EFFICIENCY OF RICE FARMERS IN NIGERIA: POTENTIALS FOR FOOD SECURITY AND POVERTY ALLEVIATION.

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Abstract

Self-sufficiency in rice production has eluded Nigeria for a long time despite over 36 years of efforts by the Government of Nigeria towards its realization. Chains of economic activities in the Nigerian rice industry like harvesting, parboiling, drying, milling/threshing etc are largely executed by women and children. Government of Nigeria has therefore not relented in her effort to develop the rice enterprise as this will put money and food into the hands of the very vulnerable segment of the Nigerian society. This study examines the efficiency of rice farmers in Nigeria, identifying the inefficiency variables in an effort to eliminate wastes and thus set the crop sub-sector on the path of growth and development. The trend analysis identified a huge rice supply deficit, huge rice import bills and very low rice productivity in Nigeria. Thus while Nigeria and other developing economies grapple with the problem of food/rice production the developed economies face other issues like quality and safety of food. In contrast, trend analysis results for developed agricultural economy indicates high productivity trend. Nigeria's rice productivity problems occurred despite over 4.9 million hectares of available land suitable for rice production in Nigeria. Primary data were then collected form randomly sampled 300 rice farmers in Kogi State Nigeria using a structured questionnaire. The data were analyzed using the Stochastic Frontier production function. Further findings of the study indicated that the elasticity of mean value of rice output with respect to farm size (0.74), labour use (0.14), fertilizer (0.24), were of increasing function. The returns to scale value of 1.82 for significant elasticities was realized indicating a sub-optimal rice production process. The firm-specific indices of technical efficiency vary widely between 0.7 x 10^{-8} and 0.91 with a mean of 0.54. Technical efficiency in rice production in Nigeria could be increased by 46% through better management and use of available resources. The study indicated that this could be achieved through farmer specific factors including age, farming experience, household size, education and improved rice variety. Key recommendations of the study include access to improved rice variety, access to improved rice processing technology and access to markets and extension services.

Keywords: rice farmers, efficiency, food security, poverty.

Introduction

Rice (*Oryza sativa*) is a major staple food for millions of people in West Africa and the fastest growing commodity in Nigeria's food basket (Atande), 2003). The demand for rice has been increasing at much faster rate in Nigeria than in other West African countries since the mid 1970s. For example, Nigeria's

per-capita rice consumption level has grown significantly at 7.3% per annum, rising from 18kg in the 1980s to 22kg in 1990s.

Although rice production in Nigeria has boomed over the years, there has been a considerable lag between production and demand level with imports making up the shortfall. As per the Nigerian Agricultural Policy document (Nigerian, 1989), specific objective of agricultural sector policies is the attainment of self-sufficiency in basic food commodities with particular reference to those food commodities which consume considerable shares of Nigeria's foreign exchange and which can be produced locally within the country.

In this regard therefore, Nigeria will aim to be more than self-sufficient in the production of all cereals except wheat, most roots and tubers, most grain legumes, most oil seeds and nuts, most vegetables and fruits and most vegetable oils. Going by this policy scenario therefore production of rice in Nigeria is bound to expand for several reasons:

rice import consumes considerable share of Nigeria's foreign exchange;

the proportion of rice in the food basket of Nigerians has continued to rise; and

Nigeria has the capacity for the expansion of rice production.

In Nigeria, rice grown on 1.77 million hectares ranks fifth after sorghum (4.0m ha), millet (3.5m ha.) cassava (2.0m ha) and yam (2.0mha), but if placed on a social scale, it can well be ranked first because it is no longer just a mere festival meal as in the past, but the staple of most homes in urban, and rural area (Longtau, 2003). Nigeria is endowed with favourable ecologies for rice cultivation. Virtually all the rice growing ecologies (the upland irrigated, inland valley swamp, deep water floating and tidal mangrove swamp) abound in Nigeria. Estimates by WARDA (1996), Singh et.al. (1997) and Imolehin and Wada (2000) put potential and actual areas for rice production at 4.6-4.9 million hectares and 1.77 million hectares respectively. Out of the actual land area under rice an estimated output of 2.3 million tonnes are realized (NCRI, 1997). This translates to a low productivity of about 1.3 tonnes per ha. Given this low productivity, the technical efficiency of rice farmers need be analysed and the technical inefficiency factors identified so as to realize Nigeria's rice policy objectives.

The rice cropping system and the post harvest services in Nigeria encompass a wide range of agricultural activities raging from land clearing, seed bed preparation, broadcasting, fertilizer application, weeding and bird scaring. Others include harvesting, threshing, par-boiling, drying, winnowing, bagging and marketing and distribution. These activities are largely executed manually and women and children the very vulnerable segments of the society are largely involved. Rice production expansion in Nigeria is therefore bound to reduce drastically the foreign exchange spending on rice importation and more importantly it could lead to the transfer of money into the hands of the very vulnerable group of the Nigerian economy. Thus food security and poverty alleviation may be the direct benefits of rice production expansion in Nigeria. The need to analyse and identify the constraining factors to technical efficiency of rice farmers in Nigeria becomes paramount.

The objective of this study is therefore to determine the efficiency of rice farmers in Nigeria and the potentials for expansion of output. The specific objectives are to:

analyse rice production trend (yield and hectarage) in Nigeria and in some selected developed agricultural economies, 1970-2004;

analyse rice import trend in Nigeria, 1970-2004;

analyse rice import price trend, 1970-2004;

analyse the socio-economic characteristics of rice farmers in Nigeria;

estimate the technical efficiency of rice farmers in Nigeria; and

identify the determinants of technical inefficiency of rice production in Nigeria;

Self-sufficiency in rice production has eluded Nigeria for a long period. In 1970 for example, the Federal Government Rice Research Station (FRRS) was established at Badeggi, by the Federal Government of Nigeria which signalled a major policy thrust with respect to rice research in Nigeria. The major aim for the establishment of FRRS was the development and multiplication of improved varieties of rice seeds for distribution to rice farmers for improved productivity. In 1972, the National Accelerated Food Production Project (NAFPP), a Federal Government of Nigeria and USAID joint research and extension programme aimed at evolving self-sufficiency in production of five crops-rice, maize, sorghum, millet and wheat-was established. A time frame of 1980 was set for the accomplishment of the programme.

During the period of NAFPP, three crop research institutes were set up, among which was the National Crop Research Institute (NCRI). This institute was mandated to carry out research on rice for improved productivity and an enhanced socio-economic benefit NCRI (1988) and Akpokodje et al. (2001).

Despite these concerted efforts to make Nigeria self-sufficient in rice production, the achievement of the policy objective has remained elusive. The need to examine the efficiency of the Nigerian farmers as well as the determination of the technical inefficiency of the rice farmers with a view to re-direct efforts towards the realization of the policy objective in the crop subsector, becomes paramount.

Efficiency of a production system or unit means a comparison between observed and optimal value of its output and input. The concept of efficiency in farm resources usage is concerned with the relative performance of processes in transforming given inputs into output. It is also defined as the quantity of output per unit input. For some detailed account on efficiency and efficiency measurement see Seyoum et al. (1998); Battese and Coelli (1995) and Coelli (1994).

Methodology

For this study, farm level data were collected on 300 rice farmers in Kogi State, Nigeria. Kogi State is one of the 36 States of Nigeria located in the North-Central part of Nigeria. The State is drained by the two major rivers in Nigeria-Benue and Niger. It is therefore suitable for rice cultivation.

Sampling Technique

Three-phase multistage sampling programme for the choice of Local Government Areas, communities and households were carried out.

Kogi State is divided into four zones namely zones A, B, C, and D. A total of twelve Local Government Areas (LGA's) were selected for the study, three per zone, through a randomized sampling design. And from each of the twelve selected LGAs, five communities that typify the State in terms of rice production were drawn employing a randomized sampling design. Finally from each community five households were drawn for the study through a randomized sampling design giving a total of 300 household respondents.

Data Collection

Primary data were generated through the use of structured questionnaires that were distributed and administered to 300 rice farmers in the study area, out of which 282 farmers returned questionnaires with analyzable data.

Secondary data and information were collected from published materials like journals, proceedings, reports (annual, bi-annual, quarterly etc) textbooks etc. World Bank sources and Food and Agriculture Organization (FAO) etc constituted other sources of secondary data as well.

Method of Data Analysis

Descriptive statistics such as graphical analysis, percentages, range, trend analysis etc were used for the analysis of specific objectives (i) – (iv). Inferential statistics such as Cobb-Douglas stochastic frontier production function, multiple regression analysis etc were used for the analysis of specific objectives v & vi.

Model specification

The stochastic frontier production function for rice production adopted in this study as specified by the Cobb-Douglas functional form (Seyoum et.al., 1998) is defined thus:

$$\text{Log Yi} = \beta_o + \beta_i \log X_{2i} + \beta_3 \log X_{3i} + \beta_4 \log X_{4i} + \beta_5 \log X_{5i} + V_i \quad U_i \quad \ldots\ldots\ldots\ldots(1)$$

Where Y_i = output of ith farmer (kg)
X_1 = is farm size (ha)
X_2 = is labour in man-days
X_3 = fertilizer in kg
X_4 = Agro chemical in litre
X_5 = quantity of seed planted in kg.
V_i = Random error that is assumed to be normally distributed with zero mean and constant variance (σ^2_{vi}) and U_i is technical inefficiency effects which are independent of V_i, and have half normal distribution with mean zero and variance (σ^2_{ui}).

Following Battese and Coelli (1995), the mean of farm specific technical inefficiency U_i is defined as:
$U_i = \sigma_0 + \sigma_1 Z_{1i} + \sigma_2 Z_{2i} + \sigma_3 Z_{3i} + \sigma_4 Z_{4i} + \ldots$ …… (2)

Where:

Z_1 is age of farmer, a priori expectation is positive.
Z_2 is educational level of farmers, a priori expectation is negative.
Z_3 is household size, a priori expectation is negative.
Z_4 is experience of farmer, a priori expectation is negative.
Z_6 is rice variety used (improved variety = 1, Traditional variety = 0), a priori expectation is negative.

Rice output is expected to be influenced positively by farm size, labour, fertilizer used, agrochemical and quantity of seed planted.

The model defined by equations 1 & 2 was proposed by Battese and Coelli (1995). The parameters of the model, that is the β's the σ's and the variance parameters:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ ..... (3), and

$\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ ..... (4)

are simultaneously estimated using the method of maximum likelihood. The computer programme FRONTIER 4.1 developed by Coelli (1994) that computes the parameters estimates, by iteratively maximizing a nonlinear function of the unknown parameters in the model subject to the constraints was used. The value of the γ indicates the relative magnitude of the variance associated with the distribution of inefficiency effects, U_i. If U_i in the stochastic frontier are not present or alternately, if the variance parameter, r, associated with the distribution of U_i has value zero, then σ_u^2 in equations 1 &2 is zero, and the model reduces to a traditional production function with variables: rice variety, age, household size, educational level and farming experience all included in the production function meaning that inefficiency effects are not stochastic.

The functional form for the stochastic frontier is defined by equation (1). The function is a modified version of a Cobb-Douglas model. It permits different levels of productivity associated with different proportions of farm size, labour etc.

Results and Discussion

Figure1 shows the domestic rice production trend for Nigeria, 1970-2004. It indicates violent fluctuations. These violent swings are unobservable in the rice production trend of a developed economy such as the United States of America (Figure 1b) where the problem of food/rice has long since gone beyond the issue of productivity to such issues like food safety and quality. The observed unsteady pattern of rice production in Nigeria in the past 34 years was largely due to the instability in the government policy in the subsector.

Figure 1: Domestic Rice Production Trend for Nigeria 1970 to 2004

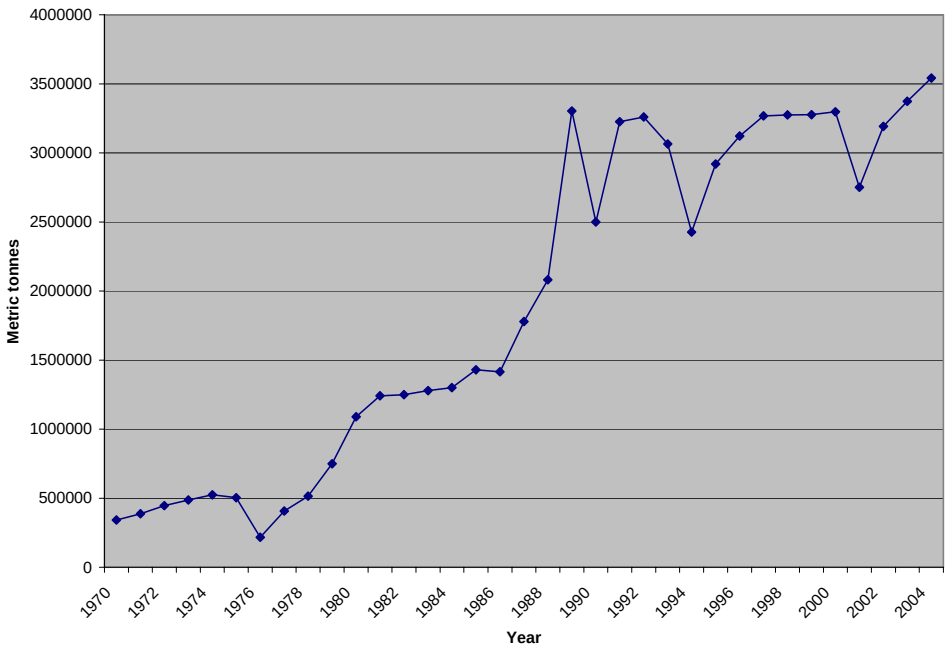
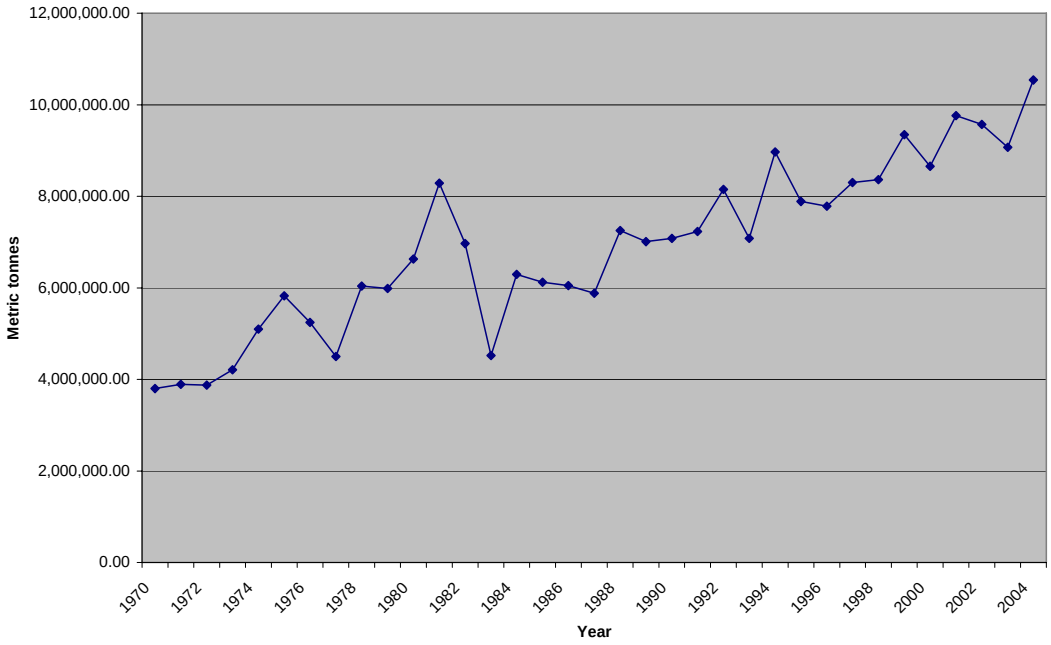


Figure 1b: Domestic Rice Production Trend for the United States of America 1970 to 2004



The implications of the production trend in Nigeria are further understood using the rice import volume and the domestic rice yield trends (Figures 2 and 3). Notice that while the import volume has continued to increase for most of the years, the yield has continued to drop across the years. This is further quantified by correlating the two variables. The co-efficient is -0.618 and it is significant at 1% level. As the volume of imported rice continued to rise, the productivity of the domestic rise farmers continued to drop. The imported rice comes at a much cheaper rate and the price continues in a downward trend as seen in Figure 4. Thus rice fields in Nigeria are bound to contract with all the attendant income, employment, foreign trade and food self-sufficiency implications.

Figure 2: Import rice trend 1970 - 2004

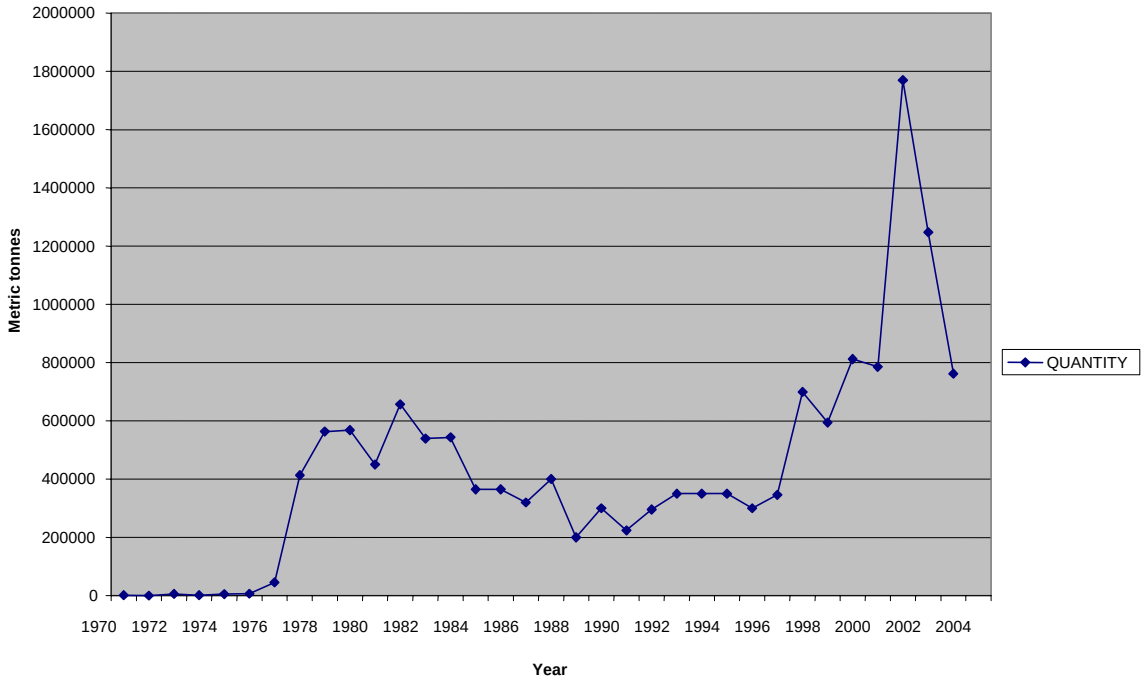


Figure 3: Rice yield trend 1970 - 2004

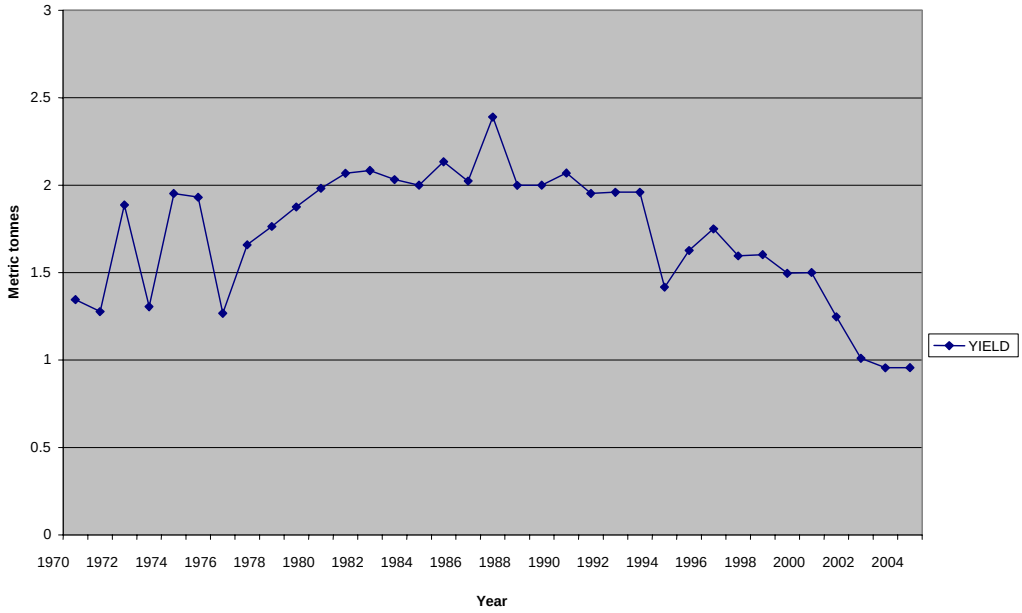
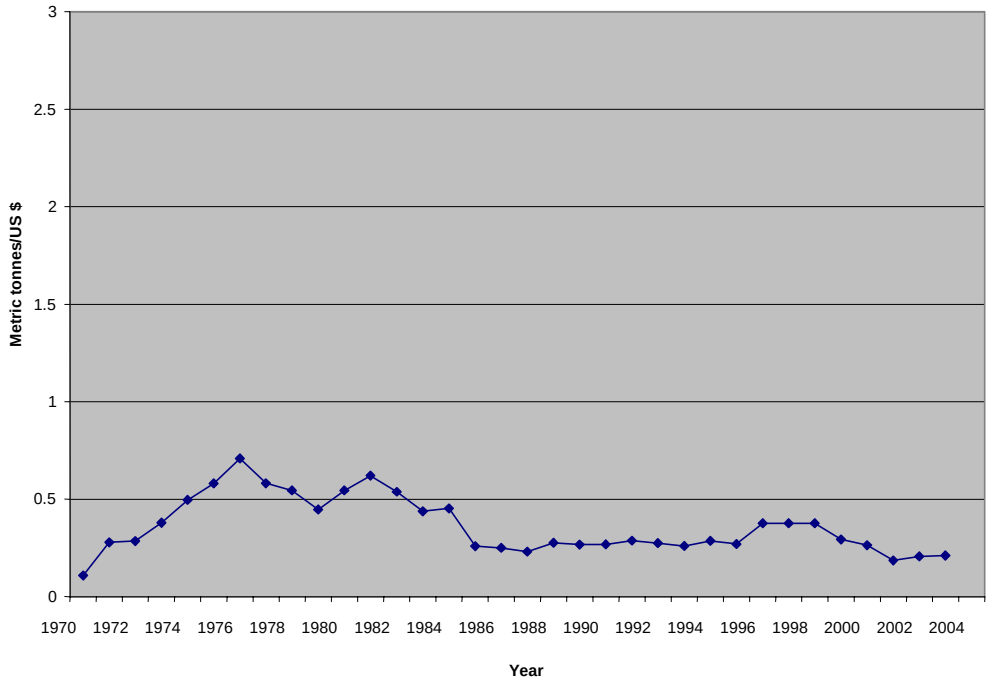


Figure 4: Import rice price



These implications assume a huge magnitude with the widening gap between the total rice demand and total deficit. The mean test for total demand and deficit 2.34 and 0.42 million tonnes respectively is significant at 1% level.

Tables 1 & 2 show some selected demographic and socio-economic characteristics of the rice farmers.

Table 1: Percentage Distribution of some Demographic Characteristics of Nigerian rice farmers.

	Factor	Frequency	Percentage.
a.	Age		
	11-20	2	0.71
	21-30	37	13.12
	31-40	83	29.43
	41-50	90	31.91
	51-60	53	18.79
	60	17	6.03
	Total	282	100.00
b.	Sex		
Male		242	85.82
Female		40	14.18
Total		282	100.00
c.	Marital status		
Single		30	10.64
Married		248	87.94
Widow/ divorced		4	1.42
Total		282	100.00

Table 2: Percentage distribution of some selected socio-economic characteristics of Nigerian rice farmers.

Variables		Frequency	Percentages
a.	Level of Education		
	Formal education	109	38.65
	Primary education	62	21.99
	Secondary education	75	26.60
	Tertiary education	36	12.72
	Total	282	100.0
b.	Household size		
	1-5	88	31.21
	6-10	175	62.06
	11-15	14	4.96
	> 15	5	1.77
	Total	282	100.00
c.	Farming experience (Year)		
	1-15	147	52.13
	16-30	95	33.69
	31-45	33	11.70
	46-60	7	2.48
	Total	282	100.00
d.	Farm size (ha)		
	0-2	102	36.17
	2-4	151	53.55
	4-6	20	7.10
	> 6	9	3.19
	Total	282	100.00
e.	Rice variety		
	Local/traditional	252	89.36
	Improved	30	10.64
	Total	282	100.00

Many of the respondents 32% fall between the age of 41 and 50 years. In all, more than 61% of the respondents were between the age of 31 and 50 years. This result suggests that most of the farmers are young people who are still strong and full of energy to make meaningful impact in agricultural production. The average age of the sample respondents was 43 years. This was close to the research finding of Okoruwa and Ogundele (2003) which put the average of Nigerian rice farmers at 42 years.

Rice producers in the study area are dominated by the male which accounts for 85.8% of the respondents indicating that men who naturally are the stronger gender carry out most of the activities on the farms. This result suggests that sex increases technical efficiency of rice farmers in the study area.

The study revealed that the largest proportion of the respondents (87.9%) was married. The finding is in consonance with the research finding of Horna et.al. (2005) that most rice farmers in the study area are married.

About 38.7% of the respondents did not attend any school, 22.0% and 26.6% attended primary and secondary schools respectively. About 12.8% attended post secondary school. In all, about 61.4% of the respondents are literate farmers. This result is in agreement with the finding of Akpokodje et.al. (2003) that majority of rice farmers in Nigeria could read and write.

Majority of the respondent (62.1%) had between 6-10 household size, 31.2% had between 1-5 household size, 5.0% had between 11-15 while 1.8% had 15 household size or more. This result suggests that there would be adequate supply of family labour in the study area.

Most of the respondents (52.1%) have been growing rice between 1 to 15 years, 33.7% have been growing rice between 16 and 30 years, 11.7% have been growing rice between 31 and 45 years while 2.5% had been growing rice for between 46 and 60 years. The average farming experiences of rice farmers in the study area is 17.6 years.

About 53.6% of the respondents have farm size of between 2-4 hectares under rice cultivation, 36.2% had between 0 and 2 hectares, 7.1% had between 4 and 6 hectares and 3.2% had 6 hectares or more. The mean farm size per farm family was 2.26 hectares.

Large number of the respondents (89.4%) planted the local rice variety while 10.6% planted the improved variety. Based on the low level of utilization of the improved input, the technical efficiency of the rice farmers is bound to diminish.

Table 3 shows the maximum likelihood estimates for the efficiency of rice farmers in the study area. The elasticity of rice output with respect to farm size (0.74), labour use (0.14), fertilizer (0.24), pesticide (0.01) and seed rate (0.70) were of increasing function. However, given that only the coefficient of farm size, labour uses, fertilizer and seed rate were statistically significant it follows that increasing farm size, labour use, fertilizer and seed rate would result to an increase in the rice output of the rice farmers in the study area. Furthermore, the return to scale value of 1.82 is an increasing return to scale since the value is greater than unity. This means that there are potentials for rice output expansion in the study area as the efficiency of rice production in the study area is sub-optimal.

Table 3: Maximum Likelihood estimates for the parameters in the Stochastic Frontier Production Function Model for the rice farmers in Nigeria.

Variable	Parameter	Estimate	T-ratio
Stochastic Frontier			
Constant	β_0	3.78	2.59*
Ln land (ha)	β_1	0.74	4.05 *
Ln labour (man-day)	β_2	0.14	2.36 *
Ln fertilizer (kg)	β_3	0.24	4.59 *
Ln pesticide cost (N)	β_4	0.01	1.35
Ln seed rate (kg)	β_5	0.695	11.42*
Inefficiency model			
Constant	σ_0	-4.39	-9.38*
Age	σ_1	-0.05	-9.00*
Farming Experience	σ_2	0.17	1.91
Household size	σ_3	2.38	-24.33*
Education	σ_4	0.20	0.58
Rice variety	σ_5	-0.10	-14.64*
Variance Parameters			
Sigma squared	σ^2	37.260	7.80*
Gamma	γ	0.995	889.62*
Log likelihood function		379.00	

Source: *Field survey, 2006*
* T-ratio significant at 1% level.

The estimated coefficients of inefficiency model in Table 3 indicates that the coefficients of age, household size, and rice variety are negative and significant at 1% level. This result suggests that technical inefficiency effects in rice production in the study area declined with increase in age, household size and planting of improved rice variety. In order words, they have positive effects on technical efficiency in rice production. They are therefore important for achieving effective utilization of inputs in rice production in Nigeria.

Farmers who are relatively younger and have large family size and planted improved rice variety achieve higher levels of technical efficiency in rice production in Nigeria. The implication is that policy that would encourage younger farmers in rice production and supply more improved rice varieties to rice farmers would ensure efficient use of resources in rice production in Nigeria.

The firm-specific indices of technical efficiency vary widely among the farmers ranging between 0.17×10^{-8} and 0.91 with a mean technical efficiency of 0.54, Table 4.

Table 4: Distribution of Technical Efficiency from Stochastic Frontier Model

Technical efficiency	Frequency	Percentage
< 0.31	39	13.83
0.31-0.50	70	24.82
0.51-0.70	103	36.52
0.71-0.90	68	24.11
0.91-0.99	2	0.71
Total	282	100.0

Mean efficiency = 0.54
Minimum efficiency = 0.17×10^{-8}
Maximum efficiency = 0.91
*Source*s: *Field survey, 2006.*

This result suggests that technical efficiency in rice production in the study area would be increased by 46% through better use of available resources given the current state of technology, this could be achieved through farmer specific factors which include age, farming experience, household size, education and improved rice variety. This also means that if the average farmer in the sample was to achieve the technical efficiency level of his most efficient counterpart, then the average farmer could realize 41% cost saving (i.e 1-[54/91]). Similarly, the most technically inefficient farmer would realize 99% (i.e 1-[1.7×10^{-8}/91]) cost saving to achieve the efficiency level of the most technically efficient farmer. Thus, the subsectoral policy that would enhance the use of more production inputs by the rice farmers in Nigeria is of great benefit to Nigeria at large. First it will push the production phase from region 1 to region 2 (region of optimal input use) thus expanding the rice output. The dependence on the foreign market for rice supply to Nigeria is reduced; food security for Nigerians is enhanced. Food aids with its attendant politics and national security dimensions are reduced. There is employment generation as more people are engaged in the rice enterprise to accomplish the various tasks - land preparation, seed broadcasting, fertilizer application, weeding, bird scaring and harvesting. Greater employment generation comes as greater needs for the multiple post-harvesting activities built-up with the enlarged harvest. More women and children, the very vulnerable group who commonly accomplish, the relevant activities - par-boiling, drying, marketing and distribution, are employed. Income re-distribution to the greater advantage of women and children comes as major gains from the rice enterprise expansion.

The estimated sigma squared (37.26) was significantly different from zero at 1% level. This indicates a good fit and the correctness of the specified distribution assumption of the composite error term. In addition, the magnitude of the variance ratio, γ was estimated to be high at 0.995, suggests that the systematic influences that are unexplained by the production function are the dominant sources of errors. This means that 99.5% of the variation among the rice farms in the study area is due to differences in technical efficiency. Thus, the results of the diagnostic statistics confirm the relevance of stochastic frontier production function for the analysis of the efficiency of the Nigerian rice farmers.

Conclusion and Recommendation

The realization of the Nigerian Government Agricultural Policy objective in the rice sub-sector will continue to be a mirage going by the current state of technology in the industry. The rice farmer specific inefficiency factors which include age, farming experience, household size, education and improved rice variety, are other key issues which constraint the setting of the industry on a clear path of growth and development. These elements have therefore beclouded the potentials of the industry for full realization of food security and poverty alleviation. It is therefore recommended that the Government and other relevant agencies should improve rice farmers access to improved rice varieties, modern rice processing technology, rice markets and extension services. Adequate financial assistance and credit facilities should also be made available to the rice farmers to enable them expand the crop output.

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