Original scientific paper

UDC: 575.222.2
DOI: 10.2478/contagri-2020-0004

ADOPTION OF RICE POST-HARVEST TECHNOLOGIES AMONG SMALLHOLDER FARMERS IN OSUN STATE, NIGERIA

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SUMMARY

The study assessed adoption of rice post-harvest technologies among smallholder farmers in Osun State, Nigeria. Data were collected from 120 respondents through a structured interview schedule using a multistage sampling procedure. Percentages, means, Chi-square and correlation were used to analyse the data and draw inferences. The results show that about 52.5% of the respondents had favourable perception, while 47.5% had unfavourable perception towards adoption of the rice post-harvest technologies. Rice milling (mean=4.54) and harvesting matured panicles at the right time (mean=4.47) ranked highest among the adopted post-harvest technologies, while majority (65%) of the respondents adopted the rice post-harvest technologies at moderate level and 35% had high level of adoption. Inadequate capital (mean=1.75) and poor extension contacts (mean=1.67) were the major constraints associated with the adoption. Also, there was significant association between sex ($\chi^2=38.174$), marital status ($\chi^2=32.85$) and adoption of the rice post-harvest technologies, while age ($r=-0.531$), household size ($r=0.414$) and the quantity of rice produced ($r=0.345$) had significant relationship with adoption of the post-harvest rice technologies. There was moderate level of adoption among the farmers. Financial institutions, governments and non-governmental organisations should provide functional credit facilities and government should employ more extension agents to promote adoption of high-quality enhancing post-harvest technologies for sustainable rice production in Nigeria.

Key words: rice farmers, post-harvest technologies, adoption

INTRODUCTION

Rice is one of economically most important food crops in many developing countries and it has also become a major crop in many developed countries where its consumption has considerably increased (Ajala & Gana, 2015). In most of the developing countries, rice availability is equated with food security and closely connected to political stability. Changes in rice availability, and hence its price have caused social unrest in several countries (<http://ricepedia.org/challenges>). According to Shahbandeh (2019), there has been a slight increase in global consumption of rice over the last decade. In the 2018/2019 cropping season, about 490.27 million metric tons of rice was consumed worldwide, while in the 2008/2009 cropping season it was 437.18 million metric tons. In fact, per capita rice consumption has grown from 3 kg in 1960s to estimated 37.5 kg in 2014 (UARK, 2015) and it is expected to further increase due to increase in population and urbanization. Although rice production has been on the increase since 1965 (USDA, 2019), it has not kept up with the demand due to ever-growing population in Nigeria.

Rice grain is mostly consumed boiled (or fried) as the main staple food but it is also widely used for snacks, appetizers, rice soups and desserts. Rice is also used as flour, for making rice wine and as an ingredient for beer and

liquor. Rice bran is sometimes processed and sold as food supplement. Most of bran and other remains from milling are used as animal feed. Rice straw, husks and bran, among others, are also valuable for composting and fertilizing rice field (Ricepedia, 2019).

The potential of arable land in Africa is 637 million hectares; therefore, there is great potential for expanding rice cultivation (Oteng & Sant'Anna, 2015). Rice is grown in a whole range of agro-ecological zones, from humid forests to the Sahel savannah in Nigeria. The total area under rice cultivation in West Africa is about 4.4 million hectares (ha), with the rain-fed upland and rain-fed lowland ecosystems each accounting for about 1.7 million ha and irrigated land accounting for another 0.5 million ha (Samado et al., 2015). Although rice production has increased over the years from an average of 300,000 tonnes in 1990s to over 4 million tonnes in 2013 (FAOSTAT, 2015), the increase in production has been achieved by expansion in the cultivated area, which has increased over the years from 14,000ha in 1960s to 2,863.815 ha in 2013. Despite the availability of land and enormous water body in Nigeria, irrigation remains the major part of agriculture that has not been harnessed to achieve maximum rice production. Rice has the potential to improve nutrition, boost food security, foster rural development and support sustainable land use (Igboji, et al., 2015).

The rising demand for rice in Nigeria has been attributed partly to increasing population, increased income levels, rapid urbanization and associated changes in family occupational structures (Uduma, et al., 2016). According to the National Bureau of Statistics, annual household expenditure on rice accounted for 10% of household food spending and 6.6% of total household spending in 2011. Similarly, the annual rice consumption of 32 kg per capita is the highest of all staples in Nigeria (PricewaterhouseCoopers, 2018). Although rice accounts for a significant proportion of the food requirements of Nigerian population, it is observed that the demand for rice has always exceeded the supply, since Nigeria has a favourable market for rice production. However, due to the poor quality of locally produced rice, most consumers prefer the imported rice from other countries such as Thailand, Bangkok, and China to the indigenous rice (Idris, et al., 2013). The reason is that most Nigerian rice processors lack adequate technology to meet international standards, as locally produced rice contains a lot of stones and other impurities. To meet the increasing demand, the government rely on importation of milled rice to bridge the gap between the domestic demand and supply.

In a bid to curb the importation of rice and increase production and quality of local rice, successive governments in Nigeria embarked on programmes such as Agricultural Transformation Agenda (ATA) etc. which favour mass production of local rice in order to end rice importation in Nigeria. Besides, recent post-harvest research efforts geared towards the reduction of post-harvest losses have also been directed towards the development of rice production and processing to meet the changing taste of the consumers and improve the environment. Therefore, different quality-enhancing post-harvest technologies have been developed and disseminated to rice farmers in Nigeria by various research institutes such as West African Rice Development Agency (WARDA), International Institute of Tropical Agriculture (IITA) and National Cereals Research Institute (NCRI). These technologies include using appropriate harvesting techniques such as threshing, winnowing, drying, improved parboiling, milling, storage, and even polishing of local rice to reduce wastage and improve the quality of the rice. These would ensure acceptability of local rice that would command a better price in the market and improve the country's foreign exchange in rice importation. But the question is to what extent the rice farmers have adopted these technologies disseminated to them. This necessitated the undertaking of this study. This study therefore assessed the adoption of improved rice processing technologies among farmers in Osun State, Nigeria. The study specifically examined the perception of the respondents towards adoption of the rice post-harvest technologies; determined the level of adoption of rice post-harvest technologies by the farmers; and determined the relationship between socio-economic characteristics and adoption of the rice post-harvest technologies.

MATERIAL AND METHODS

The study was carried out in Osun State, Nigeria, which lies between the latitude 7° 30' 0" N and longitude 4° 30' 0" E. The state is bounded in the south by Ogun state; in the North by Kwara state; in the west by Oyo state; and in the East by Ondo and Ekiti states. It is located in the south-western part of Nigeria, covering the area of approximately 14,875 square kilometres. It has three agricultural zones: Ife/Ijesha, Iwo and Osogbo zones. Multistage sampling procedure was used in selecting 120 farmers for the study. At the first stage, one local government area (LGA) was purposely selected from each of the agricultural zones, making a total of three LGAs because of their involvement in rice production and processing. These LGAs are: Olorunda from Osogbo zone, Oriade from Ife/Ijesha zone and Iwo from Iwo zone. At the second stage, two rice producing communities were purposely selected from each of the LGAs based on predominance of rice production and processing. These include Kelebe community and Oke-Osun

farm settlement from Osogbo (Olorunda LGA), Ogbaagba and Elekuro community from Iwo (Iwo LGA) and Iwaraja and Erinmo communities from Ife/Ijesha (Oriade LGA). At the third stage, thirty five percent of the rice farmers were randomly selected from each community, making a total of 120 rice farmers. Quantitative data were collected through the use of a pre-tested and validated structured interview schedule on adoption of the post-harvest technologies and respondents' perception of the rice post-harvest technologies. Percentages, means and standard deviations were used to summarise the collected data, while chi-square and Pearson product moment correlation analyses were used to draw inferences on the hypothesis.

Measurement of Variables

The dependent variable for this study is adoption of the rice post-harvest technologies. It was measured by using the five stages of adoption (awareness, interest, evaluation, trial and adoption) of these technologies. The respondents were asked to indicate the adoption stages on 11 technologies and their reactions were scored according to: Awareness (1 point), Interest (2 points), Evaluation (3 points), Trial (4 points) and Adoption (5 points). The total score of each respondent was summed up as the adoption score and categorised into 3 groups as low, moderate or high, using equal interval method.

RESULTS AND DISCUSSION

Respondents' Perception of Adoption of the Rice Post-harvest Technologies

The results presented in Table 1 show that the respondents have different perceptions towards adoption of improved rice processing technologies using the ranked mean scores. When comparing individual perception mean score with the grand mean score ($mean=2.67$), the results reveal that the respondents had positive perception towards the following statements: local rice production can be improved using the new rice processing technique ($mean=4.09$), rice processed with improved technologies is better in quality and command a higher price in the market than rice processed with the traditional method ($mean=4.08$), it is better to use a mechanical drier so as to prevent contamination and introduction of impurities ($mean=4.03$), use of a mechanical thresher is easier and better than a manual one because it prevents contamination ($mean=3.99$), threshing immediately after harvesting and drying improves the rice quality, ($mean=3.74$), it is cost-effective to use rice processing technologies in terms of the quality of the output ($mean=3.67$) and threshing on a mat or tarpaulin or modern thresher prevents introduction of sands, pebbles, and other foreign matters. ($mean=3.64$). On the other hand, the respondents had unfavourable perception towards the statements with the mean score of less than the grand mean score of ($mean=2.67$). These statements include: drying rice on bare floors or roadside introduces contamination and impurities ($mean=2.06$), it is too expensive to use improved rice processing technologies ($mean=1.63$), it is not necessary to remove impurities and contamination before milling ($mean=1.52$), improved rice processing facilities are not readily available ($mean=1.47$), among others.

Figure 1 reveals that 33.5 percent of the respondents had unfavourable perception, while more than half (66.5%) had favourable perception towards adoption of the post-harvest technologies. The fact that majority of the farmers had favourable perception towards adoption might influence their decision to adopt these technologies. This implies that there is potential for adoption of improved post-harvest technologies among farmers in Nigeria if relevant stakeholders could motivate them by providing enabling environment for making such decisions. This is in line with the findings of Takam-Fongang et al. (2019), who established that if farmers have favourable perception of the yield, it would positively influence adoption of improved maize varieties in Central Cameroon.

Table 1. Farmers' perception of adoption of rice post-harvest technologies

Statements	Mean	Standard Dev.
Local rice production can be improved using the new rice processing technique	4.09	1.05
Rice processed with improved technologies is better in quality and command a higher price in the market than rice processed with the traditional method	4.08	0.94
It is better to use a mechanical drier so as to prevent contamination and introduction of impurities	4.03	0.86
Use of a mechanical thresher is easier and better than a manual one because it prevents contamination	3.99	0.95
Threshing immediately after harvesting and drying improves the rice quality	3.74	1.36
It is cost-effective to use rice processing technologies in terms of the quality of the output	3.67	1.35
Threshing on a mat or tarpaulin or modern thresher prevents introduction of sands, pebbles, and other foreign matters	3.64	1.06
Drying rice on bare floors or roadside introduces contamination and impurities	2.06	0.87

It is too expensive to use improved rice processing technologies	1.63	0.61
It is not necessary to remove impurities and contamination before milling	1.52	0.61
Improved rice processing facilities are not readily available	1.47	0.55
Use of a mechanical thresher for threshing is a waste of money	1.45	0.61
Improved rice post-harvest technologies are not compatible with our culture	1.38	0.58
The old method of processing rice is better than improved method	1.38	0.55
There is no need to thresh on a mat or tarpaulin	1.28	0.45

Grand mean=2.67

Source: Field survey, 2017

Figure 1. Chart showing the level of the respondents' perception (Source: Field survey, 2017)

Adoption of Rice Post-harvest Technologies

The results in Table 2 reveal generally high level of adoption of eight out of eleven improved rice processing technologies disseminated to the farmers. This could be attributed to high level of awareness of the mentioned technologies among the farmers. As it is known that awareness is a prerequisite for adoption of technologies, awareness of agricultural technologies is very important since it stimulates farmers' interest in innovations and practice. Specifically, adoption of rice milling (*mean*=4.54) ranked highest. This is because of the drudgery associated with local milling using pestle and mortar and reduction of sand contents in rice, because fine sand is usually placed inside the parboiled rice and mixed to aid in abrasion to remove the husk from the grain. This result is in line with the findings of Adejoh et al. (2017) and Nasiru (2014) that rice milling was the most adopted processing technology by rice farmers. This technology was followed by harvesting of matured grain at the right time (*mean*=4.47), threshing on a mat or tarpaulin over a clean concrete floor (*mean*=4.44), removal of floating immature grains, residual dirt and stones (*mean*=4.32), wet cleaning of a paddy with clean water (*mean*=4.31) and preventing a paddy from touching the ground during heaping, threshing, winnowing, drying and packing (*mean*=4.16). This could be attributed to the fact that timely harvesting of matured grains, wet cleaning, improved threshing on concrete with a tarpaulin or mat and removal of dirt and stones would enhance the quality of rice to make better economic results.

Further results in Table 3 show that majority (65%) of the respondents adopted all rice post-harvest technologies at moderate level, while 21.7 percent and 13.3 percent of the respondents adopted them at high and low level, respectively. This is contrary to the study of Ojo et al. (2018), who reported a relatively low level of adoption of NERICA rice technologies among rice farmers in Ekiti State, Nigeria. This could be a result of the challenges associated with adoption of these technologies, such as poor extension service, inadequate capital, high cost of rice processing machines, inadequate credit facilities and unavailability of government incentives among others. The result explains the reason behind poor quality of most locally produced rice in the country.

Table 2. Adoption of rice post-harvest technologies

Technologies	Mean	Standard Dev.
Rice milling	4.54	1.19
Harvesting of matured grain at the right time	4.47	1.24
Threshing on a mat or tarpaulin over a clean concrete floor not on bare floor or roadsides	4.44	1.30
Removal of floating immature grains, residual dirt and stones	4.32	1.22
Wet cleaning of a paddy with clean water	4.31	1.28
Preventing a paddy from touching the ground during heaping, threshing, winnowing,	4.16	1.43

drying and packing		
Soaking paddy rice in boiled water over night	4.03	1.50
Drying paddy to a safe moisture content of 13-14%	3.69	1.60
Use of a mechanical thresher/winnowing	1.43	0.75
Use of a mechanical drier	1.27	0.69
Use of a local destoning sieve	0.92	0.20

Grand mean=4.33

Source: Field survey, 2017

Table 3. Level of adoption of rice post-harvest technologies

Level	Adoption scores	Percentage (%)
Low level	Below 14.90	13.3
Moderate level	Between 14.9-22.30	65
High level	22.30 and above	21.7

Source: Field survey, 2017

Constraints Associated with Adoption of Rice Post-harvest Technologies among Farmers

Table 4 shows the constraints associated with adoption of the rice post-harvest technologies among the respondents. Inadequate capital to purchase the necessary inputs and machines ($mean=1.73$) ranked highest among the constraints that the respondents face in adoption of these technologies. This was followed by poor extension service ($mean=1.67$), high cost of machines ($mean=1.61$), inadequate skills and knowledge ($mean=1.59$), labour intensiveness ($mean=1.55$), unfavourable market situation ($mean=1.54$) and in that order. When comparing the mean scores of individual constraints with the grand mean score ($mean=1.59$), the results reveal that inadequate capital, poor extension service, inadequate skills and knowledge and high cost of machines were the major constraints hindering adoption of the rice post-harvest technologies in the study area. This is in line with the findings of Danbaba et al. (2013) and Nasiru (2014), who established that inadequate capital and high cost of processing machines were some of the major constraints to adoption of rice processing technologies among farmers in Nigeria.

Table 4. Constraints to adoption of rice post-harvest technologies

Constraints	Mean	Rank
Inadequate capital	1.73	1
Poor extension service	1.67	2
High cost of machines	1.61	4
Inadequate skills and knowledge	1.59	5
Labour intensiveness	1.55	6
Unfavourable market situation	1.54	7
Inadequate incentives from government	1.49	8
Poor infrastructural facilities	1.46	9

Grand mean=1.59

Source: Field survey, 2017

Relationship between some Socio-economic Characteristics and Adoption of Rice Post-harvest Technologies

The results in Table 5 show that there were significant associations between sex ($\chi^2 = 23.934$; $p \leq 0.01$), marital status ($\chi^2 = 34.666$; $p \leq 0.01$) and adoption of the rice post-harvest technologies disseminated to the farmers in the study area. This implies that these variables are important for adoption of these technologies in the study area. Further results in Table 6 reveal that household size ($r = 0.414$; $p \leq 0.05$) and quantity of produced rice ($r = 0.345$; $p \leq 0.05$) had positive and significant relationship with adoption of the post-harvest technologies. Age of the respondents ($r = -0.531$; $p \leq 0.01$) had negative but significant relationship with adoption of the rice post-harvest technologies in the study area. This implies that the younger the respondents, the more willingness to adopt the technologies. This result underscores the fact that older farmers are risk-averse and more conservative than the younger ones who are more innovative and receptive to new technologies. In other words, the likelihood that the farmers will make such decisions decreases as the farmers advance in age. This is in agreement with Abubakar et al. (2019), Nasiru (2014) and Jabil & Abdu (2012) that young farmers are more willing to adopt new technologies than older farmers because young farmers are more open innovations; willing to try new technologies and are not afraid of risk. Also, the results imply that the larger the household size of the respondents, the higher the adoption of the post-harvest technologies. This might be connected to the fact that most of the respondents with larger size of households would have more responsibilities and more labour assistance from members of their households, thereby

greater willingness to adopt the technologies. This is in agreement with the findings of Abubakar *et al.* (2019), who established a positive and significant relationship between household size and adoption of innovations. Also, the higher the quantity of rice produced in bags, the higher the adoption of the post-harvest technologies; this is accounted for by the fact that farmers with larger production would have enough income to acquire inputs that would assist them in adopting of the post-harvest technologies.

Table 5. Some socio-economic characteristics and adoption of rice post-harvest technologies

Socio-economic characteristics	χ^2	DF
Sex	23.934**	2
Marital status	34.666**	4
Extension contact	2.429	2
Educational status	20.122	4

**Significant at $p \leq 0.01$

Source: Field survey, 2017

Table 6. Some socio-economic characteristics and adoption of rice post-harvest technologies

Socio-economic characteristics	r
Age in years	-0.531**
Income	0.136
Farm size	0.023
Household size	0.414**
Years of farming	0.140
Quantity of processed rice (per bags)	0.345*

**Significant at $p \leq 0.01$; * Significant at $p \leq 0.05$

Source: Field Survey, 2017

CONCLUSION

Many of the respondents had favourable perception towards adoption of rice post-harvest technologies, while majority of them adopted the technologies at moderate level. However, inadequate capital, poor extension service and inadequate credit facilities were major constraints associated with adoption of the rice post-harvest technologies while age, household size and quantity of rice produced were significant for adoption of the rice post-harvest technologies in the study area.

In order to enhance the adoption, appropriate and affordable processing machines should be developed by relevant stakeholders such as national Centre for Agricultural Mechanization. Adequate and functional credit facilities should be provided for the farmers by financial institutions, governments and NGOs. Government should employ more extension agents to promote effective dissemination of appropriate technologies to the rice farmers and enhance adoption of high-quality enhancing post-harvest technologies for sustainable rice production in Nigeria.

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Submitted: 27.12.2019.

Accepted: 25.4.2020.