ALLOCATIVE EFFICIENCY OF UPLAND RICE FARMERS IN IMO STATE, NIGERIA

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ABSTRACT

This study evaluated the allocative efficiency of upland rice farmers in Imo State, Nigeria. The specific objective was to measure the allocative efficiency of resource use in upland rice production. Data were collected using structured and validated questionnaire from proportionately and random selected 49 upland rice farmers from Imo State. Data were analyzed using the allocative efficiency model. The allocative efficiency indices for upland rice farmers were 6.43, 43.87, 0.75, 1.54, 180.4, -0.01 and 65.6 for labour, seed, fertilizer, agrochemicals, capital, land and utilities respectively, implying that none of the upland rice farmers were allocatively efficient in the use of the resource inputs indicated and underutilized resources of labour, seed, agrochemicals, capital and utilities, but over utilized resources of fertilizer and land. The hypothesis was accepted because the farmers were allocatively inefficient in resource use. The upland rice farmers were found to be small scale operators. There is need to bring more land under rice cultivation for improvement of the rice production.

Keywords: Allocative, efficiency, rice, upland, resource

INTRODUCTION

Rice with the botanical name Oryza Sativa is a staple crop that has gained global acceptance. It is consumed in most if not all the households in Nigeria and it is the second most important crop after wheat in terms of production according to Tijiani & Bakari, (2014). It is widely cultivated in all the agro ecological zones in Nigeria. There are two kinds of upland rice production and they are: modern rice production commonly practiced in fields either upland or lowland and traditional upland rice production established through drilling and intercropping (Erenstein, Lancon, Akande, Titilola, Akpokodje & Ogundele, 2003).

An important source of growth for the agricultural sector according to Asogwa, Umeh, & Penda (2011) is efficiency gain through greater technical and allocative efficiency by producers in response to better information and education. Therefore considerable efforts have been put forth to the analysis of farm level efficiency in developing countries (Samarpitha, Vasudev & Suhasini, 2016). Allocative efficiency therefore reflects the ability of a farm to use the inputs in optimal proportions given their respective prices.

Although rice production has increased during the last two decades in Nigeria, the country's production capacity has remained far below the national requirement and the optimum level of input utilization is yet to be attained (Ohajianya, *et. al.,* 2019). Nigeria's inability to meet her rice consumption needs through local production has resulted in high cash outlays for importation (Osanyinlusi & Adenegan, 2016). There has not been a documented report on allocative efficiency of upland rice production system in Imo State which is the essence of this study. Consequently,there was need to analyze the economic aspects of rice production systems in the study area to enhance productivity. It is also important that farmers use resources efficiently to achieve maximum yield. That is, if rice farmers can increase productivity with the same input quantities under efficient allocation and management of resources at the farm level; this will have great implication for overall national development and food security.

The broad objective of this study was to analyze the allocative efficiency of upland rice farmers in Imo State, Nigeria. The specific objective of the study was to measure the allocative efficiency of resource-use in the rice production systems

The following hypothesis was tested:

i. Farmers are allocatively inefficient in the use of resources.

LITERATURE REVIEW

Concept of Allocative Efficiency

a. Allocative efficiency according to Dilts (2004) is a state of the economy in which production represents consumer preferences; in particular, every good or service is produced up to the point where the last unit provides a marginal benefit to consumers equal to the marginal cost of producing.

Under these basic premises, the goal of attaining allocative efficiency can be defined according to some principle where some allocations are subjectively better than others. For example, an economist might say that a change in policy is an allocative improvement as long as those who benefit from the change (winners) gain more than the losers lose

An allocatively efficient economy produces an "optimal mix" of commodities. A firm is allocatively efficient when its price is equal to its marginal costs (that is, P = MC) in a perfect market.

The allocative efficiency, or price efficiency according to Farell (1957), cited in Kyriaki, (2010) refers to the ability of an economic unit to use the optimal amounts and ratios of inputs given their cost. In other words, we have allocative efficiency when given the input prices, an economic unit produces outputs that maximize revenue, or when the mix of inputs minimizes cost.

b. Allocative inefficiency: A production process may be allocatively inefficient in the sense that the marginal product of input might not be equal to the marginal cost of that input; allocative inefficiency results in utilization of inputs in the wrong proportions, given input prices (Okoye, Onyenweaku, & Asumugha, 2009).

Theory of Allocative Efficiency

Allocative efficiency according to Badunenko, Fritsch and Andreas, (2006) has traditionally attracted the attention of economists: what is the optimal combination of inputs so that output is produced at minimal cost? A firm is said to have realized allocative efficiency if it is operating with the optimal combination of inputs given prices of inputs

Example using diagram

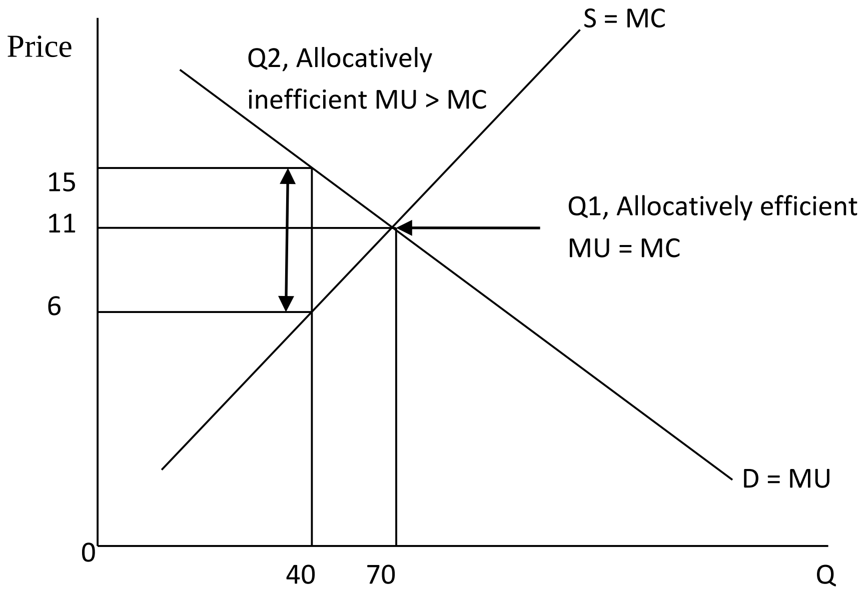

Fig. 1 Allocative Efficiency

At an output of 40 units, the marginal cost of the good is ₦6, but at this output, consumers would be willing to pay a price of ₦15. The price (which reflects the good's marginal utility) is greater than marginal cost – suggesting under-consumption. If output increased and price fell, society would benefit from enjoying more of the good (Tejvan, 2017).

Empirical Literature

Allocative Efficiency of Resource Use in Rice Production.

According to the findings of Kadiri, *et. al*., (2014), it was observed that MIC (Marginal input cost) is greater than MVP (Marginal value product) in all the variables observed which implied that, rice producers in the area did not attain optimal allocative efficiency. The result further showed that seed input (0.94) has the highest allocative efficiency, followed by family labour input (0.80). Hired labour (0.39), fertilizer application (0.35), and herbicide application (0.14) came in that order respectively, while land input (0.05) was the least allocative efficient input.

The results of the findings of Ajoma *et. al*., (2016) further confirms the result above. In their findings, estimates of allocative efficiency of production resources employed in rice farming were 282.90, 1.97, 241.80, 0.50, 223.12, and 194.05 respectively for farm size, labour, seed, fertilizer, pesticide and herbicide. The indices indicate that apart from fertilizer which was over-utilized, all other resources were under-utilized, implying suboptimal resource allocation in rice farming in Cross River state, Nigeria.

Analytical Literature

Allocative Efficiency Model

The allocative efficiency model is achieved when a given input is used to maximize profit given its price. Therefore allocative efficiency is achieved when input is used in such a way that marginal value product from the input equals it price or marginal cost (Ajoma, *et. al*., 2016).

The average physical product APP is calculated by; $APP_i = \frac{Y}{X}$ ……..(1)

Where Y and X are the mean of the output and input respectively.

The marginal physical product MPP was given as;

$MPP_{xi} = b_i \, . \, APP_i$ ……………….. (2)

where bi is the elasticity of the various inputs used

The Marginal value product (MVP) of production is given as:

$MVP = MPP_{xi} \, . PY_i$ ….……………(3)

P_Y is the output (paddy) price

P_{xi} is the price per unit of resource input used.

Marginal factor cost (MFC) is the price for each inputs used estimated as average acquisition cost.

$r = \frac{MVP}{MFC}$ ………………………………..(4)

Where: MVP = marginal value product.

MFC = marginal factor cost

R = numerical constant (In a way to substitute the efficiency focus will be based on the estimated value of R and its closeness to unity).

Allocative Efficiency is attained if: MVP = MFC…………..(5)

METHODOLOGY

Study Area

The study area is Imo State which is one of the 36 states of Nigeria and is in the South East region of Nigeria. Owerri is its capital and among the largest cities in the state. It consists of three agricultural zones namely: Owerri, Orlu and Okigwe and 27 Local Government Areas. It occupies the area between the lower River Niger and the upper and middle Imo River. The state has over 4.8 million people and the population density varies from 230 to 1,400 people per square kilometer (Achigbu & Ezeanosike, 2017). Christianity is the predominant religion. In addition to English being the official language, Imo state is a predominantly Igbo speaking state, with Ibo people constituting a majority (98%).

Imo State is bordered by Abia State on the East, River Niger and Delta State to the West, Anambra State on the North and Rivers State to the South (Amakom, 2017). The state lies within Latitudes 4°45'N and 7°15'N, and Longitude 6°50'E and 7°25'E with an area of around 5,100 sq km.The economy of the state depends primarily on agriculture and commerce. Besides Owerri, Imo state's major towns are Isu, Okigwe, Oguta, Orlu, Mbaise, Mbano, Mbieri, Orodo and Orsu.

The rainy season begins in April and lasts until October, with annual rainfall varying from 1,500mm to 2,200mm (60 to 80 inches).

An average annual temperature above 20 °C (68.0 °F) creates an annual relative humidity of 75%. With humidity reaching 90% in the rainy season. The dry season experiences two months of Harmattan from late December to late February. The hottest months are between January and March (imostateweb, 2023). The chief occupation of the local people is farming while according to Aziza Goodnews (2019), the cash crops include oil palm, raffia palm, rice, groundnut, melon, cotton, cocoa, rubber, and maize. Consumable crops such as yam, cassava, cocoyam and maize are also produced in large quantities.

The state has several natural resources including crude oil, natural gas, limestone lead, Calcium Cabornate and Zinc (Chikezie, Henri-Ukoha and Ibeagwa, 2020)

Profitable flora found in the State include iroko, mahogany, obeche, bamboo, rubber tree and oil palm. Additionally, white clay, fine sand and limestone are also found in the state.

Sample Selection

In this study, multi-stage sampling method was employed in selecting the respondents. The first stage was the purposive selection of the three Agricultural Zones (Owerri, Orlu, and Okigwe) in Imo State. The purposive selection was based on the fact that the three Agricultural Zones have areas where rice is grown using the upland system of production. The second stage was the purposive selection of one Local Government area from each zone (Owerri Zone: Ohaji; Orlu Zone: Ideato North and Okigwe Zone: Okigwe being the Local Government Areas that produce rice in large quantities in the Agricultural Zones) making a total of three LGAs. The third stage involved the random selection of one community from each of the three Local Government Areas, making a total of three communities (Mmahu in Ohaji for Owerri Zone; Ohiauchu in Aro Ndi Izuogu for Ideato North for Orlu Zone; and Umulolo in Okigwe for Okigwe Zone). The fourth stage involved the proportionate selection of upland rice farmers from each of the communities. The fifth and final stage was the random selection of rice farmers from each of the communities to obtain a total sample size of 49 upland rice farmers.

The model for determining the sample size is specified as follows:

$$n = \frac{N}{1+N(e^2)}$$

Where:

n = Sample size for the study

N = Total sampling frame

e = tolerable error level (at 5% level)

The proportionate sampling model is stated as follows:

$$n_h = N_h \left(\frac{n}{N}\right)$$

Where:

n_h= Sample size selected from each community

N_h = Sampling frame in each community

n = Sample size for the study

N = Total sampling frame

The distribution of sampling frame and sample size of the upland rice farmers in the communities is presented in Table 1.

Table 1: Distribution of Sampling Frame and Sample Size of Upland Rice Farmers

Name of Community	Sampling Frame	Sample Size
Mmahu	9	6
Ohiauchu in Arondizuogu	56	38
Umulolo	8	5
Total	**73**	**49**

Source: Survey Data: 2023

Data Collection.

Primary data were collected through a structured questionnaire. The information that were supplied by the upland rice farmers provided the bulk of the primary data. Data were collected by trained enumerators who were personally supervised by the researcher herself.

Secondary data were obtained from several sources, including Agricultural Development Projects (ADPs) annual journals, Textbooks (on statistics, allocative efficiency, production economics etc), and Journals relating to the topic.

Data Analyses

The stated objective was achieved using the allocative efficiency model (as stated above) applied to the results of the production function fitted to the data. The production function is implicitly specified as follows;

$Y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, e)$ where:

X_1 = labour (mandays)

X_2 = seed (kg)

X_3 = fertilizer (50kg bag)

X_4 = Agrochemicals (litres)

X_5 = capital (Depreciated value of fixed inputs (₦)

X_6 = land rent (₦)

X_7 = utilities (₦)

e = error term.

Four functional forms of the production function; linear, semi-log, double-log and exponential were fitted so as to select the lead equation on the basis of having the highest value of coefficient of multiple determination (R^2), highest F-value and highest number of significant variables. It is expected *a priori* that r (numerical constant) must be equal to one.

Test of Hypothesis

The results of the production function fitted to achieve the objective was used to derive allocative efficiency which was used to test the hypothesis.

Decision Rule:

Allocative Efficiency is attained if: MVP = MFC = 1 or r = MVP/MFC = 1. If $r \neq 1$, it suggests that resources are not efficiently utilized or farmers are inefficient in resource use.

RESULTS AND DISCUSSIONS

Measurement of the Allocative Efficiency of Resource Use in the Rice Production Systems

To achieve this objective of measurement of allocative efficiency of resource use in upland rice production, the resource inputs were first fitted with the output of rice in multiple regression analysis and in four functional forms of linear, semi-log, double-log and exponential. This is to obtain the coefficients of regression or Marginal Physical Products (MPP).

The results of the multiple regression analysis for the upland rice farmers are presented in Table 2.

Table 2: Results of Four Functional forms of multiple regression analyses on the relationship between Output of upland rice farmers and resource inputs

Explanatory Variables	Linear Function	Semi-log Function	Double-log Function	Exponential Function
Constant	217.2291	169.0091	125.1064	104.2291
Labour (X_1)	18.2913	2.7132	0.0812	0.0053
	(2.9969)*	(3.0053)*	(2.5859)*	(3.3125)*
Seed (X_2)	0.9244	0.7115	0.0749	0.0053
	(1.0491)	(1.1679)	(3.4358)*	(3.3125)*
Fertilizer (X_3)	17.8127	3.8466	0.0683	0.0045
	(3.5194)*	1.2834)	(3.1916)*	(3.4615)*
Agrochemicals (X_4)	10.2888	2.5928	0.0712	0.0089
	(1.0717)	(1.0722)	(3.3585)*	(1.2899)
Capital (X_5)	16.1347	1.0398	0.0022	0.0058
	(1.1212)	(0.9972)	(1.1579)	(1.2341)
Land (X_6)	-12.0614	-2.4471	-0.0014	0.0037
	(-1.1003)*	(-3.0891)*	(-2.8001)*	(-1.6087)
Utilities (X_7)	11.0317	0.8738	0.0008	0.0088
	(2.6477)*	(2.4076)**	(1.6001)	(2.8387)*
R^2	0.4216	0.3916	0.7408	0.6122
F-value	12.2915*	10.7482*	48.1039*	26.5022*
Sample size (n)	49	49	49	49

Figure in Parentheses are t-ratios
*Significant at 1% level
**Significant at 5% level
Source: Survey Data, 2023

The results show that the double-log functions gave the lead equations having produced the highest values of coefficient of multiple determinations (R^2), highest number of significant variables and highest F-values. The results of the double-log functions were therefore used for analyses and discussions. The value of R^2 were 0.7408 for the upland rice farmers which implies that about 74% of the variations in rice outputs for the upland rice farmers were accounted for by the independent variables included in the multiple regression models.

The coefficients of Labour (X_1), Seed (X_2), Fertilizer (X_3) and Agrochemicals (X_4) were statistically significant at 1% level in upland rice production system. However, land rent (X_6) was significant at 1%. These significant variables are the resource inputs affecting output of rice farmers in the study area. The coefficients of Capital (X_5) and Utilities (X_7) were not statistically significant at 5% level. These non-significant variables are not factors that influence output of rice farmers in the study area.

The coefficients of labour, seed, fertilizer, agrochemicals and utilities were positive and significant, which implies that increases in the magnitude of these variables leads to increase in output of rice farmers. The coefficient of land rent was negative and significant which implies that increase in land rent leads to decrease in rice output in the study area. The marginal physical products or coefficients of the double-log functions were used in the computation of allocative efficiency of resource use.

Table 3: Computation of Allocative Efficiency of Upland Rice Farmers

Resource Inputs	MPP/Production Elasticities	Sample Means	MVP	Factor Prices	Allocative Efficiency (AE)
Labour (Mandays)	0.0812	186	6658.4	1034.72	6.43
Seed (kg)	0.0749	30	6141.8	140	43.87
Fertilizer (50kg bag)	0.0683	4	5600.6	7500	0.75
Agrochemicals (Litres)	0.0712	5	5838.4	3800	1.54
Capital (Depreciation) (₦)	0.0022	3065	180.4	1	180.4
Land (Ha)	-0.0014	1.4	-114.8	1100	-0.01
Utilities (₦)	0.0008	1850	65.6	1	65.6

Source: Survey Data, 2023
(N/B: MPP = Marginal Physical Product, MVP = Marginal Value Product. The sample means are from cost and return analysis. Output Mean = ₦ 82,000)

The results of the computation of allocative efficiency in upland rice production is presented in Table 3. The table shows that the ratios of marginal value product (MVPx) to marginal factor cost (MFCx) show that labour, seed, fertilizer, agrochemicals, capital, land and utilities have values of 6.43, 43.87, 0.75, 1.54, 180.4 – 0.01 and 65.6 for the rice farmers. Within the limits of statistical error, none of the upland rice farmers are allocatively efficient in the use of the resource inputs indicated. The implication of these values for labour, seed, agrochemicals, capital and utilities is that these resources were underutilized, while those of fertilizer, and land were over utilized. This may suggest that there still exists the possibility of increasing rice output under the existing level of technology through the use of higher levels of labour, seed, agrochemicals, capital, utilities and reduction in the amounts of fertilizer and land use in upland and swamp rice production systems.

This finding agrees with that of Ohajianya (2006) in his study on resource use efficiency of land owners and tenants in food crops production in Imo State, Nigeria.

Hypothesis Testing

The results of the allocative efficiency indices showed that the upland rice farmers were allocatively inefficient in resource use. Therefore, the hypothesis was accepted since none of the rice farmers in the study area was found to be allocatively efficient in resource use.

CONCLUSION AND RECOMMENDATIONS

The study analyzed allocative efficiency of upland rice farmers in Imo State, Nigeria. None of the upland rice farmers was found to be allocatively efficient in the use of labour, seed, fertilizer, agrochemical, capital, land and utilities. The upland rice farmers underutilized resources of labour, seed, agrochemicals, capital and utilities, but over utilized resources of fertilizer and land.

The following recommendations were made based on the findings of this study

1. The different middle men in the supply and marketing of farm inputs especially the Ministry of Agriculture and ADP should be encouraged and motivated to provide inputs (e.g. rice seeds, fertilizer, agrochemicals etc) timely and make the inputs more accessible and affordable by the rice farmers.
2. The upland and swamp rice farmers were found to be small scale operators. There is need to bring more land under rice cultivation for improvement of the rice production. The government should encourage increased rice production by formulating policies guided to make more land available to rice farmers for production.

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