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An Assessment of Youth Empowerment through a New Technology Innovation Adoption among Rice Farmers in Kano State, Nigeria

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Abstract
This paper examines the impact of new technology adoption among youth empowerment of rice farmers in Kano State. Primary data was collected from the rice farmers communities. Multinomial logit model and marginal effect model were used. The finding of the study shows that the higher the average yearly income, the higher the farmers' adoption of modern tools than the traditional or semi-modern tools. Findings are supported by the economic theory of adoption, which links adoption choice with the utilities the farmer derives from the technology in term of productivity and increase in income. Similarly, the higher the highest educational qualification of the rice farmer, the more (2.0%) the farmer adopts modern rice farming tools; this is in line with the a priori expectation and is statistically significant at 10% level. Farmers that possess higher educational qualification tend to adopt modern tools, perhaps because of the socialisation and information parity between them are their less-educated counterparts. The study concluded that both males and females should really be encouraged to go into rice farming, as majority of the respondents from this study are males. Doing this, will further increase the number rice farmers and consequently boost local rice output.

Keywords: Technological Innovation, Rice Farmers, Empowerment, Mlogit
JEL Classification: M54, Q16

1. Introduction
Nigeria is one of the largest rice markets in Africa, with an estimated population of over 180 million people, growing at 3.2% annually and predicted to reach 221 million by 2020 (NPC, 2006). Nigeria's rice consumption has increased quite significantly over the last decade (6 – 7% per annum). Data on rice production in Nigeria has equally shown steady increase. Nigeria produced 0.343 million metric tons of rice in 1970; 1.09 million metric tons in 1980; 2.5 million metric tons in 1990; 3.298 million metric tons in 2000; and 3.219 million metric tons in 2010. Despite the place of rice in contributing to food supply in Nigeria, its production is still put at about 3.2 million tons. This has been shown to be far below the national requirement, as over $600 million worth of rice is imported annually into the country (Ohaka et al., 2013). Average per hectare yield of rice of Nigeria is far less than that

obtained in many other countries of the world (FAO, 2008). Rice in Nigeria is facing the same situation as the national level yield of rice is over 73% lower than the highest average obtained in other countries of the world (World Bank, 2012 as cited in Ohaka et al., 2013) like China (mainland), India, Indonesia, Bangladesh, Viet Nam, and Thailand where annual average production is 142.1, 103.8, 45.8, 34.6, 29.3 and 19.8 million metric tons respectively (AMIS, 2015).

The study mainly examines the factors that determine technology adoption by rice farmers as well as its impact on rice output in Kano State. The connection between technological change and production efficiency cannot be over-emphasized. Agricultural research effort can only be successful when developed technologies by research institutes are adopted by the end users to increase production (Udemeze, 2013). This study, therefore, seeks to give information that would help Cereals Research Institutes within and outside the state, farmers and universities to promote improved technological packages on rice production that would be relevant to the needs and problems of farmers in Kano State by identifying the factors determining technology adoption by rice farmers. This study covers the entire rice farmers in Kano State, made up of 44 local government areas out of which the study shall draw its sampling frame. Therefore, farmers that produce commodities other than rice are not considered by the study. The study covers both the irrigation and rain-fed farmers in the three main areas (Kura, Bunkure and Garun-mallam) where the crop is massively produced. The study collected and analysed data for the farming period of year 2016.

2. Literature Review

Conceptual Issues

Many scholars have made attempts to give a concise definition of what the adoption concept actually denotes. Technology comprises two components, hardware and software. The hardware consists of physical too that embodies technology (Chi & Yamada, 2002). The software consists of information base for the tool. In Mumford's classification (1946), "technology-as-subjects" encompasses the entire range of fabricated items intended for some use or other, including tools, utensils, utilities, apparatus and machines. Mitcham (1978), technology-as-process" includes most importantly the activities we commonly denote as making and using. The key element here is that of skill defined as 'proficiency in the use of artifact', distinguished technique from technology. Technology refers to skills, regarded as capability of particular human subjects, and technology means a corpus of generalised, objective knowledge, in so far as it is capable of practical application (Chi & Yamada, 2002).

Loevinsohn *et al*., (2013) defined technology as the means and methods of producing goods and services, including methods of organisation as well as physical technique. According to these authors, new technology is new to a particular place or group of farmers, or represents a new use of technology that is already in use within a particular place or amongst a group of farmers. Technology is the knowledge/information that permits some tasks to be accomplished more easily, some service rendered or the manufacture of a product (Loevinsohn*et al*., 2013). Technology itself is aimed at improving a given situation or changing the status quo to a more desirable level. It assists the applicant to do work easier than he would have in the absence of the technology hence it helps save time and labour (Bonabana-Wabbi, 2002).

Empirical literature review

Extensive review of the literature on technology adoption in developing countries, by Feder *et al.*, (1985) in Bravo-Ureta *et al.* (2005) revealed that the various factors that influence technology adoption can be distinguished into three broad categories; factors related to the characteristics of producers; factors related to the characteristics and relative performance of the technology and institutional factors. Alarima *et al.* (2011) examined factors affecting the adoption of sawah technology by rice farmers in Nigeria using regression analysis. Factors identified affecting farmers' adoption of sawah technology were attitude of farmers, attributes of sawah technology, access to contact farmers and household size influenced the adoption of sawah technology. The study showed that attributes of the technology, access to contact farmers and size of the farmers' households were found to be positively related to the adoption variable and statistically significant. Furthermore, Nasiru (2014) stated that the factors related to the characteristics of producers include educational level, experience in the activity, age, gender, level of wealth, farm size, labour availability, risk aversion, etc. He asserted that the factors related to the characteristics and performance of the technology include food and economic functions of the product, the perception of individuals of the characteristics, complexity and performance of the innovation, its availability and that of complementary inputs, the relative profitability of its adoption compared to substitute technologies, the period of recovery of investment and the susceptibility of the technology to environmental hazards. He further opined that the institutional factors include availability of credit, the availability and quality of information on the technologies, accessibility of markets for products and inputs factors, the land tenure system, and the availability of adequate infrastructure.

Also, Matata *et al.* (2001) listed factors like personal, institution, environmental and socio-economic factors as influencing technology adoption. Adesina and Baidu-Forson (1995) found that age was negatively related to probability of participating in rice development projects, though Asante et al. (2011) recorded a positive relationship.

Saliu *et al.* (2016) examined the socio-economic determinants of the adoption of improved rice technologies by small scale farmers in Kogi State, Nigeria, using multistage random sampling to select 120 registered rice farmers with the Kogi State Agricultural Development Project (ADP). Ordered probit regression was used to analyse the data. Result of the estimated ordered probit revealed that farm size, household size and contact with extension agents favoured the adoption of all the eight most important rice technologies which could be used as a measure towards pleasant disposition to commercial rice farming.

Oladele and Kolawole (2013) examined the ex-ante adoption of Sawah rice production technology in Kwara State Nigeria using a logit regression analysis. They found that the significant determinants of adoption of Sawah rice production technology in Kwara State to be practicability of the technology, labour requirement, extension support/training, age, education, farming experience, and gender. Other factors are knowledge of rice cultivation, returns to investment, access to credit and loans, use of family labour, availability of seeds/planting materials, cultivate rice on low land, existing farmers groups, information on rice from input dealers, information on rice from extension officers, information on rice mobile phones and distance to market.

Theoretical framework

This study used the Theory of Reasoned Action (TRA). The theory states that an individual's intention to adopt an innovation is influenced by his attitude towards the behaviour and subjective norm (Tooraj & Sahel 2011). A person's behaviour is determined by their intention to perform the behaviour. The attitude towards performing the behaviour is an individual's positive or negative belief about performing the specific behaviour. Therefore, attitudes are the beliefs a person accumulates over their lifetime. This theory also opines that the intention to perform behaviour depends upon the product of the measures of attitude and subjective norms (Hillmer, 2009). If a person perceived that the outcome of behaviour is positive, they will have a positive attitude towards performing that behaviour and vice versa (Onyeneke, 2017).

3. Methodology

Model Specification

The multinomial logit model used in this study is adopted from Nimoh *et al.* (2012), KIP (2013) Takeshima *et al*. (2013) and Justice & Seth (2014), little modifications were however made on it to suit the objective (i) of this study; Let y denotes the level of technology adoption from modern to semi-modern to traditional technologies taking on the values 1, 2, and 3 respectively and let x denote a matrix of conditioning variables (in this study the technology adoption determinants). Since the probabilities must sum to unity, $Pr(y = 0|x)$ is determined once the researcher know the probabilities for $j = 1, 2, . . . ,j$.

Let x be a 1xK vector with first-element unity. The multinomial logit (MNL) model has response probabilities;

$$pr(y_i=0|x)=e^{x'\beta i} / \left(\sum_{k=1}^{k-1} e^{x'\beta i} \right) \quad \ldots 1$$

$$pr(y_i=j|x)=e^{x'\beta i} / \left(\sum_{k=1}^{k-1} e^{x'\beta i} \right) \quad \ldots 2$$

whereβ_i is k x 1 vector coefficients of exogenous variables, $i = 1, 2, .., j$.

Let the utility of the irrigated rice farmer be represented by U. Then, the utility gained by adopting a kind of technology, T will be U_i (T). If T=0, T=1& T=2 given that three category of technology are available; farmer adopts the modern, semi-modern or traditional kind of technology.

Therefore, a farmer adopts technology 0 if:

$$U_i(0)>U_i(1) \& U_i(2) \quad \ldots 3$$

1 adoption takes place when

$$U_i(1)>U_i(0) \& U_i(2) \quad \ldots 4$$

2 adoption takes place when

$$U_i(2)>U_i(0) \& U_i(1) \quad \ldots 5$$

Therefore, considering that the decision to adopt depends on some factors such as farm, then;

$$U_i^*(0)=\frac{1}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=X_i\beta+\varepsilon_i \qquad ......6$$

$$U_i^*(1\&2)=\frac{e^{x'\beta i}}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=X_i\beta+\varepsilon_i \qquad ......7$$

where $\mathcal{E}_i$ is the error term and is assumed to be continually distributed and has symmetry around zero.

If the probability of adoption is $pr(y_i=0|x)$, then probability of non-adoption is $pr(y_i=j|x)$. Replacing the first left hand side of equations 4, 5 and 6 results in

$$pr(y_i=0|x)=\frac{1}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=X_i\beta+\varepsilon_i \qquad ......8$$

$$pr(y_i=j|x)=\frac{e^{x'\beta i}}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=X_i\beta+\varepsilon_i \qquad ......9$$

Where $pr(y_i=0|x)$= is the conditional probability of adoption of the reference variable by farmer *i* conditional on the explanatory variables, and $pr(y_i=j|x)$ is the probability of adoption of the other alternative variables (1&2) by farmer *i*,x are the variables hypothesised to explain adoption and β is the vector of parameters to be estimated. The estimable econometric models are:

$$y_i=\frac{1}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=\beta_0+\beta_1PS+\beta_2AGE+\beta_3TECST+\beta_4GPOL+\beta_5AC+\beta_6HHS+\beta_7EDU+\beta_8FP+\beta_9EXP+\beta_{10}AT+\beta_{11}SOW+\mathcal{E}_i \qquad ......10$$

$$y_i=\frac{e^{x'\beta i}}{\left(1+\sum_{k=1}^{k-1} e^{x'\beta i}\right)}=\beta_0+\beta_1PS+\beta_2AGE+\beta_3TECST+\beta_4GPOL+\beta_5AC+\beta_6HHS+\beta_7EDU+\beta_8FP+\beta_9EXP+\beta_{10}AT+\beta_{11}SOW+\mathcal{E}_i \qquad ......11$$

Where PS is the farmer’s plot size, AGE is the farmer’s age, TECST is the Cost of the technology, GPOL is the government policy on the technology, AC is agricultural credit, *HHS* is the farmer’s household size, EDU is the educational qualification of the famer, *FP* is the farmer’s farming purpose, EXP is the farmer’s year of experience in rice farming business, AT is the access to the modern technology and *SOW* is the source of water to farmer.

Target Population

The targeted population of this study consists of all the registered rice farmers in the three (3) rice farming areas. These farmers are spread across the three local government areas where rice is mainly cultivated. The areas consist of about1, 200 registered rice farmers. Kura, Bunkure and Garun-mallam has 500, 400 and 300 registered rice farmers respectively

(Muhammad & Hamisu, 2014).The local governments are further made up of various communities whom main occupation is farming.

Sample Size

Kura, Bunkure and Garun-mallam have 12000 registered farmers each having 5000, 4000 and 3000 rice farmers, respectively. Therefore, the sample from the three farming groups will be used. Taro and Yamen (2003) recommended the formula below for the determination of sample size from a given population. Therefore, in this study, the sample size, *n*, is given by;

$$n = \frac{N}{\{1+N(e)2\}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad 12$$

$$= \frac{12000}{\{1+12000\,(.05)2\}} = \frac{12000}{\{1+12000\,(.0025)\}} = \frac{12000}{\{1+30\}} = \frac{12000}{\{31\}} = 387\text{respondents}$$

Therefore, the total sample size for the study is 387rice farmers from the study area.

Sampling Technique

This study adopted the multistage sampling techniques as the sampling procedure is in three stages. In the first stage, the sample was divided into three major rice producing local government areas. These local government areas include Kura, Bunkure and GarunMallam. This division was in such a way that a total of one hundred (100) farmers was included in each of the local governments. The second stage involved dividing each local government into four communities since a local government contains more than four communities. Therefore, in each community, a total of twenty five farmers were drawn. The sample therefore, consists of twelve (12) communities. Finally, the selection of the twenty five (25) farmers from each of these communities was done using the random sampling technique. This procedure is an important approach because it avoids mix up of certain parameters that are important in the study (Muhammed & Hamisu, 2014).

The Study Area

Kano State is situated in the Sudan Savannah agro ecological zone of Nigeria located between latitudes 9^{o} 30’ and 12^{o}37’ North and longitudes 7^{o} 34’ to 9^{o} 25’ East. The climate of the study area is Tropical dry climate with a mono modal rainfall distribution averaging 600mm per annum with most rains occurring between May and September. Air humidity is high during the wet season and very low during the dry season. Average temperature is 29^{0}C with minimum temperature occurring from November to February and highest temperature occurring in March and April (Olofin & Tanko, 2002). The intensive production of rice in various rice production clusters have led to processing and marketing of rice in large processing clusters which are scattered in production clusters of Kura, Karfi, Kwanar Dawaki, Tudun Wada, Bunkure, Garun Mallam and Chiromawa (COMEIN, 2007).

Method of Data Collection and Analysis

This study reported its findings from field survey, hence it made use of the cross sectional data. The data were gathered by distributing a well structured questionnaire (and if need be applying direct interview method) to the targeted respondents from the three rice producing groups; Kura, Bunkure and Garun-Mallam. These groups’ selections were based on the concentration and intensity of rice farming activity as well as the resources available to the researcher. The data collected were analysed using version 14.0 of the STATA statistical software and involved the estimation of multinomial logit (mlogit) model

4. Result

Table 1; Determinants of the Level Modern Rice Farming Technology Adoption in Kano State (Estimated co-efficient of the multinomial logit model)

Variables	Traditional Tools	Modern Tools
Sex	12.99857***	-1.92061*
	(.9838291)	(1.14512)
agesq	.0001826	.0003746***
	(.0001149)	(.0001143)
heq	.0191809	-.1036027
	(.0950111)	(.0982083)
cf	.000012	.0000142*
	(8.37e-06)	(8.31e-06)
lcach	-.0859691	-.4410731*
	(.2300213)	(.2448904)
lcirs	-.8728965	-.1356291
	(.7120153)	(.558259)
lsac	-.4914238	-.7260902*
	(.3983859)	(.4110887)
fs	-.1923355	.1403761
	(.3171729)	(.2419687)
nrf	.3988416	.2419687*
	(.2519286)	(.2243544)
layi	-.0872687	.3208624
	(.2061261)	(.3208624)
lacimp	-.1673555	-.8780411***
	(.3160353)	(.3138259)
Observations	299	299

Source: Author's computation using stata 14 statistical package

Having estimated the multinomial logit model whose estimate is presented above, it can be observed that the multinomial log-odds of adopting traditional tools of farming when all other variables are held constant, is higher by about 12.99 units when the farmer is a male rather than a female. This appears to be negative and statistically significant at 1%. This is, perhaps because the male sex is believed to be more energetic than the female and also more resisting to change than the female. This is in agreement with a priori expectation and in line with the findings of previous studies by Ebojoi *et al.* (2012) and Nasiru (2014). Furthermore, this variable is at 10% significant in terms of adopting semi-modern or modern tools of rice farming. In addition, the estimated marginal effects of this coefficient in Table 2 were found to be statistically significant at 1% level. The result shows that the probability of rice farmers adopting modern rice farming tools will decrease by 1.28% and increase that of traditional tools by about 2.8% when the household head is male. These variables are all significant at 1% levels each for both the traditional, semi-modern and modern choices.

Table 2: Determinants of the Level Modern Rice Farming Technology Adoption in Kano State (Marginal Effects)

Variables	Traditional Tools 0	Semi-Modern Tools 1	Modern Tools 2
Sex	2.812546***	-1.524004***	-1.288543***
	(.1970605)	(.269851)	(.1748942)
agesq	.0000104	-.0000646***	.0000542***
	(.0000211)	(.000022)	(.000018)
heq	.011457	.0085985	.0200555*
	(.0177732)	(.0194484)	(.0161137)
cf	1.44e-06	-3.17e-06*	-1.73e-06
	(1.45e-06)	(1.76e-06)	(1.27e-06)
lcach	-.0496888	-.0372663	-.0869551**
	(.0431284)	(.0471549)	(.0407027)
lcirs	-.169375	-.1307907	-.0385843
	(.140266)	(.124491)	(.1012974)
lsac	-.0433192	.1415603**	-.0982411
	(.0750982)	(.0731039)	(.0715818)
fs	-.049006	.0083201	.0406858
	(.0571978)	(.055881)	(.0405961)
nrf	.0371513	-.1119628***	.0748115**
	(.044035)	(.0465593)	(.0352891)
layi	-.0409039	-.0231795	.0640835*
	(.0396031)	(.0408514)	(.0342498)
lacimp	-.0280254	-.1183821**	-.1464075***
	(.0600204)	(.0612717)	(.0511079)
Observations	299	299	299

Source: Author's computation using stata 14 statistical package

AGESQ variable is the square of the farmer's age, positive and statistically significant at, though, 1% on the adoption of modern tools but by insignificant units in traditional, semi-modern or modern farming tools. Thus, when the farmer's age is high, the multinomial log-odds of adopting the modern rice farming tools is higher by 0.0003 units than the younger farmers when all other variables are held constant. This is in line with our a priori expectation and conforms with findings of Oladele and Kolawole (2013), Nasiru (2014) and Asante et al. (2011). Further, the results explain that geometric increase in the age of the farmer increases the probability of adopting modern technology by a meager 0.005% and 0.001% for traditional. However, it reduces the chances of adopting semi-modern tools by an approximate 0.006%. These variables are significant at 1% each for semi-modern and modern respectively and not for traditional.

From the table above, this variable represents the highest educational qualification of the farmer and it is line with our a priori expectation, though for the traditional category but not for the modern. The variable also shows higher mlog-odds for adopting modern farming tools when the farmer possesses a higher educational qualification by an average of -0.10 units and 0.01units for the traditional tools. The positive, though not significant, conforms to the conclusion of previous researches like Ebojoi *et al.* (2012), Oladele & Kolawole (2013) and Nasiru (2014).In the same connection, a 2.0% probability of adopting modern rice farming tools is envisaged for a farmer who possesses a higher educational qualification. 0.8% and 1.1% are the predicted probabilities of adoption semi-modern and traditional tools of rice farming respectively, although, these variables are statistically insignificant except for the modern category at 10% level (Ebojoi *et al.* 2012; Oladele & Kolawole, 2013; Nasiru, 2014).

ICACH variable represents the natural log of cost of agro-chemicals. It is negatively related to the level of technology adoption which conforms with the a priori expectation of the variable. The variable shows higher multinomial log-odds for adopting modern farming tools when the cost of agro-chemicals is high by an average of 44.1units and 8.5 units for the traditional tools. This is perhaps due to the fact that some farmers may be risk lovers and therefore, expect the modern agro-chemical to be relatively more efficient and effective than the traditional, thus the reason the price is higher. Furthermore, the marginal effects of the variable portrays a higher elasticity for the modern agro-chemical with 8.6% decrease in the adoption of modern tools as result of a unit increase in the cost of agro-chemicals when other variables are held constant and vice versa. This exhibits the highest as the probabilities for the traditional and semi-modern are 4.9% and 3.7 % respectively.

ICIRS based on the result of the estimated MNLM coefficients in Table 2, this coefficient was found not to be statistically significant at all levels. The result shows that on average, when other variables are held constant, the farmers' multinomial log-odds of adopting modern farming tools instead of traditional is lower by about 0.13 units when the cost of improved rice seed is high. This is because it is believed that farmers are rational and will buy inputs with lesser prices and this conforms with the a priori expectation. That is, farmers tend to adopt tools that are less-expensive than those that are more expensive and therefore the log-odds of adopting them will be far higher and therefore, tend to have higher probability of adoption. However, these co-efficient are not statistically significant when it comes to farmer's decision to adopt traditional or modern tools of rice farming respectively. In the same line, the estimated marginal effects show that the probability of adopting modern tools is approximately 3.8% while that of semi-modern is 13% and 16.9% for the traditional tools of rice farming.

ISAC based on the estimated model in Table 2 which shows the coefficients of the variable, natural log of source of agric credit was found to be statistically significant at 1% (modern) level. The result shows that the multinomial log-odd of adopting modern tools of rice farming (compared to traditional) is higher by about 0.72 units as for traditional is 0.49 units. Likewise, the result of the estimated marginal effects depicts a 5% statistical significance for semi-modern tools (only) and has the highest probability of adoption with about 14.1%, 9.8% and 4.3% responses from a unit change in the source of agric credit (agric bank or otherwise) for semi-modern, modern and traditional tools respectively. These findings conform to a priori expectation and this is because when the farmers source for fund to finance their rice farming activities, they tend to enjoy that right of complete ownership and therefore may not bother to or even easily find modern tools than when the funds were given to them by the government (through banks or its agencies) which mostly accompany it with HYVs and other tools like fertilizers.

FS **b**ased on the estimated coefficients of the MNLM in Table 2, this variable (farm size) was found to be statistically insignificant at all levels. The results have shown that when a farm size increase by one unit (other factors held constant), the multinomial log-odd of adopting traditional instead of modern tools reduces by about 0.19 units. Likewise, the increase in the size of farm increases the multinomial log-odd of adopting modern rice farming tools by 0.14 units, all things being equal. This (later) conforms to a priori expectation, that the larger the farm size, the more the possibility of adopting modern tools in other to amass productivity. Also, from the estimated marginal effects, all but the traditional tools category appear to be positive conforming to the a priori expectation. The traditional, although negative, has the highest probability of decrease in adoption as a result of a unit increase in the farm size with about 4.9% while semi-modern has a positive probability of adoption by about 0.8% and finally the modern tools of rice farming maintains a 4.0% probability of adoption given a unit increase in the farm size.

NRF coefficient was found to be statistically significant at 10% (for modern tools only) level. The results show that a 1% increase in the number of rice farms will lead to an increase in the multinomial log-odd of adopting traditional tools by about 0.39 units all things being equal. Additionally, a 1% increase in the number of farms will cause an increase in the multinomial log-odd of adopting modern rice farming tools by about 0.24 units. This is in concord with a priori expectation, that is, as number of farms increases, farmers tend to look for ways of reducing the cost and increasing output by simply reducing number of labour in weeding, cultivation etc. This is because, the higher the number of farms, the higher the potential of the revenue generation of the farm and thus, the use of modern fertilizers, seeds, herbicides, as well as their application methods is sacrosanct, all things being equal. In the same way, the variable was, for the estimated marginal effects, statistically significant at 1% and 5% levels for semi-modern and modern tools respectively although the sign on semi-modern negates the a priori expectation. The result shows that there is a 3.7% probability of adopting the traditional tools when the number of farms increases and vice versa. In addition, an 11.1% probability of decrease in the adoption of semi-modern tools was predicted and finally, all things being equal, an increase in the number of rice farms of a farmer increases the probability of adopting modern tools by an average of 7.4% and vice versa.

LAYI coefficient was not found to be statistically significant at all levels for (traditional and modern tools) the coefficient estimates. The estimated marginal effect shows a 10% statistical significance for the modern tools and has the highest probability. The estimated coefficient results show that a 1% increase in the natural log of the average yearly income of the farmer will lead to decrease in the multinomial log-odd of adopting traditional tools by about 0.08 units all things being equal. Additionally, a 1% increase in the natural log of the average yearly income of the farmer will cause an increase in the multinomial log-odd of adopting modern tools by about 0.32 units. Also, albeit all but the modern categories in both the coefficient and marginal effects estimates conform with a priori expectations of the variable, the marginal effects estimates show that an increase in the farmer average yearly income (in natural log) increases the probability of adopting the modern rice farming tools by about 6.4%, all things being equal. Conversely, increase in the income from farming decreases the probability of adopting traditional and semi-modern tools by about 4.0% and 2.3 % respectively. This is because, the higher the income, the higher the ability of the farmer to afford costly modern tools of rice farming so as to maximize output, all things being equal.

LACIMP is the notation for natural log of average cost of inputs in this study. From the result of the estimated model, the coefficient of this variable, for the modern category, was found to be statistically significant at 1% level (Table **3**). The result has shown that a 1% increase in average cost of inputs reduces the multinomial log-odd of adopting modern tools compared to traditional tools by about 0.87 units, when all other variables are held constant. Similarly, a 1% rise in the average cost of inputs reduces the multinomial log-odd of adopting traditional tools by about 0.16 units when all things being equal. Furthermore, the estimated marginal effect of this variable shows that there is a negative significant relationship between the probability of modern tools adoption and the average cost of rice farming inputs (Table **3**). A 1% rise in the average cost of rice farming inputs leads to about 14.6% increase in the probability of adopting modern tools rice farming when other factors are held constant.

Homoscedasticity and Normality Tests

Table 3: Cameron & Trivedi's decomposition of IM-test

Source	Chi^2	df	prob.
Heteroskedasticity	13.69	8	0.0903
Skewness	12.37	3	0.0062
Kurtosis	78.64	1	0.0000
Total	104.69	12	0.0000

Source: Author's computation

Table 4; Test of Multicollinearity

Variable	VIF	1/VIF
Llheq	1.01	0.991544
Sexsq	1.01	0.991763
age4	1.00	0.999773
Ayi	1.01	0.990990
Llfs	1.01	0.991672
Mean VIF	1.01	

Source: Author's computation

Slightly below table 4, which contains the result of the estimated OLS model for socio-economic determinants of modern rice farming fertilizer adoption in Kano State, Nigeria is the overall test statistic (F-value) of the model which indicates that the estimated model is statistically significant at 0.1% (p-value = 0.000). Moreover, in order to further ascertain the validity of the model, various post estimation tests were conducted although the robust standard errors were estimated.

The Heteroskedasticity and normality tests were conducted using Cameron and TrivediIm-test. The tests results are contained in Table 4 above. The result of the heteroscedasticity and normality tests recommends that we do not reject the null hypothesis of homoscedasticity and normality. Thus, the model is normally distributed and the variances are stable across time.

Contained in table 4 above is the VIF test for measuring the extent of multicollinearity among the independent variables. Based on the result, since none of the VIF value reached a value of 10, we therefore believe that there is no problem of multicollinearity among the included variables in the model and therefore, the study maintained all the variables for the purpose of estimation.

5. Conclusion and Recommendation

The result has shown that the higher the average yearly income, the higher the farmers' adoption of modern tools than the traditional or semi-modern tools (table 1). This finding is supported by the economic theory of adoption, which links adoption choice with the utility the farmer derives from the technology in term of productivity and increase in income. Therefore this will leads to empowerment throughout the farmers communities. Similarly, the higher the highest educational qualification of the rice farmer, the more the farmer adopts modern rice farming tools (table 2). This is in line with the a priori expectation and is statistically significant at 10% level. Farmers that possess higher educational qualification tend to adopt modern tools, perhaps because of the socialisation and information parity between them are their less-educated counterparts. The result further indicated that the higher the average cost of the inputs, the lower the probability (14.6%) of adopting modern tools and this supports the theory demand in relation to adoption (or acquisition) of new tools and their respective costs

Having conducted an empirical investigation of the level of adoption of modern rice farming technology by rice farmers in Kano State, Nigeria, the following recommendations were offered based on the findings of the study. In order to discourage the use of traditional and less semi-modern tools of rice farming in Kano State, Nigeria, farmers need to upgrade their farming tools to modern technology which will improve yields. This empowers both male and female farmers in their locality. Both male and female should really be encouraged to go into rice farming, as majority of the respondents from this study have been male. Doing this, will further increase the number rice farmers and consequently boost local rice output.

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