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Perceived Effectiveness of Japan International Cooperation Agency (JICA)-Rice Processing Technologies Utilization among Rice Processors in Kogi State, Nigeria

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Abstract

In recent years, global rice consumption has seen a substantial increase, and consumption is expected to continue rising due to its significance in household diets worldwide. However, successful rice processing requires specific operations. This study assessed the effectiveness of Japan International Cooperation Agency (JICA) Rice Processing Technologies Utilization among rice processors in Kogi State, Nigeria. A three-stage sampling technique was employed to select one hundred and eighty (180) rice processors for the study. Data collection utilized a questionnaire complemented with an interview schedule, and the analysis employed descriptive statistics (frequency counts, percentages, and mean). Results revealed that the majority (91.1%) of the respondents were female with a mean age of 47.6 years. Additionally, 86.7 percent were married, and 56.7 percent had primary education. It was also found that extension agents (72.2%) were the main sources of information on JICA rice processing technologies in the study area. Furthermore, the study found that all JICA initiatives were effective. However, the false bottom at parboiling for quality paddy rice ($\bar{X}$ = 3.99) and the Ajifa mill for milling clean rice grains with a good appearance ($\bar{X}$ = 3.98) were rated as the most effective JICA initiatives by the respondents. Consequently, the study recommends that the government should encourage and organize free adult literacy classes to increase processors' knowledge and orientation toward processing activities.

Keywords:
JICA- rice technologies, false bottom, milling, parboiling, de-stoning

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INTRODUCTION

Rice (Oryza sativa) is a crucial source of nutrition for humanity (FAO, 2013). Nearly half of the global population relies on rice as a fundamental food source (Oguntade, 2011; Shahbandeh, 2021). Rice is extensively cultivated in countries like Bangladesh, China, Japan, India, the Philippines, and many others. In Nigeria, rice stands as one of the country's primary staple crops. A significant proportion of Nigerians, regardless of their ethnic group, depend on rice for their daily sustenance (Raheem et al., 2021). Rice is gradually emerging as the most essential staple food in Nigeria due to its affordability as a source of carbohydrates for both human consumption and animal feed (Nwozor and Olanrewaju, 2020). It is noteworthy that globally, West Africa leads in both rice production and consumption, estimated at 64.2 and 61.9 percent, respectively (FAO, 2020).

Agriculture serves as the backbone of the Nigerian economy, primarily by providing employment opportunities for its growing population, alleviating poverty, and contributing to overall economic growth (Olajide et al., 2015; Komolafe, 2018). In 2021, the agricultural sector contributed approximately 27 percent to Nigeria's total Gross Domestic Product (GDP) (National Bureau of Statistics (NBS), 2021). Rice stands out as one of the major staple foods in Nigeria (Oladimeji et al., 2020). Various actors participate in the rice production chain, engaging economic agents who facilitate the movement of goods and services from production and processing to the end user (Hussaini et al., 2021; Ezuzie et al., 2020). The cultivation and processing of rice represent the primary activities along the value chain in Nigeria (Okonkwo et al., 2021). Rice cultivation, or farming, involves cultivating a piece of land to grow rice, while rice processing encompasses methods used to prepare rice for consumption or preservation, including husk removal and sometimes grain polishing (Adejoh, Madugu and Shaibu, 2017). These processing operations aim to alter the rice's form while maintaining its quality (Zohoun et al., 2018). Another key objective of rice processing is to reduce food losses, enhance food security, generate income, especially for households, and stimulate local production (Kwofie & Ngadi, 2017). Rice paddy consists of the husks, cortex, embryo, and endosperm. Processing paddy rice involves various operations to separate the endosperm from other components while minimizing fragmentation and impurities and preserving its nutritional value (FAO, 2013). These operations are essential for improving the quality of rice intended for consumption (Nwozor & Olanrewaju, 2020).

In Nigeria and other parts of West Africa, rice processing is not being carried out optimally, leading to significant variations in the quality of milled rice (Kodama, 2018). Processors encounter numerous challenges in producing high-quality rice due to the continued use of primitive methods (Nwachukwu et al., 2020). Consequently, locally produced rice often suffers from issues such as stones, breakages, and dark grains, while the demand for better-quality imported rice has steadily increased over the past two decades (Okeke and Oluka, 2017). For these reasons, it has become imperative for rice processors to acquire techniques that can enhance the quality of rice, ultimately contributing to improved food availability, increased income for farming households, and fostering international trade partnerships (Raheem et al., 2021). Enhanced rice quality will boost the demand for locally produced rice and increase income in local rice processing. Consequently, rice processors will be motivated to expand their production scale. According to the Kogi State Ministry of Agriculture, the main rice-producing areas in Kogi State are Ibaji and Idah (Zone A), Bassa (Zone B), Lokoja (Zone C), and Ejiba (Zone D). As part of the effort to boost rice production, the state has established rice farms in Koto, Okumi, Galele, and the Sarkin Noma Irrigation Project sites (Abdulazeez et al., 2019).

The Japan International Cooperation

Agency (JICA) is a government agency responsible for delivering the majority of Official Development Assistance (ODA) on behalf of the Japanese government. JICA is dedicated to supporting economic and social development in developing countries and promoting international cooperation. Since its establishment on October 1, 2008, JICA has grown into one of the world's largest bilateral development organizations, operating through a network of over 97 overseas offices and engaging in projects in more than 150 countries (JICA, 2022). As part of JICA's efforts to increase rice production, achieve self-sufficiency, address rice processing challenges, and enhance the industrial capacity for producing high-quality milled rice in Nigeria, the Federal Government of Nigeria (FGN) partnered with JICA through the Federal Ministry of Agriculture and Rural Development (FMARD). Together, they worked on the development and introduction of rice processing technologies, including the False Bottom, clean drying slab, standard miller, and destoner. These technologies were introduced as part of the 'Rice Post-harvest Processing and Marketing Pilot Project (RIPMAPP),' targeting small-scale rice processors in Nigeria, including Kogi State. In Kogi State, the project was implemented from 2015 to 2016 in collaboration with the Kogi State Agricultural Development Project (Kogi-ADP) and Ajifa Mill, a modern cottage mill (RIPMAPP, 2016). The primary objective of the program was to encourage local rice production and processing on a commercial scale, bridging the significant gap between domestic demand and supply. Additionally, the program aimed to achieve self-sufficiency in rice, enhance food security, and ensure nutritional security in the country. Throughout the program, a special focus was placed on training selected rice farmers and processors engaged in commercial rice processing within the rice-producing areas of the state. This training was designed to enhance the capacity of commercial rice processors and equip them with the skills needed to produce high-quality milled rice that is free from stones and other impurities.

Since the inception of the program and the adoption of JICA initiatives in Kogi State, there has been a notable absence of studies aimed at evaluating the effectiveness of these initiatives among the users. Consequently, there is a significant gap in our understanding of how well the JICA initiatives are being utilized in Kogi State.

The specific objectives of this study, therefore, were as follows:

(i) To identify the socio-economic characteristics of the rice processors.

(ii) To investigate the sources from which rice processors obtain information about JICA rice processing technologies.

(iii) To assess the perceived effectiveness of JICA's improved rice processing technologies among rice processors.

(iv) To identify the challenges and constraints faced by processors in the utilization of JICA processing technologies.

This study aimed to fill the knowledge gap and provide valuable insights into the utilization and impact of JICA initiatives on rice processing in Kogi State.

METHODOLOGY

Study Area

Kogi State, with its capital in Lokoja, is situated in the North-central region (Middle-Belt) of Nigeria. It was created on August 27, 1991, from portions of Kwara and Benue States. The state is widely recognized as the "Confluence State" due to the convergence of the Rivers Niger and Benue within its borders. Kogi State holds a unique central position among all the states in the Nigerian federation and is situated between Latitude 7°30'N and Longitude 6°42'E of the equator, as per the Department of Land Survey Kogi State (2010).

The state boasts a population of approximately 3,595,789 people and covers a total land area of about 30,354.74 square kilometers (NPC, 2006). The largest ethnic group in Kogi State is the Igala, followed by the Ebira and Okun ethnic groups. Additionally, there are several minority ethnic groups, including the Magongo, Bassa, Oworo, Nupe, Ogori, among others.

Kogi State experiences two distinct seasons: the dry season and the rainy season. Precipitation typically occurs between April and October, while the weather is generally dry from November to March. The state benefits from favorable ecological and climatic conditions, boasting an average temperature of 26.8°C and an annual precipitation/rainfall of approximately 747mm. These conditions create a conducive environment for the cultivation of a wide range of agricultural products, including yam, cassava, rice, cowpea, cocoyam, maize, millet, guinea corn, palm produce, melon, groundnuts, and various others. Agriculture serves as the cornerstone of the state's economy, and its abundant agricultural resources are evident in its ability to produce valuable cash crops such as cocoa and cashew.

Sample Procedure and Sample size

A three-stage sampling technique was employed to select respondents for the study. Here's a breakdown of the sampling process:

First Stage: Three (3) Local Government Areas (LGAs) were purposively selected from the total of twenty-one (21) LGAs in the state. The selected LGAs are Idah, Ibaji, and Igalamela-Odolu LGAs. These LGAs were chosen because they are the only areas in Kogi East where JICA training on improved rice processing technologies took place.

Second Stage: Within each of the selected LGAs, three (3) JICA beneficiary communities were randomly chosen.

Third Stage: In each of the selected beneficiary communities, a random sample of twenty (20) beneficiaries was chosen.In total, the sample size for the study comprised one hundred and eighty (180) respondents.

This rigorous sampling technique ensures that the study captures a representative and diverse group of beneficiaries who have received training on improved rice processing technologies in the selected areas of Kogi State.

Data Collection

Primary data for this study were collected using a questionnaire administered through personal interviews. The analysis of the objectives was conducted as follows:

Objectives i, ii, and iii:

Descriptive statistics, such as frequency distribution, percentages, and means, were employed for the analysis.

Objective iii:

This objective was assessed using a four-point Likert scale with the following values: highly effective=4, effective=3, mildly effective=2, not effective=1.The scores from each respondent were summed together (e.g., 4+3+2+1) and then divided by 4 to calculate an average score. A midpoint value of 2.5 was used as a benchmark for decision-making. Specifically, mean values greater than 2.5 were considered effective, while mean scores less than 2.5 were deemed not effective. This approach to data analysis allowed for a comprehensive evaluation of the study's objectives and provided a clear way to categorize the effectiveness of the JICA initiatives based on the respondents' perceptions.

RESULTS AND DISCUSION

Socio-economic characteristics of respondents

The results presented in Table 1 indicate several key findings regarding the demographic characteristics of the small-scale rice processors in Kogi State:

Approximately 60 percent of the respondents fell within the age range of 40-49 years. The mean age of the small-scale rice processors was 48 years, indicating that they are still in their economically active years. This suggests that they are capable of effectively utilizing the improved rice processing technologies and may contribute to increased productivity and value-added activities like rice processing. This finding aligns with the research of Waziri et al. (2014), who also noted that individuals between the ages of 41-50 are typically in their economic prime and are more receptive to innovation, technically efficient, and effective. A significant majority, specifically 91.1 percent, of the respondents were female, while only 8.9 percent were male. This indicates that women play a predominant role in rice processing in the study area, which is consistent with the findings of Salami et al. (2017) in Kwara State, Nigeria.It also aligns with the common observation that women are often more involved in agricultural processing activities. The majority of respondents, accounting for 86.7 percent, were married. Being married may entail various social obligations, and married processors may be more committed to engaging in multiple production activities to support their family's basic needs. About 86.7 percent of the respondents reported household sizes ranging from 4 to 7 members, with an average household size of 6 people.This finding is consistent with prior research that has indicated that a substantial percentage of rice processors have moderate-sized households (Tiku et al., 2017).A larger household can be beneficial in rice processing as it may help in reducing the overall cost of processing, given the rigorous activities involved at various stages of rice processing. Overall, these demographic findings provide valuable insights into the profile of small-scale rice processors in Kogi State, which can be useful for designing targeted interventions and support programs in the agricultural sector.

In terms of education level, only 56.7 percent in the study area had primary education, while 36.7 percent had no formal education. It is interesting to note that a few (0.5%) had tertiary education. These figures suggest a low level of education among the rice processors but also imply that they are not entirely illiterate. The level of a processor's education is of paramount importance to their processing skills, as it is believed that education makes people more inclined toward change. Educated individuals tend to view change as a means of improving human conditions, similar to the perspective put forth by Amamgbo et al. (2011), who suggested that education positively correlates with the adoption and utilization of innovation.

The rice processors in the study have an average of 16 years of experience in rice processing, with the majority (80%) having up to 15 years of experience. This implies that the rice processors have been involved in processing activities for a significant duration. More experienced processors are expected to possess greater knowledge and should have mastered the best processing techniques to reduce post-harvest losses and processing costs. This finding aligns with the research of Chikaire et al. (2017), who suggested that the longer an individual spends in a particular business, the more skillful and experienced they become in managing it.

Sources of information on JICA improved rice processing technologies

Table 2 reveals that the majority (72.2%) of the respondents acquired information and knowledge about JICA's improved rice processing technologies through extension agents. This suggests that extension agents in the study area efficiently fulfilled their role in training on JICA's improved rice processing technologies, which also encompassed the various operations involved in rice processing. This finding aligns with the research conducted by Tsado et al. (2018), who reported that extension agents were among the major sources of information and knowledge regarding improved rice varieties in Niger State, Nigeria.

The results also indicate that mass media was not used for disseminating information about JICA's improved rice processing technologies. However, it's important to acknowledge the speed and widespread coverage of mass media in conveying agricultural innovations, as information can be effectively conveyed to various individuals across different segments of society simultaneously. This observation is consistent with the findings of Saleh et al. (2018), who emphasized the essential role of mass media in piquing the in-

Table 1

Socio-economic Characteristics of Respondents

Socio-economic Characteristics	Frequency	Percentage	Mean
Age (in years)			
< 30 years	0	0.0	47.6
30 – 39 years	8	4.4	
40 – 49 years	108	60.0	
50 years and above	64	35.6	
Sex			
Male	16	8.9	
Female	164	91.1	
Marital status			
Single	1	0.5	
Married	156	86.7	
Divorced	5	2.8	
Widowed	11	6.1	
Separated	7	3.9	
Household size			
< 4 people	2	1.1	
4 – 7 people	156	86.7	5.9
> 7 people	22	12.2	
Level of education			
No formal	66	36.7	
Primary	102	56.7	
Secondary	11	6.1	
Tertiary	1	0.5	
Years of experience in rice processing			
< 5 years	2	1.1	
5 – 9 years	5	2.8	15.8
10 – 14 years	29	16.1	
15years and above	144	80.0	
Purpose for rice processing			
Family consumption only	3	1.7	
Both family consumption and sales	177	98.3	
Rice processing as major occupation			
Yes	165	91.7	
No	15	8.3	

Table 2

Distribution of The Respondents Based on Their Sources of Information on JICA Improved Rice Processing Technologies Its Importance on Processors' Output Level

Variables	Frequency	Percentage
Sources of information about JICA Improved Rice Processing Technologies		
Family and Friends	50	27.8
Extension Agent	130	72.2
Importance of the information to output level		
Yes	177	98.3
No	3	1.7

terest of farmers and processors in new ideas and practices. Mass media aids farmers and processors in making informed decisions regarding their agricultural and processing activities while also reinforcing key messages.

The majority (98.3%) of the respondents acknowledged that the information was crucial to their output level. Only 1.7 percent of the respondents held a different perspective, primarily because their production was solely for family consumption, and they believed the information was still beneficial to the quality of rice they consumed. This finding aligns with the research conducted by Adio et al. (2016), who argued that agricultural information services play a significant role in enhancing agricultural production. This is because information is vital, and an informed mind is enriched.

Difference between the Estimated Quantity of Rice Paddy Parboiled Weekly Before and During the Use of JICA Improved Rice Processing Technologies

The results presented in Figure 1 demonstrate an enhanced output level resulting from the adoption of JICA Technologies. Specifically, before the implementation of JICA technologies, only 2.7 percent of the respondents were able to parboil more than 10 bags of 50kg rice paddy weekly. However, with the integration of JICA Technology, there has been a substantial increase, with 32.2 percent of the respondents now capable of parboiling more than 10 bags of 50kg rice paddy on a weekly basis. This finding is consistent with the research conducted by Rehman et al. (2016), which highlights that modern and improved agricultural technology plays a pivotal role in achieving higher farm yields and output, ultimately leading to increased economic profits.

Perceived effectiveness of JICA improved rice processing technologies

As depicted in Table 3, the beneficiaries of JICA rice processing technologies evaluated the effectiveness of these technologies when compared to their prior experience with conventional processing methods. The results indicate that the majority (98.3%) of the respondents found the JICA rice soaking method to be highly effective in the process of soaking paddy rice.

In contrast, the traditional method involves pre-soaking paddy in fresh cold water overnight, followed by boiling in hot water for several hours, often taking between 16 and 24 hours to complete one batch. Occasionally, paddy is not soaked at all but is washed and parboiled immediately. The JICA-recommended soaking process involves placing paddy in warm water for a few hours before parboiling. This entails heating some water

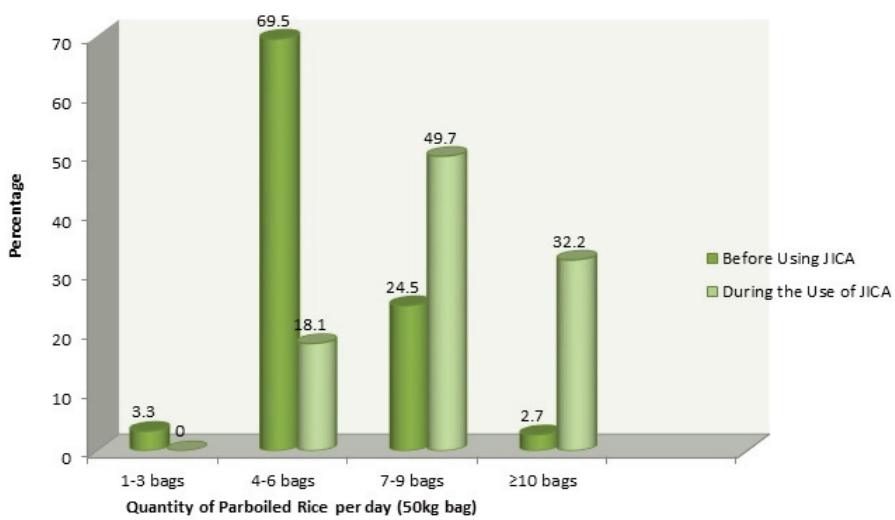

Figure 1. Estimated Quantity of Rice Paddy Parboiled Weekly Before and During the Use of JICA Improved Rice Processing Technologies

until discernible bubbles appear, typically reaching a temperature between 65°C and 70°C. The fire is then extinguished, and the soaking process begins, with paddy either added to the heated water or heated water poured onto the paddy. The paddy is left to soak for 8 to 10 hours, resulting in a moisture content of approximately 30 percent to 35 percent. It is advised that this process be conducted in the evening so that other processing activities can resume the following morning. The JICA-recommended method enables processors to achieve rapid and consistent water absorption, which is the primary objective of soaking.

Numerous studies have emphasized that soaked paddy should ideally reach a moisture content of about 30 to 35 percent for proper solubilization, a process that typically takes about 36 to 48 hours with cold water soaking (Ituen & Ukpakha, 2011; Champathi Gunathilake, 2018). According to Ituen and Ukpakha (2011), hot water soaking has proven highly effective in parboiling paddy because it significantly reduces soaking time from approximately 36 hours to about 3 hours. This facilitates larger-scale production of processed rice within a shorter timeframe. In hot water soaking, water and heat are added to the rice simultaneously, leading to a rapid increase in the rate of solubilization due to the elevated temperature. Additionally, hot water soaking requires less water compared to cold water soaking since there is no need for frequent changes of soak water (Kwofie and Ngadi, 2017).

The results also revealed that the majority (99.4%) of the respondents found the use of JICA-Rice parboiling method (False Bottom technology) to be highly effective in producing high-quality rice grains. This method differs from conventional parboiling practices in Nigeria and West Africa, where paddy rice is typically boiled rather than steamed. Boiling often results in darker-colored rice due to the absence of a lid, allowing steam to escape and leaving the paddy rice at the top undercooked, which can lead to breakage during milling (RIPMAPP, 2016; Danbaba et al., 2019). In contrast, the False Bottom technology separates water and paddy while using a lid to retain steam. This results in a shorter steaming time and whiter rice. When the temperature is evenly distributed through the uniform circulation of steam, it leads to consistent coloration and a whiter appearance of the rice grains.

Moreover, the majority (97.8%) of the respondents affirmed that the milling method introduced by JICA was highly effective in achieving clean whole grains. Additionally, a significant proportion (80.6%) of the respondents reported that the de-stoner technology introduced by JICA was effective in separating stones from rice grains. These findings clearly indicate that the respondents held a favorable opinion of JICA's processing technology, which has contributed to the improvement of rice production quality in Kogi State. However, it's important to note that rice processors in the region still face various challenges in their efforts to produce high-quality rice, primarily because they may not fully embrace new technology (Nwachukwu et al., 2020). Consequently, there has been a consistent increase in the demand for better quality imported rice over the past two decades (Okeke and Oluka, 2017).

The results of the analysis presented in Table 4 reveal a mean difference of 0.64, indicating a significant difference in the output level of rice processors before and after using JICA Improved Rice Processing Technologies (p-value <0.01). This suggests that the utilization of JICA's improved rice processing technologies has led to an increase in the output level of rice processors.

CONCLUSION AND RECOMMENDATIONS

Based on the findings, it was observed that rice processors in the study are relatively young, predominantly married, and mostly females. The dissemination of information on JICA technologies primarily occurs through extension agents. It was also evident that the use of the false bottom at parboiling quality

Table 3

Perceived Effectiveness of JICA Improved Rice Processing Technologies

JICA Improved rice processing technologies	Not effective freq. (%)	Mildly effective freq. (%)	effective freq. (%)	Highly effective freq. (%)	Mean	Remark
JICA rice soaking method	-	-	3 (1.7)	177 (98.3)	3.98	Effective
JICA- Rice parboiling method (False Bottom technology) to achieve quality paddy rice.	-	-	1 (0.6)	179 (99.4)	3.99	Effective
JICA- Milling method (Ajifa mill) to achieve clean whole grains.	-	-	4 (2.2)	176 (97.8)	3.98	Effective
JICA-De-stoner at de-stoning	-	4 (2.2)	145(80.6)	31 (17.2)	3.15	Effective

Table 4

Result of Paired Sample T-test Analysis on difference in the output level of rice processors before and during the utilisation of JICA improved rice processing technologies

	Mean (tons)	Mean difference	SD	SE	*t*-value	df	*p*-value
Before the use of JICA technologies	2.32	0.64	0.631	0.048	-13.196	179	0.000
Using the JICA technologies	2.96		0.828	0.62			

paddy rice, the speed of the false bottom at parboiling quality paddy rice, the JICA rice soaking method, and the Ajifa mill for milling clean rice grains with good appearance were all effective methods of rice processing.

In conclusion, JICA's improved rice processing technologies are effectively disseminated by extension agents to rice processors. Empirical evidence from this study indicates that not only do processors understand these methods, but they also embrace their utilization. Therefore, the study recommends that local government authorities should encourage and organize free adult literacy classes to enhance processors' knowledge and orientation regarding the use of JICA processing activities. Additionally, mass media should be utilized to disseminate information about these technologies to processors in other regions, increasing their familiarity with JICA technologies and promoting their utilization for enhanced agricultural production and food security.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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