systems (SES) theory, which acknowledges the interconnections between human systems and ecological systems (Folke et al., 2010). It focuses on feedback mechanisms, adaptability, and the necessity for multi-scalar governance in addressing complex environmental challenges, such as climate change (Ibrahim, Olusola, & Magaji, 2025). In the context of Dutse LGA, irrigation farming is viewed not only as an agricultural method but as an integrated socio-ecological practice that mirrors resource availability, knowledge systems, institutional frameworks, and environmental feedback. The SES theory also emphasises resilience—the ability of systems to withstand disturbances and reorganise while changing—an essential component of climate adaptation in resource-limited contexts.

3. Empirical Review

The topic of climate change adaptation in agriculture has garnered considerable academic attention in Nigeria, particularly in the northern region, where climate variations are most pronounced. A multitude of research efforts have investigated how farmers respond to increasingly unpredictable weather patterns, the significance of irrigation, and the institutional and socioeconomic elements that influence their ability to adapt.

Odjugo (2021) offers one of the pioneering studies, indicating that northern Nigeria has experienced consistent increases in temperature and declining rainfall over the last thirty years. These alterations have led many smallholder farmers to rely on irrigation-based agriculture as their primary means of survival. In a related investigation, Yusuf and Umar (2024) examined the adaptive strategies employed by millet and sorghum farmers in Kano and Jigawa states. Their results show that, although there is a relatively high level of awareness regarding climate change, the actual implementation of adaptation practices is hindered by limited access to agricultural financing, insufficient meteorological data, and inadequate institutional assistance.

Building on this foundation, Olayemi and Oni (2022) emphasised the crucial importance of agricultural extension services and the dissemination of climate-related information. Their study indicates that farmers with access to consistent and timely information through extension agents were more inclined to implement enhanced irrigation techniques, such as drip systems or scheduling based on weather predictions. However, these services are often underfunded and irregularly available in rural northern Nigeria, leaving significant knowledge gaps for subsistence farmers.

Ahmed and Ibrahim (2024) utilised panel data from 2015 to 2020 across five northern states to investigate obstacles to climate-smart irrigation among tomato farmers. Their econometric model revealed that the high expenses associated with irrigation inputs (such as diesel-powered pumps, pipes, and upkeep) represent a significant constraint. The research also found that farmers who had access to solar-powered technologies demonstrated greater resilience and productivity; nonetheless, only a small percentage could afford such advancements due to insufficient support from the government and NGOs. These results align with the emerging consensus that renewable energy solutions are critical for sustainable irrigation in sub-Saharan Africa.

A gender-focused perspective is presented by Tanko and Suleiman (2024), who carried out a cross-sectional survey of irrigation farmers in Bauchi and Yobe States. Their research revealed gender-specific barriers to adaptation, including land tenure insecurity for women, exclusion from agricultural decision-making processes, and cultural norms that restrict women's mobility and participation in community adaptation initiatives. The authors assert that unless these gender disparities are addressed through inclusive policies, the benefits of adaptation efforts will continue to be inequitably distributed.

In terms of technological adaptation, Chukwu and Abdulmalik (2023) examined the influence of mobile-based climate information platforms (such as SMS weather alerts and agricultural advisory applications). Their results indicate that these platforms greatly enhance farmers' capabilities to plan irrigation schedules and diversify their cropping systems. However, the study also observed high levels of digital illiteracy and limited smartphone access in rural areas, which restricts the broader effectiveness of these tools. They suggest integrating these platforms with community radio and traditional extension systems to achieve broader outreach.

Recent studies have continued to emphasise the interplay between institutional frameworks, infrastructure gaps, and local coping mechanisms. Bello et al. (2023) investigated climate adaptation strategies in Sokoto and Kebbi states, discovering that in areas where local government authorities actively participated in building and maintaining irrigation infrastructure, adaptation outcomes were more favourable. In contrast, regions that lacked such public investment exhibited higher agricultural vulnerability, particularly

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among smallholder households. This highlights the significance of decentralised governance and participatory planning in climate adaptation.

In a similar vein, Musa and Adamu (2023) examined the relationship between education and the adoption of adaptation strategies in Katsina and Jigawa states. Their findings indicated that farmers with at least a secondary education were markedly more inclined to implement diversified irrigation methods, agroforestry practices, and soil conservation techniques. This discovery reinforces the notion that developing human capital is a crucial prerequisite for effective climate change adaptation in rural settings.

There is an expanding collection of literature that emphasises market access and value chains. For instance, Usman and Gambo (2024) analysed farmers participating in the Hadejia Valley Irrigation Scheme. They noted that stable market access affected farmers' willingness to invest in irrigation technologies and climate-resilient seeds. In contrast, price fluctuations and inadequate road infrastructure hindered such investments, perpetuating a cycle characterised by low productivity and food insecurity. The authors suggested enhancing rural infrastructure and bolstering farmer cooperatives to ease the procurement of inputs and marketing of products.

Despite the valuable insights offered by these studies, a significant gap remains in localised assessments that accurately reflect community-specific contexts. Much of the current research utilises a framework based on state-level or agro-ecological zones, which often obscures the detailed realities present in specific Local Government Areas (LGAs), such as Dutse. Although broader studies capture general trends, they frequently fail to convey the lived experiences of farmers who navigate a complex interplay of environmental challenges, social dynamics, and policy shortcomings at the grassroots level (Ismail, Bash, & Magaji, 2019).

This research aims to fill that gap by employing a mixed-methods assessment of climate change adaptation practices among irrigation farmers in Dutse LGA, Jigawa State. Unlike previous studies that primarily depend on secondary data or large-scale surveys, this research incorporates direct insights from farmers, local officials, and extension agents. Additionally, it combines qualitative thematic findings with quantitative data to offer a comprehensive understanding of adaptive capacities and constraints.

By situating the study within the Sustainable Livelihoods Framework and utilising contemporary findings from 2023 to 2025, this research provides new empirical evidence that can guide policy interventions designed to meet the specific needs of communities like Dutse. Considering the critical importance of irrigation for climate adaptation and food security in northern Nigeria, such localised investigations are not only timely but vital for achieving Sustainable Development Goals (SDGs) 1 (No Poverty), 2 (Zero Hunger), and 13 (Climate Action).

The body of empirical literature addressing climate change adaptation in Nigerian agriculture is expanding, there is an urgent need for micro-level investigations. These community-focused studies examine the structural, cultural, and technological dimensions of adaptation. This research contributes to this new frontier by presenting a case study that illustrates the real-time challenges, innovations, and possibilities within a semi-arid LGA that is significantly impacted by climate stresses.

3. Methodology

3.1 Research Design

This study employs a mixed-methods research approach, combining both quantitative and qualitative methods to gain a comprehensive understanding of the barriers and opportunities associated with climate-resilient irrigation farming in Dutse LGA, Jigawa State. The mixed-methods design enables the triangulation of diverse data sources, enhances the credibility of the findings, and facilitates an in-depth investigation of both quantifiable patterns and personal experiences. The quantitative section included structured survey questionnaires distributed to a representative sample of irrigation farmers. In contrast, the qualitative section involved Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) with stakeholders, including agricultural extension agents, traditional leaders, and local government representatives.

3.2 Study Area

The study was conducted in the Dutse Local Government Area (LGA), situated in the south-central region of Jigawa State, within the Sudan-Sahel ecological zone. This LGA is characterised by semi-arid climate conditions, with an average annual rainfall ranging

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from 600 mm to 900 mm. The populace primarily relies on subsistence and smallholder agriculture, with irrigation farming (utilising fadama lands, shallow wells, and tube wells) being a crucial source of income owing to the decreasing dependability of rain-fed agriculture. This area is vulnerable to climate-induced challenges, including prolonged droughts, seasonal fluctuations, and desertification, making it an ideal site for this study.

3.3 Population and Sampling

The focus population included all registered and non-registered smallholder irrigation farmers in Dutse LGA. A multi-stage sampling approach was adopted. In the first stage, five wards with significant irrigation activity were purposefully chosen: Limawa, Sakwaya, Kiyawa, Dundubus, and Yalwan Damai. In the second stage, random sampling was conducted to select 40 farmers from each ward, resulting in a total of 200 irrigation farmers for the quantitative survey.

For the qualitative aspect, five Focus Group Discussions (FGDs) were held (one for each ward), with each group consisting of 8-10 participants chosen based on gender and age. Additionally, ten Key Informant Interviews (KIIs) were conducted with key stakeholders, including officials from the Jigawa State Agricultural Development Programme (JARDA), community leaders, extension workers, and representatives from local farmer cooperatives.

3.4 Data Collection Instruments

Data collection utilised a semi-structured questionnaire designed to gather information on participants' socioeconomic attributes, access to irrigation resources, exposure to climate risks, current adaptation strategies, and perceived obstacles and opportunities. The questionnaire consisted of both closed-ended and open-ended questions.

For qualitative data, FGD and KII guides were created to examine topics such as local perspectives on climate change, traditional coping strategies, institutional support, and the influence of gender on adaptation. All instruments underwent pre-testing in a pilot survey to ensure they were clear, relevant, and culturally suitable.

3.5 Method of Data Analysis

Quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were employed to summarise the characteristics of respondents and their adaptation behaviours. Inferential analysis, including logistic regression, was applied to identify the predictors of climate-resilient adaptation practices.

Logistic Regression Model Construction: To quantitatively assess the likelihood of farmers adopting climate-resilient irrigation techniques (such as mulching, water conservation methods, and the use of solar pumps), a binary logistic regression analysis was conducted. The dependent variable was coded in binary form:

- 1 for *adopters* of at least one climate-resilient irrigation practice,
- 0 for *non-adopters*.

The independent variables included:

- Education Level (0 = no formal education, 1 = formal education),
- Extension Contact (0 = no contact, 1 = contact),
- Access to Credit (0 = no access, 1 = access),
- Farm Size (continuous, in hectares),
- Farming Experience (continuous, in years),
- Gender (0 = female, 1 = male).

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Logistic Regression Model: Let PPP represent the probability that a farmer adopts climate-resilient irrigation practices. The logistic regression model is expressed as:

$$\text{Log}(P1-P)\beta 0+\beta 1(\text{Education})+\beta 2(\text{Extension})+\beta 3(\text{Credit})+\beta 4(\text{Farm Size})+\beta 5(\text{Experience})+\beta 6(\text{Gender})+\varepsilon$$

Qualitative data gathered from focus group discussions (FGDs) and key informant interviews (KIIs) were analysed thematically using NVivo software. The transcripts were coded and examined to identify recurring themes and patterns related to adaptation obstacles, indigenous knowledge systems, institutional dynamics, and prospects for enhancing resilience strategies. These insights were cross-verified with quantitative findings to improve the richness and validity of the conclusions.

To ensure the study's validity, the instruments were evaluated by specialists in climate adaptation, agricultural extension, and rural development. A pilot study was conducted in a neighbouring local government area (LGA) to identify and rectify any inconsistencies. The reliability of the quantitative tool was measured using Cronbach's alpha, yielding a coefficient of 0.82, which indicates a strong internal consistency. Using multiple data sources (surveys, FGDs, KIIs) facilitated methodological triangulation, thereby bolstering the credibility of the results.

The Jigawa State Ministry of Agriculture Research Ethics Committee granted ethical approval for the study. Informed consent was obtained from all participants, who were assured of anonymity, confidentiality, and the voluntary nature of their involvement. Participants were also informed of their right to withdraw at any time without consequences. Data were securely stored and exclusively utilised for academic purposes.

Despite employing a meticulous methodology, certain limitations are recognised. Firstly, the dependence on self-reported data may lead to recall bias or social desirability bias. Secondly, focusing on a single LGA may limit the extent to which the findings can be generalised to other areas. Lastly, the cross-sectional design of the research restricts its capacity to capture seasonal variations in adaptation strategies. Nevertheless, the mixed-methods approach and the depth of local engagement offer valuable insights for policy and practice.

4. Data Analysis and discussion of Result

This part of the paper presents and discusses the findings of the study focused on climate-resilient irrigation farming in Dutse LGA. The analysis is structured into three key sections: (i) the socioeconomic characteristics of the respondents, (ii) quantitative results regarding barriers and opportunities for climate adaptation, and (iii) qualitative insights derived from FGDs and KIIs.

A total of 200 irrigation farmers were surveyed across five wards in Dutse LGA. The demographic and socioeconomic profile of the respondents is outlined in Table 1 and elaborated upon below.

Table 1: Socioeconomic Characteristics of Respondents (N = 200)

Variable	Category	Frequency	Percentage (%)
Gender	Male	156	78.0
	Female	44	22.0
Age Group (years)	18–30	38	19.0
	31–45	92	46.0
	46–60	54	27.0
	Above 60	16	8.0

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Variable	Category	Frequency	Percentage (%)
Marital Status	Married	172	86.0
	Single	18	9.0
	Widowed/Divorced	10	5.0
Educational Attainment	No formal education	48	24.0
	Primary	58	29.0
	Secondary	64	32.0
	Tertiary	30	15.0
Farming Experience (years)	Less than 5	42	21.0
	6–10	88	44.0
	11–20	46	23.0
	Above 20	24	12.0
Farm Size (hectares)	Less than 1	71	35.5
	1–2	81	40.5
	3–5	38	19.0
	Above 5	10	5.0
Main Source of Irrigation	Tube well	72	36.0
	Fadama (floodplain)	64	32.0
	Motorised pumping (diesel)	38	19.0
	Solar-powered pumping	26	13.0

The analysis of socioeconomic data reveals that irrigation farming in Dutse LGA is primarily dominated by men (78%). However, a significant 22% of the respondents are women, indicating a rising, although still limited, involvement of females in irrigation agriculture. The majority of respondents (46%) fall within the productive age range of 31 to 45 years, suggesting a relatively youthful farming demographic with vigour and potential for innovation.

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Regarding educational background, 76% of farmers have attained at least a primary level of education, with 15% having completed tertiary education. This degree of educational achievement is promising, as it enhances the chances of understanding and implementing climate-smart practices (Musa & Adamu, 2023).

A majority of respondents (86%) are married, suggesting that irrigation farming serves as a vital source of income for family units. The level of farming experience is notably high, with 44% having 6 to 10 years of experience and 23% possessing between 11 and 20 years of experience. This wealth of experience indicates a considerable amount of indigenous knowledge and adaptive techniques that could be leveraged for more structured interventions.

Concerning land ownership, 76% of the respondents cultivate 2 hectares or less, reflecting small-scale farming operations. This situation is consistent with the general profile of smallholder agriculture in northern Nigeria, which is typically labour-intensive and resource-constrained. The prevalent use of tube wells (36%) and fadama land (32%) indicates dependence on traditional and semi-modern irrigation methods. Only 13% of farmers reported utilising solar-powered systems, underscoring the limited adoption of renewable irrigation technologies, mainly due to issues related to cost and accessibility.

These socioeconomic traits are crucial for understanding both the challenges and opportunities associated with climate-resilient irrigation. For example, smaller land sizes and restricted financial means may limit investment in modern irrigation systems. Conversely, educational levels and youth engagement could facilitate the adoption of innovative adaptation practices if supported by enabling conditions such as extension services and credit availability.

4.2 Challenges to Climate-Resilient Irrigation

Both quantitative and qualitative findings highlight several interconnected challenges that obstruct the successful implementation of climate-resilient irrigation methods among farmers in Dutse LGA. These obstacles can be divided into technical, institutional, economic, socio-cultural, and environmental categories. Table 2 presents a summary of the frequency of significant challenges reported by survey participants.

Table 2: Reported Barriers to Climate-Resilient Irrigation (N = 200)

Barrier	Frequency	Percentage (%)
High cost of irrigation equipment and fuel	154	77.0
Limited access to extension services	138	69.0
Inadequate access to climate information	122	61.0
Poor access to credit facilities	114	57.0
Erratic electricity and low solar coverage	106	53.0
Lack of water storage infrastructure	88	44.0
Gender discrimination in land access	72	36.0
Cultural misconceptions about climate change	61	30.5

Discussion:

The primary barrier cited was the high expense of irrigation equipment and fuel, noted by 77% of participants. Increasing diesel prices, along with a lack of subsidised alternatives, have rendered motorised farming unfeasible for the majority of smallholders.

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This observation is consistent with the findings of Ahmed and Ibrahim (2024), who highlighted the cost-prohibitive nature of irrigation technology in northern Nigeria.

Approximately 69% of farmers reported having limited access to agricultural extension services, which restricts their exposure to innovative and climate-resilient practices. Many reported that extension agents visit infrequently, often only once or twice a year, typically after crucial planting decisions have already been made. This situation results in poorly timed advice, limited awareness of weather conditions, and inadequate adoption of improved irrigation methods.

Access to climate information remains unsatisfactory for 61% of farmers. Most rely on traditional indicators (like cloud formations or wind directions), which have become less reliable due to changing climate trends. Those with access to mobile devices rarely receive specific climate notifications, as digital platforms are underutilised due to language, cost, and literacy challenges.

Around 57% of respondents mentioned limited access to credit as an obstacle. Although there are various government programs, such as the Anchor Borrowers' Programme and NIRSAL loans, many farmers expressed frustration over the extensive documentation needed and perceived bias in loan distribution.

Concerns regarding unreliable electricity and limited access to solar irrigation technology were raised by 53% of participants. Farmers expressed dissatisfaction with the frequent power outages that disrupt the use of electric pumps, while solar systems were viewed as too expensive, despite their long-term advantages.

Qualitative insights from focus group discussions supported the findings from these quantitative results. Women participants highlighted issues of land tenure insecurity and exclusion from decision-making roles, pointing out that patriarchal norms impede their access to land and productive resources. Additionally, many participants shared cultural misconceptions, such as attributing extreme weather events to divine retribution, which affects their proactive measures for climate adaptation.

4.3 Opportunities and Adaptive Practices

Notwithstanding the identified challenges, participants mentioned several adaptive strategies and opportunities, suggesting potential avenues to strengthen climate resilience. These are summarised in Table 3.

Table 3: Existing Adaptive Strategies and Emerging Opportunities (N = 200)

Adaptive Strategy / Opportunity	Frequency	Percentage (%)
Use of traditional water conservation (e.g., sand bunds)	142	71.0
Participation in community irrigation groups	128	64.0
Use of multiple cropping or intercropping	106	53.0
Application of organic manure and mulching	94	47.0
Support from government/NGO schemes	72	36.0
Solar-powered irrigation adoption (emerging)	44	22.0
Access to indigenous climate knowledge	120	60.0

Discussion: Many farmers employ traditional methods to conserve water, such as planting in shaded areas, constructing bunds, or applying organic mulch to maintain soil moisture. Approximately 64% are members of community irrigation groups that share tools, exchange labour, and coordinate water usage, fostering resilience through collective efforts.

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Farmers also adopt intercropping and multiple cropping strategies to reduce the risk of complete crop failure due to climate variability. Practices such as applying manure and using mulch help sustain soil fertility and decrease evaporation, which aligns with the tenets of climate-smart agriculture.

Some participants mentioned receiving help from government and NGO support initiatives, such as training on irrigation efficiency and the supply of tools. However, access to this support was inconsistent and limited.

A growing number of farmers (22%) have either adopted or are experimenting with solar-powered irrigation, often supported by donor-funded programs. While this adoption rate is still relatively low, it signifies a crucial opportunity for growth, provided that affordability and technical assistance can be enhanced.

Interestingly, 60% of participants acknowledged the significance of indigenous climate knowledge that has been inherited through generations. Merging this traditional knowledge with scientific weather data was viewed as a culturally relevant approach to bolster resilience.

Logistic Regression Analysis: A binary logistic regression analysis was performed to investigate the factors influencing the adoption of climate-resilient irrigation practices (such as mulching, water-saving methods, and solar pumps), utilising key independent variables like education, availability of extension services, land size, access to credit, and farming experience.

Table 4: Logistic Regression Results

Predictor Variable	B Coefficient	Sig. (p-value)	Odds Ratio (Exp(B))
Education Level	0.894	0.003**	2.445
Extension Contact	1.136	0.000**	3.114
Access to Credit	0.785	0.015*	2.193
Farm Size	0.302	0.094	1.352
Farming Experience	0.167	0.148	1.181
Gender (Male = 1)	0.271	0.321	1.311

Note: *Significant at 0.05 level, **Significant at 0.01 level

Interpretation: The level of education emerged as a statistically significant predictor ($p = 0.003$), with an odds ratio of 2.445, suggesting that farmers with formal education are more than twice as likely to implement climate-resilient irrigation practices compared to their counterparts without formal education. The strongest predictor identified was extension contact ($p < 0.001$), with an odds ratio of 3.114, underscoring the crucial role of agricultural extension agents in facilitating adaptation through effective information communication. Furthermore, access to credit had a significant positive impact ($p = 0.015$), indicating that financially empowered farmers are more inclined to invest in climate-resilient strategies. In contrast, farm size, farming experience, and gender demonstrated positive associations with adoption, but their influence was not statistically significant at the 5% level. The findings suggest that access to extension services, education, and financial resources is vital in enabling climate adaptation. Conversely, technical and institutional barriers, such as elevated input costs, weak extension systems, and cultural norms, hinder the adoption of resilient practices. Initiatives aimed at strengthening extension delivery, enhancing access to climate information, subsidising solar irrigation systems, and promoting inclusive community engagement are essential to closing the adaptation gap in Dutse LGA.

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5. Conclusion and Recommendations

Conclusion

This research investigated the obstacles and opportunities related to climate-resilient irrigation farming in Dutse Local Government Area (LGA), Jigawa State, Nigeria, within the broader framework of climate change adaptation and rural sustainability. Utilising a mixed-methods approach that involved 200 irrigation farmers, five focus group discussions (FGDs), and ten key informant interviews (KIIs), the study uncovered a complex interaction of socioeconomic, institutional, and environmental elements influencing adaptation outcomes. The results indicate that smallholder farmers in Dutse LGA are aware of climate change and are implementing various adaptive strategies, including traditional water conservation, intercropping, organic mulching, and community-based irrigation groups. Nevertheless, these initiatives are significantly limited by systemic barriers, including the high costs of irrigation equipment, restricted access to extension services, a lack of timely climate information, and limited access to credit facilities. Gender-based disparities in land access and cultural misconceptions also undermine adaptation efforts, especially for women. The regression analysis affirmed that education, extension contact, and access to credit play a significant role in the adoption of climate-resilient practices. Conversely, the adoption rate remains low among less educated, isolated, and economically disadvantaged farmers. Although opportunities such as community-based adaptation, solar-powered technologies, indigenous knowledge systems, and new government support schemes are available, they remain underutilised or unevenly distributed within farming communities. The study emphasises the importance of a multifaceted, inclusive, and locally driven approach to climate adaptation—one that enhances institutional capacity, promotes financial inclusion, advances gender equity, and incorporates local knowledge systems. Addressing the adaptation gap in Dutse LGA calls for not only technical interventions but also social, cultural, and policy adjustments.

Recommendations

Based on the findings of this study, the following suggestions are put forth:

1. Enhance Agricultural Extension Services

Agricultural extension networks should be broadened, adequately funded, and trained in climate-smart practices. Agents stationed locally should maintain consistent engagement with irrigation farmers, particularly during the planting and harvesting periods.

2. Support Climate-Resilient Irrigation Technologies

The government, in collaboration with development partners, ought to provide subsidies for solar-powered pumps and water-saving technologies to increase accessibility for smallholder farmers. Partnerships between the public and private sectors could be crucial in promoting renewable irrigation solutions.

3. Enhance Access to Climate Information

There should be development and expansion of community radio initiatives, the use of local languages, and farmer networks to convey weather predictions and agricultural advice to rural populations. Merging traditional knowledge with contemporary meteorological data can improve decision-making at the community level.

4. Encourage Inclusive Credit Schemes

Microfinance organisations and agricultural banks should create customised loan options for irrigation farmers. Loan requirements should be simplified, and assistance should be provided to both male and female farmers, regardless of their literacy levels.

5. Tackle Gender Inequality in Land Access

Policymakers need to enforce fair land distribution and encourage women's involvement in irrigation programs. This can be accomplished through gender-inclusive cooperatives and awareness campaigns regarding land rights.

6. Integrate Local and Traditional Knowledge into Climate Policy

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The innovations of farmers and indigenous adaptation methods should be officially recognised and incorporated into local and state-level adaptation strategies.

7. Invest in Water Infrastructure

Public spending on water harvesting, small dams, and community reservoirs can help alleviate water scarcity issues and decrease reliance on unpredictable rainfall.

By adopting these suggestions, Dutse LGA and other comparable agro-ecological regions in Northern Nigeria can enhance their capacity to adapt and develop climate-resilient agricultural systems that align with national policy objectives and global sustainable development goals.

References

[1]. Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2014). Cultural Dimensions of Climate Change Impacts and Adaptation. *Nature Climate Change, 3*(2), 112–117. https://doi.org/10.1038/nclimate1666

[2]. Ahmed, L., & Ibrahim, A. (2024). Cost Barriers and Solar Technology Adoption in Irrigation Farming: Evidence from Northern Nigeria. *Nigerian Journal of Agricultural Economics, 18*(2), 55–72.

[3]. Aluko, O. O., & Magaji, S. (2020). Stagflation and poverty incidence in West Africa sub-region: Some perspectives. *International Journal of Advanced Research in Social Sciences, Environmental Studies, and Technology*, 5(1), 38–59.

[4]. Ayanlade, A., & Radeny, M. (2023). Climate Change Perception and Adaptation in Nigerian Agriculture. *Journal of Climate Adaptation Research, 15*(1), 21–35.

[5]. Bello, S. A., Usman, K., & Nwankwo, M. (2023). Local governance and climate resilience in irrigation: A study of Sokoto and Kebbi States. *Journal of Rural Development Studies, 12*(4), 102–118.

[6]. Chukwu, J. N., & Abdulmalik, H. A. (2023). Mobile Platforms for Climate Adaptation: Challenges of Digital Literacy in Rural Nigeria. *African Journal of ICT for Development, 7*(1), 66–81.

[7]. DFID. (1999). *Sustainable Livelihoods Guidance Sheets*. London: Department for International Development. Retrieved from https://www.ennonline.net/dfidsustainableliving

[8]. Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.

[9]. Federal Ministry of Agriculture and Food Security. (2024). *National Agricultural Performance Review Report*. Abuja: FMAFS.

[10]. Federal Ministry of Environment. (2021). *National Adaptation Plan (NAP)*. Abuja: Department of Climate Change.

[11]. Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. *Ecology and Society, 15*(4), 20.

[12]. Ibrahim, M., Olusola, A. T., & Magaji, S. (2025). Effects of Climate Change on Environmental Security among Vulnerable Groups in Zango Kataf Local Government Area, Kaduna State. *Loka: Journal of Environmental Sciences*, 2(2), 228–250.

[13]. Ismail, A., Bash, K. M., & Magaji, S. (2019). Socio-economic and cost-effective deforestation compliance policies versus deterrence models of regulatory compliance. *European Scientific Journal*, 15(28), 253.

[14]. Jafaru, Y., Aliyu, M.D. & Sule, M (2025). Assessing the Socio-Economic Impact of Climate Change and Poverty in Birnin Kudu Local Government, Jigawa State, Nigeria. *African Journal of Social Sciences and Humanities Research 8 (2), 11-31*

[15]. Magaji, S. & Musa, I. (2015). Effect of Household Income on Child Labour in Nigeria. Lapai *International Journal of Management and Social Sciences* 8 (1), 32-56

[16]. Magaji, S. (2008). "Family Poverty and Child Schooling in Abuja: Intervention Areas for Sustainable Development." *Nigerian Journal of Educational Administration and Planning. 8 (3). 351-367*

[17]. Magaji, S., & Adamu, A. M. (2011). "Youth Employment in Nigeria Since Independence". Nigeria at fifty: issues and challenges in governance. International Conference on Nigeria at 50. September, Abuja. Pp. 686-707

[18]. Magaji, S., & Musa, I. (2024). Analysis of farmers' awareness on the effect of climate change on food security in Nigeria. *International Journal of Humanities, Social Science and Management*, 4(3), 439–454.

[19]. Magaji, S., Ahmad, A. I., Sabiu, S. B., & Yunusa, A. A. (2024). From deforestation to pollution: Unravelling environmental challenges in Nigeria and Pakistan. *International Journal of Humanities, Social Science and Management (IJHSSM)*, 4(2), 805–814.

[20]. Magaji, S., Musa, I., & Ismail, Y. (2025). Assessing the Impact of Income Inequality on Poverty Level in Nigeria Using Auto Regressive Distributed Lag Model. *New Advances in Business, Management and Economics*. 3(7), 148-166. DOI: https://doi.org/10.9734/bpi/nabme/v3/1480

[21]. Musa, A. Y., & Adamu, M. U. (2023). Education and Adaptation to Climate Change among Irrigation Farmers in Katsina and Jigawa States. *Journal of Environmental Studies and Policy, 15*(1), 88–104.

[22]. Nigeria Meteorological Agency (NIMET). (2023). *Annual Climate Review Report: Northern Nigeria*. Abuja: NIMET Publications.

[23]. Odjugo, P. A. O. (2021). Climate Change and Its Implications for Agriculture in Northern Nigeria. *Journal of Environmental Management and Climate Research, 10*(3), 33–49.

[24]. Olayemi, T., & Oni, B. (2022). Climate information services and irrigation adaptation: The role of extension agents in Northern Nigeria. *Journal of Agricultural Policy and Extension, 9*(2), 45–60.

[25]. Sabiu, S. B., & Magaji, S. (2024). Effect of Oil Exploration and Climate Change on the Niger Delta Region of Nigeria. *Journal of Development and Society*, 6(1), 36–49.

[26]. Tanko, M. I., & Suleiman, R. H. (2024). Gender barriers in irrigation farming: Evidence from Bauchi and Yobe States. *Nigerian Journal of Gender and Development, 11*(1), 21–38.

[27]. Tanko, Y., Magaji, S., & Musa, I. (2025). Impact of Green Finance on Climate Change Mitigation in Nigeria. *International Journal of Economic Perspectives*, 19(7), 1–22.

[28]. UNDP. (2023). *Integrating Climate Risk into Sustainable Development in the Sahel Region: Nigeria Country Report*. New York: United Nations Development Programme.

[29]. Usman, S., & Gambo, T. M. (2024). Market access and irrigation investment in the Hadejia Valley. *Nigerian Journal of Agricultural and Food Security, 14*(3), 75–93.

[30]. Yusuf, A., & Umar, I. (2024). Climate adaptation strategies in Northern Nigeria. *African Journal of Agricultural Policy, 9*(2), 44–60.

[31]. Yusuf, I. A., & Umar, M. T. (2024). Constraints to climate change adaptation among millet and sorghum farmers in Kano and Jigawa. *Journal of Climate and Food Systems in Africa, 8*(1), 25–39.