COMPARATIVE ANALYSIS OF FARMERS ADOPTING R-BOX TECHNOLOGY AND NON-ADOPTERS ON THE EFFICIENCY OF RICE PRODUCTION IN BADEGGI, NIGER STATE, NIGERIA

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ABSTRACT

The study examined the impact of the adoption of R-Box rice production technology on the technical efficiency of farmers in Badeggi, Niger State, Nigeria during the 2006 cropping season. A total of 96 farmers, comprising of 48 that utilized the technology and 48 that did not were selected for the study using purposive random sampling technique. Additive multiplicative dummy variable approach was used in the analysis of data. Double logarithmic functional form was chosen as the lead equation. Results showed that the intercept shift dummy or neutral technical efficiency parameter and slope shift dummies for seed and credit are statistically significant at 5 percent, 10 percent and 1 percent levels respectively. This indicates that the two groups of farmers are characterized by factor-biased or non-neutral production functions, that is, they have different production functions. It is recommended that appropriate policies that would raise the purchasing power of farmers in the survey area in form of credit availability to enable them adopt the technology be designed.

INTRODUCTION

Rice has become a staple food of considerable strategic importance in many rapidly growing African cities, where its consumption among urban and rural poor households has increased considerably (WARDA, 2003).

WARDA (2003) also observed that Nigeria is the world's second largest net importer of rice, spending over US$300million annually on rice importation alone. There seem to be a consensus that this situation is paradoxical given the vast resource endowment in terms of agricultural potentials. Many believe that the importation trend ought to have been on the decline. Nigeria has the potential to be self-sufficient in rice production and virtually all the agro ecological zones of the country are suitable for its cultivation (FOS, 2002).

In spite of the apparent increases in domestic production, Akpokodje, *et al* (2001) and Ajibefun and Aderinola (2003) reported a declining self sufficiency ratio from 99% (in 1961 to 1975) to 79% in 1990 to 1999. The decline has been attributed to increasing population and constraints on domestic production, which has not been high enough due to price depression because of massive rice imports. The Federal Government of Nigeria cognizant of this fact had designed policies and programmes aimed at boosting domestic production to meet domestic demand since 1989 (Idiong, 2005). These include amongst others, the Fadama Rice Programme, the Japanese Assisted National Rice Production Project as well as the River Basin Development Rice Programme. Rice production technologies have also been developed by Research Institutes one of which is the R-Box Technology. A complete package for rice production with R-Box technology as its trade name was initiated by the Candel Company in collaboration with National Cereals Research Institute (NCRI), Badeggi, National Seed Service (NSS), Premier Seeds, Federal Department of Agriculture (FDA) and the Agricultural Development Projects (ADPs) of Niger State and the Federal Capital Territory (FCT), Abuja. This conservation tillage project was developed under the Presidential Initiative on Rice Production. The objective of the scheme is to demonstrate and train farmers on conservation tillage practice. Conservation tillage rice production was introduced with a view to reducing the adverse effects of conventional tillage. It is a system that creates as good an environment as possible for growing crops and that optimize conservation of soil and water resources consistent with soil and economic practices.

According to WARDA (2003), the components of the R-Box technology include: chemically dressed seed variety, a broad spectrum rice herbicide (e.g ORIZO plus), foliar fertilizer (Boost Xtra) and insecticide (ZAP). The package was sold to farmers at ₦7,000.00 (seven thousand Naira only). The yield is estimated to be about 3.7tons/hectare. The problem of low yield in rice output and its low quality necessitated the introduction of R-box technology to bring about increase in rice production. Similarly, the problem of adherence to traditional farming practices and slow rate of adoption of new technology have been identified as the repeated causes of reduction in rice output (Kehinde, 2002).

Singh *et al* (1997) observed that more than 60% of rice produced in Nigeria comes from the lowland. However, the hectarage and productivity growth is low and may be difficult to sustain because of limited tractor availability, declining soil structure and increase in the population and diversity of perennial weeds in the lowland.

Given that the technology had been disseminated to farmers, the need to evaluate the impact it has exerted on their production activities is deemed appropriate so as to create a feedback mechanism that will sharpen policy focus. Several studies have indicated the possibility of measuring the technical efficiency of a farm-firm using the additive multiplicative dummy variable approach rather than the traditional method of fitting separate models and testing the equality of coefficients between them or even the stochastic production frontier analysis (Nwaru, 2003; Tanko and Jirgi, 2007; Onyenweaku, 1994; Baggi, 1981 and Banwo, 1986).

This study therefore aims at comparing the efficiency in rice production by farmers adopting R-Box Technology and the non adopters in Badeggi Local Government Area (LGA), Niger State by disaggregating the farmers based on their adoption or otherwise of the said technology.

RESEARCH METHODOLOGY

Area of study

This study was carried out in Badeggi LGA of Niger State, Nigeria. Niger State lies between Latitudes 8°21' and 11°30'N and Longitudes 3°30' and 7°20'. It is situated in the middle belt zone of Nigeria and is indispensably one of the largest fertile agricultural lands in Nigeria covering about 8,733,170km^2 of the total land area of the country. It is characterized with distinct wet and dry seasons. With a population of over 3 million (National Population Census, 2006), over 80% of this population engage directly or indirectly in agricultural activities.

River Niger which forms the Northern boundary of the state and its flood plains as well as the availability of extensive *Fadama*, offer a unique opportunity for the production of rice and sugar cane.

Badeggi LGA has a landmass of about 1,266km^2 with a population of about 283,000 people. The LGA is known all over the nation for quality rice production which perhaps justifies the siting of the National Cereals Research Institute in Badeggi.

Data Collection

Data used for this study are primary data generated with the use of well-structured questionnaire. Multi-stage and purposive random sampling techniques were used in data collection.

Firstly, Badeggi LGA was purposively selected because rice production is the predominant agricultural activity. Second stage involved village selection. Eight villages were drawn from the frame using the random sampling procedure. The include: Katayeregi, Kambari, Zuzungi, Basanti, Badeggi, Essa, Cheche and Kansanagi. They are also reknown rice producing communities. Thirdly, twelve farmers were selected using the random sampling procedure, comprising six of those using R-box technology and six of those not using R-box technology from each of the sampled villages bringing the total number of sampled farmers to 96. Data collection was done using the cot-route approach from June to December during the 2006 cropping season.

Data Analysis

Technical efficiency refers to the ability of a given set of entrepreneurs (in this case, farmers who utilized R-box technology and those who did not), to employ the best practice in an industry so that not more than the necessary amount of a given set of resources are used in producing the "best" level of output.

In this study, the additive multiplicative dummy variable approach was used rather than the traditional method of fitting separate models and testing the equality of coefficients between them. Several authors (Tanko, 2005; Nwaru, 2003; Onyenweaku, 1994 and Banwo 1986) have adopted this model in their various investigations.

The model is specified in implicit form as follows:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, D, X_1D, X_2D, X_3D, X_4D, X_5D, X_6D, e) \ldots (1)$

Explicitly, the log linear Cobb Douglas production function is specified as:

$\ln Y = \ln A_o + B_o D + A_1 \ln X_1 + B_1 D \ln X_1 + A_2 \ln X_2 + B_2 D \ln X_2 + A_3 \ln X_3 + B_3 D \ln X_3 + A_4 \ln X_4 + B_4 D \ln X_4 + A_5 \ln X_5 + B_5 D \ln X_5 + e \ldots (2)$

Where in equations (1) and (2):

ln = Natural logarithm

Y = Output of rice (in kg)

X_1 = Fertilizer input (bags)

X_2 = Quantity of seed (kg)

X_3 = Cost of chemical (₦)

X_4 = Farm size (hectares)

X_5 = Labour input (man days)

X_6 = Amount of credit utilized (₦)

A_o = Intercept or constant term

B_o = Coefficient of the intercept shift dummy or neutral technical efficiency parameter

D = Dummy variable which takes the value of unity for farmers utilizing the R-box technology and zero otherwise

X_1D, X_2D, X_3D, X_4D, X_5D and X_6D are the slope shift dummies for fertilizer, seed, chemical, farm size, labour and credit respectively.

Ai (i=1, 2, …, 6) are the coefficients of the i[th] variable

Bi (i= 1, 2, …, 6) are the coefficients of the respective dummy variables associated with each of the variables

e = stochastic error term with Ordinary Least Squares properties

Data were fitted into equation (1) for each of the following four functional forms namely, linear, semi-logarithmic, exponential and Cobb-Douglas and the equation of "best fit" was chosen as the lead equation and was used for further discussion. The choice was based on the normal economic, econometric and statistical criteria.

RESULTS AND DISCUSSION

A summary statistics of the resource inputs and socioeconomic characteristics of the rice farmers is presented in Table 1.

Table 1: Summary Statistics of Resource Utilization and Socioeconomic Characteristics of Users and Non-users of R-box Technology in Rice Production.

Variable	Mean	Standard	Minimum value	Maximum value

	Users	Non-users	Deviation Users	Deviation Non-users	Users	Non-users	Users	Non-users
Output of rice (bags)	62.50	18.75	40.32	14.14	25.00	12.50	100.00	25.00
Farm size (hectares)	3.25	2.35	1.08	1.62	1.50	0.90	5.00	3.80
Labour/Farm (mandays)	113.48	102.05	47.89	38.13	88.79	75.10	138.17	129.00
Quantity of seed/farm (kg)	44.00	45.66	21.00	25.80	28.00	30.00	60.00	61.31
Quantity of fertilizer/farm (kg)	500.00	150.00	310.00	140.00	250.00	50.00	750.00	250.00
Agrochemicals/farm (Naira)	1375.00	0.00	855.00	0.00	850.00	0.00	1900.0	0.00
Credit (Naira)	23,750	15,900	15,500.	9,750	2,500	1,800	45,000	30,000
Age (years)	42.50	47.50	20.60	22.35	25.00	30.00	60.00	65.00
Farming experience (years)	34.37	37.75	15.60	17.38	28.73	33.00	40.00	42.50
Household size (no.)	9.00	7.00	5.20	4.70	5.00	4.00	12.00	10.00
Educational attainment (years)	7.00	6.00	6.30	5.14	0.00	0.00	14.00	12.00

Source: Field survey data, 2006.

Results presented in Table 1 shows that the average farm size is 3.25 hectares for users and 2.35 hectares for non-users respectively. A typical farmer sampled is 43 years and 48 years old for users and non-users of R-box technology respectively. Majority of sampled farmers were male, accounting for 72.92% of the total, had eight family members and had attained at least Quranic level of education.

Measurement of Technical Efficiency

The results obtained after fitting numerical data to equations (1) and (2) are summarized and presented in Table 2. The Double logarithmic functional form was chosen as the lead equation. The F-statistic is statistically significant at 1 per cent which implies that the explanatory variables included in the model adequately explained the exogenous variable and the model can be used for further analysis. The R-square value is 0.985 which implies that the explanatory variables accounted for about 98.50% of the variation in the output of rice in the survey area. The intercept shift dummy or neutral technical efficiency parameter and slope shift dummies for seed and credit are statistically significant at 5 per cent, 10 per cent and 1 per cent levels respectively. Similarly, three variables namely fertilizer, farm size and credit are statistically significant at 1%, 1% and 5% levels respectively.

The specific objective of this study is to ascertain whether any defined group of farmers is characterized by neutral, factor-biased or the same production function. The attention is focused on the slope and intercept shift dummies. Results in Table 2 indicate that the intercept shift dummy (or neutral technical efficiency parameter) for the two groups of farmers is negative and statistically significant at 5 per cent , implying that a shift in neutral technical efficiency parameter to a higher level for farmers utilizing the R-box technology exists. In other words, farmers utilizing R-box technology are more technically efficient than their counterparts and points to the positive impact the technology exerted on rice production in the survey area. The negative sign suggests a lower level of use intensity of resources by those utilizing the technology. This finding is in consonance with previous findings by Nwaru, 2005; Desai and Mellor (1993) and Nwagbo (1989). Those farmers who did not utilize the R-box technology achieved a lower level of output per unit of input due to their lower technical efficiency.

The slope shift dummies for seed and credit are statistically significant at 10 and 1 per cent levels respectively. This indicates that the two groups of farmers i.e those utilizing the technology and otherwise, are characterized by factor-biased or non-neutral production functions. That is, the two groups of farmers have different production functions. The slope shift dummy for seed (-0.130) is negatively signed suggesting a lower level of use intensity by farmers utilizing the R-box technology. Results in Table 2

Table 2 : Estimated Production Functions for Users and Non-users of R-box Technology in Rice Production.

Variables	Double log	Semi-log	Exponential	Linear
Intercept	1.627*	13.673**	-173.063	-59.667***
	(2.047)	(2.415)	(-1.980)	(-4.415)
Fertilizer	0.220**	-33.750	-13.272	5.381*

	(2.832)	(0.945)	(-1.515)	(2.452)
Seed	-4.116E-02 (-0.730)	-45.079 (1.013)	4.101 (0.676)	-0.181*** (-3.089)
Agrochemical	2.815E-02 (0.422)	1.988 (1.122)	-1.502 (-0.210)	5.257E-03 (1.369)
Farm size	0.705*** (7.787)	0.158*** (2.725)	-46.809*** (-3.648)	29.813*** (4.989)
Labour	7.506E-02 (0.819)	3.068E-03 (1.003)	-8.989 (-0.911)	0.137* (2.288)
Credit	0.124** (2.425)	1.113E-02 (0.673)	-7.088 (-1.252)	1.361E-03*** (4.560)
Intercept dummy (D)	-3.054** (-2.002)	3.753*** (32.077)	-728.742*** (-4.349)	59.571*** (10.652)
Fertilizer (D)	7.044E-03 (0.057)	6.211E-03*** (2.725)	25.957 (1.971)	46.039E-03 (0.014)
Seed (D)	-0.130* (-1.697)	9.077E-03*** (7.658)	-4.690 (-0.563)	-0.884 (-1.003)
Agrochemical (D)	-1.719E-02 (-0.214)	-6.980E-04 (0.625)	6.530 (0.758)	-1.684 (-0.635)
Farm size (D)	-0.305 (-1.659)	-3.210E-05 (-1.646)	11.524 (0.544)	-0.114 (-1.322)
Labour (D)	0.108 (0.794)	4.582E-04 (-1.330)	11.875 (0.814)	0.086 (0.447)
Credit (D)	0.415*** (3.080)	-5.170-06 (0.862)	60.872*** (3.984)	1.940** (2.432)
R^2	0.985	0.846	0.781	0.948
R^2 adjusted	0.983	0.837	0.776	0.944
F-ratio	420.024***	100.699***	293.983***	229.839***

Note: ***, ** and * implies statistically significant at 1%, 5% and 10% levels respectively. Figures in parentheses are the respective t-ratios.

also show that the slope shift dummy for credit (0.415) is positive which implies a higher level of use intensity of this resource by farmers utilizing the R-box technology, due possibly to their poor financial base which necessitated capital borrowing. This finding agrees with Amaza and Olayemi (2001) and Nwaru (2004) who opined that capital borrowing is necessary as it enables the farmer to gain access to better production technologies. Availability of credit enables the farmer increase farm size and procure production and maintenance inputs. Labour variable was not significant at explaining the output of rice, due possibly to the fact that R-box technology is a tillage conservation technology.

CONCLUSION AND POLICY RECOMMENDATIONS

Farm resources were not optimally allocated as none of the farmer groups achieved absolute technical efficiency suggesting that there is a considerable scope for improvement by reallocating the existing resources more optimally. However, rice farmers who utilized the R-box technology were found to be more technically efficient than their counterparts who did not. This points to the positive impact the technology exerted on rice production in the study area. The current state of technology used by farmers who did not use the technology is inferior and grossly inadequate to bring about significant increases in rice production. Moreover, farmers who utilized the technology were observed to have exhibited higher use intensities for credit and lesser for improved seeds. The need for provision of credit thus become imminent in increasing farmers' technical efficiency. This will involve establishment of sustainable micro credit schemes. Policies directed at consolidating farmers' holdings through the formation of farmers' cooperatives will also be useful in the study area. This would translate into increased capacity utilization, increased output and income. Increased use of credit could consequently usher in considerable improvement in productivity and drastic reduction in acute poverty in the area.

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