Journal of Agricultural Science and Practice
Volume 8(2), pages 30-37, April 2023
Article Number: 8A5BAB332
ISSN: 2536-7072
https://doi.org/10.31248/JASP2023.407
https://integrityresjournals.org/journal/JASP
Full Length Research

Factors affecting the rate of adoption of agricultural technology among small scale rice farmers in Gwagwalada Area Council of FCT, Nigeria

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Received 19th March 2023; Accepted 29th April 2023

ABSTRACT: Rice (*Oryza sativa*) is the most important food crop in the world, being a staple food for more than half of the world's population, predominantly in Asia and Africa where more than 90% of the rice is grown and consumed. The research study focused on factors affecting the rate of adoption of agricultural technology among small scale rice farmers in the study area. A simple random sampling was used to collect data from 120 respondents in which each member in the area council wards such as Dobi, Gwako,Ikwa, Paiko Tungamaje and Gwagwalada Centre has equal chance of being selected and the selection of all the members is independent of one another. The sample procedure is by the use of well-structured questionnaire, which was administered in the study area. With the use of SPSS, a descriptive analysis of the data was performed. The study's findings indicated that few agricultural innovations are being used by rice farmers in the study area. Herbicide spraying (70.83%), fertilizer application (67.50%), pesticide use (65.0%), and 'improved seeds (60.83%) were the main agricultural technological innovations used in the research region. The cost of innovation (mean = 3.74), the lack of adoption training for farmers (mean = 3.53), the inability to acquire financing facilities (mean = 3.48) and the inadequate extension service (mean = 3.25) were the main barriers to innovation adoption among rice farmers in the study area. Farmers' demographic traits, such as gender, education level, and farm size, have an impact on the adoption of innovation. Therefore, government and pertinent organizations should encourage farmer's education on the application of new innovations, and extension agents should visit regularly and make new ideas available to farmers.

Keywords: Agricultural innovations, Gwagwalada Area Council, rice farmers.

INTRODUCTION

Rice is one of the most important staple foods in Nigeria. It is grown in all states of the federation (Agro Nigeria, 2003) due to the favorable climatic condition in various producing regions (Kadiri and Eze, 2015). Nevertheless, Nigeria ranks third in rice production in Africa after Egypt and Madagascar but is the highest producer of rice in the West Africa. It rice production is still far below demand (FAO, 2016; Agro Nigeria, 2016).

For agriculture to fulfill the ever-increasing food demand, productivity must be increased. Agriculture technology has a significant impact on raising food productivity (Sennuga 2019; Adeyongo *et al*., 2021). Therefore, it is important to look at how farmers utilize new technologies. Several types of advanced methods and practices which impact the expansion of agricultural output are referred to as agricultural technology (Sennuga *et al*., 2020a; Adeyemi *et*

al., 2023). The most popular areas of technological development and promotion for crops, according to Loevinsohn *et al.* (2013), include new strains and management regimes, soil as well as soil fertility management, weed and pest control, irrigation, and water management. Challa (2013) asserts that as input and output relationships improve, novel technology tends to increase output and lower the average manufacturing cost, leading to a significant rise in agriculture income.

According to a study by Kariyasa and Dewi (2013), implementing more advanced technologies increases production, which leads to socio-economic progress. Adoption of more advanced agricultural technologies has been linked to improved nutritional status, lower prices for staple foods, more employment prospects, and increased wages for laborers who are not owners of land. It has additionally been linked to improved income and a decline in rural squalor among farm households. The effectiveness of the green revolution that Asian nations experienced is seen to have been greatly influenced by the adoption of new technologies (Chen and Ravallion, 2004; Sennuga *et al*., 2020b). According to a study by Aluko *et al*. (2021) non-adopters of agriculture technology have a hard time making ends meet and are more likely to experience socio-economic stagnation, which frequently leads to poverty.

Thus, a new agricultural innovation that improves the sustainable production of food is essential for long-term food security and economic growth. Because of this, since the early 20th century, there has been a lot of research into the dynamics of technical change in agriculture (Jain *et al*., 2009). Smallholder farmers in underdeveloped nations are especially in need of these technologies since they face numerous constraints, making them a top focus for development initiatives. For instance, many farmers operate their farms in regions with inconsistent and low rainfall levels and poor soils. Moreover, institutions and infrastructure like market sectors for irrigation, inputs, and goods, financing, and extension services are underdeveloped (Muzari *et al*., 2012). Studies on innovation and the uptake of new technology in developing countries have been embarked on over time. Moreover, research on the adoption procedure has been conducted and the effects of adopting new technologies on smallholder farmers. Yet, this is not the case when it comes to the adoption of novel agricultural and animal species, particularly in Nigeria.

There is a widespread assumption that the sub-Saharan African region's low agricultural output and food insecurity are caused by traditional institutions and technologies (Mkandawire and Matlosa, 2013). The idea is that "backward" peasants can only become more productive and secure in their access to food through institutional and technological transfer from the North to the South and from the modern sub-sector into the peasant sub-sector (Mkandawire and Matlosa, 2013). Numerous regional administrations continue to support the importation of western institutions and technologies like tractors, high-quality fertilizers, and contemporary crops as well as the reform of the region's long-standing traditional land tenure systems (Mkandawire and Matlosa, 2013). Conventional methods, tenure systems, and other institutions are viewed as pseudoscientific, antiquated, worthless, vulgar, wrong, and erroneous, as well as obstacles to greater agricultural productivity. According to literature that supports industrial-scale modern agriculture, millions of people would starve to death if land were given back to traditional farmers (FAO, 2014). Traditional farmers are characterized as being particularly "strict" in their methods and unable or unable to adapt to new ideas or possibilities when they are discussed in textbooks and analytical research papers (FAO, 2014).

By enhancing agricultural practices, expanding rural financial sector, encouraging rural population to accumulate additional capital and equipment, and creating links between research and extension, it is possible to raise agricultural productivity, technology adoption rates, and household food security and nutrition (Fadiji and Sennuga, 2020). A rise in agricultural productivity and increased usage of technologies can enhance family food consumption. An increase in food intake can also raise work production by enhancing how well the body functions and how well a healthy, normal life functions. The increased use of technology, however, may lead to high labor demands and less time for other home tasks by women (such as child care, fuel wood collecting, and water collection) (Kennedy and Bouis, 2013).

Determinants of agricultural technology adoption

Loevinsohn *et al*. (2013) claim that decisions made by farmers regarding deciding whether and how to implement new technologies are influenced by the dynamic interplay between the technology's qualities and a variety of circumstances and conditions. The process of dispersion itself is the consequence of a number of personal choices to start utilizing the new technology, judgments that are frequently made as a correlation between the unknown advantages of the new discovery and the unknown the costs of implementing it (Adangara *et al.,* 2022). For economists researching, the drivers of growth and additionally the creators and distributors of such technology, a knowledge of the factors driving this decision is crucial (Hall and Khan, 2002). Technology adoption economic research has endeavored to explain the user acceptance in connection to individual traits and endowments, incomplete knowledge, risk, and unpredictability, limitations imposed by institutions, infrastructure and the accessibility of inputs (Uaiene, 2011). Social networks and education have recently been mentioned in literature as variables influencing acceptance of new technologies (Nwali *et al*., 2022).

The theory holds that a farmer's human capital significantly influences his or her decision to accept novel

technologies. Most research on adoption have tried to gauge the human capital of farmers by assessing their family size, age, sex, and level of education (Keelan *et al*., 2010). Inference has been made that farmer education has a beneficial impact on farmers' decisions to use modern technology. A farmer's ability to acquire, analyze, and apply information pertinent to the acceptance of a modern innovation is impacted by his educational attainment (Mignouna *et al*., 2011).

Demographic characteristics of farmers and adoption of agricultural technology

Another factor that could have an effect on adoption is age. It is believed that age is the main underlying factor in adoption decisions. Yet, there is disagreement over how age affects adoption. According to research on sorghum adoption in Burkina Faso, peanut IPM in Georgia, and rice stink bug chemical control in Texas, age was determined to be a beneficial factor (Keelan *et al*., 2010). The result is believed to be the aftermath of cumulative knowledge and expertise of farming systems acquired over years of observing and testing different technologies. The age (time) of the farmer can also have a significant impact on the adoption of technology because payoffs from adoption take time to materialize while costs are incurred in the first stages.

But nonetheless, studies have also demonstrated that age is either unrelated to adoption or has no influence on farmers' choices. Age proved to be neither relevant or adversely related to adoption in research on the use of IPM sweep nets in Texas, hybrid cocoa in Ghana, rice in Guinea, fertilizer in Malawi and Forson's study on land conservation techniques in Niger (Adesina and Baidu (2015; Amungwa, 2018; Koutropoulos *et al*., 2018; Adeyongo *et al*., 2022; Forson and Acquah, 2017). Elderly farmers might not want to risk it by attempting a completely novel technique given that they might have invested many years in a certain approach. Given their advanced age and the potential of not living long enough to appreciate it, farmers may also lose enthusiasm for novel technology if they believe that technology development and its benefits will take a long time to materialize (Lai-Solarin *et al*., 2021).

Problems of adoption of agricultural innovation

The general lack of awareness among small scale farmers can be contributed to their high level of illiteracy. This contributes to the frequency of adoption of modern innovation in the study areas. The nature of the spread of innovation affects its adoption. Agricultural demonstration and personal contact among the farmers and extension agents have been reported to be responsible for the adoption of certain innovation (Adeyemi *et al*., 2023).

Obisesan (2014) pointed out the following as constraints to adoption process of most innovation; high cost of innovation, non-availability of necessary inputs, lack of adequate information as well as inadequate credit facilities. Simtowe *et al*. (2011) opined that the usage of newer technology is influenced by lack of agricultural inputs, high cost of labour and land tenancy amongst other factors. Adoption of innovation depends greatly on type and effectiveness of communication channels. According to Ekpe and Obetaan (2004), a significant element influencing the technology adoption in agriculture is the frequency of extension contact. One of the major constraints of innovation adoption is price policies for farm products, as well, as investment in physical and social infrastructures, are heavily title in support of the urban dwellers and industry (Mwangi and Kariuki, 2015).

Research objectives

The objective of this work is to discuss the variables influencing the rate at which small-scale farmers in the Gwagwalada Area Council of the FCT, Abuja, adopt innovation. Specifically, the study intends to:

1. describe the social economic of the respondents in the study area.
2. identify the technological innovations adopted by farmers in the study area.
3. investigate major factors affecting the level of adoption of innovation among small scale farmers.
4. analyze the effect of demographic traits of the respondents on their adoption of agricultural technology innovations.

METHODOLOGY

Description of the study area

The study area is Gwagwalada town, the town is located between latitude 8.25° and 25° North of the equator and longitudes 6°45' and 7°45', east of Greenwich meridian. The town is considered to be among the oldest in the Federal Capital Territory (FCT). The FCT covers some 8000 km^2 lying close to the geographical centre of the country. Its location is fully within the region generally referred to as the “middle belt” and North-Central geo-political zone. It is bounded by Kaduna State to the North, by Nasarawa State to the South-East and by Kogi and Niger States to the South and South-West respectively.

Gwagwalada is a large municipality and the headquarters of a large district in Central Nigeria. There are 10 wards in Gwagwalada Local Government Area namely: Dobi, Gwako, Ikwa, Paiko, Tungan maje, Gwagwalada centre, Ibwa, Ktunku, Staff quarters and Zuba. The main economic occupation of people in Gwagwalada Area Council of FCT, Abuja is farming. Some

of the major agricultural products have been cereal and tuber crops such as rice, guinea-corn, millet, barley, sweet potatoes, yam and so on. However, the people in this study area are more deeply involved in rice farming.

Sample size and data collection

Within the context of this research, a sample size of 120 respondents was chosen using simple random sampling. A well-structured questionnaire was used to collect data from 5 wards in Gwagwalada town such as Dobi, Gwako, Paiko, Tunga- maje and Gwagawlada town of FCT, Abuja. Each member of defined population has an equal chance on being selected and the selection of all members is independent of one another. The self-administered questionnaires that were provided to participants by the researcher were utilized in gathering main data for the study.

Data analysis

The information was analyzed through descriptive analytics and inferential statistics. Based on the survey questions, the data were examined using a statistical software for social sciences. The replies will be summarized and the degree of parallels and disparities will be demonstrated using various statistics, including mean scores, standard deviations, percentages, and frequency distribution.

RESULTS AND DISCUSSION

Distribution of respondents based on the socio-economic traits of the rice producers in the research area

The results presented in the Table 1 reveal the socio-economic characteristics of the rice farmers in the study area. 85% of the producers were males and 15% were females. Majority of the respondents are between the age of 31-40 years (40.2%) followed by people who are between the age of 21-30 years (29.2%). Most of the farmers were married (50.8%) while 38.3% were single. Also, the outcome noted that the majority of respondents (61.7%) had house hold size of 1-5 persons followed by 35.8% of the respondents who had 6-10 persons in their household. The level of education was poor among the farmers as 42.5% had no formal education (55.00%) and 30.8% only completed primary education. Farm size was also relatively low as majority of the respondents (95.00%) operated a small scale farming. The age bracket of the farmers in this research was however within the economically productive age range of 18-40 years. The results therefore agreed that young and middle-aged people are the most active in agricultural productivity. The small scale level of production can be due to the educational level as most of these farmers had no formal education which hinders their ability to interpret innovations that may be of assistance to them to expand in their farm.

The results presented in this study regarding the age range and education level of rice farmers in the study area are consistent with previous research. The finding that the majority of farmers are young and middle-aged is in line with a study conducted by Mogues and Benin (2012) in Nigeria, which found that younger farmers are more likely to adopt modern agricultural practices. The low level of education among the farmers is also supported by

Table1. Distribution of respondents according to their socio-economic characteristics.

Socio-economic characteristics	Frequency	Percentage
Gender		
Male	102	85
Female	18	15
Age (years)		
Less than 20	1	0.8
21-30	35	29.2
31-40	49	40.2
41-50	29	24.2
51 and above	6	5
Marital Status		
Single	46	38.3
Married	61	50.8
Divorced	6	5
Widowed	6	5
Separated	1	0.8
Household size		
1-5	74	61.7
6-10	43	35.8
11-15	3	2.5
Educational Level		
lack of formal qualifications	51	42.5
Adult education	2	1.7
Incomplete Primary	9	7.5
Complete Primary	37	30.8
Secondary Education	18	15
Tertiary Education	3	2.5
Farm Size		
Small scale	114	95
Large scale	6	5

Table 2. Technological innovations utilized by farmers in the study area.

Adopted improved technologies	Frequency	Percentage
Improved seeds	73	60.83
Use of advanced farm machineries	48	40.00
Irrigation	21	17.50
Spraying of herbicide	85	70.83
Pesticide use	78	65.00
Fertilizer application	81	67.50

Table 3. Major of effective adoption of innovation among small scale rice farmers.

Factors affecting adoption	Mean	SD
Cost of innovation	3.74	0.58
Lack of access to credit facilities	3.48	0.66
Lack of farmers participation in agricultural innovation programme development	3.33	0.53
Inadequate extension service	3.25	0.63
Lack of training on adoption	3.53	0.71
Unavailability of the agricultural innovation in our local market	3.23	0.57

previous research. For example, a study by Onyeneke and Uzokwe (2015) found that the majority of smallholder farmers in Nigeria had low levels of education, which limited their ability to access and utilize agricultural extension services.

Hence, the finding that the majority of farmers operate on a small scale is consistent with previous research. For example, a study by Afolayan *et al*. (2017) found that small-scale farming is prevalent in Nigeria due to limited access to credit and other resources

Technological innovations utilized by farmers in the study area

The results in Table 2 shows the type of technological innovations available to the rice farmers in the study area. The farmers showed that the most adopted technological innovation was spraying of herbicide (70.83%) followed by fertilizer application (67.50%), use of pesticide (65.00%) and improved seeds (60.83%). The ability of the rice farmers to adopt certain innovation is based in their education level and experience. The decision of adoption can also be affected by availability and accessibility. The outcomes of Table 2 therefore implied that farmers could only accept the innovations they understood and that was available and accessible. Technology adoption economic research has endeavored to explain the user acceptance in connection to individual traits and endowments, incomplete knowledge, risk, and unpredictability, limitations imposed by institutions, infrastructure and the accessibility of inputs (Uaiene, 2011). According to a study by Aluko *et al*. (2021), non-adopters of agriculture technology have a hard time making ends meet and are more likely to experience socio-economic stagnation, which frequently leads to poverty.

Factors affecting the rate of adoption of innovation among small scale rice farmers

The factors affecting the rate of adoption of agricultural technology innovation by farmers was subjected to Likert scale rating where farmers were asked to indicate their degree of acceptance or disapproval with a specific variable which impact how they adopt innovations. The result presented shows the mean rating of famers perception of a particular factor as restricting adoption of innovation. The results however showed that the major limiting factors were cost of innovation (mean = 3.74), lack of training on adoption for farmers (mean = 3.53), limited access to credit facilities (mean = 3.48), and inadequate extension service (mean = 3.25). The findings on challenges revealed the participant's agreement to the presented items as limiting factors to the acceptance of agricultural innovations and strategies. Poor adoption (and in most cases non-adoption) of agricultural innovations by rural farmers is often linked with challenges such as are listed in Table 3. These challenges, if not addressed, may continue to account for the apparent low adoption of agricultural innovations by rural farmers in Gwagwalada Area Council, Abuja. These results are supported by Amungwa (2018) who identified that inadequate farmers' participation in innovative farming programme and development have been linked to high cost of implication and poor funding, social and cultural misfit technologies/innovations for indigenous farmers.

Table 4. Logit regression on the effect of farmers' demographic characteristics on the adoption of agricultural technology innovations.

Variables	Coefficient (B)	Standard error	Wald	Sig.	Exp (B)
Gender	0.03064	0.0165	-0.208	0.0384*	0.1028
Age	0.2509	0.0120	0.802	0.4920	0.1293
Marital status	0.0953	0.0830	0.252	0.2035	0.0796
Household size	0.3057	0.2579	0.082	0.1291	0.2620
Farm size	0.0729	0.5298	0.552	0.0041**	0.8147
Level of Education	0.1426	0.4260	0.034	0.0028**	0.1476
Log likelihood	-28.19470				
NgelkerkeR^2	0.2751				

Key: * = Significant at 5% significant levels; ** = Significant at 1% significant levels (Source; Field Survey, 2023).

Logit regression on the influence of farmers' demographic characteristics on the adoption of agricultural technology innovations

The effect of farmers' demographic features on their adoption of agricultural innovation technologies was examined using the logistic regression model (Table 4). The outcome demonstrated that certain demographic traits significantly influence how much or how quickly farmers in the research area use or accept innovations. Included in this attribute are gender, farm size, and educational attainment. These findings support Onu's (2006) assertion that women face barriers to accessing or acquiring farming resources in nearly all of the nation. This emphasizes how crucial education is to farmers' access to and use of ICTs. The fact that the educational attainment of the farmer limits the adoption of agricultural innovations suggests that the more educated the farmer, the more probable it is that they will comprehend and implement new technologies or advances in their farming. Education also makes it easier to access helpful knowledge. This result supports the idea that human being are able to make sense of situations by interpreting them, synthesizing and integrating a variety of fresh knowledge in the context of what they already known.

Previous research has also emphasized the importance of education in farmers' access to and adoption of ICTs. For instance, a study by Murendo *et al*. (2012) found that education level significantly influenced the use of mobile phones among smallholder farmers in Zimbabwe. The study revealed that farmers with higher levels of education were more likely to use mobile phones to access agricultural information and to communicate with extension agents. Similarly, a study by Koutropoulos *et al*. (2018) in Greece highlighted that education was a critical factor in the adoption of precision agriculture technologies by farmers. The study found that farmers with higher levels of education were more likely to adopt precision agriculture technologies and to use them effectively

Conclusion

According to the research's findings, farmers in the study area have a poor acceptance rate for technological innovations because of their low educational levels, the size of their farms, a lack of training, the expense of the innovations, so also their inability to obtain and use them. Herbicide spraying, fertilizer use, pesticide use (65%) and better seeds were the main agricultural technological innovations adopted in the research region. Nevertheless, high cost of adopting new technology, inadequate finance, lack of modern facilities for rice production and processing, lack of extension visit and poor market system were the major constraints in the study area.

Recommendation

Based on the findings of the study, the following recommendation were suggested:

1. Extension officers should visit the study area regularly in order to encourage farmers on the use of modern technology to avoid poor acceptance rate of new innovations.
2. Hence, it is advised that the government and pertinent organizations enhance farmer's education on the application of new innovations, and extension agents should make new ideas available to farmers as soon as possible.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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