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Economics of resource use in small-scale rice production: A case study of Niger state, Nigeria

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ABSTRACT

This paper analyses the use of resources and farm income among small-scale rice farmers in Niger State. A sample set of 120 farm households was selected using a simple random sampling technique to generate primary data. The average farm size was 2.8ha and the average yield was 5,041.47 kg/ha. The average variable cost, average fixed cost and average net farm income per hectare were ₦28,839.30, ₦3,160.45 and ₦30,463.10, respectively. The major factors that significantly influenced the level of technical inefficiency with their corresponding maximum likelihood estimates were age (0.0065), household size (0.0069), farming experience (0.0001), extension contact (0.0177) and membership of a co-operative (0.2824). Pests and diseases, floods, non-passable roads and inadequate finance were the major problems of rice production. Based on these findings, it was concluded that the study area had a great potential to increase rice production and a farmer's income if efforts could be made for widespread adoption of new technologies and by addressing those constraints herewith identified. However, an effort should also be made to mobilize and encourage farmers to form co-operatives to enable farmers to pool their resources and increase the scale of operations. Furthermore, the government should make production inputs like fertilizer, improved seeds and agro-chemicals available to farmers at the right time and at subsidized rates because production inputs were some of the most important limiting resources that adversely affected rice production in the study area.

Keywords: income, Nigeria, rice, small-scale production

INTRODUCTION

Rice is indeed one of the world's most important food crops, being the staple food for over 50 percent of the world's population; it is particularly important in China, India and a number of other countries in Africa and Asia. Globally, rice is an important food crop and is increasingly preferred over many traditional foods, such as sorghum, millet and most root and tuber crops such as yam and cassava (Defoer *et al*., 2004). Rice is consumed by over 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, 40 million in Africa, 150.3 million people in America and over 120 million people in Nigeria (Daramola, 2005). It is also one of the major cereals to gain the status of a cash crop status in Nigeria, especially in those rice-producing areas where it provides employment for more than 80 percent of inhabitants as a result of the commercial activity that takes place along the distribution chain from cultivation to consumption (FAO, 2003). Due to its increasing contribution to the per capita calorie consumption of Nigerians, the domestic production of rice has been inadequate and unable to bridge the increasing demand – supply gap in Nigeria more than in any other African country since the mid 1970s. The per capita consumption of rice in Nigeria has been increasing at an annual average rate of 7.3 percent. For instance, during the 1960s the per capita annual consumption of rice in Nigeria was as low as 3kg. This increased to 18kg during the 1980s and reached 22kg in 1995 – 2000 (FAO, 2001).

According to FAS (2002), rice has great potential and can make a crucial contribution secure supplies of food and nutrition; to the generation of income; alleviation of poverty and the socio-economic growth of Nigeria. Nigeria has the potential to become self-sufficient in rice production as virtually all of its ecological zones are suitable for rice cultivation either as swamp, upland or under irrigation (FAS, 2002). The declining self sufficiency ratio in rice production indicates that Nigeria has remained a net importer of rice with well over US $267 million spent annually (Eke, 2008).

The Presidential Task Force on rice production was established in 2002; it aimed to achieve self-sufficiency and to generate a surplus for export. Achievement of this objective requires a clear understanding of the current level of agricultural productivity and a method to determine how this productivity level could be enhanced. Moreover, except for the resources used in rice production, increasing agricultural productivity may remain a mirage, indicated by the low rate of adoption of modern technology for rice production (Omotayo *et al.,* 2001).

Productivity levels can be enhanced through the use of improved technology and improvement in the technical efficiency of a resource. However, given the slow rate that farmers adopt new technology for rice production, improvement in efficiency remains the most cost effective way to enhance productivity in the short term (Blasé and Grabowski, 1985; Omotayo *et al.,* 2001). Increasing rice production efficiency requires identification of policy variables that could be strategically implemented to bring about an improvement.

The limited capacity of the Nigerian rice sector to meet its domestic demand has raised a number of pertinent questions both in policy circles and among researchers. Some of these questions are concerned with whether or not farmers are receiving remunerative profits or whether they are allocating resources efficiently in rice production.

In this study therefore, an attempt has been made to examine the economics of resource use in small-scale rice production in Niger State. The specific objectives were:

i. to evaluate the level of resource-use among small-scale rice farmers in the study area;
ii. to determine the profitability of small-scale rice production in the study area;
iii. to determine the technical efficiency of rice production in the study area and
iv. to derive policy implications from the findings of the study.

MATERIAL AND METHODS

Methodology

The study was conducted in the cropping season 2008 in some selected Local Government Areas of Niger State**.** The State is located in the Guinea Savanna vegetation zone in the north central part of Nigeria between latitudes 3º20 -7º 4'N and longitude 8º- 11º3'E. The area receives an annual rainfall of 1,200mm, which is steady and evenly distributed, usually falling between mid April and November and peaking in August with an average monthly temperature range of 23^0C to 37^0C (NSADP, 1999). Niger State covers a land area of 92,800 square kilometers, which is about 10% of the total land area of Nigeria. About 85% of this land area is arable. Niger State has a population of three million nine hundred and fifty thousand two hundred and forty nine people (3,950,249) (NPC, 2006). The State is endowed with fadama (irrigable) land found along the plains of the River Kaduna and River Niger (NSADP, 2006). The State has large areas of fadama and fertile arable land, which support rice production. The fadama area of the state is 682,331 ha, of which only 105,556 ha is currently in production (NSADP, 2006). Farming is the primary occupation of 85 percent of the state's population. However, agriculture in Niger State is predominantly in the hands of rural people who farm small holdings. It has been estimated that there are over 100,000 farm families in the state. The major crops grown in the region are rice, sugar cane, maize, millet, melon, yam, groundnut, sorghum and cowpea (NSADP, 1994).

In order to obtain a representative sample, a total of 120 rice farmers were selected three local government areas (LGAs) of Niger State; Mokwa, Lavun and Katcha. This is because there were high concentrations of rice farmers in these LGAs. From each LGA, two districts were randomly selected and from each district four villages were selected. In each village, a simple random sampling technique was used to select five farming families. Data were collected on levels of input and output, prices and socio-economic profiles of the farmers. Data were analysed using descriptive statistics, farm budgeting techniques, multiple regression analysis and a stochastic frontier production function.

The Farm Budgeting Model

The farm budgeting tool is widely used in farm management and production economics studies. The farm budgeting tool is an operation leading to determination of cost and revenue for a given production period (Olayide and Heady, 1982). Net farm income is expressed as follows:

NFI = GI – TVC – TFC ------------(1)

Where

NFI = Net farm income (₦).

GI = Gross income (total revenue) (₦).

TVC = Total variable cost (₦), and

TFC = Total fixed cost (₦).

Theoretical Frame Work

The concept of efficiency is concerned with the relative performance of processes used as inputs into outputs (Mijndadi, 1981). Research by Olayide and Heady (1982) distinguishes between two types of efficiency; technical efficiency and economic efficiency. Technical efficiency focuses on the physical productivity that occurs when a large quantity of output is consistently produced from the same quantities of measurable inputs. According to Olayide and Heady (1982), efficiency measure as the average productivity index of examples such as land, labour, capital, water etc. can only provide a meaningful index of technical efficiency if any of the resources are limited in a production process. They maintain that the use of a cost comparison in the production process as an index of technical efficiency has limited applicability where all farms do not face the same factor prices.

Economic efficiency however, occurs when a firm chooses resources and enterprises in such a way as to attain the economic optimum (maximum profit). A given resource is considered to be the most efficient when its marginal value productivity is just sufficient to offset its marginal cost (Adegeye and Dittoh, 1985). According to Farrell (1957), economic efficiency is a product of technical efficiency and price efficiency. His method has not escaped criticism. Aigner and Chu (1968) pointed out that the method is not general enough, as the assumptions imply that it is not possible to use an estimated production function that conforms to the law of variable proportions. Nerlove (1965) also makes two other criticisms. Firstly, that Farrell's method does not permit a comparison of firms in an imperfectly competitive industry and secondly, that the measure neglects differences in environments of different firms. According to the report, the last point is crucial to any definition of relative economic efficiency.

Lau and Yotopouios (1972) developed an alternative approach for measuring efficiency. They used a profit function rather than a production function. Their model consists of a single profit equation and a series of equations expressing the derived demand function for each variable input. The profit equation expresses profit level as a function of variable input prices and fixed input quantities.

The stochastic production frontier as an econometric method of efficiency measurement in production systems is established on the premise that a production system is bound by a set of smooth and continuously differentiable concave product transformation functions for which the frontier presents the limit to the range of all production possibilities (Sharma *et al.*, 1999). It has the advantage of allowing the simultaneous estimation of individual technical efficiency of the respondent farmers as well as determinants of technical efficiency (Battese and Coelli, 1995).

The frontier production model begins by considering a stochastic production function with a multiplicative disturbance term of the form:

$$Y_i = f(Xi; ß) \exp(Vi\text{-}Ui) ,\ldots\ldots \quad .. (1)$$

Where:

Y_i = Output

X_i = Vector of input quantities,

$ß_i$ = Vector of parameters

V_i = Accounts for random variation in output due to factors outside the farmer's control, such as weather and disease.

U_i = Inefficiency effect (one-sided error with U<0) i.e. U_i s are non-negative and show technical inefficiency in production.

Where:

V is assumed to be independently and identically distributed as $N^{\sim}(0, \boldsymbol{\delta}^2 V)$. A one-sided component $U \leq 0$ reflects technical inefficiency relative to the stochastic frontier, $f(xi;ß) \exp(V_i\text{-}U_i)$. Thus, U= 0 for a farm of which output lies on the frontier and U<0 for one whose output is below the frontier. The distribution of U is half-normal. Thus, the stochastic production frontier model can be used to analyse cross-sectional data. The model simultaneously estimates the individual technical efficiency of respondents as well as the determinants of technical efficiency (Battese and Coelli, 1995). The estimation of stochastic frontier production makes it possible to find out whether deviation in technical efficiencies from the frontier output is due to firm specific factors or to an external random factor. It provides estimates for technical efficiency by specifying composite error formulations to the conventional production functions (Coelli, 1996; Battese and Coelli, 1995)

The technical efficiency of an individual farmer relates to the degree to which a farmer produces the maximum feasible output from a given bundle of inputs (an output oriented measure), or uses the minimum feasible level of inputs to produce a given level of output (an input oriented measure). The technical efficiency of a farmer (i) in the context of the stochastic production function in equation 1 is:

$TE = Y_i / Y_i^*$---- -----------------(2)

$= f(X_i; ß) \exp(V_i - U_i) / f(X_i; ß) \exp V_i = \exp(-U_i)$- --(3)

Where:

Y_i = Observed value of output.

Y_i^*= Frontier output (or potential output).

Given the density function U_i and V_i, the frontier production function can be estimated by the maximum likelihood technique. The value of the technical efficiency lies between zero and one. The most efficient farmer will have the value of one, whereas an inefficient farmer will have a value lying between zero and one. The stochastic frontier model in the form of Cobb-Douglas production function was specified for this study. The maximum likelihood technique was used to estimate parameters of the stochastic frontier and the predicted technical efficiency / inefficiency of the farmers.

In the efficiency analysis, the Battese and Coelli (1995) single stage model was applied, whereby U in equation (3) is a non-negative random variable which is the efficiency associated with technical efficiency factors in production among the sampled farmers. It was assumed that the efficiency factors are independently distributed and that U arises from the truncation (at Zero) of the normal distribution, with mean V and variance δ^2 where U in equation (3) is defined as:

$U_i = f(Z_b, \delta)$ ----------- ---- (4)

Where

Z_b = Vector of farmer – specific factors and

δ = Vector of parameters.

The ß and δ – coefficients in equations (1) and (4), respectively are unknown parameters to be simultaneously estimated together with the variance parameter which is expressed in the form:

$\gamma = \delta U^2/(\delta U^2 + \delta V^2)$… … (5)

Where γ = has a value between zero and one.

Empirical Stochastic Frontier Production Function.

The Cobb-Douglas function used in this study is specified in its linearized form as:

$\text{In } Yij = \text{In } ß_0 + ß_1 \text{In} X_1 ij + ß_2 \text{In} X_2 ij + ß_3 \text{In} X_3 ij + ß_4 \text{In} X_4 ij + ß_5 \text{In} X_5 ij + ß_6 \text{In} X_6 ij + Vij - Uij$

Where:

Y = Total farm output of rice (kg)

X_1 = Farm size (hectares)

X_2 = Labour input (man-days)

X_3 = Quantity of fertilizer (kg)

X_4 = Quantity of seed planted (kg)

X_5 = Quantity of Agrochemicals (litres)

X_6 = Capital input (Naira) and this includes depreciation charges on farm equipment and pumping machine, rent on land, interest charges on borrowed capital, tractor hiring costs and irrigation charges.

$ß_0 - ß_6$ = regression coefficients estimated.

V_{ij} = normal random error assumed to be independently and identically distributed, having $N^{\sim}(O, \delta^2)$

U_{ij} = non-negative random variable associated with the technical efficiency of the farmer involved. This is defined as:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 D_1 + \delta_8 D_2$ ………(6)

Where:

U_i = Inefficiency of the i^{th} farmer

Z_1 = Age of the farmer in years

Z_2 = Level of education in number of years spent in school

Z_3 = House hold size

Z_4 = Years of farming experience (rice only)

Z_5 = Extension contact (number of meetings in production season)

Z_6 = Credit access (dummy)

1 = Access

0 = No Access

Z_7 = Membership of co-operative (dummy)

1= member

0 = otherwise

δ - Coefficients of unknown parameters to be estimated.

RESULTS AND DISCUSSION

Level of Resource Use

Land

The distribution of respondents based on the size of their farm holding is shown in Table 1. It demonstrates that the majority (90 %) of farming families in the study area had small farm holdings of 2.5 ha or less. The size of farm determines the extent to which other resources (capital, labour etc) are used for optimum productivity. According to Alamu *et al.* (2002), farmers that had more resources including land area were more likely to take advantage of new technology. Analysis of land use revealed that in total of 276 ha was cultivated by the respondents and that individual plot sizes ranged from 0.10ha to 8 ha with a mean of 2.3 ha. This indicates that the majority of farmers in the study area were small holders. This situation, where many farmers cultivate only small plots of land does not promote agricultural production beyond the level of subsistence.

Table 2 shows that over 73 % of respondents acquired their land through inheritance. The remaining 27% of land acquisition was either through, rent or borrowing. It would appear that dependence mainly on inheritance has caused this fragmentation of land holdings. As the majority (80%) of respondents in the study area owned between two to four plots. The system of land tenure by inheritance encouraged fragmentation and sub-division of land holdings. The principal economic effect of this, as reported by Araka (1990), is the potential reduction of efficiency of labour due to movement from one plot to another. Also, land improvement and conservation may be hampered owing to the need for neighbourly cooperation. Fragmented small holdings also deny farmers the benefit of scale economies.

Labour Utilization in Rice Production

Farmers in the study area utilized both family and hired labour. Levels of labour input use according to farm operations are presented in Table 3. They show that a total of 131.97 man day/ha of labour was used. The use of family labour was most prevalent in the area, accounting for over 53 % of the total labour used, while hired labour accounted for 47 % of the total labour requirement. However, the fact that up to 47 % of labour input was hired shows the potential of rice production to generate employment in the area.

This is very important in terms of income generation and commercial activity in the area, as a result of its multiplier effects. Those who get their income either as farmers or labourers will spend such income, which will constitute income to others who will also spend it, and so on. The results further show that, over 28% of the total labour in rice production was on weeding, followed by planting (18.49%) and land preparation (17.26%). Therefore, more than 64% of labour used in rice production was absorbed by these three operations.

Capital Inputs in Rice Production

Results show that farmers used both durable and non-durable capital assets. Durable capital included pumps, cutlasses, hoes, axes, sickles and calabashes while non-durable capital inputs employed included fertilizer, seed and agro-chemicals. The study also reveals that about 13% of respondents in the study area obtained credit from formal sources. Farmers in the area financed rice production from their savings. Only 13 % had access to formal credit provided by cooperatives. In Nigeria, efforts have generally been made to reach farmers with formal credit. However, small-scale farmers have largely been by-passed because, among other problems, they lack the collateral demanded by financial institutions. This category of farmers is therefore left to their own devices to overcome shortages of capital in farming operations. All sampled farmers used chemical fertilizer. Table 4 shows that 90% of respondents used 100 kg/ ha of fertilizer or less. Most of them however, complained of an inadequate supply of the commodity. It is probably this inadequate supply that accounted for low level utilization. The analysis revealed that, individual fertilizer quantity ranged from 15kg to 500kg with a mean of 120kg / ha which falls far short of the recommended 250-350 kg /ha for upland and lowland swamp rice production systems (Okoruwa and Ogundele ,2004). It would appear therefore, that increased access to the commodity could increase returns to small-scale rice production.

Seeds used for planting were obtained locally from the market or from neighbors. Only few of the respondents used improved seed varieties. The rice seeds were either planted directly in the field or raised in nursery beds before transplanting to the field. Most farmers demonstrated a lack of knowledge of where to obtain improved seeds. This may be an indication that the Niger State Agricultural Development Project, the agency responsible for agricultural extension in the area, was not making much headway to increase farmers' awareness of improved technologies.

The study revealed that, the average seed rate was 20 kg/ha, which is less than the 45-65 kg/ha recommended for upland, lowland and swamp rice production systems (Wilson and Wilson, 1994). The use of improved seeds could increase yield and returns in the area. Most (92%) of the farmers used agrochemicals to control weeds on their farms. The quantities used however, were generally inadequate. For instance, the average application of agro-chemicals was 1.98 litres/ha, which falls short of the recommended 4 litres/ha of Weedoff, Sarosite and Oriozo plus for rice (NCRI, 2004). Farmers attributed this problem to the high cost of chemicals. Most of the weeding was done manually using a hoe.

Profitability of rice production

The total cost of production, as indicated in Table 6, was N31,999.78/ha. The table further reveals that variable costs accounted for over 90.12% of the cost of production, while the fixed cost accounted for less than 10 %. This finding agrees with that of Baba *et al*., (1998), Ibrahim *et al*,. (2005) and Tsoho (2005) who, in separate studies all found that variable costs accounted for 99%, 95.20% and 92.55% respectively of the total cost. Evidence that fixed costs accounted for such a small proportion of the total cost confirms that fixed capital investment in the study area was low. This was expected as the farmers had such limited access to the credit that would have enabled them to acquire fixed capital inputs for farm expansion. Hence they relied on their savings, which were low because of their low incomes. Consequently, they were able to afford only rudimentary tools such as hoes, cutlasses, sickles and the like which are cheap but that could not be relied upon to expand rice production.

Among the variable costs of rice production, the cost of labour input alone constituted 50 percent. The cost of labour was however, dominated by the imputed cost of unpaid family labour that accounted for 53.11% of the total labour cost (see Table 4). The cost of family labour, although not directly incurred by farmers was imputed on the assumption that if a farmer and his family had not worked on the farm, they could have hired out their labour to other farmers at the standard rate in the study area. This again, is in agreement with the findings of Baba *et al*,. (1998). In their study in Sokoto State, Nigeria, they reported high level of labour utilization (77% of total cost of production).

The net farm income in the study area was ₦30,463.10/ha, with the rate of return on investment reaching 117% while the gross ratio, operating ratio and fixed ratio were 0.51, 0.46 and 0.05 respectively. All these ratios were less than 1 indicating that rice farming was profitable and has the potential to increasing rural income. The NFI recorded in the area was not only because of effective exploitation of available human and material resources, but also because of better marketing prospects of rice with the federal government's ban on importing food. This finding is in line with those of Idiong (2005), Erhabor and Kalu (1990), Baba (1993) and Baba and Etuk (1990) who recorded high positive financial returns to fadama farming.

Table 1. Distribution of respondents according to farm size.

Farm size(Ha)	Frequency	Percentage
0.1-1.5	63	52.50
1.6-2.5	45	37.50
2.6-3.5	4	3.33
3.5-4.5	3	2.50
4.6-5.5	2	1.67
>5	3	2.50
Total	120	100

Mean farm size 2.30; SD 0.12;

Source: Field survey, 2008

Table 2.Distribution of respondents according to farmland ownership.

Source of Farmland	Frequency	Percentage
Inherited	88	73.33
Rented	5	4.17
Borrowed	27	22.50
Total	120.00	100.00

Source: field survey, 2008

Table 3: Family and non-family labour inputs by operations (man-days / ha).

Operation	Family labour man–day	%	Hired labour man-day	%	Total labour man-day	%
Nursery	6.28	8.95	3.14	5.08	9.42	7.14
Land prep	5.18	7.39	17.60	28.45	22.78	17.26
Planting	7.50	10.70	16.90	27.32	24.40	18.49
Watering	22.35	31.88	0.00	0.00	22.35	16.94
Weeding	18.75	26.75	18.56	30.00	37.31	28.27
Harvesting	6.12	8.73	5.67	9.16	11.79	8.93
Others	3.92	5.59	0.00	0.00	3.92	2.97
Total	70.10	100.00	61.87	100.00	131.97	100.00

Source: field survey, 2008

Table 4: Distribution of farmers according to level of fertilizer use

(kg/ha)	Frequency	Percentage
01-50	78	65.00
51-100	30	25.00
101-150	5	4.17
151-200	3	2.50
201-250	3	2.50
>250	2	1.67
Total	120.00	100.00

Mean fertilizer level120; SD 1.87; Source: Field survey, 2008

Table 5: Distribution of farmers according to level of seed use (kg/ ha)

Level of Seed	Frequency	Percentage
01-10	80	66.67
11-20	33	27.50
21-30	4	3.33
31-40	2	1.67
41-50	1	0.83
Total	120.00	100.00

Mean seed 20; SD 0.32; Source: Field survey, 2008

Table 6: Cost and returns associated with rice production (₦/ha).

Item	Cost	Percentage	Returns
Gross Revenue (GR)			**62,462.88**
Variable costs (VC)	**28,839.30**	**90.12**	
Seeds	3,173.83	9.92	
Fertilizer	7,935.90	24.80	
Agrochemical	2,772,62	8.67	
Family labour (opportunity cost)	10573.43	25.93	
Hired labour	4,736.62	14.80	
Fuel (for pump)	875.00	2.73	
Pump Maintenance/repairs	234.43	0.73	
Marketing/transp cost	793.00	2.48	
Fixed cost (FC)	**3,160.43**	**9.88**	
Depreciation on pump	2,160.00	6.75	
Depreciation on farm tools	1,000.43	3.13	
Total cost (TC)	**31,999.78**		
Gross Margin			**33,623.58**
Net Farm Income (NFI)			**30,463.10**
Gross ratio			**0.51**
Operation ratio			**0.46**
Fixed ratio			**0.05**
Return on capital investment			**1.17**

Source: Field survey, 2008

Results of the Maximum Likelihood Estimation of Stochastic Frontier Production Function

The results of the estimated stochastic frontier production function are shown in Table 7. Labour, seed and capital contributed significantly to the output of rice, while the coefficients of fertilizer and agro-chemicals were not significant. The results indicate that the estimated coefficient for labour is positive as expected and significant at (P<0.05).

The positive coefficient and significance of the labour input implies that its availability is determined to a great extent by the level of output that can be obtained from the farm. This agrees with the findings of Ogundele (2003) and Adeoti (2001) who also reported the input of labour as a positive coefficient. They affirmed that labour is a significant factor that positively influences change to output. The estimated coefficient for the input of capital is positive and significant at (P< 0.01). The amount of capital input per farm determines the necessary level of investment in a farm. Tanko (2003) observed that in traditional agriculture, capital investment on fixed assets was negligible. High level of investment, ceteris paribus, is expected to translate to a higher return. Therefore, the 0.0058 elasticity of capital implies that a 1% increase in capital input would lead to an increase of 0.0058 percent in total output.

It was also observed that fertilizer, which is one of the most critical inputs in rice cultivation, was surprisingly not significant. This finding however, agrees with that of Idiong (2006) and Okoruwa and Ogundele (2004), who in separate studies found that fertilizer did not significantly contribute to the technical efficiency of rice production due to low usege of the input.

Furthermore, the coefficient for seed input is positive and statistically significant. This indicates that output of rice increased directly with seed quantity. This agrees with the findings of Aye and Oboh (2004) who reported that quantity of rice seed was directly related to output. Results in Table 8 show that the estimated sigma-square is relatively large and statistically significant (P< 0.01). This indicates a good fit and the correctness of the specified distributional assumption of the composite error term Aderinola and Ajibefun (2003) and Kebede (2001) in their various investigations obtained similar results.

Moreover, the estimated variance ratio (the gamma) of 0.58 percent, is suggesting systematic influences that are unexplained by the production function are the dominant sum of random error. In other words, the presence of technical inefficiency among the sample farms explains about 58 percent of the variation in output level of rice grown. This confirms that in the specified model, there is the presence of a one-sided error component. This also implies that the effect of technical inefficiency of farmers is significant and that a classical regression model of production function based on ordinary least squares estimation would be an inadequate representation of the data.

The results of the technical efficiency model show that, the coefficient of age is positive and significant (P< 0.05). Also, the estimated coefficient of household size is statistically significant (P< 0.01). This suggests that farmers who have more people in their households tend to be more efficient in rice production. Although it is theoretically plausible that more adults in a farmer's household should correspond to a larger work force thus a saving in labour expenditure; the amount of labour available for farm work depends fundamentally on two factors; the number of people in a family who can actually work on the farm and the length of time for which each member is prepared to work on the farm. Consequently, what matters is not size of the family per se, but the composition and quality of those capable of working on the farm.

Furthermore, the coefficient of farming experience is positive and statistically significant ($P< 0.05$). This is expected because farmers with more experience are likely to be more efficient in organizing their production and executing farm operations. This supports the view of Coelli and Battese (1996) who pointed out that aged farmers are relatively more efficient in production because it is possible that such farmers gained more years of farming experience through 'learning by doing', and thereby becoming more efficient.

Extension contact is positive and statistically significant ($P<0.05$). This is also expected because access to extension services enables farmers to acquire more technical knowledge and access to improved production technology, which makes them more efficient in production.

Furthermore, the coefficient of membership of a cooperative is positive as expected and statistically significant ($P< 0.05$). Membership of co-operative affords a farmer the opportunity of sharing information on modern rice practices by interacting with other farmers. In addition, co-operatives may be an avenue for acquiring improved inputs and for marketing products at more remunerative prices. The use of improved inputs is bound to increase a farmer's technical efficiency. These findings are consistent with those of Idiong (2005), Aderinola and Ajibefun (2003) and Nwaru (2004) who reported positive production elasticity with respect to membership of co-operative in various places in Nigeria.

Technical efficiency levels of rice farmers in the study area

Table 8 shows that estimated technical efficiencies range from 0.53 for the least efficient farmer to 0.99 for the farmer that attained the highest efficiency, with a mean of 0.75. This efficiency distribution shows that over 89 percent of the rice farmers attained technical efficiency of 60% or above, while none had below 50 %. These results also indicate that the average rice farmer would require about 25% cost saving to become a fully efficient rice farmer while the worst performing farmer would require 47%. The results therefore, show that there is room for the average farmer to increase his efficiency level.

Table 7: Results of Maximum likelihood estimation of the stochastic production frontier function in rice production.

Variable	Parameters	Estimated coefficient	T-ratio
Production factors			
Constant	β_0	4.9919	5.3906***
Labour (X_1)	β_1	0.1138	2.3932**
Fertilizer (X_2)	β_2	0.0879	1.2361 ^{NS}
Seed (X_3)	β_3	0.3536	2.4975**
Agrochemicals(X_4)	β_4	0.0341	0.5017^{NS}
Capital (X_5)	β_5	0.0058	6.6750***
Sigma-Squared		0.73	6.9176***
Gamma		0.58	2.7235***
Log likelihood	L l f	-62.3933	
	LRT	13.6579	
Inefficiency factors			
Age (Z_1)	δ_1	0.0065	9.7745***

Education (Z_2)	δ_2	0.018	0.9250 ^{NS}
Household size (Z_3)	δ_3	0.0069	4.7866***
Farming experience (Z_4)	δ_4	0.0001	2.3040**
Extension contact (Z_5)	δ_5	0.0177	5.7123***
Credit access (Z_6)	δ_6	0.137	0.1375 ^{NS}
Membership of cooperative (Z_7)	δ_{67}	0.2824	2.3225**

Note: ***, ** and NS implies statistically significant at 1%, 5% levels and not significant, respectively.
Source: Output of the stochastic frontier production function version 4.1, 2008

Table 8: Distribution of rice farmers according to their levels of technical efficiency

Efficiency class	Frequency	Percentage
<0.60	13	10.83
0.60-0.69	40	33.33
0.70-0.79	27	22.5
0.80-0.89	19	15.83
0.90-1.00	21	17.50
Total	120.00	100.00
Mean	0.75	
Minimum	0.53	
Maximum	0.99	

Source: Derived from survey data, (2008).

CONCLUSION

The study revealed that small-scale rice producers were not fully technically efficient; this implies that there is scope to increase rice production and farmer's income through more efficient utilization of resources. The significant factors that determined technical efficiency were labour, seed, capital, age, size of household, farming experience, extension contact and membership of a co-operative. The study further revealed that small-scale rice producers were not fully technically efficient implying that there is scope to increase rice production and farmers' incomes through more efficient utilization of resources. The significant factors that determined technical efficiency were labour, seed, capital, age, size of household, farming experience, extension contact and membership of co-operatives.

POLICY IMPLICATIONS

In view of the current global effort to achieve the Millennium Development Goals (MDGs), Nigeria, as a part of this effort should aim to integrate within the present presidential initiatives on rice production; a food policy measure that will strategically ensure that rain-fed rice farmers follow appropriate farm practices in the course of adopting technology. In this regard, a more realistic package that will increase the ratio of the number of farmers to extension contact should be encouraged as a vital step towards increased rice production in Niger State in particular and in Nigeria at large. Similarly, farmers in the study area need to form co-operatives to improve accessibility to improved inputs such as fertilizer, agro-chemicals and institutional credit. The adoption of such inputs could be further encouraged through more effective extension services. There is an urgent need for feeder roads in rural areas to facilitate the transportation of products to markets. This will facilitate efficient dissemination and utilization of technology at the grassroots level.

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