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ADOPTION OF PRODUCTION TECHNOLOGIES BY LOWLAND RICE FARMERS IN LAVUN LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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A B S T R A C T

The study examined adoption of production technologies by lowland rice farmers in Lavun Local Government Areas of Niger state. Structured questionnaire was used for data collection. A multi-stage sampling procedure was employed where a total of 181 lowland rice farmers were randomly selected by 5% proportionate to size. Data were analyzed using descriptive and inferential statistics. Farmers' adoption index indicated majority on relatively high scale adoption of nursery practice (81.8%), transplanting and spacing (69.1%) and harvesting (54.7%). The relatively low adopted practices by the majority were water management (76.0%), herbicide (84.0) and rate of fertilizer application (57.5%). Land preparation recorded majority (77.4%) on a medium scale basis. The study identified constraints to include: high cost and low availability of farm inputs, lack of credit facilities and insect infestations among others. The results of Tobit multivariate regression model indicated household size, farming experience, extension contacts, training participation and distance from market were significant (P≤0.01) determining factors influencing adoption of lowland rice production technologies; farm size and social capital were also significant (P≤0.05). Adoption of rice technology package is sustainable among the rice farmers if the constraints are overcome. It is therefore recommended that the agricultural extension agencies should give priority attention to the significant factors identified by this study while formulating development strategies and programs for different categories of farmers.

Keywords: Level of adoption, constraints and tobit multivariate regression.

INTRODUCTION

Rice has become an important economic crop and major staple food of strategic significance across much of the region in Africa. Driven by changing food preferences in the urban and rural areas and compounded by high population growth rates and rapid urbanization, rice consumption in sub-Sahara Africa has been growing over the years, more than double the rate of population growth (FAO, 2011). In Nigeria, the demand for rice has been increasing at a much faster rate than in other West African countries since the mid 1970s (Dontsop & Diagne, 2010). Estimated annual milled rice demand for Nigeria is 5 million tonnes (FAOSTAT, 2013), while paddy production is about 4.8 million tonnes (CBN, 2013). The national rice supply-demand gap is bridged by importation which has constituted serious drain on the nation's foreign exchange. An average of 32 kg of rice is consumed annually per person, while about 2 million hectares of land is presently cropped to rice (FAOSTAT, 2013). Despite the importance and vast fertile land for rice production in Nigeria, the country is faced with some challenges to reach self-sufficiency in rice production. Some of these constraints included low level of production resources, low adoption of improved agricultural farming practices and inadequate extension delivery system. In recent years, a lot of adaptive researches were conducted in Nigeria to generate and develop appropriate rice production technologies by the National Cereals Research Institute (NCRI) and disseminated through a farmer linkage systems program to the end users. The adoption of new agricultural technology, such as the High Yielding Varieties (HYV) and good management practices could lead to significant

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increases in agricultural productivity in Nigeria. Unfortunately, these research technologies have not been fully adopted by rice farmers into their conventional farming system. Despite some previous researches aiming at providing answers to the question of low adoption of technologies (Umar et al.,2009, Ojohomon et al., 2006); the empirical evidence indicative of farmers' adoption levels of the recommended agronomic practices for lowland rice production in Lavun area is scanty. Therefore some questions are pertinent: what are the farmers' levels of adoption of lowland rice production technologies? What factors determine level of adoption of these technologies? What are the major constraints facing lowland rice farmers in the study area?. This study is an attempt to provide answers to the above questions. The findings of the study would add to the limited empirical studies on factors influencing farmers' level of adoption in agricultural development projects especially in study area, and would also inform policy in addressing these factors as entry points in promoting farmers' participation in rice development project

Conceptual Framework of The Study: The decision to adopt any novel technology has been suggested to be based on utility maximization (Rahm and Huffman, 1984). The concept of utility maximization has been used as theoretical or conceptual framework for adoption of many innovations or improved farm technologies (Adesina & Baido-Forson, 1995; Baido-Forson, 1999, Richard *et al*., 2013). The decision of a farmer to use improved technology is complex and can be modelled as consisting of two mutually exclusive processes. The first is to make decision to adopt the technology, while the second is to decide on the level, given that adoption has taken place.

Adoption index shows the extent and intensity of use of a technology. Farmer who adopts one tenth or 1% of a recommended practice is not treated as the same as one that adopts such at 100% level. For example, index for an ith farmer who applies chemical fertilizer : the fertilizer application consists of three practices; if the farmer adopts 1 out of the 3 practices the farmer index for fertilizer practice is 1/3 = 0.33. Accordingly, scores were arbitrarily scaled to arrive at some categorization of adoption, for example low, medium and high (Rahimeto, 2007; Maiangwa *et al.,* 2007 & Tadesse, 2008). The actual adoption index score ranges from 0 – 1. Thus, adoption indices of the farmers were categorized into low adoption = 0.01 – 0.33; Medium adoption = 0.34 – 0.66; and high adoption = 0.67 – 1.0. Adoption index of each farmer which shows the intensity of use of the recommended practices was treated as continuous dependent variable.

Objectives of the Study: The broad objective of the study was to examine adoption of production technologies by lowland rice farmers in Lavun Local Government Area of Niger State. The specific objectives were to:

- determine the levels of adoption of production technologies by lowland rice farmers in the study area.
- assess the factors influencing farmers' level of adoption of lowland rice production technologies in the study area.
- identify important constraints in adopting production technologies by lowland rice farmers in the study area.

METHODOLOGY

The Area of Study: Lavun Local Government Area (LGA) is in Niger State located in the Guinea Savannah Zone of Nigeria. The LGA is bordered to the North-West by Gbako and Bida; to the South by River Niger; to the East by Katcha ; to the West by River Kaduna. It lies between Latitude 90 1200'N and longitude 50 3600'E. (Balki, 2012). It has distinct dry and wet seasons with mean rainfall of between 76.2 mm and 1016 mm. The minimum temperature, which is 25oC, occurs in December - January whiles the maximum that is 38oC, in March - April. The vegetation is Guinea Savanna with mixture of trees, shrubs, herbs, and grasses. The soils are of low to medium fertility levels and can be used for growing cereals, root and tree crops. The LGA has a population of 209,017 (NPC, 2006).

Sampling Technique and Sample Size: A multi-stage sampling technique was employed for the study. In the first stage, three districts (Doko, Gaba and Bussu) were purposively selected based on their production status of lowland rice and exposure to on-farm research activities and trainings organized by the National Cereals Research Institute. In the second stage, three lowland rice producing villages were randomly selected from each of the three selected districts to make a total of nine villages. The third stage involved random selection of rice farmers drawn by 5% proportionate to size in each of the nine villages. A total of 181 lowland rice farmers were used for the study.

Data Collection Methods and Sources: Primary data were collected through interview with the use of structured questionnaire as the survey instrument. Data collection exercise was conducted with assistance of extension officers overseeing the selected areas of study and field enumerators who were trained for that purpose. The field work was conducted from February to November, 20014.

Analytical Techniques: Adoption index of individual farmers was calculated using the formula adapted from Tadesse, (2008). Simple descriptive statistics (frequency count and percentage) was used to determine the farmers' distribution across adoption categories. This was done to achieve objective (i) of the study. Tobit multivariate regression model was used to assess the factors influencing level of adoption of production technologies. Percentage ranking of constraints was employed for objective (iii).

Model specification: Tobit modelling frame work is presented as follows

$Yi^* = \beta Xt + \mu t$ (t = 1,2----------------N) (1)

Where Yt^* captures the adoption indices of the lowland rice farmers. Thus, Tobit analysis of factors influencing adoption of lowland rice production technologies is specified as: $Yt = \beta 0 + \beta 1X1 + \beta 2X2$--------------$\beta nXn$ (2)

Where the X(s) are the independent socio-economic and institutional variables and β (s) denotes parameter estimates.

Empirical model: Yt = Indices describing levels of adoption of lowland rice production technologies by ith farmer denoted (AI) = β0 + β1 EDU (Level of education) + β2 HHSZ (Household size) + β3 FRMEXP (Farming experience) + β4 FRMSZ (Farm size) + β5 EXPMED (Exposure to media) + β6 EXTCON (Extension contacts)+ β7 TRNG (Training participation)+ β8 DSMKT (Market Distance) + β9 SOCAP (Social capital) + e(Error term).

Table 1. Expected effect of the explanatory variables included in the model.

Variables	Definition	Expected effect
Level of education	Number of years of formal schooling	+
Household size	Number of persons in the household	+
Farming experience	Number of years of engaging in rice cultivation	+
Farm size	Number of hectares devoted to rice cultivation by the farmer	+
Exposure to media	Dummy 1= listing to radio or television and 0 = otherwise	+
Extension contact	Number of extension contact with extension agent in the last 2 years.	+
Training participation	Number of Agricultural training attended in the last 2 years.	+
Distance from market	Kilometre distance from home to market/ proximity to market	_
Social capital	Membership of farmers' association Dummy 1= yes, 0=otherwise	+

Recommended Lowland rice Production Technologies: This refers to sequence of management practices and husbandry activities recommended for producing lowland rice as promoted in collaboration with NCRI Badeggi.

Establishment of nursery: Prepare seed bed at least 7 days before the seed are sown.

Seed bed should be 1 to 1.5m wide, 10m long, and 4 to 6cm above the ground surface.

Soak the seeds for 24 hours; incubate seeds by covering with polyethylene bags or raffia palms for another 48 hours for seed to sprout.

- Spread the sprouted seeds uniformly on a puddle nursery bed
- Flood the bed to 2-3cm depth to prevent weeds and also ensure easy pulling of seedlings.
- Land preparation (preparing field for rice):
- Plough and harrow the field.
- Flood the field for about 2 weeks to kill weeds.
- Remove water after 2 weeks and mark out the field into basins (10 x 5m) with hoe.
- Construct bunds to retain water and suppress weeds
- Irrigate or allow water into the basins. After levelling, remove the excess water

- Transplanting and spacing:
- Transplant seedlings to the main field between 14 and 21 days after sowing.
- Transplant at rate of 2-3 seedlings per hill
- Transplant at a space of 20 x 20 cm

Water management: Maintain the water level up to 5cm level from 1 week after transplanting until grains mature.

- Drain the water a week before harvesting.

Fertilizer application rate: Apply 4 bags (50kg) of NPK 15-15-15 before transplanting. and should be worked well into the soil.

- Apply 2 bags (50kg) of urea with 2 splits at 4-6 weeks after transplanting.
- Apply another urea (2 bags per 50 kg) at panicle initiation.

Chemical weed control: For post emergence, 3 weeks after transplanting apply Rycestar Orizoplus TM at 15ml (1 peak milk tin) per knapsack sprayer (15 litre sprayer) in 400 litres of water Or Delmin Forte (2,4-D) plus Propan 360 (propanil) at 250ml in 20 litres of water/ha.

- 1 week after the application, let the water back into paddy field at depth of 10cm.

Maturity period and harvesting: The crop is ready for harvest when the grains are hard and are turning yellow/brown (30-45 days after flowering or a month after 50% flowering).

- Cut the stems about 10-15cm above the ground
- Lay harvested rice crop in upright position for drying (5-10 days) before threshing.

RESULTS AND DISCUSSION

Table 2. Distribution of respondents based on adoption index of lowland rice production technologies (n= 181).

Production technologies	Adoption categories and score range		
	Low 0.01-0.33	Medium 0.34-0.66	High 0.67-1.0
Establishment of nursery	12 (6.6)	21 (11.6)	148 (81.8)
Land preparation	23 (12.7)	140 (77.4)	18 (9.9)
Transplanting and spacing	25 (13.8)	31 (17.1)	125 (69.1)
Water management	134 (76.0)	32 (17.7)	15 (8.3)
Rate of fertilizer application	104 (57.5)	46 (25.4)	31 (17.1)
Herbicides	152 (84.0)	21 (11.6)	8 (4.4)
Maturity/harvesting	18 (9.9)	64 (35.4)	99 (54.7)

Source: Survey data, 2014. Figures in Parentheses indicate percentage of adopter.

The results presented in Table 2 reveal that the nursery practices recorded 81.8% high level adopters. The high adoption level of this production practice could be attributed to compatibility of the practice to the farmers' tradition and indigenous knowledge, and manifest advantage the nursery practice has over the direct sowing in term of vigour and yield. In addition, exposure to trainings, frequent extension contact and farming experience were the probable reasons for the high adoption level in the study area. The finding is in line with Umeh & Chukwu (2013) who reported a relatively high scale adoption of nursery establishment among rice farmers in Eboyin state, Nigeria. The finding is indicative of modern trend of nursery practice by rice farmers. The results further show that land preparation practices recorded 77.4% medium level adopters. This technology was seen as a compatible innovation even though not optimally adopted in line with specifications. Transplanting and spacing recorded majority (69.1%) of high level adopters. This implies that the farmers in the study area had began to realize the benefits of transplanting, one of which is that it minimizes early weed growth and competition that are more serious in the direct-seeded rice. This result however contradicted Hossain *et al.* (2001) that rice farmers were in partial (poor) adoption of the recommended transplanting and spacing because the practice needs additional labor and skill and it is difficult for them to manage. The adoption indices also reveal 76.0% adopters on a relatively low scale adoption of the water management. This occurred as a result of difficulty to maintain the exact volume of water as specified for the management of paddy field. It is in principle to expect that when the land preparation is poorly done in paddy there will be a corresponding poor water management. The low adoption level of this practice is traceable to lack of modern irrigation facilities, inadequate technical skills, and time and labour intensive. Furthermore, rate of fertilizer application was adopted by a well above average proportion (57.5%) on a low adoption scale. This implies a sub-optimal level of rate of fertilization application among rice farmers in the area. However, the reason could be attributed to high cost and low-availability of the fertilizer. When little quantity is available as a result of short supply or lack of fund, consequently below recommended quantity and dosage is applied. More so, adoption of chemical weed control practice recorded 84.0% low level adopters. The finding agrees to Ojohomon *et al.* (2006) who observed that the adoption of herbicide was low relative to improved variety and fertilizer because hand weeding readily substituted herbicide. This implies that adopters perceived hand weeding as the best technology option to herbicides due to high cost of the product. The maturity period and recommended harvesting techniques were adopted on a relatively high scale by 54.7% of the adopters.

Table 3. Tobit estimate of factors influencing adoption of lowland rice package.

Variable	Coefficient estimated	Standard error	Z- statistic	P > |Z|
level of education (X1)	0.0023949	0.0020771	1.153002NS	0.251
Household size (X2)	0.0345149	0.0095479	3.614921***	0.000
Farming experience (X3)	0.0130565	0.0013311	9.808805***	0.000
Farm size (X4)	0.0370918	0.0183676	2.019415**	0.032
Exposure to media (X5)	0.0030031	0.0019479	1.541712NS	0.125
Extension contacts (X6)	0.1060612	0.0174943	6.062614***	0.000
Training participation (X7)	0.0760892	0.0184676	4.120146***	0.000
Distance from market (X8)	-0.0088355	0.0017999	-4.908884***	0.000
Social capital (X9)	0.0349647	0.0131069	2.667656**	0.028
Constant	0.2546392	0.0265596	9.587464***	0.000

Log likelihood function: 251.6889; Average log likelihood: 0.982113; LR Chi- square (9) = 415.43; Pseudo R2 = 0.8767

Sig. Code: *** (1%), ** (5%) and NS (Not significant).

Table 3 reveals the result of tobit estimate of factors influencing adoption of lowland rice package. Of all the nine variables included in the model, seven indicated significant influence on the extent of adoption of the lowland rice production technologies. The R2 value of 0.8767 implies that the variable included in the model accounted for 87 percent of variation in adoption of lowland rice production technologies. Each coefficient shows the extent to which the variable exerts influence on the adoption of such technologies. The log likelihood function indicates a Chi-2 – squared value of 415.43 significant at 1% level. This means the model as a whole fits significantly ($P \leq 0.01$). On the other hand, it implies that all explanatory variables included in the model jointly influence the intensity of use of lowland rice production technologies by the farmers in the study area. The results reveal that Household size variable has positive and significant ($P \leq 0.01$) influence on the level of adoption of the lowland rice production technologies in the study area. The finding is in line with Adniji *et al.* (2007) and Idrisa *et al*. (2012) whose position suggested that Households with large family size may readily adopt new agricultural production practices on a relatively high scale than those with smaller family size since labour force is available. The results further indicate that farming experience has positive and significant ($P \leq 0.01$) relationship with adoption level of the production technologies. Similar finding was reported by Mamudu *et al.* (2012) and Balarebe (2012) that experience improves farmers' skill at production which implies a more experienced farmer may have a lower level of uncertainty about innovations performance and also be able to evaluate the advantage of technology being considered. Farm size was found positive and significant ($P \leq 0.05$) in determining factor influencing level of adoption of lowland rice production technologies. That is, a relatively large farm size can initiate farmers into adoption of more numbers of technologies compare to small size farm land. Farmers with large farm size can afford to devote part of their farms for lowland rice production without significantly affecting the total land left for the production of the staple food crops compared to small land holders. Land size is also one of the indicators of the level of economic resources available to farmers (Ajibefun, 2006). Extension contact positively and significantly ($p \leq 0.01$) influenced the extent of adoption of production technologies in the study area. The implication is that, frequency of extension visits for dissemination of information and advisory services would give the farmers more confidence to sustain the use of production technology package. In fact, the influence of extension contacts can counter balance the negative effect of lack of years of formal education in the overall decision to adopt certain technologies, and can create better awareness about the potential gains of improved agricultural innovations. This is in tune with Tiamiyu *et al.* (2001) who observed that the variable for extension contact had a positive coefficient, indicating that adoption of quality rice management practices increases with increase in the number of extension visits and services offered to farmers. Training participation was found positive and significant (P<0.01), and the finding agrees to a priori expectation of the study. It thus signifies that training has positively and significantly influences the adoption level of the lowland rice production technologies in the study area. Similar result was reported by Dereje (2006), Rahimeto (2007) and Richard *et al.* (2013). The results suggested that adopters with relatively more exposure to training activities would be more equipped in term of technical skills and detail knowledge required for the use of improved technologies.

The technical knowledge helps farmers to effectively adopt the recommended practices. The results further indicate that distance from market has negative coefficient (-0.008835) and significant (P≤0.01). The result conforms to a priori expectation of the study. The negative coefficient is an indication that as distance to market decreases it invariably means a close proximity thereby adoption and use intensity of production technologies increases. This implies that short distance to the nearest market centre and the frequency of contact that the farmer maintains with it has contributory influence on adoption of production techniques. The closer they are to the nearest market, the more likely it is that the farmer will receive valuable information (Roy *et al.,* 1999). This agrees to Rahimeto (2007) who opined that adoption of technologies is expected to increase as distance to market decreases. The findings reveal that social capital positively and significantly (P≤0.05) related with the level of adoption of lowland rice production technologies. Social capital was a dummy variable indicating a binary response whether or not the adopters belong to any form of farmers' association. The result implies that the adopters worked in groups and associated with other fellow farmers in the study area. It is believed that membership of association would help contribute to the level of adoption of innovations.This result affirms the a priori expectation of the study. However, contrary to this submission, Ogunsumi & Ewuola (2005) reported a negative relationship of membership of farmers' co-operatives with adoption of soybean production technologies in Southwest, Nigeria.

Table 4. Distribution of respondents based on constraints to adoption of lowland rice production package (n=181).

Constraints	Frequency (*)	Percentage	Ranking
High cost of inputs	62	31.3	1st
Low availability of inputs	40	20.2	2nd
Low soil fertility	31	15.7	3rd
Lack of credit facilities	28	14.1	4th
Insect infestation	21	10.6	5th
Over flooding	16	8.1	6th
Total	198	100	-

Source: Survey data, 2014 *Multiple Response

The results of the study in Table 4 reveal that 31.3% of the adopters were constrained by the high cost of inputs (chemical fertilizers, agro-chemicals and tractor hiring to carry out tillage operations) and ranked first in the order of magnitude. In addition, low availability of inputs was a constraint to 20.2% of the adopters to optimally comply with the recommendations. This situation was ranked second in order of importance. Soil low fertility (nitrogen deficiency) as a result of continuous cropping and excessive water erosion and leaching was a constraint to 14.1% of the adopters. Also, 15.7% of the adopters highlighted lack of credit facilities as an important constraint to adoption of lowland rice technologies in the study area. The finding is agrees to (Umar *et al.,* 2009; Singh & Varshney, 2010).

CONCLUSION & RECOMMENDATIONS

Level of compliance with recommended practices and specifications varied among the lowland rice farmers. Production practices were not optimally adopted such as water management, rate of fertilizer application and use of herbicide. The scenario was traceable to some constraints including high cost and low availability of the recommended inputs, lack of credit facilities, and flood disaster among others. Some practices were adopted on relatively high scale because there were perceived as compatible innovations, while the medium level adopted practice was land preparation. In addition, household size, farm size, farming experience, extension contacts, training participation, distance from market and social capital indicated significant influence on the level of adoption of the production technologies. It can thus be implied that adoption of production technologies by lowland farmers could be sustained provided the constraints are overcome. This could lead to a significant increase in the level of adoption of new ideas, improved practices and innovations thereby increasing rice productivity in Nigeria.

The study recommends that policy that will make agricultural inputs available and accessible to farmers should be formulated by policy makers.

It is also recommended that the challenges of soil low fertility and over flood of rice fields should be addressed by introducing to farmers cost effective soil conservation management practices and good irrigation schemes.

Formation of rural cooperatives and associations should be encouraged to easily access credit facilities from various financial institutions such as micro finance and agricultural banks. This would enable them to expand their investment in rice productions.

Extension message should be made simple and more relevant to the farmers' situations. Also, extension activities should focus on training of more farmers especially those with little experience and educational level.

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