# Efficiency of Resource use in Rice Farming Enterprise in Kwande Local Government Area of Benue State, Nigeria.

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**Abstract**

*This study examines the resource use efficiency in rice production in Kwande Local Government Area of Benue State Nigeria. The data for the study was collected from 100 rice farmers in the four districts of the study area using a simple random sampling technique. Cobb Douglas production function and technical efficiency techniques were used as analytical tools. The study revealed coefficient of elasticity of Cobb Douglas production function of 1.3 which implies that rice farmers in the area are producing in the first stage of production. The technical efficiency estimates reveal that all the Marginal Physical Productivity (MPPs) were higher than the Average Physical Product (APPs) which also suggest that, the farmers were producing in the first stage of production. The study concludes that rice farmers in kwande local government were technically inefficient in rice production. Emergent from the findings, it was recommended that concerted efforts from individual rice farmers, government and research institution to establish farmers' participatory extension service to ensure timely supply and proper use of rice farm inputs in order to improve farmers resource use efficiency.*

## *1.1 Introduction*

Globally, rice is a very important food crop. It is an ancient crop consumed as healthy and staple food by more than half of the world population. Rice is consumed by more than 4.8 billion people in 176 countries and is the most important food crop for over 2.89 billion people in Asia, over 40 million people in Africa and over 150.3 million people in America (Biyi, 2005). According to Jones, (1995), rice is the second most important cereal in the world after wheat in terms of production; while Nigeria ranks the highest as both producer and consumer of rice in the West Africa sub region. Akande and Akpokodje (2003), opined that, since the mid-1970s, rice consumption in Nigeria has risen tremendously, at about 10% per annum due to changing preferences while domestic production has never been able to meet the demand leading to considerable imports which today stands at about 1,000,000 metric tons yearly. The imports are procured on the world market with Nigeria spending annually over US $300 million on rice imports alone. Similarly, Biyi (2005) observed that the annual domestic output of rice still hovers around 3 million metric tons, leaving the huge gap of about 2 million metric tons annually, a situation, which has continued to encourage dependence on importation.

Some of the reasons for the gap are connected with fluctuations of water table, and attendant dangers of flooding, inadequate water supply at the end of the dry season, shortage of agrochemicals, usage of unimproved seeds, crude mode of production, high cost of labour among others (Kolawole and Scones, 1994; Atata and Voh, 1994). Studies have shown that rice production in Nigeria is primarily done by small-scale producers, who do not measure their efficiency and elasticity of production, neither do they measure the yields produced from other rice farmers. According to Federal Ministry of Agriculture (1993) as contained in Goni and Baba 2007, "the low agricultural productivity in Nigeria is revealed by the actual yields of major crops such as rice compared with potential yields". In a related manner, Biyi (2005), opined that, Nigeria has the potential to increase her domestic share of the rice market in a medium to long-term investment strategy that can develop into self-sufficient industry locally. This implies that there is the tendency to increase output of rice in Nigeria with the available land if productive resources are used efficiently; hence the imperativeness of this study given the functional relationship between the level of output and efficiency of inputs use.

The choice of Kwande local government area of Benue for this study is predicated on the premise that Benue is one of the states that enjoys comparative advantage in the production of rice in the country (Biyi, 2005); and Kwande local government on the other hand, is where rice is produced at least twice in a year. Thus, the objective of this study is to determine the productivity and efficiency of resource-use in rice farming in the study area. In pursuit of the objective of this study, the paper is structured as follows; following the introduction, section II deals with the theoretical framework, section III is the methodology, section IV contains the results and discussion and section V presents the conclusion and recommendations.

## *2.1 Theoretical Framework*

### 2.1.1 Production Functions

Kontsoyians (1979) conceptualized a production function as purely the technical relationship between the physical inputs and output. It describes the laws of proportion, represent the technology of the firm and include all the technically efficient methods of production. According to Jhingan (2003), a production function expresses a functional relationship between quantities of inputs and outputs. It shows how and to what extent output changes with variation in inputs during a specified period of time. Technical efficiency and allocative efficiency are two important concepts relating to production function. Technical efficiency refers to the ability of producers to obtain a certain level of outputs, while allocative efficiency is the ability to choose the level of inputs that maximizes profit, given factor cost (Olayide et al, 1982). According to Umoh and Yusuf (1999), productivity is generally measured in terms of the efficiency with which factor inputs, such as land, labour, fertilizer, herbicides, tools, seeds and equipment etc are converted to output within the production process.

Ehui and Spencer (1990) as contained in Goni, Mohammed and Baba 2007, identified two measures of productivity namely, partial productivity and Total Factor Productivity (TFP). Partial productivity is measured as the ratio of output to a single input. The ratio of output to all inputs combined is the total factor productivity. Generally, two approaches are used in measuring Total Factor Productivity (TFP). These are the growth accounting or index number approach and the econometric or parametric method. The econometric method is based on an econometric estimation of the production function or the underlying cost or profit function (Goni, Mohammed and Baba, 2007).

A profit equation may be given as:

Profit equation is $= Y.P_y - (\underline{k} + x.p_x)$ … (1)

Where Y = output (yield)

$P_y$ = unit price of output

$P_x$ = unit price of input

X = quantity of input

$\underline{K}$ = fixed input

$\pi = Y.P_y - (\underline{k} + x.p_x)$

$$\frac{\partial \pi}{\partial x} = \frac{\partial y}{\partial x} p_y - p_x \quad \ldots \quad (2)$$

MPP = $\frac{\partial y}{\partial x}$, where MPP = marginal physical product.

$P_y.MPP = P_x$ … (3)

$MVP = P_x$ (MPP = MUP)

Where MVP = marginal value product.

$MVP = P_x$ … (4)

MR = MC … (5)

Where MR = marginal revenue, MC = marginal cost

$$APP = \frac{TPP}{x} \quad \ldots \quad (6)$$

Where APP = Average physical product

TPP = Total physical Product

X = unit of inputs

$$EP = \frac{MPP}{APP} \qquad \ldots \qquad (7)$$

EP = elasticity of production
MPP = marginal physical product
APP = average physical product

According to Farrel (1957), the elasticity of production which is the percentage change in output as a ratio of a percentage change in input is used to calculate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of input.

When $\Sigma EP = 1$; it is constant return to scale
$\Sigma EP < 1$; it is decreasing return to scale
$\sum EP > 1$ it is increasing return to scale

**2.1.1.1 STAGES IN A PRODUCTION FUNCTION**

Essentially, production function shows three stages of production, that is, stage I, stage II and stage III.

In stage I, the TPP increases at an increasing, rate; the MPP in this stage, increase and reach it maximum and begin to decrease. In the same stage, APP increases until it reaches a peak and lies above MPP. The point where APP = MPP marks the end of stage I and stage II begins.

In stage II, the TPP continues to increase at a decreasing rate; while both MPP and APP are decreasing but MPP decreases faster. Both MPP and APP continue to decrease until MPP is zero when TPP reach its maximum point. This marks the end of stage II and the beginning of state III.

In stage III, the TPP begins to decrease, while the MPP is negative and the APP remains positive. Stage II is therefore, the rational stage of production while stages I and III are irrational stages of production (Olukosi and Ogungbile, 1989).

**2.1.1.2 Production Functions Commonly Used**

According to Ekpebu (2002), there are many functional forms that could be used to describe production relationships, but in practice the commonly used forms are linear, quadratic and Cobb-Douglas functional forms.

(i). The linear production function is used to measure linear relationships between inputs and outputs. For two variable inputs, the function can be mathematically expressed as:

$$Y = a + b_1 x_1 + b_2 x_2$$

Where y = outputs
$X_1$ and $x_2$ = variable inputs
$b_1$ and $b_2$ = the parameters to be estimated and they determine efficiency of the inputs on output,
a = constant.

According to Kalaitzandonakes et al (1992), the linear function is not a good measure of an optimum production because the coefficients assume constant marginal productivity.

(ii). The quadratic function is used to measure the direct effects of inputs on output. It has the advantage of being differentiated twice thus making it possible for first and second condition for optimization to be established (Olayide and Heady, 1982).

For two variable inputs the quadratic function can be expressed as:

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_1^2 + b_4 x_2^2 + b_5 x_1 x_2$$

Where y = level of output
$X_1$ and $x_2$ = variable inputs , $b_1$ and $b_2$ = the measure of the direct effect of the level of inputs on output,
$b_3$ and $b_4$ = the measure of the rate of change , $b_5$ = the coefficient of interactive effects, and
a = constant term.

Upton (1979) opined that the quadratic function can never show both marginal product at low levels of inputs and decreasing marginal product at higher levels of input in the same equation.

(iii). The Cobb-Douglas production is used by more than the linear and quadratic functions. Cobb-Douglas production function shows a functional relationship between inputs and output.

For two variable inputs, the function can be expressed as

$$Y = AL^{b_1} K^{b_2} e$$

Where Y = level of output, L and K = variable inputs, A = multiplicative constant , $b_1$ and $b_2$ = the coefficient of L and K and they represent the direct measure of elasticity of the respective factors of production, and e = error term

The sum of $b_1$ and $b_2$ indicates the nature of returns to scale, Upton (1979) observed that, the Cobb-Douglas production function cannot show both increasing and diminishing marginal productivity in a single response curve and as a result it does not give a technical optimum and may lead to the over estimation of the economic optimum.Despite these disadvantages researchers still find the Cobb-Douglas production function useful in analysis of survey where many variable inputs are involved and it is necessary to measure returns to scale, intensity of factors of production and overall efficiency of production. It can also provide a means of obtaining coefficients for testing hypotheses (Cobb and Douglas 1928; and Erhabor, 1982). While commenting on the superiority of Cobb-Douglas production function over other forms of production functions, Ellebu, Koku and Ogidi (2003) stated that, Cobb-Douglas production function is used more than the other two because it satisfies the economic, statistical and econometric criteria of many studies than others.

## *3.1 Methodology*

### 3.1.1 The study area

The survey was conducted in Kwande local government area of Benue state, Nigeria. The local government is bordered on the West by Vandeikya and Ushongo local governments on the South by Cross River on the North-East by Taraba state and Republic of Cameroon. The local government is predominantly Tiv-speaking people, while rice is generally cultivated at least twice in a year in the area

### 3.1.2 Sample selection

Kwande local government is divided into four districts, Nanev, Turan, Ikurav-ya and Ishangev-ya. A total of 100 rice farmers were randomly selected twenty five each were randomly selected from each of the four districts.

### 3.1.3 Data collection

Data collected for this study include: farm yield, amount farm inputs such as farm size, fertilizer, planting seeds, Herbicide/pesticide and labour. This date was generated from both primary and secondary sources using the following instrument of date collection: questionnaire, interviews and field measurement.

### 3.1.4 Data analysis

In this study, Cobb-Douglas production function and measures of technical efficiency of resource such as APP, MPP, MVP, MFC were used to achieve the objective of this study.

**Model specification**

Specifically, the Cobb-Douglas production function was explicitly specified as follows:

$$Y = A\, X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5}$$

Where A = constant , $X_1$ = Land (ha), $X_2$ = fertilizer (bags), $X_3$ = Herbicides (lit), $X_4$ = seeds (bags) , $X_5$ = labour (man/day)

The function is easy to estimates in logarithmic form as by $Y = \log A + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5$

## *4.1 Result and Discussion*

The data collected from the respondents were used to run regression analysis so as to determine the relationship between inputs (Farm size, fertilizer, herbicides, seeds and labour) and the output of rice (in bags). The results obtained are shown in the table 1 below.

Table 1: The regression results

| Variables | Co-efficient | t | Sig |
|---|---|---|---|
| Constant | -0.386 | 1.495 | 0.0797 |
| $X_1$ | 0.768 | 12.517 | 0.00 |
| $X_2$ | 0.131 | 2.208 | 0.030 |
| $X_3$ | 0.051 | 0.965 | 0.337 |
| $X_4$ | 0.074 | 1.596 | 0.114 |
| $X_5$ | 0.28 | 0.572 | 0.569 |

$R^2 = 0.895$, $\overline{R}^2 = 0.889$, $R = 0.946$.

Thus, representing the co-efficient in the Cobb-Douglas production function: we have:

$$Y = -0.386\ X_1^{0.768} X_2^{0.131} X_3^{0.051} X_4^{0.074} X_5^{0.28} \quad \ldots \quad (1)$$

By linearising the above equation, we have

$$\text{Log } y = \log 0.386 + 0.768 \log x_1 + 0.131 \log x_2 + 0.051$$
$$\log x_3 + 0.74 \log x_4 + 0.28 \log$$

The results showed that all inputs were positively related to the output of rice. The $R^2$ of 0.895 implied that 89% of variation in the output of rice in the area is explained by the inputs specified in the Cobb-Douglas production function. Furthermore, farm size and fertilizer significantly affect the output of rice at 1% and 5% level of significance. Though, other inputs affect the output of rice positively but are not significant. Thus, it can be inferred that a unit increase in the farm size will lead to 77% increase in the output of rice, while a unit increase in the quantity of fertilizer application will lead to 13.1% increase in the output of rice. The elasticity of production which is the sum of the coefficients of Cobb-Douglas production function ($b_1 + b_2 + b_3 + b_4 + b_5$) is 1.3 which suggests that rice farmers in the area can increase their rice output by increasing their farm size and fertilizer application. This implies an increasing return to scale. That is to say that the farmers are producing in the first stage of production.

Measure of technical efficiency of resource such as APP, MPP, MVP, MFC were derived and presented in table 2 below.

Table 2: Values of estimates of efficiency parameters

| Resources | APP | MPP | MVP | MFC | MVP/MFC |
|---|---|---|---|---|---|
| Farm size (ha) | 4.48 | 4.93 | 24650 | 10,000 | 2.465 |
| Fertilizer (bags) | 9.12 | 10.03 | 50,150 | 2500 | 20.06 |
| Herbicides (lit) | 5.86 | 6.4 | 32,000 | 1000 | 32.00 |
| Seeds (bags/100kg) | 13.8 | 15.18 | 75,900 | 6000 | 12.65 |
| Labour (man/day) | 3.55 | 3.91 | 19,500 | 15,000 | 1.3 |

An average of 31.88 bags of rice were produced by 100 farmers in the study area using a total of 711.5 hectares of land, 349.5 bags of fertilizer, 544 litres of herbicides, 231 bags of seeds of rice and 897 man hours of labour respectively. An average selling price of a bag of rice was fixed at ₦5000.00. By comparing the values of APP and MPP in the table for all the inputs, it suggests that the farmers are producing in the first stage of production since all the MPPs were higher than the APPs. The values of the MPP show that the farmers are more efficient in the use of seeds and least efficient in the use of labour. Given the level of technology and prices of both inputs and outputs, efficiency of resources use was further ascertained by the ratios of the MVP to the MFC. The table revealed that all the ratios for the inputs are greater than unity. This suggests that all the inputs are under-utilized. This means that rice output in the area can be increased if more of such inputs (farm size, fertilizer, herbicides, seeds and labour) are utilized.

### *5.1 Conclusion and Recommendations*

Emergent from the findings of this study, it was concluded that rice farmers in Kwande local government were technically inefficient in the use of farm resources. This may be as a result of high cost of fertilizer, seeds, labour herbicides and rent. This implies that technical efficiency in rice production in Kwande local government could be enhanced through better use of such inputs. To ensure efficiency in the use of resources in rice production in the area, concerted efforts from the individual farmers, government and research institutions is highly imperative. The individual farmers should make efforts to embrace improved version of rice production while the government should ensure that farmers' participatory extension service delivery for rice farmers. In addition, the government should ensure that farm inputs are made available to the farmers at the right time and at subsidized prices. Finally research institutions should intensify research efforts on rice in order to have improved varieties that give high farm yield within a short time.

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## *Appendix :* Estimates of efficiency parameters

$$APP_{x_1} = \frac{TPP}{x_1} = \frac{3188}{711.5} = 4.48$$

$$APP_{x_2} = \frac{TPP}{x_2} = \frac{3188}{349.5} = 9.12$$

$$APP_{x_3} = \frac{TPP}{x_3} = \frac{3188}{544} = 5.86$$

$$APP_{x_4} = \frac{TPP}{x_4} = \frac{3188}{231} = 13.8$$

$$APP_{x_5} = \frac{TPP}{x_5} = \frac{3188}{897} = 3.55$$

$$APP_{x_5} = \frac{TPP}{x_6}$$

The marginal physical products were devices as:

$$EP = \frac{MPP}{APP} \quad MPP = EP.APP$$

Therefore,

$$MPP_{x_1} = 1.10 \times 4.48$$
$$= 4.928$$

$$MPP_{x_2} = 1.10 \times 9.12$$
$$= 10.03$$

$$MPP_{x_3} = 1.10 \times 5.86$$
$$= 6.4$$

$$MPP_{x_4} = 1.10 \times 13.8$$
$$=15.18$$

$$MPP_{x_5} = 1.10 \times 3.55$$
$$= 3.91$$