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Adoption of improved Production Practices among Rice Farmers in North-western Zone of Nigeria

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Abstract
This study examined the adoption of improved rice production practices by farmers in Northwestern Nigeria. Data were collected from 463 farmers purposively selected from 16 Local Government Areas in Kebbi, Sokoto, Kaduna and Jigawa States, using structured interview schedule and Focused Group Discussions. The data were analyzed using descriptive and inferential statistics. The socioeconomic characteristics of respondents showed that majority 40.2% are youth below 40 years, 58.3% are educated and 53% have farming experience above 10 years. Findings from the study showed that 95.25% of the respondents were aware of improved varieties (95%), while planting techniques were adopted by 94.25% of the farmers. Focused Group Discussion showed that, farmers prepared to grow indigenous variety (Danboto) because it is high yielding. Majority (31%) of the farmers were in the moderate adopter category. High cost of fertilizer recommendations (43.28%), low availability of improved seeds (22.89%) and lack of improved storage facilities (16.92%) were the major constraints to the adoption of improved production practices. This study concluded that majority of the farmers were moderate adopters. Hence, the study recommended improved farmers' access and use of agricultural inputs, especially, fertilizer recommendations and to explore inherent characters of indigenous varieties by breeders to develop ecology specific, high yielding and climate smart rice varieties.
Keywords: *Adoption, Production Practices, Rice farmers*

Introduction

A sectoral analysis of Nigeria's Gross Domestic Product (GDP) according to Food and Agriculture Organization (FAOSTAT, 2020) revealed that agricultural sector accounted for 22.35% of the Gross Domestic Product (GDP) with over 70% of the over 210 million people in Nigeria engaging in agriculture mainly at subsistence level. According to FAO (2020) report, land area under rice cultivation grew from 3.1 million hectares in 2015 to 5.9 million hectares in 2018 then slid down to 5.3 million hectares in 2020. Rice is a critical staple food in Nigeria with an estimated monthly per capita consumption of about 46.3 kg making Nigeria the highest consumer in West Africa. Nigeria also accounts for 20% of Africa's consumption in 2020 (PWC, 2018). The three main rice production systems in Nigeria include rain-fed lowland, rain-fed upland and irrigated lowland, that is increasingly being cultivated (Onyeneke, 2015). Daramola (2020) reported that rain-fed lowland ecological systems contributed about 47% of total rice production, while irrigation systems accounted for about 16% and rain-fed upland systems, 30%. However,

combined output from these rice production systems cannot meet the annual rice demand of over 7 million tons in 2020. (Daramola, 2020)

Given the importance of rice, the Nigerian government has accorded high priority to rice production, leading to a peak record production of 5.04 million tons in 2020 (USDA, 2022). However, production still falls short of the desired quantity due to low yield of just 2 tons per hectare as against 4-5 tons Asian average. Also, population explosion and influx of people to urban areas really call for concerted efforts to improve rice production given the foremost position occupied by rice in the Nigerian diet, by using best general agronomic practices.

The effect of adopting new innovative farming techniques can be evaluated from its pro-poorness; that is the extent to which low-income, small-scale farmers benefit from the practices more than the non-poor (Wossen et. al., 2022) This, along with several studies were carried out on adoption of new innovations on farm practices, which is dependent on careful assessment of socio-economic, technical and institutional factors as indicated by Ayim et al. (2022).

However, according to some studies, only few rice farmers use improved production practices with seeds obtained from past harvests. Abdoulaye, (2023) and most other adoption behaviour studies examined adoption of a single component of the technology package instead of the whole package. It must be mentioned that farmers mostly adopted components of the package sequentially as indicated by Abdoulaye, (2023). The development, dissemination and acceptance of these new practices or innovations could hold the key to the achievement of self-sufficiency in rice production in Nigeria leading to the desired food security and improvement in the standard of living of the population. In this regard, it is therefore, pertinent to analyze the adoption pattern of improved production practices observed in the main rice production system among rice farmers in North-western Nigeria. Specific objectives of this study were to describe some of the socioeconomic characteristics of the rice farmers in the study area, examine status and adoption levels of the improved production practices such as; use of improved seeds, recommended seed rate, improved water management practices, fertilizer application, pest and disease control, harvesting, as well as improved storage facilities, while establishing constraints observed in the use of the improved production practices.

Methodology

Study Area

The study was conducted in the North-western Nigeria, which comprises Sokoto, Kebbi, Zamfara, Katsina, Kaduna, Kano and Jigawa States. The area has a combined projected population of 49,942,306 from a projected growth rate of 2.9% - 3.3% per annum (UNFPA, 2015). The area is about 217,000 square kilometres representing almost a quarter of Nigeria's land area. The study area has international boundaries with Niger Republic to the North and on the southwest, with Benin Republic. The elevation of the study area is between 250 and 350 metres above sea level. The river system represents the principal drainage network in this region.

Over 80% of the inhabitants of the study area are practicing one form of animal and or crop farming or the other. They produce crops such as millet, guinea corn, maize, rice, potatoes, cassava, groundnuts and beans at a subsistence level; wheat, sesame, sugarcane, cotton and assorted crops and vegetables for cash (StopLearn, 2023).

Sample and Sampling Procedure

The study used a multi-stage stratified sampling framework. Four levels of stratification were employed, which included the State, the Local Government Area, the village and the household levels. The study was limited to four States. The 4 States selected representing about 60% of the total States in the study area were Kebbi, Sokoto, Kaduna and Jigawa States which was done on the basis of the share of each State in national rice cropped area. Also, four Local Government Areas were selected from each of the State with three villages randomly selected from each Local Government Area giving a sum of forty-eight villages from the study area.

A total of 20,304 rice farmers were obtained from the Rice Farmers Association of Nigeria (RIFAN) in the four States that constituted the study area from which 3% of the rice farmers were randomly selected for enumeration from the 48 villages, selected for the study. This gave a total of 609 respondents.

Data Collection Methods

Primary data and secondary information were collected to answer the research questions and achieve the objectives of this study using interview schedules and focus group discussion. The questionnaire was administered to 609 individual rice farmers, but only 463 (76.03%) of the questionnaires were found useful due to excessive missing data.

Both descriptive and inferential statistics were used in the analysis of data. Descriptive statistics such as range, ranking, means, weighted means, percentage and frequency distributions were used to achieve objectives of the study. The adoption level of rice farming refers to the number of improved practices for rice farming adopted by a rice farmer when the farmer has complete information on how to use the practice and its merits. For this study, the level of adoption was measured as the ratio of each practice adopted by the farmer against the recommended ratio of that technology. The adoption index shows the extent a farmer has adopted a whole set of packages of practices calculated using the formula adapted from Tadesse (2008). The scores were further subjected to descriptive statistics using frequency and percentages to identify the real distribution of each technology in the category of the adoption index so that a generalized conclusion can be drawn with respect to the category the practice was recorded by the rice farmers. Thus, low, moderate and high adoption of recommended practices.

The adoption index is a continuous variable that varies from 0 - 1 depending upon a farmer's degree of adoption of the practice. On the basis of adoption index, farmers were therefore classified into three categories: low, medium and high adopters. The overall adoption index of all the farmers was categorized into four distinct categories, that is, none=0, low adoption =0. 01-0.33, medium adoption=0. 033-0.66 and high adoption level=0. 67-1.0. The adoption score of 0 indicates non-adoption of improved rice production package and the adoption score of 1 implies the farmers have adopted all the practices according to the recommendation. If the adoption score falls above the value of 1, it indicates the farmers used some of the practices above the recommended rate. In order to identify the level of adoption of improved rice production package, the adoption index of individual farmers was calculated as modified from Tadesse (2008):

$$AI_i = \frac{\sum_{i=1}^{n} \left| \frac{RVAi}{RV} + \frac{PTAi}{PT} + \frac{PDCi}{PDC} + \frac{WMi}{WM} + \frac{HTAi}{HT} + \frac{STAi}{ST} \right|}{N^p}$$

Where i = 1, 2, 3 ----------n, and n= total number of farmers

AI_i = Adoption index of i^{th} farmer
N_p = Number of recommended practices
RVA_i = Improved rice varieties used by the i^{th} farmer
RV = Rice varieties recommended for rice production
PTAi = Planting practices adopted by the i^{th}farmer
PT = Recommended planting practices
PDCi = Pest and disease control practices used by the i^{th}farmer
PDC = Recommended pest and disease control practices
WMi = Water management practices used by ith farmer
WM = Recommended water management practices
HTA_i = Harvesting practices used by the farmer
HT = Recommended harvesting practices
STAi = Storage practices used by the farmer
ST = Recommended storage techniques for rice cultivation.

Results and Discussion

Socio-economic Characteristics of the Respondents

The results in Table 1 revealed that over two-thirds of the respondents were between the age category of 31-50 with a mean age of 41years, implying presence of youthful and agile population. The presence of youths is an important asset for efficient production and change in the study area. The result on age agrees with the findings of Adekunmi (2022) in the study of rice farmers awareness and perception of climate change in Ondo State, Nigeria who equally reported similar age range for rice farmers. Also, almost all of the respondents were male and married and male.

Over half of the respondents (58.3%) had low formal education with no membership of any associations. The literacy level of farmers could enhance their level of understanding and desirability of adopting innovation and farm technologies or interacting with extension agents. Educated farmers are in better position to comprehend associated issues related to climate change as attested by Mwinkom *et al.* (2021) in their study of factors influencing climate change coping and adaptation strategies in North-western Ghana. Similarly, majority (39%) had farm size of less than 1 hectare. The average farm size is 1.5, mainly acquired through inheritance, thus indicating that rice cultivation in the study area was on a marginal technical smallholder unit.

Table 1 : Distribution of respondents' socio-economic characteristics **n=463**

Variables	Frequency	Percentage (%)	Mean
Age (Years)			
21-30	94	20.4	41
31-40	186	40.2	
41-50	140	30.3	
>50	43	9.1	
Gender			
Male	435	93.9	
Female	28	6.1	
Marital status			
Married	435	93.9	
Single	20	4.5	
Divorced	4	0.8	
Widow/widower	4	0.8	
Household size			
1-5	70	15.2	
6-10	256	55.3	6
11-15	95	20.5	
>15	42	9.0	
Education level			
Primary	115	25.0	
Secondary	88	18.9	
Tertiary	67	14.4	
Non-Formal	193	41.7	
Membership of association			
Member	193	41.7	
Non-member	270	58.3	
Rice farming experience (years)			
1-5	56	12.1	
6-10	161	34.8	3
11-15	102	22.0	
16-20	88	18.9	
>20	56	12.1	
Farmland size (ha)			
< 1.0	182	39.4	
1.0-2.0	130	28.0	1.5
2.1-3.0	147	31.8	

> 3.0	4	0.8
Source of land acquisition		
Inheritance	260	56.1
Rent	130	28.0
Purchase	63	13.6

Source: Field Survey, 2019

Status and adoption levels of the improved production practices

Table 2 showed improved rice production practices tried and adopted by the respondents. The results showed that seed of improved varieties (87.47%), harvesting practices (62.20%) and planting practices (60.91%) ranked first, second and third respectively of the rice farming practices the farmers had tried before adoption. Other practices the farmers adopted include planting practices (94.25%), seed of improved varieties (79.05%) and storage methods (66.30%) of the farmers had adopted these practices. The least practices which farmers were aware of, tried and adopted are water management (61.99%), storage method (34.13%) and fertilizer application (41.25%) respectively. This might be in agreement with Armengot, et. al., (2023) who observed the decision to accept or reject an innovation is based on some trade-off of sorts between perceived benefits of the system to the user and the complexity of learning ways of using the system.

The very low adoption rate of fertilizer application (41.25%) might be because the farmers used varying doses of fertilizer, which in most cases, was less than the recommended rate. This might be due to the high cost or non-availability of fertilizer to farmers. The practices with low adoption values may imply that the respondents have not known their relevance to their production. However, the low adoption of some of the practices could just be a matter of choice.

Focus group discussions with some respondent's revealed birds control practices to be the main pest control practices. This study also showed non-adoption of improved seeds might have been stalled by the use of *"Dan boto"* indigenous seed. *Dan boto* is capable of giving an extremely high yield based on its unique agronomic traits in contrast to the other varieties they use suggesting the need to explore the inherent potentials of this variety.

Table 2: **Distribution of Farmers Based on Trial and Adoption Status of Improved Rice Production Practices (n=463)**

Varia	**T**	**Adop**	**Non-**
Planting technologies	282(6	441(9	22(
Water	271(5	197(4	266(5
Seed of	395(8	269(7	55(2
Fertilizer	209(4	191(4	273(5
Pest and	258(5	293(6	170(3
Harvesting	288(6	250(5	213(4
Storage	158(3	307(6	156(3
T			

Source: Field survey, 2019

The categorization of farmers based on adoption of improved rice practices on Table 3 indicated that 30.57% of the farmers were in the moderate adopter category, 28.19% were in the non-adopter category while 23.11% were low adopters. Only 17.93% were high adopters. Fertilizer application, water management and harvesting techniques were not adopted by most of the farmers. In other words, over 82% of the respondents were partial adopters with 17.93% being full adopters of above-mentioned practices. The reason for this non-adoption might be due to the costs involved in these practices. Thus, the recommended practice was not fully practicable.

Omonona and Arulegba (2023) observed that diffusion of improved practices depends on availability of farm inputs such as fertilizer. Other factors negating adoption of new practices may be the high cost of agricultural innovations, unavailability of the practice, risk element involved, ignorance of the existence of new innovations and the conservative attitudes of most farmers (Osabuohien *et al.* 2023).

Table 3: Distribution of Farmers Based on Level of Adoption of Improved Rice Production Practices

Adoption Category	Adoption Index Score	Frequency	Percentage
Non-Adopters	0.0	131	28.29
Low Adopters	0.01-0.33	107	23.11
Moderate Adopters	0.34-0.66	142	30.67
High Adopters	0.67-1.0	83	17.93
TOTAL		463	100

Source: Field Survey, 2019

Constraints observed in the use of the improved production practices.

Entries in Table 4 showed that some of the respondents had some issues in comprehending the complete use of some practices due to high cost of fertilizer (43.28%), low availability of improved seeds (22.89%) and lack of improved storage facilities (16.92%). However, the practices that had the least problems were pest and disease control (4.98%) and harvesting techniques (11.93%). This finding is in agreement with that of Omonona and Arulegba (2023) which showed that adoption of some practices is impeded by high cost and low availability of farm inputs.

Focus group discussion, however, revealed that some areas that produce irrigated rice with a very high achievable yield of over 5 tons per hectare faced serious threat of flooding caused by the bursting of the dam embankment. This is seen as a constraint on the use of improved water management practices.

Table 4: Distribution of Respondents based on Constraints in the Use of Improved Rice Production Practices. n=463

Constraint	Frequency	Percentage
High-cost Fertilizer	200	43.28
Low availability of improved seed	106	22.89
Lack of improved Storage facility	78	16.92
Pest and diseases	24	4.98
Poor harvesting technique	55	11.93
TOTAL	463	100

Source: Field survey, 2019

Conclusion and Recommendations

Based on the findings of the study, the majority of the farmers were Moderate adopters of recommended practices. Farmers were aware of seeds of improved varieties but planting techniques was the most adopted practice by the farmers, while fertilizer application was the major un-adopted rice farming practice. The main constraints encountered by the respondents related to the use of improved rice production practices has to do with high cost of fertilizer.

Based on the findings of the study, the following recommendations were made:

1. Improve farmers' use of agricultural inputs, especially fertilizers by educating the farmers on fertilizer rate, time and methods of applications by the extension workers.
2. Develop indigenous crop varieties by research agencies to increase their positive traits for increased adoption by the farmers.
3. Encourage farmers' participation in on-farm demonstration trials during variety development, release, seed multiplication and dissemination of improved rice varieties and production practices. This will promote uptake of newly developed rice varieties and production practices.

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