IMPACT OF THE HADEJA JAMA'ARE RIVER BASIN DEVELOPMENT AUTHORITY (HJRBDA) ON AGRICULTURAL PRODUCTION AND FOOD SECURITY IN JIGAWA STATE

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ABSTRACT
This study assesses the effectiveness of the Hadejia Jama'are River Basin Development Authority (HJRBDA) in enhancing agricultural productivity and food security in Jigawa State, employing a mixed-methods approach within the framework of the hydraulic society theory. Quantitative data were collected from farmers utilising HJRBDA irrigation schemes, while qualitative insights were obtained through key informant interviews with policymakers and agricultural experts. The study findings reveal that while HJRBDA has contributed to increased rice and wheat production, its impact is hindered by infrastructural deficits, inconsistent policy implementation, and climate variability. Previous studies broadly classify River Basin Development Authorities (RBDAs) as ineffective, but this study identifies localised successes and argues for a differentiated approach to evaluating RBDA performance. The study advances the literature by integrating irrigation governance with food security discourse in semi-arid regions. It recommends increased funding for infrastructure maintenance and a more coordinated policy framework to enhance irrigation efficiency. Additionally, farmer training programs should be institutionalised to improve water management practices. This study contributes to existing scholarship by highlighting both the potentials and limitations of RBDAs in Nigeria, challenging the reductionist view that irrigation alone guarantees food security. It emphasises the need for an integrated policy approach that incorporates climate adaptation, market access, and institutional reforms to maximise the effectiveness of irrigation schemes in ensuring sustainable agricultural development and food security in Jigawa State.

Introduction

Agricultural production and food security are globally central to both socioeconomic stability and environmental sustainability. Food production underpins the economies of many countries, especially in regions where agriculture accounts for a significant portion of employment and GDP. However, factors like climate change, water scarcity, and land degradation have increasingly threatened the availability of resources critical to food production, particularly in developing economies. Globally, over 800 million people are food insecure, with a significant portion in Africa (FAO, 2023). Many countries have initiated policies and projects aimed at enhancing food production and security by implementing irrigation systems and improving water management practices, essential for buffering against erratic rainfall patterns that threaten crop yield stability (FAO, 2023).

In Africa, where a large portion of the population depends on subsistence farming, food security is intimately linked to water access and climate resilience. The continent hosts multiple river basins that support agricultural activities, including the Nile, Niger, and Zambezi. The sustainability of these water sources is vital, as they enable irrigation, fishing, and other agricultural activities. Many African countries are adopting advanced river basin management systems and enhancing infrastructure to maximise agricultural productivity. Egypt, for example, has increased its dependency on the Nile River through efficient water management practices and policy frameworks supporting irrigation projects to address food shortages and secure a stable food supply for its growing population (El-Sherif et al., 2023).

Meanwhile, Ethiopia has been investing in the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile, which, despite tensions with downstream countries, is intended to boost irrigation potential and hydroelectric power, with the aim of improving local agricultural productivity and food security (Gebrehiwot, 2022). These cases underscore the strategic importance of river basin management to bolster food production in regions susceptible to climate variability and limited rainfall. Across the Sahelian regions of Africa, including parts of Nigeria, drought and desertification have been accelerating. These environmental pressures increase the importance of effective water management systems like HJRBDA, as irrigation could provide a critical safeguard against food shortages in times of drought. In 2023, Chad, for example, implemented large-scale irrigation initiatives targeting drought-prone areas, with success in increasing rice and maize yields (Ibrahim et al., 2023). Similarly, Kenya's Tana River Basin has implemented improved water management to support agriculture, reducing dependency on unpredictable rainfall. The success in these regions illustrates the potential of well-managed river basins to improve food security and agricultural productivity.

Nigeria, being part of the Sub-Saharan region and one of Africa's most populous nations, faces distinct challenges concerning food security. The country grapples with population pressure, climate change, and insufficient water resource management, all of which impact agricultural productivity. Agriculture remains crucial in Nigeria, providing jobs for over 35% of the labour force, with a substantial portion of agricultural output depending on rain-fed farming (NBS, 2022). This dependency makes the agricultural sector highly vulnerable to climate-related disruptions, particularly in the northern regions, where seasonal and erratic rainfall patterns limit crop yields and threaten food availability. Nigeria established several River Basin Development Authorities (RBDAs), including the Hadeja Jama'are River Basin Development Authority (HJRBDA), aimed at improving irrigation infrastructure and supporting food production through better water resource management. The RBDAs are mandated to facilitate agricultural development, increase water supply for various uses, and improve flood control. Despite the ambitious objectives, the effectiveness of these RBDAs has varied, with significant challenges arising from inadequate funding, poor infrastructure, and limited stakeholder engagement (Adamu & Zakar, 2023).

The Hadeja Jama'are River Basin, in particular, plays a critical role in Nigeria's food security landscape. Covering areas within Jigawa, Kano, and Bauchi states, the basin supports thousands of hectares of agricultural land. It serves as a major water source for both smallholder and large-scale farms. The HJRBDA was established to promote sustainable irrigation and increase crop production in a region heavily reliant on seasonal rains. The Hadeja-Jama'are Basin has also become vital due

to its proximity to Lake Chad, a water body that has experienced drastic shrinkage over the past decades. This reduction has significantly impacted agricultural activities, fisheries, and local livelihoods dependent on the lake. Consequently, effective management of the Hadeja Jama'are Basin has become a priority, not just for Jigawa State but for the broader Lake Chad Basin area, which includes several countries dependent on this ecosystem (Olufemi et al., 2023).

In Jigawa State, the HJRBDA has contributed to notable increases in the cultivation of crops like rice, wheat, and vegetables, which are essential for food security in Nigeria. Rice production, in particular, has surged due to enhanced irrigation and government support through agricultural policies. Rice is a staple in Nigeria, and domestic production is essential to reduce the high costs associated with rice imports. However, these advances have not been without challenges. Despite HJRBDA's success in some areas, farmers in Jigawa State face difficulties due to issues like inadequate maintenance of irrigation infrastructure, conflicts over water usage, and insufficient technical support to maximise agricultural yield (Yusuf & Abdullahi, 2023). Another challenge affecting HJRBDA's impact on agricultural productivity is climate change. Increasing temperatures and shifting rainfall patterns impact water availability in the Hadeja Jama'are Basin, as well as other basins across Nigeria. The Sahelian zone, where Jigawa is located, has been experiencing higher-than-average temperatures and increasingly erratic rainfall patterns. This has led to fluctuations in river flow and, consequently, in the reliability of irrigation systems. For instance, in the past decade, recurring floods and droughts have affected the region, causing both crop losses and displacement of farming communities. The erratic nature of these events calls for adaptive water management strategies, including improved water storage, flood control measures, and resilient crop varieties that can withstand harsher conditions (Adetunji et al., 2022). Insufficient funding and lack of coordination between federal, state, and local governments have hampered the effectiveness of river basin authorities in Nigeria (Musa, Ahmed, & Suleiman, 2022). The HJRBDA has contributed to some improvements in agricultural production. However, the lack of continuous investment in irrigation infrastructure and the absence of comprehensive policies addressing climate resilience have limited the potential gains. It is against this backdrop that this study examined the impact of the Hadeja Jama'are Basin Authority on Agricultural production and food security in Jigawa State.

"It is against this backdrop that this study examines the impact of the Hadeja Jama'are Basin Authority on agricultural production and food security in Jigawa State. While previous studies have explored various aspects of river basin management in Nigeria, there remains a gap in the literature regarding the specific role of HJRBDA in mitigating the challenges of climate variability, irrigation inefficiencies, and policy implementation at the local level. This study aims to address this gap by assessing the effectiveness of HJRBDA in enhancing food security and agricultural sustainability in Jigawa State."

Statement of the Research Problem

The Hadeja Jama'are River Basin Development Authority (HJRBDA) was established to enhance agricultural productivity and food security in Jigawa State by providing sustainable irrigation infrastructure and water management systems. However, despite its existence, the region continues to experience erratic agricultural output due to climate variability, inefficient irrigation practices, and weak policy implementation. Jigawa State, located in the Sahelian zone, is highly vulnerable to climate change, with increasing temperatures and irregular rainfall patterns affecting crop yields. Annual rainfall in northern Nigeria has decreased by 15% over the past two decades, leading to prolonged dry spells that disrupt farming activities (Nigerian Meteorological Agency (NiMet, 2023). The inadequacy of irrigation infrastructure under HJRBDA has further compounded this issue, as many irrigation channels remain underdeveloped or poorly maintained, limiting farmers' access to water. Despite government interventions, only 30% of irrigable land in Jigawa State is currently utilised, compared to the national average of 45% (Adamu & Zakar, 2023). This shortfall in irrigation development restricts farmers from cultivating crops year-round, exacerbating food insecurity.

Furthermore, policy inconsistencies and poor coordination between federal and state governments have hindered the full potential of

HJRBDA. Many farmers lack access to extension services, improved farming techniques, and financial support to adopt climate-resilient practices. Musa, Ahmed, and Suleiman (2022) highlight that over 60% of farmers in the region rely on rain-fed agriculture, leaving them exposed to climate shocks. Additionally, security challenges, including farmer-herder conflicts and banditry, have disrupted farming activities, displacing thousands of rural households. The persistent challenges faced by HJRBDA indicate a significant gap in the literature regarding its effectiveness in addressing climate variability, irrigation inefficiencies, and policy implementation. This study seeks to critically examine these gaps and propose sustainable interventions to enhance food security in Jigawa State.

Clarification of Concepts

i. **Agricultural Production:** Agricultural production encompasses the processes involved in cultivating crops and rearing livestock to sustain food supply and economic growth. In Jigawa State, the reliance on rain-fed agriculture limits productivity, making irrigation crucial for stabilising yields. However, inefficient irrigation systems and climate variability disrupt farming activities, leading to seasonal food shortages (Adamu & Zakar, 2023). The Hadeja Jama'are River Basin Development Authority (HJRBDA) was established to address these issues, yet its impact remains constrained by poor infrastructure, limited funding, and policy inconsistencies (Musa et al., 2022). Emerging research emphasises the need for climate-smart agriculture and precision irrigation to optimise water use and enhance food production (Olufemi et al., 2023). Strengthening HJRBDA's role in promoting efficient water management alongside modern agricultural practices is imperative for achieving food security and economic stability in Jigawa State, particularly in the face of increasing climate-induced challenges (NiMet, 2023).

ii. **Food Security**: Food security refers to the availability, accessibility, and affordability of nutritious food for a population. In Jigawa State, erratic rainfall and inefficient irrigation have exacerbated food insecurity, threatening livelihoods (Adamu & Zakar, 2023). The Hadeja Jama'are River Basin Development Authority (HJRBDA) plays a pivotal role in mitigating these challenges, yet gaps in policy implementation and infrastructure hinder its effectiveness (Musa et al., 2022). Strengthening adaptive water management and integrating climate-resilient farming practices could enhance food security. A shift towards precision agriculture and sustainable irrigation is crucial for long-term stability (Olufemi et al., 2023).

iii. **Irrigation:** Irrigation is the artificial application of water to support crop production, which is crucial in regions with erratic rainfall, like Jigawa State. The Hadeja Jama'are River Basin Development Authority (HJRBDA) was established to enhance irrigation, yet inefficiencies persist due to outdated infrastructure and poor water governance (Adamu & Zakar, 2023). Climate change has further strained water availability, necessitating adaptive strategies such as drip irrigation and smart water management systems (Musa et al., 2022). Integrating technology-driven irrigation models with community participation could optimise water use, improve yields, and strengthen food security in arid zones (Olufemi et al., 2023).

iv. **Climate Resilience:** Climate resilience involves the capacity of systems, communities, and ecosystems to cope with, adapt to, and recover from climate-related stresses, such as extreme weather events and shifting seasonal patterns. In agriculture, resilience includes adopting drought-tolerant crops, improving water management, and implementing sustainable farming practices. Building climate resilience is essential for maintaining agricultural productivity and food security amid climate variability (IPCC, 2023). Resilient practices protect livelihoods, reduce disaster risks, and support environmental sustainability (Adetunji et al., 2022).

Research Methodology

Data Collection and Analysis

This study adopts a mixed-methods approach, integrating quantitative and qualitative methods to assess the impact of the Hadeja Jama'are River Basin Development Authority (HJRBDA) on agricultural production and food security in Jigawa State. According to the National Population Commission (NPC, 2022), Jigawa State has an estimated population of 6.2 million people. The study's sample size is determined using Taro Yamane's (1968) formula:n=N1+N(e2)n = \(N)(1 + N(e^2). Where N is the population size, e is the margin of error (0.05), and n represents the sample size. This calculation provides a scientifically valid sample size for data collection. A multi-stage sampling technique, combining probability and non-probability approaches, is used. Stratified random sampling ensures fair representation of farmers across various LGAs under HJRBDA's jurisdiction, while purposive sampling targets key stakeholders, including agricultural officers, irrigation experts, and policymakers. Data collection involves structured questionnaires administered to farmers and semi-structured interviews with stakeholders. Quantitative data was analysed using descriptive and inferential statistics, such as regression analysis, to examine the relationship between irrigation practices and food security. Qualitative data was subjected to thematic analysis to extract meaningful insights. This methodological approach ensures a comprehensive assessment of HJRBDA's role in enhancing agricultural productivity in Jigawa State.

Theoretical Framework

This study will adopt the hydraulic society theory, propounded by Karl Wittfogel (1957), Donald Worster (1985), and Marty Melosi (2000). The theory posits that societies relying on large-scale irrigation and water management systems develop centralised governance structures to control water resources effectively. Wittfogel (1957) argued that hydraulic civilisations, such as ancient China and Mesopotamia, depended on bureaucratic control over irrigation for agricultural sustainability. Worster (1985) expanded this perspective by linking water management to environmental determinism, emphasising the role of irrigation in shaping social and economic hierarchies. Melosi (2000) further contextualised the theory within modern governance, stressing the interdependence of water resource management, policy frameworks, and technological advancements in contemporary agricultural systems. These theoretical foundations make the Hydraulic Society Theory relevant in assessing the HJRBDA's role in food security through water governance and irrigation development.

Unlike previous studies that applied the Hydraulic Society Theory to broad irrigation management and state control, this study focuses on its micro-level impact in Jigawa State, specifically analysing how HJRBDA's water governance structure influences smallholder farmers' productivity. While past research emphasised state control and resource monopolisation, this study examines how decentralised irrigation practices affect local food security, stakeholder participation, and climate resilience. Additionally, earlier works on Nigeria's River Basin Authorities have primarily highlighted policy inefficiencies. In contrast, this research integrates empirical data to assess how irrigation interventions directly affect agricultural output and food security metrics in Jigawa State. By using mixed-methods analysis, this study expands the theory's frontier beyond governance structures to the practical implications of water access, infrastructure efficiency, and climate adaptation strategies within a specific regional context.

Relationship between Agricultural Production and Food Security: A Perspective

Agricultural production is the backbone of food security worldwide, as it determines the availability, accessibility, and affordability of food. According to FAO (2023), global agricultural output has been significantly impacted by climate change, land degradation, and population growth, affecting food security, particularly in developing regions. However, while FAO emphasises the importance of technological innovation in improving agricultural yields, it does not fully explore the socio-political dynamics that hinder effective implementation. A more nuanced examination by local scholars is necessary to bridge the gap between global policy prescriptions and local realities.

In the study of Olayemi (2022), agricultural production in Africa has been constrained by inadequate infrastructure, poor irrigation facilities, and climate variability, all of which undermine food security. While Olayemi correctly highlights the necessity of sustainable land use and irrigation to enhance agricultural resilience, his study overlooks the role of government policies in mitigating these challenges. Policy interventions, such as subsidies and extension services, can significantly bolster agricultural productivity, thereby strengthening food security across the continent.

Similarly, Bello & Yusuf (2021) examine the relationship between agricultural productivity and food security in Nigeria, identifying climate variability, poor mechanisation, and inefficient water resource management as major constraints. Their findings align with previous studies emphasising these barriers but fail to adequately account for the role of smallholder farmers, who constitute the bulk of Nigeria's agricultural workforce. Addressing smallholder-specific challenges through improved access to credit and agricultural inputs could further solidify the nexus between food production and food security.

In the study of Ibrahim et al. (2023), an assessment of Nigeria's River Basin Development Authorities (RBDAs) revealed that irrigation projects contribute significantly to increased crop yield and food security. However, the study lacks a critical evaluation of the institutional inefficiencies within the RBDAs, particularly concerning mismanagement and policy inconsistencies. A more comprehensive analysis would need to consider the governance structures and funding mechanisms of these institutions to ensure sustainable agricultural productivity.

According to Yusuf & Abdullahi (2023), the Hadeja Jama'are River Basin Development Authority (HJRBDA) has played a crucial role in improving food production in Jigawa State by providing irrigation infrastructure and supporting smallholder farmers. While their study acknowledges the successes of HJRBDA, it underestimates the ongoing challenges, such as conflicts over water usage, siltation of irrigation channels, and limited technical expertise among farmers. Addressing these issues through strategic policy reforms and community engagement is critical to maximising the basin's potential for food security.

From the reviewed literature, it is evident that agricultural production and food security are deeply intertwined, with irrigation, climate resilience, and policy implementation playing pivotal roles. However, while global and national perspectives highlight broad challenges, local studies provide specific insights into the practical constraints affecting food security, particularly in Jigawa State. To enhance the impact of agricultural initiatives, there is a need for more integrative approaches that combine infrastructure development, policy support, and community-driven solutions tailored to the unique needs of the region.

Assessment of the Effectiveness of Hadejia Jama'are River Basin Development Authority (HJRBDA) in Agricultural Productivity and Food Security in Jigawa State

The assessment of the effectiveness of the Hadejia Jama'are River Basin Development Authority (HJRBDA) in agricultural productivity and food security in Jigawa State necessitates a critical interrogation of its institutional role, operational efficiency, and the broader theoretical implications of its interventions. This study will cover the extent to which HJRBDA has facilitated sustainable agricultural development in Jigawa State and its contributions compared with existing theoretical postulations on water resource management and food security.

Theoretically, this study engages with the hydraulic society theory, which emphasises the centrality of water management institutions in ensuring agricultural stability and social order (Wittfogel, 1957). If water control mechanisms are indeed pivotal to agricultural productivity, why has food security remained precarious in Jigawa State despite the presence of HJRBDA? This question situates the study within the broader debate on the effectiveness of River Basin Development Authorities (RBDAs) in Nigeria. While past studies have highlighted the role of RBDAs in irrigation expansion (Adamu & Zakar, 2023), empirical data suggest that challenges such as poor infrastructure, inefficient water distribution, and limited farmer engagement continue to undermine their potential. This study's findings align with

Adetunji et al. (2022), who argued that while RBDAs have contributed to irrigation schemes, their impact remains inconsistent due to climate variability and governance inefficiencies.

Empirical data from Jigawa State reveal that HJRBDA has made measurable contributions to agricultural productivity, particularly in the cultivation of rice and wheat, yet structural limitations persist. How does this align with global perspectives on irrigation and food security? Studies in Egypt and Ethiopia, where large-scale irrigation systems have significantly enhanced food production (El-Sherif et al., 2023; Gebrehiwot, 2022), demonstrate that effective water governance leads to increased crop yields. However, unlike Egypt's structured water management policies, HJRBDA operates under fragmented administrative and funding structures, limiting its overall efficiency. The inconsistency in policy implementation at the federal and state levels exacerbates this issue, mirroring Musa, Ahmed, and Suleiman's (2022) findings that a lack of coordination between governing bodies impedes sustainable agricultural development in Nigeria.

Comparatively, the study questions whether HJRBDA's irrigation interventions have significantly enhanced food security in Jigawa State. While Ibrahim et al. (2023) document increased maise and rice yields due to large-scale irrigation projects in Chad, findings in Jigawa show only marginal improvements in yield stability, with persistent challenges related to climate change and irrigation maintenance. This divergence suggests that while irrigation remains a fundamental tool for food security, its effectiveness is contingent on continuous investment, policy coherence, and climate adaptability. In Kenya's Tana River Basin, for instance, improved irrigation efficiency has reduced reliance on erratic rainfall, leading to sustained food production (Olufemi et al., 2023). The absence of a similar comprehensive approach in Jigawa State raises concerns about the sustainability of current agricultural interventions under HJRBDA.

Further interrogating the study's findings reveals both consistencies and deviations from previous research on agricultural productivity in Nigeria. According to Yusuf & Abdullahi (2023), the primary limitations of river basin authorities include inadequate funding, poor infrastructure maintenance, and water use conflicts—issues that this study reaffirms within the Jigawa context. However, while existing literature often frames RBDAs as largely ineffective, this study identifies pockets of success in localised irrigation projects that have increased rice production. This nuanced perspective challenges monolithic assessments of RBDAs and argues for a differentiated approach that acknowledges both institutional failures and site-specific successes.

The theoretical implications of these findings extend beyond HJRBDA's operational effectiveness to the broader discourse on food security governance in semi-arid regions. If water resource management is as crucial as posited by the hydraulic society theory, why does food insecurity persist despite extensive irrigation schemes? This contradiction suggests that water management alone is insufficient without complementary policies addressing input supply, farmer training, and market access. Musa et al. (2022) contend that beyond irrigation, a holistic approach involving climate adaptation strategies and stakeholder collaboration is essential for sustainable food security. This perspective aligns with this study's conclusion.

In summation, this study demonstrates that while HJRBDA has made contributions to agricultural productivity in Jigawa State, its impact remains constrained by systemic inefficiencies, inadequate funding, and climate variability. The findings both support and challenge existing literature by acknowledging the partial successes of irrigation projects while critiquing the broader inefficiencies in Nigeria's RBDA framework. Consequently, this study calls for policy reforms, improved funding mechanisms, and adaptive irrigation strategies to enhance food security outcomes in Jigawa State and beyond.

Discussion of Major Findings

The study identified six findings regarding the impact of the Hadeja Jama'are River Basin Development Authority (HJRBDA) on agricultural production and food security in Jigawa State.

i. **Impact on Agricultural Productivity**: The study finds that HJRBDA has contributed to increased rice and wheat cultivation in Jigawa State, aligning with previous studies that acknowledge the role of irrigation in enhancing crop yields (Adamu & Zakar,

2023). However, these gains are not uniform across all farming communities due to infrastructural limitations and climate variability.

ii. **Infrastructure Deficiencies**: Despite HJRBDA's mandate to improve irrigation, poor maintenance of irrigation canals and water distribution inefficiencies persist. This finding is consistent with Yusuf & Abdullahi (2023), who identified inadequate infrastructure as a major constraint limiting the success of RBDAs in Nigeria.

iii. **Policy and Administrative Challenges**: The study confirms Musa, Ahmed, and Suleiman's (2022) argument that inconsistent policy implementation and lack of coordination between federal and state agencies undermine RBDA efficiency. Unlike Egypt's structured water governance, HJRBDA suffers from fragmented administrative structures, limiting its effectiveness.

iv. **Climate Variability and Water Availability**: Findings indicate that unpredictable rainfall and recurring droughts in Jigawa State negatively impact irrigation reliability. Unlike large-scale projects in Chad and Kenya, which have adapted to climate challenges (Ibrahim et al., 2023; Olufemi et al., 2023), HJRBDA lacks sufficient adaptive strategies.

v. **Limited Farmer Engagement and Training**: The study highlights that while irrigation facilities exist, many farmers lack adequate training on water-efficient farming techniques. This aligns with Adetunji et al. (2022), who emphasised the need for technical support alongside irrigation expansion for sustainable productivity.

vi. **Partial Food Security Gains:** While irrigation has stabilised some crop yields, food insecurity remains prevalent due to market access issues and inconsistent policy support. This supports the argument by Musa et al. (2022) that irrigation alone is insufficient without complementary agricultural policies.

Conclusion

The findings of this study reaffirm the centrality of irrigation in agricultural productivity and food security, aligning with the hydraulic society theory, which underscores the role of water management in sustaining agriculture (Wittfogel, 1957). However, while previous studies (Adamu & Zakar, 2023; Yusuf & Abdullahi, 2023) have generally characterised RBDAs as inefficient due to infrastructural deficits and policy inconsistencies, this study presents a more nuanced perspective by highlighting localised successes within HJRBDA's interventions in Jigawa State. While irrigation schemes have improved rice and wheat cultivation, their impact remains constrained by climate variability, poor governance structures, and inadequate farmer engagement. Unlike studies in Egypt and Ethiopia (El-Sherif et al., 2023; Gebrehiwot, 2022), which emphasise structured water governance as key to irrigation success, findings in Jigawa State reveal that fragmented policies and weak institutional coordination undermine sustainability. Similarly, Ibrahim et al. (2023) documented substantial food security improvements through large-scale irrigation in Chad, whereas in Jigawa, gains remain marginal due to inconsistent support mechanisms. This study expands the discourse by arguing that while water resource management is critical, its effectiveness in ensuring food security depends on complementary policies addressing infrastructure, climate adaptation, and market access, thereby challenging reductionist views that attribute food security solely to irrigation development.

Recommendations

Based on the study's findings, the following six recommendations are proposed to enhance the impact of the Hadeja Jama'are River Basin Development Authority (HJRBDA) on agriculture and food security in Jigawa State:

i. The government and HJRBDA should prioritise the rehabilitation and expansion of irrigation canals, ensuring efficient water distribution by investing in modern irrigation technology, such as drip and sprinkler systems, which can mitigate infrastructural deficiencies and improve water efficiency.

ii. A structured and harmonised policy framework is needed to strengthen coordination between federal and state agencies by establishing a dedicated intergovernmental task force that can enhance policy implementation and streamline administrative functions for more effective water governance.

iii. HJRBDA should integrate climate resilience measures, such as constructing water reservoirs, promoting drought-resistant crop varieties, and implementing weather forecasting systems to enhance farmers' adaptive capacity against unpredictable rainfall and droughts.

iv. Capacity-building programmes should be introduced to educate farmers on water-efficient farming techniques, irrigation management, and modern agricultural practices.

v. The government should facilitate access to credit facilities, input subsidies, and efficient transportation networks to address food insecurity.

vi. **The government should establish** sustainable funding mechanisms, including public-private partnerships and international donor support, to ensure the continuous operation and maintenance of irrigation projects.

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