Impact of Irrigation on Rice Cultivation Methods among Small Farmers in North Central, Nigeria

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ABSTRACT

Rice production and irrigation are inextricably linked, irrespective of the adopted cultivation system. The study was to examine the impact of irrigation on rice cultivation systems among rice farmers in north central Nigeria. The study involved the survey of 196 active rice farmers in the previous planting season using copies of well-structured questionnaires administered by trained enumerators, and selection of rice farmers was achieved through multistage sampling procedure. Specific objectives were to describe socioeconomic and input characteristics, profiling of irrigation water sources, identification of adopted source of irrigation water by rice farmers, assessment of cultivation system adoption and intensity of rice production and examining factors militating against access to seamless access to irrigation water. Various analytical tools were employed to achieve the objectives, such as descriptive statistics, multinomial logit (MLN), endogenous switching regression (EWR) and Likert Rating Scale (LRS). The result indicated that farm size, farming experience, and annual income were on average of 2.39ha, 23.6 years, and N 646,145.66k. Well water was the most used irrigation source by farmers, with the highest score of 85.2%. The multinomial logit result indicated that the use of boreholes was positively and significantly influenced by distance to water source and years of education, while the use of dams was influenced by gender and the number of cooperative trainings that rice farmers attended during the season. Switching regression results suggested that the correlation coefficient rho_1 and rho_2 were positively significant at p<0.01 and p 0.05, respectively, suggesting that an individual rice farmer who chose to adopt swamp cultivation system had lower rice output in the category than a random individual from the sample would have realized. Farmers were constrained by the shortage of water arising from keen competition for water between them and the herdsmen, while it was recommended that efforts be made to ensure that an early-maturing, drought-resistant, and short-duration rice variety be provided for optimal production that will keep pace with the food needs of an ever-increasing population.

Keywords: Cultivation, Farmers, Irrigation, Multinomial Logit, Rice Cultivation

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I. INTRODUCTION

1.1 Background of the Study

Water plays paramount role as a veritable resource in the production of crop and livestock in the temperate and tropical areas globally. When it is a limiting factor, agricultural practices remain passive and productivity is unachievable even when fertile land is accessible and usable. The use of land and water for agriculture has not yet peaked, but all evidence points to slowing growth in agricultural productivity, rapid exhaustion of productive capacity and generation of environmental harm (State of the World's Land and Water Resources for Food and Agriculture (SOLAW), 2021; Food and Agriculture Organization (FAO)& UN-Water, 2021). The direct impact of weather events on cropping, grazing, forest systems and soil health is difficult to separate from the overall environmental outcome of land and water management practices (Turetsky, 2019; Tubiello et al., 2013). Reduced or erratic rainfall and more frequent and severe drought periods extend soil moisture deficits on some soils but extend periods of waterlogging on others. Heavier rains are likely to increase the risk of soil erosion on cultivated lands, on moderate to steep slopes where runoff rates are high, and where the land has inadequate vegetative cover (Food and Agricultural Organization, 2017; Li et al., 2004). Intensified and shorter rainfall events combined with higher evaporation and transpiration rates will lead to decreased erosion from water and raindrop impacts, and accelerated runoff and strong winds will reduce soil moisture available for plant growth.

Different sources of water exist; rainfall, underground water and these include well water, borehole and dam among others. Rain fed agriculture is the predominant agricultural production system worldwide most especially in the sub-Sahara Africa that is endowed with the opportunity of bimodal rainfall. In 2018, the world cultivated area was 1557 million ha, of which 1,221 million ha (78 percent) was rain-fed, producing about 60 percent of global crop output in a wide variety of production systems according to Food and Agriculture Organization Corporate Statistical Database (FAOSTAT, 2020). The most productive rain-fed cropping occurs in the temperate zones of Northern America and Europe, and in the sub-tropics and humid tropics. Rain-fed cropping in highland areas and the dry tropics tends to be relatively low yielding with low-input practices associated with subsistence farming. In sub-Saharan

Africa, 97 percent of staple production is rain-fed, the area of cereals has doubled since 1960 and also in Central America and the Caribbean, and rain-fed cultivation had expanded by 25 percent in the last 40 years. The production cycle could be extended and productive resources could further be mobilized and utilized optimally if alternative sources of water could be made available for agricultural purposes through irrigation (Temple, 2011; Dugue et al., 2015).

Irrigation is significant in securing food supplies and supporting economic development in many countries of various continents of the world ranging from desert to rainforest and its importance is likely to grow given the impacts of climate change (Hannah & Saleemul, 2005; Tambo & Abdoulaye, 2012). Agricultural production using irrigation shares approximately 40 percent of total agricultural output (FAO et al., 2018). Land set aside for irrigation can stabilize the production of high-value crops, particularly eliminating the risk of unreliable rainfall but more importantly, timely delivery of adequate soil moisture to the crop and maximization of yield response (Adegbola, 2007; Beke, 2012). Irrigation in combination with drainage offers an important adaptation strategy to combat drought and flooding risk as the climate changes (Alhumaid, 2020). Land area equipped for irrigation (including all full water control irrigation systems, equipped wetlands and spate irrigation) has almost doubled over the past 60 years, from 139 million ha in 1961 to over 328 million ha in 2018, with groundwater-sourced irrigation accounting for some 108 million ha which is 33 percent of the equipped area (Lowder, Sánchez & Bertini, 2019). Over the same period, land equipped for irrigation has increased from 10 percent of the total cultivated land to 21 percent. Since 2010, equipped areas have exhibited little or no growth in reported statistics, even as the global production of irrigated crops continues to increase. This, of course, may be due to changes in the pattern of production such as: increased cropping intensities and yields on existing continuously irrigated areas; infilling of gaps between equipped areas and actually irrigated areas (areas harvested) hence production from areas not registered in national statistics as “equipped for irrigation” (Siebert & Döll, 2007).

Cereals crops are widely consumed in the sub-Sahara Africa and Nigeria in particular. In Nigeria, maize, millet, sorghum and rice production are favourably supported by the available land and bimodal rainfall regime in the south which trickles down to modal in the northern region of the country, hence, intensive use of irrigation in the less advantaged parts (Awulachew & Ayana, 2011; Adela & Aurbacher, 2018;). Most consumed of cereals in Nigeria is rice and its desire to consume and patronage has created a wide gap between its demand and supply. In an effort to bridge the gap, therefore, local production is more encouraged by the current government through introduction of subsidies, training programmes and loans as means of encouragement (Central Bank of Nigeria (CBN), 2018). Nevertheless, local production seemed not to keep pace with population growth, based on this, importation by government and individuals through smuggling further narrowed the demand supply gap but the resultant effect further weakened the economy by reducing the foreign reserve and weakening of economic currency (CBN, 2018). Further effort to intensify rice production saw government support in terms of improving on irrigation infrastructures and provision of irrigation facilities to complement the past efforts of the River Basin Development Authority services which mostly concentrate in the Nigeria characterized with low rainfall (Idachaba, 2006; Akinyosoye, 2005).

Statistics further showed that global production of rice reaches 755,473,800 tonne per year, but Nigeria is yet to maximize its potential to meet local demand as well as for export (Guardian, 2022). Nigeria is the highest producer of rice in Africa and sixth at the global level with a total of 218,541, 291 tons per year. With the quantity produced annually, Nigeria still imports 2,000k MT of rice annually, meaning that the quantity produced locally cannot be sufficient to feed the consumption need of about 200million of its population(Ezedinma, 2008; Kebbeh et al., 2003). In order to bridge the demand-supply gap and keep the price of rice affordable at least, at the home-front, there is a need to embark on massive rice production. Raising the level of production, apart from consumption purpose will address official and smuggled of annual quantity imported which results in loss of foreign exchange earnings and ever-dwindling currency value (FAO, 2022).

A lot of studies had been carried out on rice production in relation to irrigation but few studies had been done on the cultivation of rice based on typical varieties of upland and swamp rice production. The overarching goal of this study is to generate information that helps decision makers to discern and understand impact of Irrigation on Rice Cultivation methods among Small Farmers in North Central, Nigeria. This disparity in this study and the previous works was the study area, middle belt Nigeria, where water is a critical and limiting factor in the production of the crop. The study will help the policy makers, immensely, in the area of decision making towards massive production of rice in the nearest future, hence the need to mobilize and harness optimal resources towards attaining the threshold of optimal productivity. This study seeks to answer the following research questions: what are the socioeconomic and input characteristics of rice farmers? What is the notable water sources used in irrigating rice farms? What are the determinants of the water source adopted for irrigation in the rice farm by farmers? What are the determinants of the choice of cultivation and the quantity of rice produced by farmers? The specific objectives are to describe the socioeconomic and input characteristics of the rice farmers; profile the notable source of water used for irrigation of rice farms; identify determinants of water source adopted by rice farmers in the study area and examine factors affecting choice of rice variety cultivated and the intensity of production.

1.2 Hypothesis for the Study

H_0: Monthly water consumption does not significantly affect rice output of farmers

II. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in the middle belt otherwise called north central which comprised Benue, Kogi, Kwara, Nasarawa, Niger, Plateau and Federal Capital Territory. The area is located at the core centre of the country as the name indicates. The entire area is located on latitude 10^0 20' 00"N and longitude 7^0 45' 00" E. The area is bounded in the North by Southwest Nigeria, in the West by Southwest and Benin Republic, in the East by North East Nigeria and bounded in the South by South East Nigeria. The entire middle-belt of Nigeria has a total population of 14,616,682 (National Population Commission, 2006. The mean annual temperature ranges from 24^0C to 37^0C and mean annual rainfall of between 100 and 200cm^3 (Iloeje, 2007). The climate of North Central Nigeria is characterized by a rainy season which starts in December and lasts till March. North Central is blessed with luscious vegetation and fertile soil which is good for cultivating various types of crops, notable among them are maize, sorghum, yam, cassava, millet, pepper, tomato and cowpea among others. Based on this abound opportunity, the north central is referred to as "food basket of Nigeria". The only limiting factor to farming in the area is rainfall which is distinctly deficient in intensity, distribution and amount.

2.2 Source of Data

For the purpose of achieving the objectives stated in the study, data uses were obtained from primary source. Some data used include salient variable bordering on the socioeconomic characteristics, profitability, water use by farmers, inputs used in rice production and production constraints amongst others. Some of them are age, experience, marital status, fertilizer, herbicide, seed, farm size, revenue and extension contacts to mention but few.

2.3 Instruments Data Collection

Copies of well-structured questionnaire were used in the survey to collect data from the respondents. Also, camcorder was used in capturing the respondents and cell-phone was used in recording the interview granted by the respondents. Trained enumerators were employed to interview the respondents and use the equipment as appropriate for the intended purpose.

2.4 Sampling Technique

Multistage sampling procedure was used in the selection of respondents for the study. The first stage was the purposive selection of Niger state being one of the states in the north central with high concentration of active rice farmers. In the second stage, five local government areas with high number of rice farmers were purposively selected, while in the third stage, forty farmers were randomly selected from each of the local government areas early selected. A total of two hundred farmers (200) were reached but 196 responses from the survey were used for the final analysis while two responses were rejected due to biased responses and unreturned copy of questionnaire. Table 1 presents detailed sampling procedure and Figure 1 also presents the map of the study area

Table1

Details of Sample Procedure of Rice Farmers

First Sampling Stage (Purposive)	Second Sampling Stage (Purposive)-LGA	Third Sampling Stage (Random) Proposed Respondents	Real Sampled Respondents
Niger	Lavun	40	39
	Edati	40	38
	Agaie	40	40
	Gbako	40	39
	Mashegu	40	40
		200	196

Source: Computer from Field Survey, 2021.

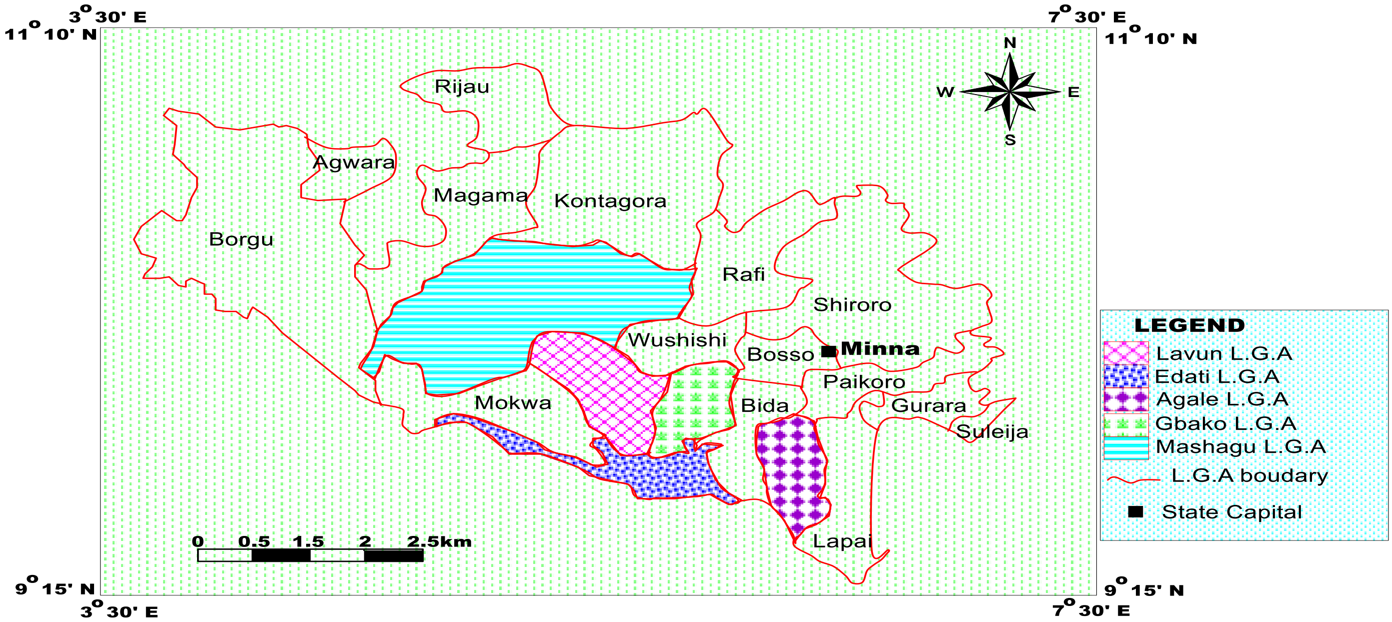

Figure 1
Map of the Study Area Showing the Local Government Area of Massive Rice Production
Source: Federal Ministry of Information and Culture, Niger State

2.5 Analytical Tools

2.5.1 Descriptive Statistics

Descriptive statistics was employed in describing the socioeconomic characteristics and various sources water available for rice farmers; this includes frequency counts, percentages and mean.

2.5.2 Multinomial Regression

MNL is used to analyse the determinants of household demand for water from available sources for irrigation on rice farms. The choice of the model follows Gujarati (2004). The model is given as:

$$\text{II}_{jk} = \frac{\exp(\beta_k' X_j + \theta'\text{Zjk})}{\sum_{i=1} exp(\beta_1' X_j + \theta'\text{Zjl})} \quad \ldots\ldots 1$$

II_{jk} is the probability that individual j chooses alternative k. X_j represents the characteristics of individual j while Z_{jk} represents the characteristics of the kth alternative for individual j. $\beta_1 \ldots \beta_m$ are m unknown regression parameters explaining the household characteristics while θ represent regression coefficient explaining different sources of water, such as well, borehole and dam which are coded 0, 1 and 2 as dependent variables respectively.

2.5.3 Switching Regression Model

The switching regression model (SRM) is used to correct for possible sample selection bias which may arise from other interventions that provide multiple services to farmers in addition to adopted rice cultivation method. Sample selection bias arises when factors unobserved by the researcher but known to the farmers affect both the choice of technology as well as other decision variables (Fuglie &Bosch, 1995). The SRM approach is divided into two stages.A probit model in the first stage will be applied to determine the relationship between a farms chosen cultivated rice variety condition and a number of socioeconomic and input variables, is employed as follows:

$$C^* = \gamma' Z_i + \varepsilon_i \quad \ldots\ldots 2$$

In equation (1), C^* is dichotomous (1,0), indicating whether observation I is upland or swamp rice or not; Z_i represents a vector of explaining variables such as farm size, farming experience, distance to water source and extension contact; γ is a vector of parameters; and ε_i is a random error term. Rice cultivation types are reflected in the responses used to define a criterion function which is an observable; dichotomous variable I where,

I = 1; if $\delta'^{Z_i} + \varepsilon_i = 0$ ……3

I = 0; otherwise

A probit maximum likelihood estimation is used to estimate the parameter δ in equation 3. It is assumed that var (ε_i) =1 since δ is estimable only up to scale factor.

Rice output of the two groups of farmers is modelled by reduced for equations specified by:

$P_{cc} = \beta_{1i}X_{1i} + \varepsilon_{1i};$ if I=1

$P_{ncc} = \beta_{2i}X_{2i} + \varepsilon_{2i};$ if I=0 ………………………………………………………………………...……...4

Where variables P_{cc} and P_{ncc} represent rice output for upland and lowland rice cultivation among farmers.

X_{1i} and X_{2i} are vectors of exogenous variable,

β_{1i} and β_{2i} are vectors of parameters, and

ε_{1i} and ε_{2i} are random disturbance terms

Maximizing the bivariate likelihood function for this model is feasible but time consuming (Maddala, 1994). Therefore, following Lee (1978), a two-stage estimation method is used to estimate the system equation (3) and (4). The conditional expected values of the error terms ε_{1i} and ε_{2i} e:

$$E(\varepsilon_{1i} /\delta'Z_i) = E(\sigma 1_\varepsilon \varepsilon_i/\varepsilon_i = \delta'Z_i) = \sigma 1_\varepsilon \frac{\emptyset(\delta' Z_i)}{\varphi(\delta' Z_i)}$$

$$E(\varepsilon_{2i} /\delta'Z_i) = E(\sigma 2_\varepsilon \varepsilon_i/\varepsilon_i = \delta'Z_i) = \sigma 2_\varepsilon \frac{\emptyset(\delta' Z_i)}{1-\varphi(\delta' Z_i)}$$

Where $\emptyset$ and φ are the probability density function and the cumulative distribution function of the standard normal distribution respectively. The ratio $\varphi/\emptyset$ evaluated at $\delta'Z_i$ for each 1 is the Inverse Mill Ratio (IMR). For convenience,

$\lambda 1_{1i} = \emptyset(\delta'Z_i)/ \varphi(\delta'Z_i$ (for swamp rice cultivation)

and

$\lambda 1_{2i} = \emptyset(\delta'Z_i)/ [1-\varphi(\delta'Z_i)]$ (for upland rice cultivation)…………………………………………………….5

These terms are included in the specification of equation (3)

$P_{cc} = \beta_1 X_{1i} + \sigma_{1u}\lambda_{1i} + \varepsilon_{1i};$ if I=1

$P_{ncc} = \beta_2 X_2 + \sigma_{1u}\lambda_{1i} + \varepsilon_{2i};$ if I=0…………………………………………………………………..….………6

Specification of dependent variables in the switching regression is as given below:

Y= Swamp=1; Upland=0

X_1= Farm size (in hectares)

X_2= Farming experience (in years)

X_3= Extension contacts (in no.)

X_4= Gender (Male=1; Female=0)

X_5= Monthly irrigation water supply (in litres)

X_6= Total input value (in naira)

X_7 = Education (in years)

X_8 = Distance to source of water (in kilometers)

2.5.4 Likert Rating Scale

The five point likert type scale was used to identify constraints faced by rice farmers in having access to sufficient water for irrigation of rice farm in the study area. These are defined as: 5= Strongly Agreed 4= Agreed, 3 = Undecided, 2= Disagreed and 1= Strongly Disagreed. The scores were then calculated as follows:

Weighed Score (WS) = 5n + 4n + 3n + 2n + 1n = Total Score for each constraint …………………………………….7

Where n = Frequency of each constraint for each rating.

Mean Score (MS) $= \frac{Total\ Score\ of\ Each\ Constraint}{Total\ Number\ of\ Respondents}$ ……………………………………………………………………….8

Rank = Value of the MS was then used to rank the severity of the limitations faced by the respondents.

2.5.5 Test of Hypothesis

Student t-test was used to test the relationship between the quantity of water used for irrigation on farm by farmers and the quantity of rice output. The tool is amenable to handling continuous variables without bias or error of inconsistency. The formula is presented as follows:

$$t = \frac{X-\mu}{\frac{s}{n^{0.5}}}$$ ………………………………………………………………………………………………….9

s= Standard deviation

μ=Theoretical mean of the population

X= Observed mean of the sample

n= Sample size

III. RESULTS & DISCUSSION

3.1 Socioeconomic and Input Characteristics of Rice Farmers

Socioeconomic and input characteristics of the rice farmers are presented in Table 2. Most of the rice farmers had an average of 2.39 hectares indicating that they operate on small scale. This result agrees with Adubi and Daramola (1996) expressed in their study that most of the farmers in Nigeria operate on small scale. Rice farmers used an average of 50.5kg of seeds per hectare and this is believed to be based on the planting method of drilling or broadcasting adopted. Broadcasting and drilling use more seed than placement in which seeds are planted using preplanned spacing. Hybrid seeds are in many cases result in better yield and also possess the quality of pest and disease resistance, rice farmers used more of hybrid seed than open pollinated seed to enhance better output. Fertilizer used by rice farmers is an input that a high premium is placed on in order to realize expected output, to achieve this more dose of fertilizer must be used as the land under cultivation is cropped all year round and average of 112.63kg was used across the study area. Based on this, shifting cultivation is not achievable and fallowing cannot be used as source of replenishing nutrients lost from farmland as a result of continuous cropping but only the use of fertilizer, which can be organic and inorganic in nature.

Labour used by farmers was an average of 75.5 man-days per season. Chemical method of weed control is used in the post planting period which were probably systemic has a high potency and highly efficacious and the effect last longer and reduce labour in weeding operation. Sex revealed that male rice farmers outnumber their female counterparts; this may be due to the arduous nature of rice operation from land clearing to annual termination of the entire production process. The maximum and minimum age among the rice producing farmers are 20 years and 75 years respectively and an average age of 48.14 years. It could be inferred from this result that rice producers are very young and are in their active phase of life. This agrees with the findings of Adeolaet al. (2008) that rice producing farmers are in their active farming years and is likely to enhance their production.

Years of experience of farmers are 23.6years which indicates that they possess sound experience which can help them to surmount occupational odds and cope with risks. Mean value of about 7 members was recorded for household size, meaning that rice farmers had moderate household size. Extension contacts in the last season were an average of 9 contacts as against the recommended contacts of 24 annually. This indicates that farmer in the area are short of modern innovation and technique. Average seasonal income of farmers stood at N646,145.66 per annum which is equivalent to $994.07 (@650/US1) in a year.

Table 2

Socioeconomic Characteristics of the Rice Farmers

Variable	Minimum	Maximum	Mean	Std Dev.
Farm size (in Hectare)	0.80	5.00	2.39	0.91
Quantity seed (in kg)	20.0	120.0	50.5	17.8
Seed Variety(Open Poll.=1; Hybrid=2)	1.00	2.00	2.05	0.55
Quantity of Fertilizer(in kg)	45.0	250	112.6	48.0
Quantity of Labour (in Man-days)	17.0	134.0	75.5	20.5
Quantity of Herbicide (in Litres)	5.0	16.0	9.65	2.25
Sex (Male=1; Female=2)	1.0	2.0	1.295	0.46
Age (in years)	20.0	75.0	48.14	12.1
Farming experience (in years)	2	67	23.6	12.7
Households size (in No.)	1	17	6.5	2.86
Extension Contact (no.)	2	24	9	6.7
Annual Income	54,000	1,584,000	646,145.66	285,942.17
Sample size (n) =196				

Source: Computer from Field Survey, 2022.

3.2 Source of Irrigation Water on Rice Farm

Sources of water for irrigating rice plantation on rice farms are contained in Table 3. Choice of well water was found to be highest with 85.2%. The use of the source may be due it high accessibility rate and cost effectiveness of putting it in place, however, it may not be a perennial source of water as the water table is very low making water unavailable at the peak of dry season. About 69% of rice farmers patronized borehole as source of water supply to the farm but it was confirmed that the source, though reliable in terms of all-time water supply for rice production but it is very expensive to put in place. To ensure availability of borehole in the area, local and central government in the state provide for farmers as a direct assistance to support rice cultivation. Fifty two percent of the respondents harness water resource originated from dam. It is a source with wide surface and large quantity of water but dam does not make sufficient water available all-year round. This made it less reliable to depend on by rice farmers owing to the fact that they prefer the water source that is capable of giving expected quantity of water throughout the production season.

Table 3
Different Sources of Water for Rice Irrigation

Farm Water Source	Number of Farmers	Percentage
Well	167	85.2
Borehole	137	68.9
Dam	102	52.0

Source: Computer from Field Survey, 2022.

3.3 Multinomial Logit Estimate of Determinants of Choice of Irrigation Source among Rice Farmers

Table 4 presents results on determinants of chosen method of irrigation adopted by the rice farmers. LRchi2 (30.55) is significantly different from zero at 1% while the log likelihood ratio (193.355) suggest that the model was fit and appropriate. Distance to water and years of education positively influenced the use of borehole relative to adoption of well water. When more of the variables are used, there will be higher probability of using the irrigation source by farmers. Quantity of monthly water supply for irrigation in the rice plantations was found to be negatively significant, suggesting that it negatively influenced the probability of using borehole as a source of water among rice farmers. Adoption of dam as a source of irrigation for rice farmers shoes that years of experience and season of the year negatively and significantly influence the probability of using dam as source of water for rice farm irrigation. An attempt to increase the use of the variables supports the use of well source of water. Similarly, gender and attendance of cooperative training by rice farmers increased the probability of increasing the use of dam by farmers while they concurrently decreased the use of well source of irrigation.

Result of the marginal effect suggest that a unit increase in farm size, quantity of water supplied monthly and seasonal water availability increased the probability of using well water. Also, number of cooperative training attendance increases the probability of using well water among the rice farmers.

Table 4
Determinants of Chosen Irrigation Method and Intensity of Rice Output

Number of Observations =196 Log likelihood =193.355	LR chi2 = 30.55 Prob>chi2 = 0.000		Pseudo R^2 = 0.0732			
Variable	Borehole		Dam		Marginal Efffects	
	Coeff.	z-value	Coeff.	z-value	dy/dx	z
Constant	3.6375***	3.85	-3.8711	-0.83	-	-
Farm size(in Ha)	-0.1666	-0.58	-0.2385	-0.75	0.0492***	3.78
Dist. to water source(in km)	0.6190***	3.01	0.2116	0.34	-0.1095	-0.86
Farming experience(in years)	0.5191	1.25	-0.2938**	-2.67	-0.0405	-0.47
Qty month water supply (ltrs)	-0.6921**	-2.70	-0.1651	-0.59	0.1147**	2.08
Number of extension contacts	0.2180	0.73	0.3174	0.97	-0.0649	-1.01
Season (Wet=1; Dry=0)	-0.5868	-1.53	-1.2601***	-3.14	0.2163**	2.87
Age(in years)	-1.0484	-1.19	0.7982	0.79	0.0596	0.31
Gender (Male=1; Female=0)	0.2321	0.59	0.8280**	1.81	-0.1183	-0.39
Years of education	0.7018*	1.71	0.3904	0.92	-0.1405	-1.64
Coop. training attendance (No)	0.0214	0.06	0.5331**	2.27	-0.0610**	-2.74

Base Outcome: Well=0; (*) dy/dx is for discrete change of dummy variable from 0 to 1
Y=Pr(Irrigation Method=0) (Predict) = 0.4617
Source: Computer from Field Survey, 2022.

3.4 Endogenous Switching Regression Estimate of Adopted Cultivated Rice Variety and Intensity of Output

Results of the cultivation selection equation are reported in the section of the output headed cultivation system. Results of the output regression in the swamp rice cultivation are reported in the riceoutput_1 section, and the output regression in the upland cultivation is reported in the rice output_0 section. The correlation coefficient rho_1 and rho_2 are positive with 0.1805 and 0.2735 respectively and are also found to be significantly different from zero in both cases, that is, cases of riceoutput_0 and upland cultivation. Rho_1 being positively and significantly different from zero, the model suggests that individuals choose to adopt swamp cultivation system had lower rice output in that category than a random individual from the sample would have realized. Similarly, those adopting upland cultivation system also have the same experience in the area of rice production.

The likelihood ratio test for joint independence of the three equations is reported in the last line of the output. The variable sigma, \Inst1, \Inst2, \r1 and \r2are ancillary parameters used in the maximum likelihood procedure. Sigma_1 and Sigma_2are the square root of the variances of the residuals of the regression part of the model, and insignificant is its log. \r1 and \r2 are the transformation of the correlation between the errors from the two equations. According to the result presented in Table 5, number of seasonal extension contacts, monthly quantity of water supplied, value of total input and distance to irrigation water source were found to be significant at different level and possessed signs of interest. All the significant variables mentioned increased seasonal rice output. Extension contacts stimulated an increase in rice production owing to technical advice and introduction of new technology which were adopted by farmers with resultant appreciable output. Water was found to be a critical contributor to rice output, and, the more the timely quantity of water supplied, with other basic resources mobilized, rice output will increase as expected. Also, total inputs that are germane to rice production when used appropriately in quality and quantity terms will bring forth proportional rice output. Distance of irrigation water source to the rice farm is an indicator to availability of water for farm irrigation at all points in time. With proximity to water, more water is expected to be available in irrigating rice that for the farms with ample distance to water source.

Choice of most-preferred method of rice production was positively influenced by farm size, farming experience, number of extension contacts and total inputs while age of farmers was negatively signed but also influenced farmers' decision. Farm size played a significant role in the choice of method used by rice farmers as with more farm size, a farmer must carefully and meticulously choose a method that will minimize the production threatening risks so he can realize quantity of harvest and income far above production cost. Farming experience was also a critical factor according to the result. With more years of experience, more suitable cultivation method was chosen by farmers which might not be achievable if the decision was wrong. Number of seasonal extension contacts was also found to influence choice of appropriate cultivation method that was capable of stimulating bumper production. Amount of total input used was also an indicator of the method of farm cultivation adopted by farmers. Conversely, age was found to influence decision of farmers in the choice of cultivation method negatively. With an advanced age, farmers' decision might be incapable of attaining efficient production performance and production peak.

Table 5

Determinants of Chosen Cultivation Method and Intensity of Rice Output

Number of Observation		=196
Wald chi2		= 11.02
Prob > chi2		= 0.0008
Log likelihood		= -259.33
Variable	Coefficient	z
Rice Output_1		
Constant	11.9872***	8.76
Farm size (in Ha)	0.0047	0.06
Farming Experience (in years)	-0.1111	-1.23
Extension Contact (No.)	0.0382***	3.54
Gender(Male=1; Female=0)	0.0680	0.64
Monthly irrigation water supplied (in litres)	0.0152*	1.75
Total input value(in naira)	0.2691**	2.25
Education(in years)	0.1182	1.33
Distance to water source (in km)	0.2782*	1.73
Rice Output_0		
Constant	14.2841***	8.17
Farm size (in Ha)	0.0779	0.85
Farming Experience (in years)	-0.0474***	-3.34
Extension Contact (No.)	0.0533	0.52
Gender(Male=1; Female=0)	-0.0311	-0.23

Monthly irrigation water supplied (in litres)	-0.1454*	-1.68
Total input value(in naira)	0.0661	0.40
Education(in years)	-0.2419**	-2.61
Distance to water source (in km)	-0.0350	-0.18
Cultivated Rice(Swamp=1; Upland=0)		
Constant	-4.3736	-1.49
Farm size (in Ha)	0.1104***	3.72
Gender(Male=1; Female=0)	0.2033	0.97
Monthly irrigation water supplied (in litres)	0.0429	0.32
Education(in years)	0.0091	0.04
Farming Experience (in years)	0.4327*	1.95
Extension Contact (No.)	0.0467**	2.30
Total input value(in naira)	0.4624**	2.10
Distance to water source (in km)	0.2746	0.88
Occupational training attended (No.)	-0.1099	-0.47
Cooperative training (No.)	0.3237	1.55
Age of farmers (in years)	-0.0374***	-3.88
/Ins1	-0.7698	-9.05
/Ins2	-0.6638	-5.48
/r1	0.1825	0.36
/r2	-0.2806	-0.51
Sigma_1	0.4630	
Sigma_2	0.5149	
Rho_1	0.1805	
Rho_2	-0.2735	
LR test of indep. Eqns. : chi2(1) = 0.23	Prob>chi2 =	0.6304

Source: Computer from Field Survey, 2022.

3.5 Factors Militating Against Irrigation of Rice Farm

Table 6 presents results on constraints militating against rice farm irrigation. Keen competition for water between herdsmen and rice farmers was voted most affecting among the constraints highlighted with highest mean score of 4.24. It is very clear that both livestock and crop enterprises require water to keep the business active. The area is characterized with modal rainfall of about four months in the year which is never sufficient for rice production during the dry season no matter the technology for conservation. The competition between herdsmen and rice farmers in many cases always results in quarrel which in many cases prevents timely cultivation of rice and hitch-free irrigation. Seasonal drought in the middle-belt Nigeria hampers availability of underground water which could be accessed, tapped and utilized for irrigation was rated second with mean score of 3.94. Also, the season makes water table very low in the dry season which makes water inaccessible when efforts were made to sink well. In this case, it is borehole that can proffer solution to the perennial irrigation problem among rice farmers owing to the fact that it is deeper and capable of reaching the water table, no matter the depth.

Lack of access to credit for implementation of localized irrigation farm was identified as third challenge. It was observed that rice farmers were willing to device a more localized and suitable irrigation plan but funds were an impediment that prevented them from achieving the goal. Dearth of labour was identified by rice farmers as fourth problem hindering irrigation of rice farm irrigation. Due to some experienced hindrances which made water unavailable on the farm, there was a need for intensive labour effort in channeling water efficiently to all the areas of the farm. Price of pumping machine was identified as not being affordable by individual farmer. Pumping machine, if affordable by farmers will improve the pumping rate and make enough water available on the individual farmer's rice farm, it was rated fifth. The high and unstable price of the machine might be due to the ruling unfavorable exchange rate. Insufficient help from government in terms of more sources of water such as drilling boreholes was rated sixth and scored 3.52. Rice farmers believed that government can make a vital contribution in the area of capital provision but this according to them was available but not sufficient enough to surmount the perennial water shortage.

Scarcity and high price of fuel hinder timely pumping of water was rated the seventh problem of irrigation in the right farm according to the responses provided. Diesel or petroleum is used in powering pumping machine but their regular availability is not guaranteed and this hampers seamless irrigation water supply to rice farm. Shortage of water due to insufficient pumping machine hence uneven distribution of water across farmlands was rated eighth among the factors with the mean score of 3.10. It could be inferred from this response that it is either that the horsepower of the pumping machine is very low and it is incapable of pumping with high pressure to various destination or the area to be covered for irrigation is too large per unit machine.

Topography of the farmland creating hills and valleys that hampers flow of water to intended farm areas and Elite hijack of water most especially at the peak of dry season are rated ninth and tenth respectively. With undulating farmland area, irrigation machine must have higher horsepower in order for water to ascend and descent hills and valleys, thus, making water available to rice plantation. Elites among rice farmer were also identified as major hindrance to timely and even reticulation of water across farms. They prefer to be treated preferentially because of their large scale farm practice.

Table 6

Likert Scaling Index Result Examining Constraints Militating Against Rice Farm Irrigation

Variable	1(SD)	2(D)	3(U)	4(A)	5(SA)	WS	MS	Rank
-Seasonal drought hampers availability of underground water at the peak of dry season.	7(3.6)	16(8.0)	31(15.6)	70(35.2)	72(36.7)	772	3.94	2nd
-Scarcity and high price of fuel hinders timely pumping of water.	10(5.0)	24(12.1)	39(19.6)	115(57.8)	8(4.0)	675	3.44	7th
-Shortage of water due to insufficient pumping machine hence uneven distribution of water across farmlands	9(4.5)	32(16.1)	99(49.7)	42(21.1)	14(7.0)	608	3.10	8th
-High price of pumping machine due to unfavourable exchange rate.	4(2.0)	15(7.5)	40(20.1)	110(55.3)	27(13.6)	729	3.72	5th
-Keen competition for water between herdsmen and rice farmers making sufficient water unavailable to farmers.	6(3.0)	12(6.0)	20(10.1)	48(24.1)	110(55.3)	832	4.24	1st
-Topography of the farmland creating hills and valleys and this hampers flow of water to intended farm area.	18(9.2	109(55.6)	36(18.4)	21(10.7)	12(6.1)	488	2.50	9th
-Insufficient help from government in terms of more sources of water such as drilling boreholes.	9(4.6)	22(11.2)	42(21.1)	104(53.1)	19(9.7)	690	3.52	6th
-Low labour availability to use in making water available across farm areas.	9(4.6)	22(12.2)	41(20.9)	57(29.1)	65(33.2)	733	3.74	4th
-Lack of access to credit for implementation of localized irrigation plans.	10(5.0)	24(12.1)	32(16.1)	54(27.1)	76(38.2)	750	3.83	3rd
-Elite hijack of water most especially at the peak of dry season.	76(39.2)	40(20.1)	37(18.6)	31(15.6)	10(5.0)	443	2.26	10th

SA: Strongly Agreed; A: Agreed; U: Undecided; D: Disagreed; SD: Strongly Disagreed.

Source: Computer from Field Survey, 2022.

3.6 Test of Hypothesis

Result on the relationship between monthly quantity of water supplied to rice farm and the quantity of rice output among rice farms in the study area. Quantity of water (21.487; $p<0.01$) and quantity of rice output (31.636; $p<0.01$). The two variables were found to be significant at 1%, indicating that the null hypothesis will be rejected while the alternative hypothesis which says, there is a significant relationship between monthly quantity of water to rice farms and the quantity of rice output realized, would be accepted. It could be inferred that, with sufficient and timely supply of water to rice farms, all other things being equal, efficient production is inevitable.

Table 7

Test of Relationship between the Quantities of water supplied to Rice Farm and Output

Variable	t	df	Sig.(p<0.01)	Mean Difference
Quantity of Water	21.487	195	0.000	3752.464
Quantity of Rice Produced	31.636	195	0.000	646145.66

Source: Computer from Field Survey, 2022.

IV. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

It could be concluded from the results that farm size (0.0492; p<0.01), quantity of monthly water supply (0.1147; p<0.05) and season of production (0.2163; p<0.05) positively influenced irrigation water supply to rice farm. Farm size (0.1104; p<0.01), farming experience (0.4327; p<0.1) and extension contact (0.0467; p<0.05) were found to influence adoption of swamp rice cultivation in the study area.

5.2 Recommendations

Based on the findings in the foregoing was that:

(i) High yielding, early maturing and drought resistant rice variety should be made available to rice farmers;
(ii) Skill improving training should, from time to time organize for rice farmers;
(iii) More sustainable water sources such as river and river basin should be made functional through intervention of government with the support of technocrats and non-governmental organizations for sustainable strategy blue print for perennial water provision;
(iv) Rural farm households should be encouraged to live in their natural environment with enticement triggered by social, farm, institutional and physical amenities and;
(v) Farm inputs should be made available to rice farmers and credit facilities be adequately provided.

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