Analysis of Improved Technologies' Adoption by Male and Female Rice Farmers in Abia State

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Abstract: **Technology adoption has been noted as very crucial to increasing local production of rice in Nigeria, especially among the smallholder farmers. The study broadly analyzed improved technology adoption among male and female rice farmers in Abia State, Nigeria. The study examined the adoption of improved rice technologies by male and female rice farmers in Abia state, Nigeria. Multistage sampling technique was employed in data collection using structured questionnaire. The collected data were analyzed using simple descriptive statistics and inferential tools such as the probit model. The study revealed that mean off-farm income of male and female rice farmers were 15694.44 and 8812.5 naira respectively while their mean farm sizes were 1.08 and 0.57 hectares respectively, implying that the female gender was more resource-constrained than the male farmers. Improved rice varieties, pudling, chemical fertilizer, appropriate spacing and bird-scaring technologies were the improved technologies adopted by majority of both male and female rice farmers while tractor, Fadama technology, herbicide, pesticides, minimum tillage and organic manure were poorly adopted by both genders. Majority of male (54.17%) and female (80.56%) rice farmers were non adopters of improved technologies. The result showed further that the male farmers had higher adoption rate of 70.21% compared to the female farmers whose adoption rate was 29.79%. This could be linked to the fact that the male rice farmers are more business-oriented than the female farmers and are more fitted to the drudgery nature of rice production than the female farmers. The Probit result showed that the pseudo R2 was 0.6406, 0.5050 and 0.7873 for male, female and pooled result respectively. The probability of adoption of technologies by farmers was statistically and significantly determined by age of the household head, educational level of the farmer, extension services received by the farmers during the production period, off-farm income, access to credit, and farming experience. The study concludes that both genders were actively involved in rice production but the female gender was more resource-constrained. It is recommended that extension services be strengthened, tractor hiring services be provided, and gender-related limitations to accessing production resources be revised.**

Keywords— **adoption, technologies, rice, gender, production**

I. INTRODUCTION

Rice is one of the most important staple foods for the majority of the world's population. Its consumption is increasing, more than any other staple, with the increasing population (IRRI, 2014). According to Osabuohien et al. (2018) increasing domestic demand for rice has been linked to consumer preferences, increasing incomes, and rising urban population among others. Yet only about 57% of the 6.7 million metric tons of rice consumed in Nigeria annually is produced locally (Mohammed et al., 2019).

Nigeria has the potential of being self-sufficient in rice production and can even export rice. This is because rice grows in all ecological zones in the country with huge untapped land area for rice production (Chidiebere-Mark et al., 2019). It is worth noting that rice production in Nigeria is concentrated in the hands of rural dwellers, who are smallholders (men and women). The problems remain that there are gender-related hindrances to accessing the limited resources required for production (Nkwachukwu, 2017). Dankor et al. (2019) had also noted that low adoption of improved technologies among the farmer, especially the smallholders, is the reason for the existing gap between demand and supply of rice. Iheke and Nwaru (2014) had earlier noted that innovation adoption, which is the key to increasing productivity is very low among Nigerian rice farmers.

With the fast-growing population and rising food demand, sustainable food security is achievable through increased productivity using improved technologies in rice production. consequently, there have been commendable efforts by the government at various levels to encourage private sector investment in rice improve local production, with the aim of increasing its local production. These include removal of restrictions on areas of investment and maximum equity ownership in investment by foreign investors, free transfer of capital, profits, and dividends (that is, no currency exchange controls), total removal of import duty on agricultural machines and tax holiday for agricultural investments (Osabuohien et al., 2018).

The smallholders and gender inclusion have not really been given priority in rice development policies of the government, knowing that they are the key players in local rice production. Hence the study on analysis of adoption of improved technologies among male and female rice farmers in Abia State.

II. METHODOLOGY

A. Study area

The study was conducted in Ohafia Agricultural Zone in Abia State of Nigeria. The State lies within approximately Latitudes $4^040/$ and $6^014/$North and Longitude 7^010 and 80 East and has a population density of 448.4 per square kilometer (NPC, 2006). The climatic condition of the State permits the cultivation of a wide variety of crops ranging from tree crops like cocoa, palm plantations, arable crops, cereals, vegetables, fisheries, and livestock. Rice crop stands out as the sole crop in the area but farmers in some parts of the State plant okra or cucumber and other vegetables after harvesting rice on a rotational basis.

B. Sampling procedure and data collection

A multistage sampling technique was used to select the respondents. In the first stage, Ohafia Agricultural Zone was selected purposively, out of the three agricultural zones in Abia State, as a result of its level of rice production. Three local government areas were randomly selected from the zone from which two communities each were randomly selected. Subsequently, three villages were selected from each of the communities to have a total of eighteen villages. The sample size consisted of ten (10) farmers drawn from each of the 18 villages making a total of 180 farmers. Lists of all the male-headed and female-headed rice farming households were compiled to form the sampling frame. A random selection of five male-headed and five female-headed rice farming households from the lists compiled from each of the eighteen villages was done bringing the number to a total of one hundred and eighty respondents (ninety male farmers and ninety female farmers). The data were collected using structured questionnaires and oral interviews. One hundred and forty-four questionnaires (80%) were retrieved which comprised seventy-two male farmers and seventy-two female farmers.

C. Data analysis

IBM SPSS Statistics version 22 was used for data analysis. The statistical tools used were descriptive (mean, frequencies, and percentages) statistics and inferential statistics like the probit regression model and Z – test statistics.

III. RESULTS AND DISCUSSION

A. Socio-economic characteristics of the respondents

The socio-economic characteristics of farmers by gender were examined in this section.

Table I. Socio-Economic Characteristics of The Respondents

Socio-economic characteristics	Male farmers	Female farmers
Age (years)	41	49
Household size (years)	8	8
Years of education (years)	7	6
Farming experience (years)	18	19
Off-farm income (naira)	15694.44	8812.5
Farm size (ha)	1.08	0.57

Source: Authors' field survey

Table 1 indicates that the mean ages of male and female respondents were respectively 41years and 49 years. This is similar to the findings of Rashid et al. (2019) and Nnodim and Raji (2020) whose study showed that majority of arable crop farmers were between 40-49 years. The higher mean age of female gender to that of the male gender may be attributed to the fact that rural women form the most important majority of the developing nations, and the women continue to farm to provide food for the family even when their male counterpart had retired. The result also indicates that the rice farming population is aging and this has the tendency of declining the productivity of the farmers. The mean household size of the male and female farmers were eight persons for each gender, an indication that the rice farmers have large household size and this has direct effect on labour supply especially family labour. This is in line with the findings of Osuji (2017) who reported that the farmers sampled had average household size of nine persons. The scholar further explained that it indicates availability of family labour for farmers sampled.

The result showed that the male and female farmers had about average of seven and six years of education respectively while the male and female farmers had mean farming experience of 18 and 19 years respectively. The mean off-farm income of farmers was 15964.44 naira and 8812.50 naira respectively for male and female farmers respectively, indicating that the female rice farmers are more resource constrained than the male rice farmers. The mean farm size of the farmers was 1.08 and 0.58 hectares for the male and female farmers respectively, pointing to the fact that the females had smaller holdings than the male farmers, and this agrees with the studies of Obalola and Ayinde (2018) and Ikerowo and Tehinloju (2021). This result is also in line with the study of Todaro and Smith (2011) who stated that the smallholder women rice farmers cultivate smaller portions -less than one hectare- mostly for household consumption. This could be attributed to the fact that the female gender have limited access to land and other resources compared to the male farmers due to gender related issues.

B. Adoption of Improved Technologies

The improved technologies in rice production examined were improved seed technology, fertilizer, herbicide, pesticide, organic manure, minimum tillage, appropriate spacing (20cm x 20cm), bird scaring technology, Fadama technology (refers to irrigable, low-lying plains underlain by shallow aquifers found along major river systems), tractor use and puddling. The distribution of respondents based on the technologies adopted is shown in Table 2, for both male and female rice farmers.

Table 2: Socio-Economic Characteristics Of The Respondents

Technologies	Male farmers		Female farmers	
	Frequency	Percentage	Frequency	Percentage
Improved seed	72	100	72	100
Chemical fertilizer	54	75.00	41	56.94
Herbicide application	29	40.28	21	21.00
Pesticide application	22	30.56	18	25.00
Organic manure	19	26.39	08	8.00
Minimum tillage	01	1.39	0	0.00
Appropriate Spacing	41	56.94	47	62.28
Birdscaring technology	57	79.17	58	80.56
Fadama technology	01	1.39	02	2.78
Tractor use	0	0.00	0	0.00
Puddling	68	94.44	65	92.28

Source: Authors' field survey

Table 2 revealed that the improved rice seed was adopted by most of the male and female farmers. Tractor and Fadama technologies were not used at all due to unavailability of the technologies during the study period. Other technologies adopted by majority of male and female rice farmers were puddling, chemical fertilizer, appropriate spacing and birdscaring technology Generally, herbicide, pesticides, minimum tillage and organic manure were not adopted by majority of the respondents. The result is similar to the result obtained by Zedweldet al. (2017); Osabohein, Osabohein and Ese (2018) and Oyelere (2020) in their separate studies.

C. Adoption indices of farmers by gender

Adoption index was obtained as (adoption score for each respondent)/(total adoption score for all the respondents) x 100, farmers with adoption index less than 50% were categorized as non-adopters while those with index greater than 50% were classified as the adopters. The result was presented in Table 3.

Table 3: Classification Of Farmers Into Adopters And Non-Adopters

Socio-economic characteristics	Male farmers Frequency (%)	Female farmers Frequency (%)	Z-value
Adopters	33 (45.83%)	14 (19.44%)	3.3818
Non-adopters	39 (54.17%)	58 (80.56%)	
Total	72 (100%)	72 (100%)	

Source: Authors' field survey

The result showed that only 46% and 19% of the male and female rice farmers were adopters of innovation while 54.17% and 80.56% of male and female rice farmers in the study could not adopt improved technologies in rice production. The low adoption level of both male and female farmers could be attributed to the poor extension services received by the farmers during the production period, and poor access to credit which is required to finance innovation adoption. The result confirms the findings of scholars like Omiunu (2014) and Nnodim and Raji (2020) who established that although these improved technologies exist, farmers still use the traditional method, and this could have declining effect on arable crop productivity.

Adoption level differences in improved technologies between male and female adopters were tested using the Z-test and the result is also presented in Table 4. The mean adoption of the male farmers is 61.4815 while the mean adoption of the female rice farmers is 51.6667. The standard deviation of the male farmers was 11.9565 while that of the female farmers was 12. 8355. The p-value of 0.0006 indicates that there was a statistically significant difference in the adoption level of male adopters and female adopters. This is similar to the findings of Olusunkanmi and Yusuf (2014) and Umeh and Chukwu (2015) who established those male farmers adopt innovations better than female farmers. This could be as a result of the fact that most technologies are tailored towards the male farmers and the female farmers are more resource constrained, thus ignores technologies due to cost of adoption.

D. Determinants of Adoption by Gender

Probit regression was used to estimate the effect of selected variables on adoption of improved technologies. The pseudo R^2 of 0.640 and 0.505 for the male and female rice farmers respectively show that 64% and 50% of the variation in probability of adoption of improved technologies in rice production was explained by the independent variables included in the model. The result is presented in Table 4.

Probability of adoption of male rice farmers were significantly determined by age of the household head, educational level of the farmer, extension services received by the farmers during the production period, off- farm income, access to credit and farming experience.

Age was significantly and negatively related to the probability of adoption of improved technologies indicating that a year increase in age of the male farmers reduces the probability of adoption by 0.49%. This agrees with the results obtained by Marteyet al. (2013), Onumadu and Osahon (2014), Iheke and Nwaru (2014) that the younger farmers are more innovative and are more likely to take risk such as introducing the use of improved technologies. Contrarily,Olusunkanmi and Yusuf (2014) and Kariyasa and Dewi (2012) established a positive and significant relationship between age and probability of adoption such that as the male farmers get older, they become more experienced which allows them to access the attributes of an improved technology relative to younger household head in rice production.

Table 4: Determinants Of The Probability Of Adoption Of Improved Technology By Gender

Variable	Male farmers	Female farmers	Pooled
Intercept	0.7200(6.13)***	0.4079(1.12)**	-2.1070(-2.04)**
Age	-0.4897(-3.19)***	-0.0553(-1.76)	-0.0478(-3.10)***
Educational level	0.06989(3.23)***	0.8202(3.24)***	0.0581(2.75)***
Household size	0.6989(0.91)	0.6779(0.54)	0.0184(0.36)
Extension visit	0.3538(2.95)***	0.8952(3.61)***	0.1392(3.07)***
Off-farm income	0.0000(2.84)***	-0.0002(-1.37)	0.0000 (2.01)**
Access to credit	0.2823(2.95)***	0.3114(3.35)***	0.9907(2.79)***
M/cooperative	0.1121(0.21)	0.5387(2.05)**	0.0380(0.09)
Farming experience	0.5091(3.27)***	-0.0444(-0.79)	-0.0068(-0.40)
Farm size	0.2349(1.02)	0.3283(2.12)***	1.8650 (2.08)**
Dummy Pseudo R^2	0.6406	0.5050	0.6520(2.46)** 0.7873

Source: Authors' field survey, *= 10% significance level, **=5% significance level, *** =1% significance level, figures in parenthesis = t-ratio M/cooperative= membership of cooperative.

Education was significant at 1% and positively related to the probability of adoption of male and female rice farmers implying that the probability of adoption of technologies in rice production increases for every additional year of education. Formal education gives farmers the ability to perceive, interpret and respond to new information much faster (Ologhonet al., 2012;Marteyet al.,2013; andIheke and Nwaru, 2014).

Extension contact measured in number of visits was significant at 1% and positively related to the probability of adoption and this implies that the probability of adoption increases as the number of visits per rice farming season increases. This is in line with the results of findings of Odoemenem and Obinne (2010) and Ghimire et al. (2015)who asserted that frequent extension visits and meetings between farmers and extension workers would enlighten the farmers and create better awareness for the potential gains of improved technologies in rice production.

Off-farm income of farmers had positive and significant relationship at 1% with probability of adoption of male farmers implying that as they have more fund from other sources like trading, salary, cash gift from relatives, the more they would be willing to adopt innovations because more fund would be available for financing innovations. The result is consistent with Marteyet al.(2013) and Rashid et al.(2019) who opined that household heads that earn off-farm income are able to meet the financial demands associated with participation of improved technologies.

Access to credit also has positive and significant relationship with the probability of adoption at 1% level of probability for the male farmers. This indicates that with increased access to credit, the probability of adoption of improved technologies in rice production increases. The is in agreement with Okoye (2014) who reported that farmers spend more on innovation adoption with credit than without credit, because credit afforded the farmers the opportunity for more access to farm inputs.

Membership of cooperative had a positive relationship with the probability of adoption for female farmers and was significant at 5% level of probability. This implies that female farmers got involved more in cooperative activities. This is because cooperative societies are good sources of quality inputs, labour, credit, information and organized marketing of agricultural products. This agrees with the opinion of Mwangi and Kariuki (2015) and Ikuerowo and Tehinloju (2021) that involvement in cooperative organizations helps farmers to adopt innovations.

Farming experience was positively and significantly related to probability of adoption at 1% level of significance. This implies that a year increase in farming experience could lead to an increase in the probability of adoption of the selected improved technologies. Odoemenem and Obinne (2010) reported that farmers count more on their experience for increased productivity. This is because they would be willing to adopt innovations in rice production, which is key to increasing productivity. This deviated from Saliuet al. (2016) whose result showed a negative relationship between probability of adoption level and farming experience.

The coefficient of farm size was also significant at 1% level of probability and had a positive relationship with probability of adoption of improved technologies implying that as land area cultivated to rice by the female farmers increase, the probability of the female farmers adopting innovations would increase. This is similar to the findings of Onumadu and Osahon (2014), Okoye (2014) and Ajewoleet al (2015) who opined that large scale farmers are more inclined to adopting new technology which have the potential of increasing productivity and efficiency.

The dummy which represent the gender of rice farmer was significant at 1% and positively related to the probability of adoption. This implies that the probability of adoption of male rice farmers is higher than that of their female counterpart. This agrees with the work of Rashid et al.(2019).The overall result of the pooled data was in conformity with Nkwachukwu (2017) that technologies are tailored towards the male farmers.

IV. CONCLUSION AND RECOMMENDATIONS

This study concluded that the farmers in this research had inadequate off-farm income, and this led to their low adoption of improved rice farming technologies. In addition to income, inadequate technical advice by extension personnel also

impacted on the low adoption of improved rice farming technologies.There is a wide gender gap in both off-farm income and adoption of rice farming technologies which are attributable to unequal access to credit facilities, and disparity in education attainment – the males are more favored than the females in both.

The study, therefore, recommends that extension services in the study area should be strengthened by offering services, especially in aspects that show low adoption in this study like the tractor and fadama technologies; tractor hiring services should be encouraged through private-public partnership; farmers' organization should be strengthened among the farmers; subsidization of fertilizers and other agrochemicals to enhance their affordability by rural farmers should be encouraged by the government and provision of micro credit facilities to farmers, especially the female gender. Above all, gender-related limitations (in relation to access to land and credit facilities) to rice production and adoption of technologies should be given urgent attention by agricultural development stakeholders..

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