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# Determination of the level of resource-use efficiency in Quality Protein Maize (QPM) production in Kaduna State, Nigeria

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**Abstract**

*The study aimed at determining the level of resource use efficiency in Quality Protein Maize (QPM) production in Kaduna State. Multi stage sampling technique was used to sample 170 respondents from four L.G.As. where QPM is mostly produced. Data were collected through questionnaire administration during the 2009 cropping season. Data analysis was done using multiple regression and estimation of resource-use efficiency ratio. The results showed that fertilizers, family and hired labour were over utilized while land and seeds were under utilized in the production process. This implied that, in order to scale-up output, levels of fertilizers, family and hired labour ought to be reduced while land and seeds ought to be increased.*

**Key words:** Resource-use, Efficiency, Quality Protein Maize, Kaduna State

## Introduction

In the early 1960's Nigeria was self sufficient in food production, supply outstripped demand thus food was cheap and the citizens appeared to be well fed. Today, however, Nigeria is a net importer of food despite advances in science and technology. Nigeria still finds it difficult to equate the supply of food with the ever increasing demand for food, a situation Utomakili and Molue (`1998) attributed mainly to uncontrolled growth in population and inefficient utilization of productive resources. Fakayode et al (2008) observed that the problem with Nigeria agriculture centers on the efficiency with which farmers use resources on their farms. Inefficiency of resource use according to Udoh and Etim (2008) can seriously jeopardize and hamper food production and availability. The consequences of resource under utilization or over utilization either way translates into economic waste due to poor management of productive resources, thus farmers are likely to incur losses as a result of waste in resource over utilization or loss in revenue due to inability to optimize yield or output from production effort. According to Alabi *et al.* (2005) one way to increase the domestic maize supply to meet the growing demand of Nigerian populace is to employ production resources more efficiently. Efficient management of resources according to Olukosi and Erhabor (1988) can result in same level of output using less quantity and quality of input, while it is also possible to obtain a higher level of output with a less proportionate higher level of input. According to Omage *et al*. (2008) the normal maize varieties used in human and livestock diets has two significant flaws, like all cereals, it is low in protein (9-10%) and it does not provide the essential amino-acids (Lysine and tryptophan) in sufficient quantities for nutritional needs of humans and farm animals, thus as far as protein quality is concerned the normal maize variety has poor protein quality. He further reported that QPM contains twice the amount of essential amino-acid than normal maize varieties and it yields 10% more grain than the traditional varieties of maize. This could mean that the quality protein maize (QPM) has the potential of reversing the inadequate protein intake of most Nigerians. The study is aimed at determining the economics of quality protein maize (QPM) production to ascertain whether resources are efficiently utilized. This is necessary because, if the deficit gap between QPM supply (production) and demand (consumption) is to be bridged then resources must be efficiently utilized. Furthermore it is hoped that the study outcome may enable farmers scale down on wasting resources and this may lead to expanded growth in food production which will provide more employment opportunities for the rural communities while at the same time mitigate rural urban drift.

## Methodology

### The study area

Kaduna State is located between latitudes $9^0{}_N$ and $12^O{}_N$ and longitudes $6^O{}_E$ and $9^0{}_E$ of the prime meridian (Alabi *et al*. 2005). There are twenty three (23) Local Government Areas .in the state and it covers an area of 44,408.3 square kilometers. According to National Population Commission (NPC) (2006) the state has a population of about 6,066,562. The vegetation of the state is divided into Northern Guinea Savanna in the North and Southern Guinea Savanna in the West. The state enjoys a rainy season of about six months. There is heavy rainfall in the southern part of the state like Kafanchan and reduces towards the northern part of the state like Zaria with an average rainfall of about 10616mm. The lowest mean temperature is recorded during the hamattan period. This occurs between November and February with a range of between $18^0C$ to $23^0C$. The people of these areas are predominantly farmers. The array of crops grown either in mixture or sole crops includes: maize, sorghum, Soya beans, cowpea, groundnuts, and yam while Maize is planted between April/May and June/July depending on the location. However, it may be planted anytime of the year if water is available for irrigation.

### Sampling technique

Multi-stage sampling was used to arrive at the sample used for the study following Asika (2001). At the first stage four LGA's were purposively selected because of the high level of maize production in the areas. The second stage involved a random selection of (20) villages out of a total of (40) from the four LGA's. The third and final stage involved a proportionate random selection of farmers in each village. A list of Villages where QPM is grown and the population of farmers who grew QPM was obtained from the extension agents. In all, 170 respondents were interviewed using a well structured questionnaire. Data were collected from two sources, primary and secondary. Primary data were collected from the farmers during the 2009 cropping season. Information collected covers farmer's personal characteristics, production variables i.e. farm size, seeds, fertilizer and labour used as well as possible problems faced while relevant secondary information were collected from literature, published works and official government documents.

**Analytical technique**

The technical relationship between inputs and output is analyzed through a production function of the general form:

$Y= f (X_1, X_{,2} \quad X_{,3} \quad X_{,4} \quad X_{,5} \quad X_{.6})+ e$………………1 .

Where,
Y = output of QPM Maize (Kg)
$X_1$ = Farm size (ha)
$X_2$ = Seeds (kg)
$X_3$ = Fertilizer (kg)
$X_4$ = Family labour (man–days)
$X_5$ = Hired labour (man- days)
$X_6$ = Chemicals (liters or grams)
f= functional notation.
e= error term

To establish the technical relationship between input and output, three forms of production function viz: linear, semi-log and Double –log were specified and fitted to the production data. The best fit for this study was the linear function. A combination of criteria such as magnitude of the coefficient of multiple determinations ($R^2$), the level of significance of the overall equation (F-statistics), the level of significance of each coefficient (t-values) and the correct signs of the coefficient relative to a priori expectation informed the choice.

The functional forms are represented below:

**Linear function:**

$Y= bo +x_1b_1 + x_2b_2 + x_3b_3 + x_4b_4 + x_5b_5 + x_6b_6 + e$ ……….2

**Cobb Douglas function:**

$Y= b_0x_1^{b1} \quad x_2^{b2} \quad x_3^{b3} \quad x_4^{b4} \quad x_5^{b5} \quad x_6^{b6} \quad e$……………..3

Which was linearized in the form of double-log as expressed below:

**Logarithmic transformation**:

$\text{Log } Y=\log b_o+b_1\log x_1+b_2\log x_2+b_3\log x_3+b_4\log x_4+b_5\log x_5 + b_6\log x_6 + \log e$ … …..4

**Semi-log function:**

$Y = b_o + b_1\log x_1 + b_2\log x_2 + b_3\log x_3 + b_4\log x_4 + b_5\log x_5 + b_6\log x_6 + e$ ……5

In all the functional forms the variables y, $x_1$-$x_6$ are as defined in equation 1,
$B_o$= intercept
$B_i$= Regression coefficients
e = the error term.

**Estimation of resource efficiency**

The regression coefficients obtained from the estimated production function were used to compute the marginal physical product (MPP) and marginal value product (MVP). Marginal factor cost (MFC) was used along with the marginal value product to determine the resource use efficiency as expressed below.

Where

MVP = $MPP_{ij}$ Py……….7

Where

$MPP_{ij} =$ dy / dx = b…….8

$$r = \frac{\text{Marginal Value Product}}{\text{Marginal Factor Cost}} = \frac{MVP}{MFC}$$

Where

r = Efficiency ratio

MVP = Value of one unit of output resulting from using one additional unit of a variable input resource.

MFC = Cost of one unit of a variable input used..

**Marginal value product and marginal factor cost**

The MVP was estimated from the product of the marginal physical product and unit price of the output (P y). According to Afolami and Ayinde (1996) as cited by Idowu *et al,* (2007) the marginal productivity of resource $X_i$ is given by the expression

dy /d x (P y) Linear form…………...9

$b_i$ (Y/X) P y Cobb Douglas form………10

Where

y = Mean of quality protein maize output.

$X_i$ = Mean of variable input (resource).

Resource $X_{Ij}$ = 1, 2, 3…..$X_n$

P y = Price per unit of QPM (P y)

$b_i$ =Estimated parameters of resource $X_i$

The mean of the market prices of resources was used as the opportunity cost.

When

MVP/MFC > 1, resource use is below optimum, implying under utilization.

MVP /MFC <1, resource use is above optimum, implying over utilization and MVP /MFC = 1, resource is optimally used or efficiently used.

## Results and discussion

### Analysis of the Production function

A production function describes the physical relationship existing between the quantities of inputs and output. Out of the four production functions tried i.e. Linear, Double-log, Semi-log and Quadratic, the linear function was chosen as the lead equation and the result is presented in Table 1. It shows that the value of co-efficient of multiple determination ($R^2$) was 0.88 indicating that about 88% of the variation in output of QPM is explained by the variable inputs included in the multiple regression model. The F-ratio of 241.192 was significant at 1 % level of probability which means that all the inputs jointly contributed to the output of QPM. In addition the t-value indicates that farm size and seeds as variable factors were positively significant at 1 % level of probability, implying that a further increase in the use of land and seeds will lead to further increase in output. Quantities of fertilizer, Family labour and hired labour were not significant.

**Table 1:** Results of Linear Production Function Analysis for QPM

| Variable | Regression Co-efficient | Standard Error(SE) | t-value |
|---|---|---|---|
| Constant | 946.309 | 121.514 | 7.788 |
| Farm size (Ha) | 1188.659 | 140.562 | 8.456*** |
| Quantity of seed (kg) | 36.465 | 7.142 | 5.106*** |
| Quantity of fertilizer (kg) | -0.059 | 0.074 | -798 NS |
| Family Labour (Man-day) | -1.868 | 1.655 | -1.1292 NS |
| Hired Labour (Man-day) | -6.506 | 2.782 | -2.338 NS |
| bi | 1188 | | |
| $R^2$ | 0.880 | | |
| $R^2$ adjusted | 0.877 | | |
| F-ratio | 241.192*** | | |

**Source:** Field Survey, 2010; NS= Not Significant; ***Significant at 1 % level of probability

**Efficiency ratio of resources used in Quality Protein Maize (QPM) production**

According to Hague (2007) the term production efficiency in agriculture can be broadly defined to include concepts of technical efficiency, allocative efficiency and economic efficiency. An efficient farmer allocates his land, labour, water and other resources in an optimal manner so as to maximize his income on a sustainable basis. Resources are said to be efficiently allocated when the value of marginal product of each resources equals its price or when the marginal value is just sufficient to offset its acquisition price ( Olayemi and Onyenwaku,1986). Resource use efficiency provides guide to farmers on how to apportion their resources to maximize profit.

For the various resource inputs included in the model, the opportunity costs used are the market prices that prevailed during the production season. The market price of land service was taken as N1000. The computed marginal value products (MVP) and marginal factor cost (MFC) for the quality protein maize farmers in the study area is presented in Table 2: The Table shows that the ratio of marginal value products to marginal factor costs for land and seeds, are greater than one while that for fertilizer, family labour and hired labour are all less than one. The implication here is that land and seeds were underutilized while fertilizer, family labour and hired labour were over-utilized. Underutilization of farm size and seeds imply that farmers will not be able to realize high yield while over-utilization of production resources imply high cost of production and this may act as a disincentive to the continuous growing of QPM in the study area. This to some extent is in agreement with the findings of

Alamu and Ibrahim (2004) who reported that extra –Early Maize farmers over-utilized their fertilizer and labour, but under-utilized seed. In a related study carried out by Ugwu (1990) as cited by Usman *et al*. (2009) they reported that the danger, however, is that inefficiency in resource allocation could limit the level of return to an enterprise and in turn affect its attractiveness for more resource allocation. there is an urgent need to advise the farmers to scale down on the use of these resources or to expand the hectares devoted to QPM production.

**Conclusion and recommendations**

It could be concluded from the results that fertilizer, family labour and hired labour were inefficiently utilized because they were over utilized. This means that farmers should reduce the quantities of fertilizer, family labour and hired labour used in the production of QPM in order to bring about increase in output. Land and seeds were under-utilized as such further increase in their use by the farmers will lead to increase in output as well.

**Table 2:** Marginal Value Products (MVP) and Marginal Factor Cost (MFC)

| Input Variable | MPP | MVP | MFC | MVP/ MFC | Efficiency |
|---|---|---|---|---|---|
| Land (Ha) | 1188.659 | 59432.95 | 1000 | 59.43 | Under Utilization |
| Quantity of seed (kg) | 36.465 | 1823.25 | 200 | 9.11 | Under Utilization |
| Quantity of fertilizer (kg) | -0.059 | 2.95 | 100 | 0.029 | Over Utilization |
| Family Labour (Man-day) | -1.868 | 93.4 | 400 | 0.23 | Over Utilization |
| Hired Labour (Man-day) | -6.506 | 325.3 | 400 | 0.81 | Over Utilization |

**Source:** Field Survey, 2010 Py =Unit price of output = ₦50

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