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EXPLORATORY FACTOR ANALYSIS OF THE PERCEIVED CONSTRAINTS AFFECTING RICE FARMERS OF KANO RIVER IRRIGATION (KRIP) KANO STATE, NIGERIA

Abdulazeez H. Wudil*, Asghar Ali, Sarfraz Hassan, Khalid Mushtaq
Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Punjab, Pakistan.

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ABSTRACT

To empirically factor out the perceived constraints affecting rice production in the Kano River Irrigation Project Kano State, Nigeria, the current study used cross-sectional data collected through a semi-structured questionnaire complemented by an interview schedule from 217 rice farmers selected via a multi-stage sampling technique in 2020. High input cost, inadequate training, unreliable water supply, waterlogging, and insufficient credit were identified as significant risk factors affecting rice production in the research area. In addition, the orthogonal rotation took into account ten restrictions impacting rice cultivation in the examined area: technical, biological, insect infestation, output price, marketing, extension, flooding, credit, soil, and health. As a result, the study suggests that a market economy be developed, corruption be reduced, and policy design and implementation be transparent. Project management and other stakeholders should empower farmers through training and workshops to operate and maintain their irrigation schemes through WUAs. It is also critical for the government to supply and subsidize farm inputs, low-cost finance, and other agricultural services, such as rice marketing chains, production diversification, and other agricultural services.

Corresponding Author: Abdulazeez H. Wudil
Email: azeezhud4real@gmail.com

INTRODUCTION

Nigeria is Africa's most populous country and the world's seventh most populous country (Adekola *et al.*, 2016). In 2019, the country's estimated population was 203million people, with a rural population of 51.4 percent and a population density of 212 persons per square kilometre (Adelowokan *et al.*, 2019). Agriculture, which employed 36.55 percent of the country's economically active people in 2017, was the country's largest employer (Adelodun and Choi, 2018). Low-input technologies and small landholdings of between 0.5 and 2.5 hectares characterize the farming system. The country is tormented by severe poverty and food insecurity (Adebayo and Ojo, 2012; Otaha, 2013; Metu *et al.*, 2016). According to available data, the country's population has grown from 41 million in 1963 to 89 million in 1991 and 140 million in 2006 (Anaele, 2014). With a growth rate of 2.59 percent from 2019 (Nzeadibe and Ejike-Alieji, 2020). Most policymakers' and experts' minds worry whether the country's resources can keep up with the growing population.

Irrigation farming helps farmers to produce all year, resulting in increased agricultural output and income. The current situation on irrigation performance in Nigeria, on the other hand, has not been adequately examined. Only 10-15% of the full irrigation potential of 2.0 million hectares is now irrigated. In Nigeria, 70 percent of the country's untapped irrigation potentials are in the north, where average rainfall is low. With dam developments strewn across the country, the country's irrigation opportunities are vast. Conversely, most dams that the government has built are either underdeveloped or neglected (Yahaya, 2002). Irrigation facilities such as the Hadeja-Jama'are River Project have a utilization rate of approximately 50%. At the same time, irrigation operations at the Zobe Dam in Dutsin-Ma, Katsina, built 40 years ago, are currently negligible. Also, the area farmed at the Bakolori Irrigation Dam in Zamfara State, part of the Sokoto Rima Water Project, is not proportional to the amount of water in the Dam. According to (Okeola and Balogun, 2017), there are approximately 264 Dams in Nigeria with a combined storage capacity of 33 billion m^3 of water for multipurpose usages, such as water supply, agriculture, hydropower, fisheries, and eco-tourism. The Federal Government owns 210, the states possess 34, while the private organizations own 20. Around the vicinities, these Dams contain around 350,000 ha of irrigable land accessible for development.

Furthermore, 27 minor Earth Dams are under construction across the country, with a maximum potential irrigable land of 2,700 ha. Despite the enormous irrigation potentials of the country, food insecurity is very diverse and alarming. Ben-Caleb (2015) reported that 54.4 percent of the Nigerian population lives in poverty, out of which 22 percent were defined as the "poorest of the poor" i.e., awfully poor. Food insecurity has been a severe issue that requires attention through increased production and productivity of small-holder farmers, especially in the Savannah region of the country (Osinubi and Apanisile, 2021). Due to the significance of rice as an essential food crop in Nigeria, increasing its cultivation has been given greater attention by the authorities during the last ten years. However, irrespective of this development, average outputs do not generally exceed 2 tons per ha for rain-fed and 3 to 3.5 tons per ha in the irrigated field, lower than the potential yield of 6 and 8 tonnes for rain-fed and irrigated, respectively.

Cohen and Reynolds (2014) argue that it is essential to understand the causes of the production challenges to achieve true sustainability in agricultural production. Similarly, Trienekens (2012) and Mabuza *et al.* (2013) stated that a complete understanding of the underlying constraints preventing the production system from working was essential before proposing steps to help any agricultural industry thrive; these arguments were the basis of this study. The current study adds to the literature on rice production constraints in the Kano River Irrigation Project, Kano, Nigeria. Its goal is to examine the socio-economic characteristics of the rice farmers, the challenges they confront in rice production and recommend appropriate policy actions to address those constraints.

LITERATURE REVIEW

There is no question that irrigation systems have been haunted for decades by many problems called a continuous and vicious cycle of rehabilitation and deterioration (Tibor *et al.*, 2000). Compared to Asia, agricultural irrigation water use efficiency in Sub-Sahara Africa has been marked by inefficiencies and incompetent management (Nwa, 2003). Nigeria's irrigation development has faced inconsistent and unstable policies and an inappropriate legal framework over the years (Uduma *et al.*, 2016). According to, Goldface – Irokalibe (2015); Adelodun and Choi (2018), water and agriculture were separate entities under different ministries, resulting in a disjointed and inconsistent approach to irrigation development. Over the years, Nigeria's irrigation development has been hampered by uneven and insecure policies and an ineffective legal structure (Ogunjimi and Adekalu, 2002; Amede, 2015; Bjornlund *et al.*, 2016). Farmers' involvement in the large-scale irrigation system was hampered by their inadequate knowledge of irrigation techniques (Bjornlund *et al.*, 2016). Furthermore, technology in large-scale agricultural irrigation systems, such as land clearing, field levelling, canals construction, and drains, ruins small-scale farming methods and makes most practicing farmers homeless (Yahaya, 2002). According to Anyebe (2015), the Sokoto Rima River Basin Development Authority failed to meet one of its flood protection and control goals, leading to the loss of agricultural land and the marginalization of farmers.

Likewise, the flood inundated a rice farm of around 3,200 hectares under the Lower Niger River Basin Development Authority's Tada-Shonga irrigation project. Anyebe (2015) stated that constant flooding of some large-scale irrigation schemes thwarts river basin development aims. In addition, Oravee (2015) reported late receipt of funds and low operating costs substantially impact most irrigation programs. The land and water resources in virtually all large-scale irrigation schemes in Nigeria are underutilized (Adelodun and Choi, 2018; Tatlhego and D'Odorico, 2021). Moreover, assessments of small-holder irrigation indicated that many of the projects have performed below expectations (Perret, 2002; Fanadzo *et al.*, 2010; Fanadzo and Ncube, 2018). However, Perret (2002) and Fanadzo *et al.* (2010) identified the major problem as technical shortcomings resulting from bad design and planning, poor strategic and operational processes, wrong land tenure agreements, and a lack of technical competence. Burney and Naylor (2012), Poussin *et al.* (2015) viewed the constraints from marketing perspectives and unvalued that local pricing slumps occur during harvest season due to a lack of market connectivity and suitable storage facilities

However, some studies have focused on the head-tail disparity from an economic standpoint. Inadequacy is the main problem associated with the water supply at the tail-end of any irrigation scheme (Shantha and Ali, 2011). According to Paranage (2018), poor infrastructural facilities and weak organizational capacities could result in head-tail reach. Additionally, Aheeyar (1999), Thiruchelvam and Pathmarajah (1999), and Aheeyar (1999) alleged that low productivity, soil degradation, rise in salinity, and increased cost of controlling salinity are the major problems the tail-end farmers face. Other researchers like Singh and Panda (2013) and Djagba *et al.* (2013) focuses on high construction expenses, inadequate management, inadequate rural finance, high fertilizer costs, and infrastructures. Similarly, ineffective farmer organizations were reported by (Mercoiret *et al.*, 2006). Literature (Shah *et al.*, 2002); (Awulachew *et al.*, 2005); (Djagba *et al.*, 2013); and Ofosu *et al.* (2010) identified six factors contributing to the failure of irrigation schemes in Africa the exorbitant cost of irrigation development; inaccessibility to credit; lack of access to markets; weak governance; poor maintenance of irrigation facilities; and low productivity.

Conversely, Naing *et al.* (2008) reported that low rates of manure and fertilizer application, poor seed quality, inadequate weed control, and water management were among the restraints on rice production in Myanmar. In addition, Satishkumar *et al.* (2013) recognized significant limits as of late sowing or transplant, higher costs of high-yield-variety seed, lack of fertilizers at planting time, lack of monetary support for farmers, and insect and disease infestations. Singh (2017) showcased those seeds of good quality are not readily available in most cases. The high cost of groundwater was reported by John and Fielding (2014) and high labor costs (Singh, 2015; Nonvide *et al.*, 2017). In sum, researchers have majorly concentrated on the most severe production constraints neglecting the socio-economic challenges (John and Fielding, 2014).

METHODOLOGY

This section explained the study area, methods of data collection, and analytical techniques used for data analysis.

Study Area

The Hadejia-Jama'are River Basin Development Authority (HJRBDA) manages the Kano River Irrigation Project (KRIP). The Federal Government of Nigeria used Tiga Dam to deliver irrigation water to three local government areas (Kura, Bunkure, and Garin-Malam). Kano is located at 12^0 3^I North latitude and 8^0 32^I East longitude.

The Kano River Project is a large-scale, capital-intensive irrigation plan in Kano State that would cover 58,000 acres. The HJRBDA is in charge of the project, the first of several that would eventually encompass 146,000 acres in Kano State. The project began in 1971, with the first study completed in 1976–77, when the idea was still in its early stages and limited to 3000 acres. The wettest months are July and September, with maximum rainfall of 214.0 mm. The average annual rainfall varies greatly from year to year, ranging from 635 to 889 mm, with around 60% of it falling in July and August (Maina *et al.*, 2012).

The area's geology is made up of older granites and younger Precambrian to lower Paleozoic Meta deposits. The soils are usually reasonably deep to deep and well-drained, with a sandy loam surface texture and sandy clay loam subsoil (Shehu *et al.*, 2015).

Data Collection Techniques and Target Groups

The study used a semi-structured questionnaire supplemented by oral interviews to collect the relevant data on the constraints to rice production in the study area. The data were collected in 2020 via trained enumerators and a supervisor.

Sampling Frame

A multi-stage sampling procedure was used; in the first stage, all the three LGAs were purposively selected for the field study due to the high number of rice farmers representing the first stratum. The second stratum of the sampling technique took place at the village level. Twelve villages were chosen for the study due to more concentration of rice farmers (four villages from each of the selected LGAs).

The third phase of the fieldwork component was the primary survey in which the actual data collection took place. Due to the uneven number of farmers across the villages, a proportionate random sampling was adopted in this study, and a total of 217 rice farmers were selected (see Table 1). However, out of these numbers, only 208 questionnaires were retrieved and used for the analysis. Yamane's formula was used in determining the sample farmers used for the study. The procedure is given in equation 1:

$$n = \frac{N}{1 + N(e)^2} \dots \dots \dots .1$$

Where;

N= Total population

n= representative sample size

e = error gap (0.068)

Table 1. Sample Size and Population of the Respondents.

Local Government	Villages	Sample frame	Sample size (5percent)
Kura	Karfi	650	28
	Kura	840	36
	Bugau	280	12
	Kosawa	590	26
Garun Mallam	Mudawa	274	12
	Chiromawa	337	15
	Yada kwari	196	8
	Kadawa	207	9
Bunkure	Bunkure	724	31
	Lautaye	323	14
	Gafan	404	17
	Turba	209	9
Total		5034	217

Models Specifications

Factor Analysis

Factor analysis is planned for data on an interval scale, though it can also be applied for data in ordinal (e.g., tallies presented in Likert rankings). The items estimated in factor analysis should be related linearly to one another. This can be check by observing scatterplots of pairs of variables. Perceptibly the variables need also to be reasonably associated with each other; else, the number of factors will be virtually the same as the figure of novel variables; in such a case, conducting a factor analysis seems to be useless.

Mathematically, factor analysis is to some extent analogous to multiple regression analysis in that each variable is presented as a linear combination of the underlying factor;

$$\chi_i = A_{11} f_1 + A_{12} f_2 + A_{13} f_3 \dots\dots + A_{1m} f_m + v_i v_i \quad \dots \dots \dots .2$$

Where:

χ_i = ith standardized variable

A_{ij} = Standardized multiple regression coefficients of variable i on common factor j

f = common factor

v_i = Standardized regression co-efficient of variable i on common factor j

v_i = unique factor for i variable

m= member of common factor

The distinct factors are linked to one another, and the common factors, that is, the observed variables, can be represented as linear combinations of the common elements. The first factor accounts for the majority of the variation.

$$f_i = \omega_{11}\chi_1 + \omega_{12}\chi_2 + \omega_{13}\chi_3 \dots\dots + \omega_{1K}\chi_K \dots\dots 3$$

f_1 = estimate of the ith factor

W_i = weight or factor score coefficient

k = number of variables

Kendall's Coefficient of Concordance (W) or (KCC)

The chi-square statistic is used to test KCC. If the test statistic is 1, then all of the survey respondents agreed and gave the exact order to the circumstances on the list. If W is 0, the respondents' responses are essentially random because there is no broad agreement pattern among them. W values near the middle suggest a higher or lower level of consensus amongst the respondents. The statistical package utilized for the analysis was SPSS. KCC, created by (Kendall and Smith, 1939; Wallis, 1939), is shown below, according to (Sadiq et al., 2017).

$W = \frac{12s}{K2n\,(n2-1)-KT}$……….4

Where; s = Sum of all subjects k = Number of respondents n = Number of attributes evaluated by respondents T = Tie-correction factor

$T = \sum[tK^3 - tk]$ …….5

T $'tk'$ is the number of tied ranks in each (k) of g groups of ties.

The Chi − square statistics is expressed as;

$\chi^2 = k[n-1]$ W … … . .6

Where;

K = respondent's number

n = attribute ordered

w = KCC

Friedman's Chi-square Statistic

Friedman (1937) created Friedman's Chi-square statistic to test the premise that the rankings allocated to the topics under examination came from the same sample or population. It is a deceptive method of determining the levels of agreement among raters. It is utilized in inter-judge reliability studies because of its statistical link with Kendall's coefficient of concordance (W). The statistical package used for the analysis was SPSS. The Friedman's Chi-square statistic is given below:

$\chi^2 r = k[n-1]$ W, all the letters as previously explained

RESULTS AND DISCUSSIONS

Perceptions on Constraints Affecting Rice Production among the Project Beneficiaries

Results in Table 2 show that the project beneficiaries' most severe constraints are high cost of input, inadequate training, unreliable water supply, waterlogging, and insufficient credit. The farmers perceived erosion, poor output price, low education level, high labor cost, and poor marketing channels as moderate constraints. Similarly, poor maintenance of irrigation facilities, inadequate infrastructures, malaria, weeds, and insect infestation were the minor problems rice farmers faced in the study area. Nasiru *et al.* (2015) reported that credit was an essential factor for developing small and medium scale enterprises; its accessibility could determine the magnitude of production capability. This study's findings agree with that of Nasiru *et al.* (2015) that identified a lack of access to micro-credit as a significant constraint to the practical sustainability of small-scale production. The findings also supported that of Sulaiman (2016), who reported that inadequate training and poor marketing channels were the significant constraints to wheat production in the Jibia irrigation project, Katsina state, Nigeria. Similarly, Ladan (2019) reported that insufficient power supply and high labor costs resulted in significant water constraints and an impediment to irrigation agriculture in the Daberam Dam site of Northern Nigeria.

The grand mean value of constraints was discovered to be (2.50). Similarly, the perception index was 0.50, indicating that 50 percent of the sampled farmers in the study area saw these constraints as hurdles to rice production. Moreover, the implication of Friedman's test value indicates that the farmers' attributes assigned to the constraints are from the statistical population, and the KCC value of 0.151 indicates that the farmers' ranking was based on a weak concordance or agreement. As a result, authorities are free to disregard the order when dealing with these difficulties. Still, they should focus on what the farmers believe to be the most persistent obstacles to rice farming in the study domain.

Factor Analysis of the Constraints to Rice Production in the KRIP

Twenty-six perceived statements were submitted to exploratory factor analysis (Table 3) to investigate further the elements thought to be an impediment to rice growing among the project beneficiaries in the examined area.

The Kaiser-Meyer-Olkin (KMO) sampling adequacy test resulted in a mediocre 0.523. The perceived statements were suitable for the study based on (Wood *et al.*, 1996) guideline of accepting values greater than 0.5 (Abbas *et al.*, 2010; Beavers *et al.*, 2013). This, however, contradicts the predicted KMO range of 0.8 to 1 by (Abbasian *et al.*, 2017).

Similarly, Bartlett's Test of Sphericity (BTS) revealed that the correlation matrix was never an identity matrix.

There was no zero association between the two, indicating that there had been a relationship among the variables, as noted in the BTS significance at less than 1percent probability level.

Table 2. Perceptions on Constraints Affecting Rice Production among the Beneficiaries and Non-beneficiaries.

Constraints	Mean (Beneficiaries)	Rank (beneficiaries)
Inadequate maintenance	2.00	20
Poor infrastructure / access road	2.14	19
Lack of functional WUA	2.15	18
High input cost	3.81	1
Inadequate training	3.80	2
High labor cost	2.60	9
Low level of education	2.61	8
Insufficient credit	2.95	5
Poor marketing channel	2.63	10
High use of fertilizer/ chemical	2.63	10
Poor irrigation service	2.45	13
Poor water supply	3.07	3
Head/tail reach problem	2.53	12
Poor output price	2.70	7
Typoid	1.87	21
Inadequate extension services	2.36	15
Malaria	1.49	22
Siltation	2.43	14
Water lodging	2.96	4
Erosion	2.80	6
Flooding	2.42	15
Salinity	2.33	17
Plant disease	2.59	11
Insect pest	2.35	16
Weed Infestation	1.65	24
Birds	1.67	23
Grand mean	2.50	
Perception index	0.50	
KCC	0.151	
X2	786.041***	
Friedman test (X2)	786.041***	

Source: Field survey, 2020

Total ten factors with Eigenvalues greater than unity (Hatcher and Barends, 1996; Brown and Moore, 2012; Sadiq *et al.*, 2019) were identified as determinants limiting rice production among project beneficiaries in the study area using the Kaiser criterion. Each factor had acceptable reliability, with a Cronbach's Alpha of equal to or greater than 0.60, indicating proof of internal consistency (Altman *et al.*, 1994). The explainable ten components explained 62.5 percent of the overall variance, which was considered a respectable percentage in the social sciences (Demo *et al.*, 2012; Sadiq *et al.*, 2019). The factor was not loaded if the absolute value of the loading was less than 0.40. The factors extracted were; Technical barrier, biological barrier, insect infestation, output price, marketing barrier, extension barrier, flooding barrier, credit barrier, soil barrier, and health barrier. With a variance percentage of 11.592, the first factor labeled "technical obstacle" was loaded with two limitations; (Heads/tail reach and poor irrigation services). Pointed to the farmers' concern about uneven water distribution in the project area and the poor state of the infrastructures, these called for managerial support to maximize rice growing profitability. With an explained variance of 8.672 percent and two limitations points (weed infestations and birds), the second factor labeled "biological barrier" calls for institutional action and public awareness on the best agronomic practice to improve rice cultivation in the examined area. The third factor was poor extension services and research gaps. Pest infestation accounted for 7.311 percent of the variance and was loaded with four elements (insect pest, salinity, excessive fertilizer use, and plant diseases). This advocated for trained and more extension services and research into better ways to deal with pest infestations, plant diseases, and excessive inorganic fertilizer use.

Table 3. Factor Analysis for Constraints Affecting Rice Production among the Beneficiaries.

Constraints	Technical	Biological	Pest infestation	Output price	Market	Extension	Flooding	Credit	Soil	Health
Head/ Tail reach Problem	.948									
Poor irrigation services	.946									
Weed infestation		.971								
Birds		.968								
Insect pest			.617							
Salinity			.609							
Excessive fertilizer use			.560							
Plant diseases			.551							
Poor output price				.869						
unreliable water supply				.854						
Lack of functional WUA				.450						
Poor marketing channel					.785					
Low level of education					.553					
Inadequate training						.622				
Malaria						.604				
High input cost						.587				
Flooding							.722			
High labor cost							.685			
Insufficient credit								.731		
Inadequate maintenance								.701		
Siltation									.637	
Erosion									.625	
Waterlogging									.434	
Cholera										.782
Typoid										.607
Eigen-value	3.014	2.255	1.901	1.669	1.581	1.392	1.301	1.185	1.129	1.08
percent of variance	11.59	8.672	7.311	6.418	6.080	5.356	5.003	4.558	4.344	4.18
Cronbach's Alpha	97.2	99.4	63.6	68.7	45.6	62.3	61.23	35.4	42.8	72.6
Kaiser-Meyer-Olkin test	.538									
Bartlett's Test of Sphericity	325***									

Source: Field survey, 2020 Note: *** means significant at 1percent probability level

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Farmers' concerns about lousy output price, insufficient water availability, and the poor functioning of water user's associations were expressed in factor four, dubbed "output price barrier," which accounted for 6.418 percent of the variation; this issue necessitates institutional involvement. Factor five, labeled "market barrier," had an explained variance of 6.080 percent, indicating that farmers in the study area were concerned about poor marketing channels and insufficient formal education. This called for the establishment of favorable policies such as subsidy provision, rice export promotion, value chain enhancement, and so on. Farmers were concerned about insufficient training on water use, disease infestation, and high input costs in factor six, dubbed "extension barrier," which had an explained variance of 5.35 percent and was loaded from three components. This finding was comparable to that of Takahashi *et al.* (2019), who discovered that small-scale farmers in Nigeria face a severe challenge with extension contact.

Farmers were concerned about the high occurrence of floods and high labor costs in Factor seven, dubbed the "flooding barrier," which accounted for 5.003 percent of the total. Farmers were concerned about insufficient access to credit facilities in factor eight, designated "credit barrier," which had an explained variable of 4.558 percent and called for the need to provide farmers with adequate credit facilities to improve rice output in the examined area. Factor nine, dubbed "soil barrier," was loaded with three soil-related factors (siltation, erosion, and waterlogging), which require an excellent drainage system and better practice to help leech out the exchangeable salt in the soil. Factor ten, leveled "health barrier," was loaded with two factors (Typhoid and cholera); this might be due to poor drainage system, water lodging, and poor supply of safe treated drinking water. This called for public awareness and the provision of potable water.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, the top risk factors impeding rice production were high input costs, insufficient training, unpredictable water supply, waterlogging, and a lack of financing. In addition, exploratory component analysis was performed on twenty-six constraints. Ten factors with Eigenvalues greater than unity were identified as restrictions to rice production among sampled project beneficiaries. The Kaiser-Meyer-Olkin (KMO) sampling adequacy test resulted in a mediocre 0.523. Among the ten factors identified were barriers to technical, biological, insect infestation, output price, marketing, extension, floods, credit limits, soil, and health. Similarly, rising operating and maintenance costs, as well as deterioration of irrigation infrastructure, could undermine the scheme's long-term viability.

Effective government intervention, institutional transformation, and participation of all stakeholders in the project's conception and implementation are crucial in improving the production and productivity of rice production in the project area. It is also recommended that farmers could improve water usage efficiency by employing competent and articulated extension services. On- wheal training, adult education, and workshops on actual crop water requirements. Timely and subsidized farm inputs, low-cost financing, and other agricultural services, such as rice marketing chains, production diversification, and other agricultural services, are vital for the government to supply and support. Water supply for the tail-end needs to be better managed to solve the problem of head-tail disparities and ensure water security for all farmers. In this regard, water adequacy, reliability, and equity are paramount. In addition, Projects Management, in collaboration with WUAs, should work jointly to identify illegal water tapping along the field canal, and appropriate measures should be taken to stop the unlawful act.

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