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A REVIEW OF FOOD INSECURITY IN NORTHERN NIGERIA: ADDRESSING THE CHALLENGE THROUGH IMPROVING TECHNICAL EFFICIENCY OF IRRIGATED RICE PRODUCTION

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ABSTRACT

This study reviewed food insecurity in Northern Nigeria and the prospects of addressing it through improving the technical efficiency of irrigated rice production in the region. The aim was to identify the existing challenges and prospects of improving the technical efficiency of irrigated rice production in the region as a panacea to food insecurity. Six empirical studies (two from each of the three geo-political zones) of Northern Nigeria were examined. Eleven publications were also reviewed through content analysis to determine the prospects of improving technical efficiency of rice production. The findings showed that technical efficiency under irrigated rice production in the region was 89%. Among other inputs, farm size was positive and significant in Sokoto ($p < 0.01$), Kwara ($p < 0.05$), Borno ($p < 0.01$) and Taraba States ($p < 0.01$) for increasing the output of irrigated rice. Thus, a unit increase in farm size would increase output by their respective coefficients. The challenges identified included low utilization of irrigable land, sub-optimal use of fertilizers and agrochemicals, inadequate extension services, and low access to farm credit. The northern region has prospects of improving irrigated rice productivity given its vast natural irrigation endowments and the huge investments in irrigation infrastructure and rice farming technologies. The study recommended, among others, strengthening the collaboration between agricultural extension with subject-matter specialists in the rice subsector for the training and retraining of irrigated rice farmers on the adoption of appropriate agricultural technologies as pathways for improving irrigated rice productivity and food security in Northern Nigeria.

Key words: agricultural technologies, food production, food safety, livelihoods, sustainability

INTRODUCTION

Food insecurity is a situation when people do not have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life at all times (FAO, 2006; Lawal *et al*., 2019; Akukwe, 2020). Food insecurity has continued to be one of the most fundamental human welfare challenges in developing economies. There has been a global deterioration in food security in the past four years. In the 2022 ranking of food security based on the Global Food Security Index which has a scoring of 1-100, 6 of the bottom 10 nations (with least scores) were from Sub-Saharan Africa. Nigeria occupied the 107th position (with a score of 42) out of 113 countries (The Economist Group, 2022; Thomas and Turk, 2023).

The food security situation in Northern Nigeria has over the years been impacted by violent conflicts, the insurgency in the North-East; armed banditry in the North-West; and the perennial farmer-herder conflicts in the North Central. Other contributing factors have been the rising unemployment, inflation, and poverty rates. Equally, the rising incidences of climate change related natural disasters like floods and droughts have compounded the problem of food production, availability, and affordability with deleterious effects on the conditions of living of citizens and invariably their food security status (CARE, 2023; World Food Programme [WFP], 2023).

The enormity of these challenges engendered by these drivers of food insecurity does not only impact on Northern Nigeria, but on the country as a whole. This is because; the North is not just the hub of food production in the country, but also the zone which holds the highest potential for actualizing the attainment of self-sufficiency in food production (Adenegan and Sanni, 2019; FAO, 2020). This is the central problem which this paper seeks to address. Addressing these challenges will require multi-faceted approaches. One of these which this study espouses is increasing the technical efficiency of major food staples like rice under irrigated agriculture. This is envisaged to be a necessary route for complementing rain-fed production for sustainable food security of the entire country.

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This stance is corroborated by statistics which have shown that more than 40% global increase in food production over the past 50 years was accounted for by irrigated areas, which have doubled in area. But while the global share of irrigated land rose from 13% to 21% between 1970 and 2019, for many countries in sub-Saharan Africa, like Nigeria, it has remained much lower at 0.5% (FAO, 2014; Takeshima *et al.,* 2017; FAO, 2021). Given the strategic importance of rice for the achievement of national food security and economic diversification of Nigeria (African Union, 2023), it is imperative to raise the average rice yield of 2 t ha^{-1} to meet at least the world average yield of 4.1 t ha^{-1} on the 630,000-ha irrigated segment of its production. This will increase output by about 1.7 million tonnes (paddy) or 1.1 million tonnes of milled rice (Price Water and Coopers [PWC], 2018; ThriveAgric, 2020). But beyond expanding the irrigated area for rice production, the efficiency and productivity of the mass of small-scale farmers involved in the production process is crucial.

Therefore, irrigated rice production is an important pathway in overcoming the challenges of food insecurity in two ways. First, rice satisfies one of the pillars of food security which is food preference. It was among the world's top ranked staple food in 2019, and the third most produced crop with a global output of 0.8 billion tonnes (FAO, 2021). Rice is one of the most important staple crops in the Nigeria. Second, irrigated rice production is important in the context of increasing menace of climate change and the concomitant variations in rainfall regimes which oscillate between extreme disasters of drought and flood, making dependence on rain-fed rice production more precarious than ever for sustainable food supply and livelihoods (Takeshima *et al.,* 2017; World Bank, 2019; Tushaar *et al.*, 2020; Balasubramanya and Lele, 2022).

METHODOLOGY

This study reviewed:

1. the food insecurity in 26 states of Nigeria and the FCT based on the Cadre Harmonise's (2022) Report and the publications of The Economist Group (2022) and Thomas and Turk (2023);
2. six empirical studies on technical efficiency of irrigated rice production conducted within the past six years (2017-2023), two, from each of the three geo-political zones of the North. These studies were by Babatunde *et al*. (2017), Haruna and Damisa (2017), Mohammed *et al*. (2019), Tanko *et al*. (2019), Umaru and Maurice (2019), and Sani *et al*. (2023), and;
3. eleven publications via content analysis whose themes covered opportunities and pathways for improving technical efficiency of irrigated rice farming and food security in Nigeria (Table 1).

RESULTS AND DISCUSSION

Food Insecurity in Nigeria

The food insecurity situation in Nigeria has continued to worsen in recent times, such that while 17 million people were estimated to be critically food insecure in 2022, the number was projected to rise to 25 million between June and August of 2023 lean season (Cadre Harmonise, 2022; Thomas and Turk, 2023). The projected status of food and nutrition security for the months of June to October, 2023 (Table 2) shows that 13% of the country fell within crisis to famine food insecurity situations. But food insecurity varies across regions in Nigeria and the North-East and North-West regions have the most acute levels of food insecurity. These statistics present a precarious situation for the country and Northern Nigeria in particular which has the highest incidence (75.90%) of the crisis to famine food insecurity situation.

Technical Efficiency of Irrigated Rice Production in Northern Nigeria

Food security rests on the quartet pillars of production and availability, quality, safety, and sustainability (Babu *et al*., 2014; Keyman, 2014; Holden and Ghebru, 2016; Lawal *et al*., 2019; Thomas and Turk, 2023). But the most fundamental of these four pillars, is agricultural production. This therefore underscores the relevance of technical efficiency.

Technical efficiency analysis helps to identify areas where resources can be allocated efficiently by assessing the effectiveness and efficiency of different farming methods, technologies, and interventions (Mustafa *et al*., 2016) which provides a pathway to increase food security (Fuglie *et al*., 2016). Hence, technical efficiency analysis of irrigated rice production provides a basis for ensuring that the limited resources available in irrigated rice production are used optimally to meet the country's increasing demand for rice and food security.

The parameter estimates of the production function of irrigated rice production in the three geo-political zones of Northern Nigeria and the interplay of inefficiency variables are shown on Table 3. The values for technical efficiency ranged between 0.78 and 0.97 (with a mean of 0.89 for the 6 studies, respectively). The factors of production had different effects at different probability levels, which were accounted by 14 (inefficiency) variables in the studies covered.

Seed as an input was negative and significant at 10% and 1% in Sokoto and Kogi States, respectively, and so was fertilizer in Kano ($p < 0.01$) (Table 3); meaning that contrary to *a priori* expectation, a percentage increase in the use of these inputs were accompanied by a reduction in the yield of irrigated rice production as indicated by their various coefficients. The implication of this was that there were inappropriate or excessive application of these inputs.

Table 1: Literatures reviewed on opportunities and pathways for improving technical efficiency and food security in Nigeria

S/No	Themes (Pathways)	Publications
1	Rice development policies	FMARD (2020)
2	Agricultural extension	Adinku (2013); Akintayo and Rahji (2016); Mohammed *et al*. (2019); FMAFS (2023); Isaac (2023)
3	Transforming irrigation management	
	Improvement of irrigation and drainage infrastructure	TRIMING Project (2023);
	Addressing the low level of mechanization	IAR-NAERLS-NCAM (2019)
	Managing invasive aquatic weed species	Typha Project (2020);
	Addressing land fragmentation problems	Ayoola *et al*. (2020); TRIMING Project (2023)
4	Provision of improved and certified rice seeds	African Union (2023); FMARD (2020)

Table 2: Projected food security status of 26 states and the FCT for June-October, 2023

Zone	States covered	Total population	Food Insecurity Phase					Total of Phase 3-5	% of Phase 3-5 of population
			1	2	3	4	5		
North-Central (NC)	7	34,222,685	20,351,109	9,733,402	3,874,485	263,689	-	4,138,174*	12.09
North-East (NE)	6	31,933,949	16,007,417	10,408,210	4,936,179	578,177	3,967	5,518,323*	17.28
North-West (NW)	7	59,494,319	31,448,011	18,492,165	8,649,806	904,339	-	9,554,145*	16.06
South-East (SE)	2	10,538,877	6,211,544	3,083,591	1,122,707	121,035	-	1,243,742	11.80
South-South (SS)	3	19,168,586	11,276,380	5,973,194	1,919,012	-	-	1,919,012	10.01
South-West (SW)	2	38,254,434	24,270,338	11,046,591	2,937,505	-	-	2,937,505	7.68
Total	27	193,612,850	109,564,799	58,737,153	23,439,694	1,867,240	3,967	25,310,901	13.07

NC states - Benue, FCT, Kogi, Kwara, Nasarawa, Niger & Plateau; NE states - Adamawa, Bauchi, Borno, Gombe, Taraba & Yobe; NW states - Jigawa, Kaduna, Kano, Katsina, Sokoto & Zamfara; SE states - Abia & Enugu; SS states - Cross River, Edo & Rivers; SW states - Lagos & Ogun. Food insecurity phases: 1 - Minimal, 2 - Stress, 3 - Crisis, 4 - Emergency, 5 - Catastrophe/famine
*The northern geo-political zones accounted for 75.90% of the total 25,310,901 crisis to famine food-insecure population.
Source: Adapted from Cadre Harmonise (2022)

Table 3: Parameter estimates of technical efficiency of irrigated rice production in Northern Nigeria

Zone	North-West		North-Central		North-East	
State	Kano	Sokoto	Kwara	Kogi	Borno & Gombe	Taraba & Gombe
Technical Efficiency	0.97	0.87	0.93	0.96	0.88	0.78
			Significant variables (coefficients)			
1.Production Factors						
Farm size	-	0.760***	0.068**	-	2.85***	1.447***
Seeds	0.415***	–0.070*	-	–0.054***	-	0.274***
Fertilizer	0.324***	-	-	-	-	0.155**
Agro-chemicals	-	0.07**	-	0.328**	-	0.243**
Labour	-	0.050**	-	0.215***	0.25**	-
2. Inefficiency Parameters						
Gender	-	-	-	-	-	0.211***
Age	0.548***	–0.01*	-	-	-	–0.178***
Education	0.535***	-	-	-	–0.49*	-
Marital status	1.893***	–8.02*	-	-	-	-
Family size	-	-	-	-	-	-
Household size	-	–0.04***	-	-	-	-
Farming experience	–0.718***	-	0.100***	-	-	0.235***
Extension contacts	-	–0.190*	-	-	-	–0.492***
Coop membership	-	-	0.216**	-	-	-
Land rental cost	-	-	-	-	0.001**	-
Transport cost	-	-	-	-	0.001***	-
Access to credit	-	-	-	–0.093***	-	-
Non-farm activities	-	-	-	–0.042***	-	-
Seed variety		-	0.280**	-		-
Note: ***1% level of significance, **5% level of significance, *10% level of significance						
Source:	Tanko *et al*. (2019)	Mohammed *et al*. (2019)	Babatunde *et al*. (2017)	Haruna & Damisa (2017)	Sani *et al*. (2023)	Umaru & Maurice (2019)

The challenges of achieving the frontier technical efficiency of irrigated rice production covered by these six studies showed the effects of 14 significant inefficiency variables (Table 3). Age was positive in Kano but negative in the Gombe and Taraba States. This was the same for education, positive in Kano but negative in the Borno and Gombe States. In a nutshell, 7 variables were negative meaning that they were associated with reducing inefficiency, while 8 were positive and correlated with increasing inefficiency in the areas considered.

Kumbhakar *et al.* (2015) and Adejoh *et al*. (2018) asserted that variables with positive values are sub-optimal contributing to inefficiency thereby constituting the challenges of production. Hence, the inefficiency variables with positive coefficients are largely considered as challenges to irrigated rice production in Northern Nigeria from the stand-point of the production context. Other constraints of irrigated rice production from these six studies were the rice-growing environmental factors which were soil-related such as iron toxicity and salinity,

extreme temperatures, water constraints which hinged on scarcity, quality and management. However, the management of weeds, pests, and diseases as well as sub-optimal land and crop management interventions constituted a major determinant in moderating these production risks and invariably farmers' technical or resource use efficiency (Mujawamariya *et al.*, 2017; Saito *et al.,* 2023). This implied that ameliorating the condition of these production factors and inefficiency variables as they affected farmers in the areas covered in the study and Northern Nigeria as a whole could improve rice productivity and reduce food security challenges.

Opportunities and Pathways for Improving Technical Efficiency and Food Security

Although, rice farming in Nigeria is generally characterized by not just low average yield but also high variability in yields with huge yield gaps ranging from $1 - 4$ t h^{-1}, there still exist prospects for increased technical efficiency and productivity (FMARD, 2020). This is because of the favourable natural factor endowments and emerging policies; transformative infrastructure and measures being put in place to ameliorate the inherent restrictive factors to irrigated rice production especially in Northern Nigeria as enunciated below.

Rice development policies

Policies provide the foundation or principles upon which goals are actualized. The policies of the government in recent times are geared towards promoting private sector participation in rice the sub-sector development, by providing an enabling environment. To mitigate the constraints in the rice sub-sector in Nigeria, the first National Rice Development Strategy I (NRDS I) was developed and implemented from 2010-2018, which was instrumental to significant reduction in importation of milled rice, increased productivity as well as developing different programmes to support the rice value chain. This was followed by the National Rice Development Strategy II (NRDS II) with a 10-year (2020-2030) span designed within the framework of sustainable development. The strategy has taken into consideration current and future trends as well as challenges in the sector and provided mitigation strategies. The aim of the NRDS II is to further double production and produce surplus for the West African markets (FMARD, 2020).

Agricultural extension

The quality of extension contact determines production efficiency. Extension agents are normally expected to provide training and advisory services to farmers in order to improve their efficiencies. Invariably the frequency and quality of interactions rice farmers have with extension workers, the higher their technical efficiency and hence output would be (Adinku, 2013; Akintayo and Rahji, 2016; Mohammed *et al*., 2019). Until recently, there was no policy document guiding agricultural extension in Nigeria (FMAFS, 2023). So, the launch on November 6, 2023 of the National Agricultural Extension Policy and the Harmonized Extension Manual were a quantum leap towards improving agricultural productivity and food security issues in Nigeria. The extension policy maps out the direction of agricultural extension practice which was previously lacking while the manual focuses on how to effectively disseminate and deploy agricultural innovations and technologies to end-users using appropriate extension methods (Isaac, 2023).

The Transforming Irrigation Management in Nigeria (TRIMING) Project

The on-going intervention of the TRIMING World Bank assisted project has enhanced the prospects of irrigated agriculture in northern Nigeria. The project has intervened in five northern Federal Government -owned irrigation schemes viz Bakolori Irrigation Scheme (BIS), Dadin Kowa Irrigation Scheme (DKIS), Hadeja Valley Irrigation Scheme (HVIS), Kano River Irrigation Scheme (KRIS), and Middle River Valley Irrigation Scheme (MRVIS). The TRIMING project had four components; water resources management and dam operation improvement; irrigation development and management; enhancing agricultural productivity and supply chain; and institutional development and project management. These four components aimed at improving the productivity of irrigated agriculture of which the rice crop stands out towards improving food security. The milestone interventions of the project and success outcomes have been manifold across the various collaborating institutions as follows:

The TRIMING project based on its component two intervention has been working towards improving access to water for irrigation and improvement of irrigation and drainage infrastructure. This has been ongoing and actualizing the rehabilitation of 28,000 ha and expansion (new development) of 35,000 ha to improve the performance of a total of 60,000 ha irrigation area distributed in five existing schemes (TRIMING Project, 2023).

In addressing the low level of mechanization, the joint action research by Institute of Agricultural Research (IAR) Zaria, System Rice Intensification (SRI) and National Centre of Agricultural Mechanization (NCAM) fabricated compact indigenous irrigated rice planters, tillers/cultivators, motorized weeders and harvesters remain rays of hope in irrigated rice production in Northern Nigeria (IAR-NAERLS-NCAM, 2019).

Similarly, the typha project research by the Federal University of Gashua in conjunction with Maryland University, USA, successfully developed means of managing typha (*Typha spp*). It has harnessed it from an invasive aquatic weed species of monumental threat to the use of water bodies for irrigation the North-West and North-East regions into valuable livestock fodder and bio-gas production resource (Typha Project, 2020).

The TRIMING project intervention at the Dadin Kowa Irrigation Scheme (DKIS) has been multi-dimensional. First, the tripartite institutional research consortium of the University of Agriculture, Makurdi (UAM), Abubakar Tafawa Balewa University (ATBU), Bauchi, and the Food and Infrastructure Foundation (FIF), Abuja have churned out far-reaching recommendations from their participatory action research findings on how to address the land fragmentation problem in that irrigation enclave. Secondly, the ongoing engineering component of the project is expanding the irrigated area from 500 to 6,000 ha. The engineering component is expanding also and modernizing the irrigation and drainage infrastructure so as to improve irrigation water access to farmers in the area (TRIMING Project, 2023).

Provision of improved and certified rice seeds

Seed quality is crucial for rice productivity. The challenge of seed quality is been addressed by the Federal Government through its agencies the National Cereal Research Institute (NCRI), which produces breeder seeds and the National Agricultural Seed Council (NASC) which inspects and certifies foundation seeds produced by licensed private seed companies. The number of these seed companies has grown from about 71 in 2012 to 314 seed companies in 2020, which are specialized in the production of certified seeds. These concerted efforts will strengthen the seed system to make available climate resilient varieties adapted or tolerant to floods, drought, salinity, and heat as well as pests and diseases. It is anticipated that 66.6 ton of breeder seeds, 5,327.3 tonnes of foundation seeds, and 426,184 tonnes of certified seeds will be produced to meet the needs of 80% of rice farmers (FMARD, 2020; African Union, 2023).

Thus, given the vast irrigable land, dams and natural water bodies traversing the North, and the substantial Government investments in irrigation projects in the region, the prospects for improving irrigated rice productivity and food security are much. What may be lacking is proper implementation of policies and management of the requisite resources needed to turn around the trajectory for sustainable growth in irrigated agriculture as a whole and the rice sub-sector in particular.

CONCLUSION

Nigeria's unenviable food insecurity statistics are largely dominated by figures from Northern Nigeria. Increasing the technical efficiency of irrigated rice production is a viable pathway to increasing food production and curbing food insecurity in the region. The vast natural irrigation endowments and the increasing investments in irrigation infrastructure and rice production technologies are beacons of hope for curbing food insecurity in Northern Nigeria. The study recommends that the agricultural extension system in the country should strengthen its collaboration with subject-matter specialists in the rice sub-sector for the training and retraining of irrigated rice farmers on the adoption of appropriate agronomic practices. It also considers capacity building of farmer associations and cooperatives as pivotal to proper organization of farmers for improved access to credit and adoption of improved irrigated rice technology packages.

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