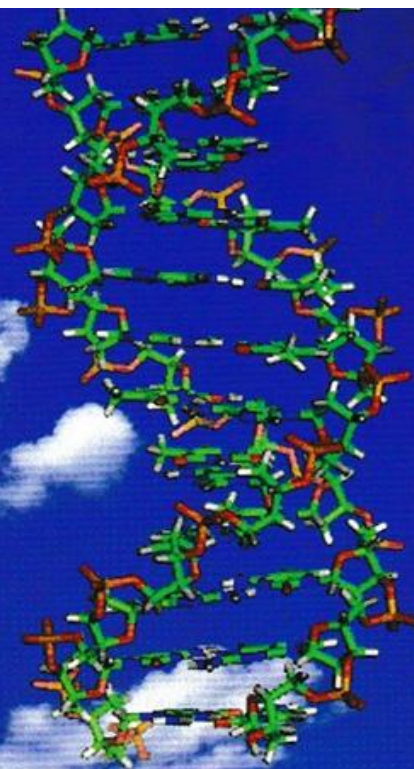
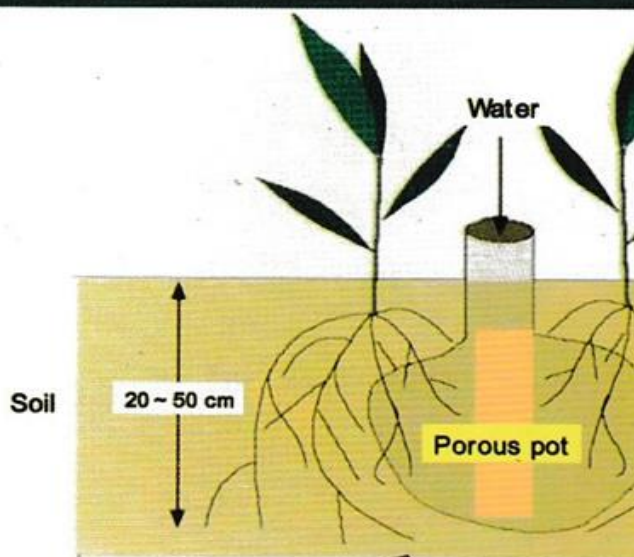


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Production Function Analysis of Upland Rice Farmers in Imo State, Nigeria

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ABSTRACT

This study analysed resource use efficiency of upland rice farmers in Imo State, Nigeria. Data were collected using questionnaires between July and September 2007, from 120 upland rice farmers in three Local Government Areas (LGAs) under the Okigwe Agricultural zone of Imo State. The data were analyzed using means, percentages, frequency distributions, and a multiple regression was performed using the ordinary least squares method. The data were further subjected to efficiency analysis. Results showed that availability of land, capital, labour, seeds, fertiliser and other inputs had a positive effect on rice output. The *Cob Douglas* was selected as the lead equation and the component variables jointly explained 89% of the variation in rice output. The efficiency analysis showed that land and labour were over-utilized while seeds and fertilizer were under utilized. The overall function indicated that the farmers were producing at the region of increasing returns to scale implying that the productivity was not at the optimum level. To attain the optimality in use of input resources and produce efficiently, the rice farmers should decrease their use of land, and, labour, and increase use of improved seeds and fertilizers.

Key words: Efficiency, inputs, rice production, allocative efficiency.

INTRODUCTION

Sufficient food is a basic requirement of all human beings. However, there are millions of people in various parts of the world whose food supply is not guaranteed. They go hungry because agricultural production especially in developing countries cannot keep pace with the growth in population. Over the years, sub Saharan Africa (SSA) has remained a net importer of food due to declining production. Ehui and Spencer (2000) noted that Sub-Saharan Africa is the only region of the world where per capita food production declined steadily over the past decades.

In Nigeria, food production was at subsistence but self-sufficient level between 1950 and 1960. During this period, agriculture was the main stay of the economy. It accounted for 30% of the gross domestic product (GDP), about 70% of labour employment, provided substantial raw materials for industries and accounted for more than 70% of the country's export earnings. Thus, the agricultural sector dominated the economy. However, with the advent of the oil boom, the agricultural growth slowed, its relative contribution to macroeconomic aggregates declined and the country started experiencing food shortages (FAO 2000; Ladele and Ayoola, 1997).

The 1970's marked an important turning point in the agricultural development of Nigeria. There was a diversion of attention from agriculture to oil exploration. Consequently, food production for domestic consumption dropped far below a consistently growing population, giving rise to wide gap between food supply and demand as well as soaring food prices. The average annual growth rate of agricultural production was between four and five percent beginning in 1986, yet the demand by households for food resources, which was on the increase was not met (Ladele and Ayoola, 1997). Although there appear to be an abundance of food supplies in the country, access by households to the desired food has remained a pressing problem in recent years. High inflation rate, food price instability and the relatively low average income earned have made an average Nigerian liable to food insecurity. National income is on the increase but the real household income is fast declining, thereby reducing the effective purchasing power of household, thus creating glut in the food market as well as insecurity to consumers (Ohajianya et al, 2003, Enwerem, 2000). Nigeria is one of the most endowed countries in the world and in order to increase productivity in agriculture, efficient use of resource is needed.

Rice is one of the food crops which has assumed great significance as a major staple food widely consumed in Nigeria (Okereke, 1988; Ohajianya and Onyenweaku, 2002). This could be seen from the astronomic rise in its domestic consumption of about 11 kg per capita per annum in 1980 to 39kg per capita per annum in 2002 (IBRD, 2005). This is partly because rice as carbohydrate food serves as the main source of calories in the diets for most African countries (Onwuka, 2005). Rice is cultivated in almost all the countries in the world with an annual world production of about 931 million tonnes which was produced from about 361 million hectares (Panayotou, 2003). In Nigeria, rice is traditionally grown only in areas with high rainfall (normally above 2000 mm per year) either as upland or swamp rice (Olufokunbi, 2004 and Todaro, 2002). Many authors have recognised inefficiency in the use of the various farm resources as the cause of low rice productivity in Nigeria (Akatugha, 2004; Dittoh, 1995 and Ohajianya 2005; Ohajianya and Onyeweaku, 2002; Odi and Nwosu, 2001). In this study, we evaluated the efficiency of upland rice farmers in Imo State, one of the highest rice consuming states in Nigeria, where there is apparently no published information on efficiency of local rice farmers.

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METHODOLOGY

This study was conducted in Imo State ($5^{\circ}40'$ - $7^{\circ}9'$ N; $6^{\circ}35'$ - $8^{\circ}30'$ E), Nigeria. The soils of Imo State fall within the broad group of Ferallitic soils on the coastal plain sand and escarpment. The vegetation is of tropical rain forest, which is the dominant natural vegetation in most parts of southern Nigeria. There are two major seasons in the year namely; the wet and the dry seasons. The wet season, which begins in April ends in October with a break in August referred to as "August Break". The dry season which lasts for four months begins in November. The total rainfall decreases from 2200mm in the south to 1900mm in the north of the state. The hottest months are January to March when the temperature is about 26°C . The relative humidity is usually high throughout the year, reaching a maximum (80%) during the rainy season. Agriculture is the major occupation and the main crops grown are cassava, yam, rice, cocoyam, maize beans, groundnuts and vegetables. Households also keep livestock such as sheep, goats, poultry, pigs, etc.

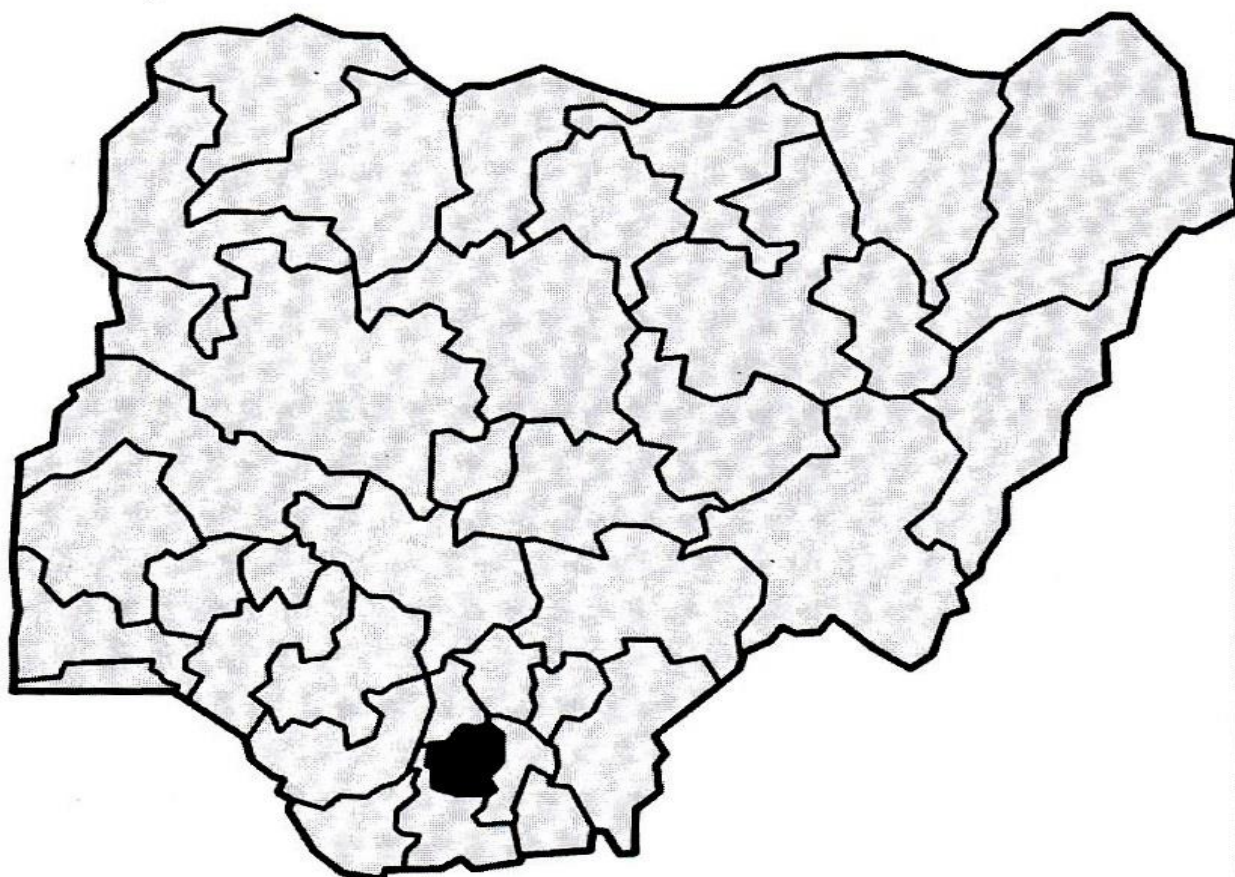


Fig.1: Map of Nigeria showing Imo State (shaded)

Sample Selection

Imo State is made up of 27 local government areas (LGAs) which are grouped into three agricultural zones, Owerri, Orlu, and Okigwe. Rice production in the state takes place only in Okigwe zone. Therefore Okigwe zone was purposively selected for the study. Okiwe agricultural zone is made up of six LGAs namely; Obowo, Ihite Uboma, Ehime-Mbano, Isiala-Mbano, Onuimo and Okigwe. However, since not all the LGAs are known for rice production, three out of the six where rice is produced both in upland and lowland areas were purposively selected for study. The lists of communities in the selected LGAs were collected from the Community Development Office at the LGA headquarters. From this list, two communities were randomly selected from each LGA, making a total of six communities. The sampling frame was the list of upland rice farmers in the selected communities. From this list, 20 farmers were randomly selected from each community making a sample size of 120 rice farmers.

The data collected were analysed using both descriptive and inferential statistics. Descriptive statistics such as mean, percentages and frequency distribution was employed to analyse the socio-economic characteristics of the rice farmers. Inferential statistical tools such as the Ordinary Least Square multiple regression was used to determine factors that influence rice output. The implicit form of the model is given as follows:

$$Q = f(X_1, X_2, X_3, X_4, X_5, X_6, e)$$

Where:

Q	=	Output of Rice (Kg)
X ₁	=	Farm Size (ha)
X ₂	=	Capital (Naira)
X ₃	=	Labour (Mandays)
X ₄	=	Seed (Kg)
X ₅	=	Fertilizer (kg)
X ₆	=	Other Inputs (Naira)
e	=	Error Term

It is expected *a priori* that the coefficients of X₁, X₂, X₃, X₄, X₅, X₆ > 0. Four functional forms of the multiple regression model; linear, semi-log, Cobb-Douglas and exponential were estimated and a lead equation selected.

Determination of allocative efficiency

Since the output of rice is measured in kg, the first derivative measures the marginal physical product, resulting from using any of the six inputs. This would make it easy to calculate price efficiency which is mathematically given as:

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$$(E) \quad \text{Allocative efficiency} = \frac{Mpp \times PQ}{P_i} = \frac{MVP}{P_i}$$

Where:

MPP = dQ/dX_i = marginal physical product of the input

PQ = Price per unit of output

P_i = Price per unit of input or the opportunity cost of the input.

MVP = Marginal value product.

The condition for efficiency is

$$\frac{MVP}{P_i} = 1$$

When the ratio is less than or greater than 1, then the farmers are not price efficient in resource utilization.

RESULTS AND DISCUSSION

Socioeconomic background of farmers

The distribution of upland rice farmers according to educational attainment is presented in Table 1. Majority (41.6%) of the upland rice farmers had primary education, 30% had no formal education while only 5% had higher education. This result implies that the upland rice farmers had low educational qualifications. This could lead to inefficient resource use and low income. Most (41.6%) of the respondents were aged 43 – 48 years, while 36.7% of them were aged 37-42 years (Table 1). The mean age of the farmers was 41.6 years, which implies that the farmers were at the active stage of life to produce the needed quantities of rice if given the enabling environment such as input support. Males constituted the majority (68.3%) of the upland rice farmers in the study area. Females were less involved because of the high labour requirements and land ownership pattern which favour the males. Married farmers were in the majority (58.3%) while 27.7% of them were still single.

Few (6.7%) of the farmers were divorced (Table 1). Since most of the farmers were married, they have added responsibilities that would make them put in more effort to increase farm output and incomes to fend for their families. Most (51.7%) of the farmers had 9-12 persons in their families, while 30% of them had 5-8 persons. About 3.3% of the farmers had 13-16 persons in their families. However, the mean family size was 8 persons.

These large family sizes are advantageous in labour supply for rice production.

Table1: Distribution of rice farmers according to socioeconomic characteristics

Educational Attainment	Frequency	Percentage (%)
No Formal Education	36	30.0
Primary Education	50	41.6
Vocational Education	8	6.7
Secondary Education	20	16.7
Higher Education	6	5.0
Total	120	100
Age Distribution (years)		
25-30	6	5.0
31-36	12	10.0
37-42	44	36.7
43-48	50	41.6
49-54	8	6.7
Total	120	100
Gender		
Male	82	68.3
Female	38	31.7
Total	120	100
Martial Status		
Married	70	58.3
Single	26	21.7
Widow	16	13.3
Divorced	8	6.7
Total	120	100
Family Size (No. of Persons)		
1-4	18	15.0
5-8	36	30.0
9-12	62	51.7
13-16	4	3.3
Total	120	100
Farming Experiences (years)		
5-10	18	15.0
11-16	64	53.3
17-22	30	25.0
23-28	8	6.7
Total	120	100

In terms of experience (Table 1), most (53.3%) of the farmers had 11-16 years farming experience, while 25% of them had 17-22 years experience in rice farming. The mean years of experience acquired by the farmers in rice farming was 14.6 years, which suggests that the upland rice farmers had reasonable experience in rice production to allow them use available resources optimally to improve production.

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Annual farm and off-farm income

The distribution of upland rice farmers according to annual farm income is presented in Table 2. Most (50%) of the respondents earned an annual farm income of ₦ 201,000 and above; 23.3% of them earned ₦ 151,000 – ₦ 200,000. The mean annual farm income was ₦ 205, 021.43 which is reasonable for a small scale farmer and is an encouragement to put in more effort in rice production and other farming activities.

Table 2: Distribution of upland rice farmers according to annual farm and off-farm income.

Annual Farm Income (₦)	Frequency	Percentage
50,000 – 100,000	8	6.7
101,000 – 150,000	10	8.3
151,000 – 200,000	28	23.3
201,000 – above	60	50.0
Total	120	100
Annual Off-Farm Income (₦)		
40,000 – 70,000	4	3.3
71,000 – 100,000	38	31.7
101,000 – 130,000	58	48.3
131,000 – 160,000	20	16.7
Total	120	100

Mean Farm Income = ₦205, 021.43; mean off-farm income = N104,266.67

Most (48.3%) of the respondents earned annual off-farm incomes of ₦ 101,000 – ₦ 130,000 while 31.7% of them earned between ₦ 71,000 and ₦ 100,000 (Table 2). Also, 16.7 and 3.3% of the respondents earned annual off-farm incomes of ₦ 131,000 – ₦ 160,000 and ₦ 40,000 – ₦ 70,000, respectively. The mean off-farm income per annum was ₦ 104, 266.67. Thus, in addition to a reasonable farm income earned by the farmers, they also earned some off farm income per annum indicating that even during the off-farm season, they gainfully engaged in other income generating activities.

Farm Size

Majority (46.7%) of the farmers had farm sizes of 1.01-1.76 hectares, while 28.3% of them had sizes of 1.77 – 2.52 hectares (Table 3). Also, 11.7, 8.3 and 5% of farmers had farm sizes of 0.25 -1.00 hectares, 2.53 – 3.28 hectares and 3.29 – 4.04 hectares respectively. The mean farm size was 1.99 hectares; thus, most of the upland rice farmers sampled are small scale farmers.

Estimation of production by upland rice farmers

Results of the multiple regression analysis are shown in Table 4. The functional forms were linear, semi-log, Cobb-Douglas and exponential. The

Cobb-Douglas function had the highest coefficient of multiple determination (R^2), highest F-cal and highest number of significant variables, and therefore was taken as the lead equation.

Table 3: Distribution of Rice Farmers According to Farm Size.

Farm Size (ha)	Frequency	Percentage
0.25 – 1.00	14	11.7
1.01 – 1.76	56	46.7
1.77 – 2.52	34	28.3
2.53 – 3.28	10	8.3
3.29 – 4.04	6	5.0
Total	120	100

Mean farm size = 1.99 hectares

Table 4: Results of multiple regression analysis of the relationship between rice output and inputs.

Inputs and important statistics	Linear Function	Semi-log Function	Cobb-Douglas Function ⊕	Exponential Function
Land (X_1)	18.3342 (2.2874)**	2.7192 (3.2291)**	0.0127 (3.7353)**	0.0083 (2.6774)**
Capital (X_2)	11.4513 (1.0889)	3.1148 (1.0908)	0.0293 (2.7383)**	0.0071 (2.2903)*
Labour (X_3)	6.3291 (1.1685)	3.0822 (1.0398)	0.0782 (2.4891)*	0.0038 (1.3103)
Seeds (X_4)	14.7384 (2.3322)*	1.9217 (1.2825)	0.0691 (3.1843)**	0.0064 (1.2308)
Fertilizer (X_5)	5.6614 (2.8036)**	2.6039 (1.2632)	0.1082 (3.5244)**	0.0042 (1.1351)
Other Inputs (X_6)	10.0318 (1.0212)	3.9144 (1.2576)	0.0109 (3.3031)**	0.0091 (2.5278)*
Constant	119.2413	111.2083	88.8109	61.0189
R^2	0.4945	0.3962	0.8942	0.5713
F*	8.6401	5.7895	74.6659	11.7697
N	120	120	120	120

⊕ = Lead equation

values in parentheses are t-ratios; * t-ratios significant at 5% level; ** t-ratios significant at 1% level

To give the production function for upland rice production in the study area, the equation was therefore given as follows:

$$\ln Q = 88.811 + 0.0127 \ln x_1 + 0.0293 \ln x_2 + 0.0782 \ln x_3 + 0.0691 \ln x_4 + 0.1082 \ln x_5 + 0.0109 \ln x_6$$

The sign of the coefficients for land (X_1), capital (X_2), labour (X_3), seeds (X_4), fertilizer (X_5), and other inputs (x_6) were positive and significant at 1% except for labour that was significant at 5%. The coefficient of determination

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showed that these inputs jointly explained about 89% of variation in rice output in the area. The coefficients of the explanatory variables which are the direct elasticities of production indicate that a 10% increase in land, labour, seeds, fertilizer and other inputs will lead to 0.127, 0.293, 0.782, 0.691, 1.082, and 0.109 percent increase in rice output respectively. The sum of the elasticities which was 0.31 indicates that the farmers were operating in the region of increasing returns to scale.

Estimation of price or allocative efficiency

The allocative efficiency indices in Table 5 showed the resource utilization efficiency by the rice farmers. The results of regression analysis in Table 4 showed that the Cobb-Douglas function gave the lead equation and the coefficients of the lead equation are also the marginal physical products (MPP) of the inputs shown in Table 5. The product of the MPP and the output price divided by the sample mean produced the marginal value product (MVP). Also, the ratio of the MVP and factor prices gave the price or allocative efficiencies. These results indicated that land and labour were over utilized while seeds and fertilizers were under utilized by the upland rice farmers. Land in the study area is in high demand, so rent is high and efficiency of use has to be high because of competition. Labour on the other hand is available as both hired and family labour and results in what has been described in Udoh and Akintola (2001) and Idiong (2006) as labour saturation; this leads to inefficiency of utilization especially in small farm plots.

Table 5: Computation of allocative or price efficiency.

Inputs And Output Prices	Elasticity	APP	MPP	Marginal Value Product	Factor Prices (FC)	Price or allocative efficiency index
Land (ha)	0.0127	619.05	8.05	563.33	2500/ha	0.23
Labour(mandays)	0.0782	8.61	0.67	46.9	400/manday	0.12
Seeds (kg)	0.0691	16	1.12	42.56	N38/kg	1.12
Fertilizer (50kg)	0.1082	8.19	0.901	63.07	N45/kg	1.40

Output price was N70/kg during the survey.

CONCLUSION

The available resources used by the upland rice farmers in Imo State were utilized at varying degrees of efficiency. The overall equation indicated that the farmers were operating in the region of increasing returns to scale region. The implication is that inputs need to be increased to further increase output.

The analysis of individual inputs however showed that land and labour were over utilized while seeds and fertilizers were under utilized. This resulted in an overall low efficiency of the upland rice farmers in Imo State. The role played by these rice farmers in supplying food in the area is quite important and they need to be encouraged. We recommend that awareness should be created in such a way that the rice farmers would understand sources and modes of credit acquisition and availability and use of agro-chemicals. They should equally be taught some fundamental farm management skills which at least will enable them plan, evaluate and appraise their farm business and be able to predict the economic implication of their investment in rice production. These factors put together would increase the efficiency of the upland rice farmers and improve the national economy.

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