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Allocative and Technical Efficiencies Among Small Holder Cocoyam Farmers in Cross River State Central Agricultural Zone, Nigeria

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Abstract

The authors investigated the allocative and technical efficiencies of resources used in cocoyam production among small scale farmers in Central Agricultural Zone of Cross River State, Nigeria. The objectives of the study were to: determine the allocative efficiency of resources used in cocoyam production in the area and determine also the technical efficiency of resources used in cocoyam production in the area. Primary data were used to conduct the study. Statistical tools employed were allocative efficiency index (AEI) and stochastic frontier production function (SFPF). Results of the allocative efficiency index showed that farm size (x1), fertilizer (x3) and herbicide (x5) were all found to be grossly underutilized since their allocative efficiency index were greater than one (1) and their marginal value product (MVP) were greater than their marginal factor cost (MFC). However, Labour (x2) alone was over-utilized. The following were recommended cocoyam farmers are advised to improve on their use of farm resources like land, fertilizer, herbicide and seeds as they were found to be under-utilized and labour should be controlled in such a way that it can be used in other farm enterprises.

Keywords: Allocative; Technical; Efficiency; Resources and cocoyam.

1. Introduction

Agriculture production is subject to great many uncertainties as a result of farmers' efficiencies in the use of productive resources. Yet more people in Nigeria earn their livelihood from this sector than from all other sectors put together. In rural Nigeria, households that depend on income from agriculture (either self-employed or as agricultural labour) accounted for nearly 70% of population [1]. Depending on the farm size; the cocoyam production can be a main source of family income or can provide subsidiary income and gainful employment to farmers. The cash income and food the crop provides in turn helps to contribute to poverty alleviation in the country.

Agricultural development in Nigeria has been constrained by resource use related problems. The sustainability of production and productivity based agricultural growth depends on proper resource use. However, inefficiency in the use of available farm resources may be one of the causative factors for high input low output of cocoyam in Nigeria. On this, Adebayo [2] contended that improving the efficiency of farm resources has remained a problem to small holder farmers, whose production process is characterized by low productivity, low income and low capital investment. According to Ojo [3] resources used in agriculture are limited in supply relative to demand for them. The author further noted that these limited resources are further in constant degradation and depletion. It therefore makes economic sense if these resources are efficiently used; this would emerge as an effective strategy to achieving goals of sustainable cocoyam production. There is threat to irreversible degradation and misuse of resources used in cocoyam production, especially in the face of zero management practices. Umoh [4] reported that this phenomenon is worrisome because of the concern of feeding a rapidly growing human population and reducing hunger. Efficiency analyses are issues of interest given that the overall productivity of an economic system is directly related to the efficiency of production of the components within the system [5]. The author further noted that the analysis of efficiency is generally associated with the possibility of farm producing a certain optimal level of output from a given bundle of resources or a certain level of output at a least cost. According to Adegeye and Dittoh [6], there are three types of resource efficiency which include:

Technical Efficiency: This is the ability of farms to employ the best practices in the production process, so that not more than the necessary amount of a given set of input is used in producing the best level of output. This means that for resource to be efficient, the ratio of the total output to that of total input must be equal to one. Shown mathematically as:

$$TE = \frac{OQ}{OP} \quad \text{(i)}$$

In the context of the stochastic frontier production function technical efficiency is obtained by:

$$TE = Y_i^*/Y_i = f(X_i;\beta)\exp(V_i - U_i)/f(X_i;\beta)\exp(V_i) \quad \text{(ii)}$$

$$=\exp(U_i) \quad \text{(iii)}$$

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Where Y_i* is the frontier output. Technical efficient farms are those that operate on the production frontier and the level by which a farm lies below its production frontier is regarded as the measurement of technical efficiency.

Allocative Efficiency: [6] further described allocative efficiency as a micro-economic concept. It is the choice of optimum combination of inputs consistent with relative factor prices. A farm firm according to them is allocativelly efficient in the use of a given factor or resource, if the farm is able to equate the value of marginal product of the factor price or is able to maximize profit with respect to that factor price. Considering a factor resource, a firm is price efficient when the ratio of the value of marginal product of a given factor to it unit price (a proxy for marginal factor cost) is equal to unity.

Economic Efficiency: According to Ojo [3] economic efficiency is an overall performance of a firm and is equal to the product of technical efficiency (TE) and allocative efficiency (AE) i.e.

EE = TE + AE (iv)

Cocoyam is a traditional crop and a cultural foodstuff in Nigeria. It has not received much research attention in spite of its great adaptability to varying farming systems and its nutritive and commercial food values Cocoyam originated from Asia and about forty (40) species are mostly grown in West Africa [7]. Cocoyam, both *Xanthosoma* species and *Colocasia* species belong to the family (Aracea). The crop is a stem tuber that is widely cultivated in the tropical regions of the world and is a well-known food plant which has a long history of cultivation, with Nigeria being the largest producer in the world and accounting for about 40.0% of the total world output [8]. Cocoyam contributes significantly to carbohydrate content of the diet of individuals especially in developing countries, and provides edible starchy storage corms or commels. According to Edet and Nsikak [9] cocoyam though less important than other tropical root such as yam, cassava and sweet potato, yet a staple food in most part of tropics and sub tropic. It contains calcium, phosphorus, vitamins A and B. Plethora of studies on cocoyam has been in the areas of production, nutrient constituent, yields and suitability of soils. Researchers have hardly given attention to efficiency of resources used in the production of the crop, this study is predicated on this premise and designed to achieve the following objectives:

i. determine the allocative efficiency of resources used in cocoyam production in the area
ii. determine also the technical efficiency of resources used in cocoyam production in the area.

2. Research Methodology

2.1. The Area of Study

The study was conducted in the Central Agricultural Zone of Cross River State, Nigeria.The zone lies between latitude 5^o - 25^o N of the equator and longitude 8^o -25^o E of the Greenwich meridian. It is bounded to the North by Yala and Ogoja local government areas (L.G.A's) to the south by Biase L.G.A, to the East by the Republic of Cameroon and to the West by Ebonyi State. It has a land mass of 8762 square kilometers, with an annual rainfall of 2942mm to 3424mm per annum [10].The zone has an average temperature is 29^o C. Farmers in the central agricultural zone are predominantly arable crop farmers, though some farmers cultivate tree crops like orange, mango cocoa and oil palm. Major crops grown in the area are yam, maize, cassava, melon, cocoyam, plantain, pepper, cocoa and rice. [11]. The Central Agricultural Zone of Cross River State is made of six local government areas (Abi, Yakurr, Obubra, Ikom, Etung and Boki).

2.2. Sampling Techniques and Size

Multi-stage sampling technique was adopted in the selection of 100 respondents which involved three stages as follows: first stage was the purposive selection of four L.G.A's based on large production of the crop. These included Etung, Obubra, Ikom and Yakurr L.G.As. Second stage was the random selection of 3 villages from each of the L.G.As earlier selected making a total of 12. The villages were Ajasor, Agbokim and Etome from Etung L.G.A, Ochon, Ofodua and Oyadama from Obubra L.G.A, Ofutop, Okuni and Akam from Ikom L.G.A and Nkpani, Ekori and Idomi from Yakurr. The third stage involved the random selection of 100 respondents from the four (4) L.G.As, ie. 25 from each L.G.A.

Table-1. Summary of Sample size

	LGA	Villages Selected	No.of Villages	No. respondents
	Etung	Ajasor, Agbokim, Etome,	3	25
	Obubra	Ochon,Ofodua, Oyadama	3	25
	Ikom	AkparabongOfutop,Okun	3	25
	Yakurr	Nkpani, Ekori Idomi	3	25
Total	4		12	100

Source: field survey data 2017

2.3. Method of Data Collection and Analytical Tools

Primary data were used for this study. The data were obtained from structured questionnaires and personal interviews and designed based on the research objectives. Objectives one and two were realized with the use of allocative efficiency index (AEI) and stochastic frontier production function model (SFPF) respectively.

2.4. Model Specification

2.4.1. Allocative Efficiency Index

The allocative efficiency index (AEI) was used to determine the efficiency of resources used in production of cocoyam. This was done by computing the ratio of the marginal value product (MVP) to the marginal factor cost (MFC) used in production. The ratio used in determining the efficiency of resources was calculated as:

$$AEI=MVP \text{ or } K= MVP, MFC\ P_x \quad (v)$$

Where: AEI or K= Allocative efficiency index MVP=Marginal value product of the various inputs. (MPP x P_y) MPP= marginal physical product, P_y = unit price of output, MFC= Marginal factor cost (cost of unit input) (P_x).

Rule of thumb: if the ratio is equal to one, it indicates that the resource is efficiently or optimally utilized. If the ratio is greater than one, it is indicative that the resource is underutilized, if the ratio is less than one, it indicates that resource is excessively utilized. Mathematically, this can be represented as:

MVP =1; the resource used is optimally efficient,
MVP >1; the resource used is underutilised
MVP < 1; the resource used is overutilized

2.4.2. Stochastic Frontier Production Function Model (SFPF)

This study used the stochastic frontier production function model (SFPF) to analyze the respondents' technical efficiency. The SFPF is the maximum feasible or potential output that can be produced by a production unit such as farm, given certain level of input and technology. The production technology of the cocoyam farmers was assumed to be specified by the Cobb –Douglas frontier production function. Following Effiong, (2004) as cited in Ettah and Nweze [5], the Cobb-Douglas SFPF model used is explicitly specified as:

$$l_nY = \beta_o + \beta_1 l_n x_1 + \beta_2 l_n x_2 + l_3 L_n x_3 + \beta_4 l_n x_4 + \beta_5 l_n x_5 + \beta_6 l_n x_6 + - U_1 \quad (vi)$$

where:

l_n = logarithm to base
Y = output of cocoyam (Kg)
x_1 = cocoyam seedlings (kg)
x_2 = hired labour (₦/ man day)
x_3 = fertilizer (kg)
x_4 = agrochemicals (₦)
x_5 = farm size (Hectare)
x_6 = capital inputs (₦)
β_o = constant term
β_0-β_2..... β_6 = Regression coefficients
U_i= random errors which were assumed to be independent and identically distributed having N (0, δ^2)

3. Result and Discussion

Table-2. Estimation of the Allocative Efficiency

Explanatory Variable	Mean	Marginal value product MVP = B. ($\bar{y}/\bar{x}$) py	Marginal factor cost (MFC)	Allocative efficiency index (AEI)= MVP/MFC	Description of efficiency index
Output(Y)	.768.509				
Land Size	0.703	16,089.826	5000	3217.9652	Under-utilized
Labour	114475	-0.040094	1000	-4.01	Over-utilized
Capital	53415	949566720	10000	9.495672	Under-utilized
Fertilizer	104.91	1168001	5000	233.6002	Under-utilized
Herbicide	2.408	2137238	2000	1068619	Under-utilized
Seeds planted	4.564	1571031	200	7855	Under-utilized

Source; field data 2017

Table 2 shows the result of the estimated allocative efficiency of the productive resources used in cocoyam production in the study area. The result indicates that farm size (X_1) has allocative efficiency index (AEI) of 3217.9652 which is greater than one, this implies that farm size was under-utilized since the marginal value product (MVP) of 16,089.826 is greater than the marginal factor cost (MFC) of 5000. This shows that cocoyam farmers in this area are still operating at a region of increasing return to scale which is the stage one of the production regions. This agrees with the findings of Ettah and Nweze [5], who reported that Nigeria has cultivatable land area of about 88.3 million hectares; only 34.2 million hectares (21.4%) of the cultivatable lands are being cultivated pointing to the underutilization of cultivable land.

Labour (X_2) has an allocative efficiency index of -4.03 which is less than one. This reveals that labour was over-utilized. Its marginal value product (MVP) of -0.040094 is less than the marginal factor cost (MFC) of 1000. This could be as a result of availability of family labour as a result of large household size of farmers in the study area. This finding agrees with that of Chukwu, *et al.* [7] who reported that the preponderance of labour for cocoyam production in Nigeria is because of large family sizes of farmers. Capital (X_3) was also under utilized as its allocative

efficiency index was 9.495672 which is greater than one (1) and the marginal value product (MVP) is greater than the marginal factor cost (MFC) 1000. This implies that farmers have limited capital to purchase farm input, this can negatively affect maximum production. This finding conforms to the work of Ashagidigbi, *et al.* [12] who reported that smallholder farmers lack capitals to engage in farming. Farmers can increase their capital through sourcing for loans from formal or informal financial institutions.

Fertilizer (X_4) has an allocative efficiency index of 233.6002 which is greater than one (1) and also the marginal value product (MVP) 1168001 is greater than the marginal factor cost (MFC) 5000. This implies that fertilizer was under-utilized. Most cocoyam farmers in the Central Agricultural Zone of Cross River State still rely on their traditional methods of farming with little or no use of fertilizer for cocoyam cultivation. This finding agrees with that of Edet and Nsikak [9] who reported underutilization of NPK and Super Phosphate fertilizer in Niger State, Nigeria. Herbicide (X_5) has allocative efficiency index of 1068619 which is greater than one (1) and it implies that herbicide was underutilized since the marginal value product (MVP) 2137238 is greater than the marginal factor cost (MFC) 2000. This shows that cocoyam farmers are still using their manual method of weeding which is stressful and time consuming. This findings is in line with the work of Ukoha, *et al.* [13] who reported that herbicides, seed and fixed inputs were underutilized in farm production in Nigeria.

Cocoyam seeds (X_6) were found to be under utilized in that its allocative efficiency index 7855 is greater than one (1) and its marginal value product (MVP) 1571031 is greater than the marginal factor cost (MFC) 200. This reveals that farmers in the study area underutilize seeds planted per hectare.

Table-3. Frequency Distribution of Technical Efficiency indices

Technical Efficiency Indix	Frequency	Percentage (%)
< 0.20	6	2.5
0.21- 0.40	9	3.75
0.4 – 0.60	17	7.08
0.61 – 0.80	66	27.5
0.81 – 1.00	142	59.16
Total	240	100
Maximum TE	0.9374	
Minimum TE	0.2024	
Mean Technical Efficiency	0.7635	

Source: field data 2017.

The summary of the technical efficiency scores for the respondent in table 3 above reveals that their technical efficiency is less than (<) 1.0, indicating that all the farmers were producing below the maximum efficiency frontier. A range of technical efficiency is observed across the sampled frame and the spread is large. The best farmer had technical efficiency of 0.94 (or 94%), while the least farmer had a technical efficiency of 0.20 (or 20%). On the average, farmers were able to obtain 0.76 (or 76%) potential output from their given combination of production input. Hence, their observed output was about 25.2% short of the maximum frontier output.

The implication of this result is that an average cocoyam farmer requires 25.2% i.e. (1-0.7635/0.9374) x 100 costs saving to attain the status of the most efficient level of cocoyam production in the area. While the least performing farmers would need (1-0.2024/0.9495) x 100 cost saving to be efficient. This implies that additional income can be made from the production of cocoyam by using more of the inputs technically by the farmers. This justify the finding of Eke-Okoro [8], who reported that cocoyam farmers underutilized farm size, fertilizer, herbicide and maize seeds while labour was over utilized.

3.1. Conclusion and Policy Recommendations

The study was carried out to determine allocative and technical efficiencies of resources used in cocoyam production among small scale farmers in Central Agricultural Zone of Cross River State, Nigeria. The study set out to realize the following objectives: determine the allocative efficiency of resources used in cocoyam production in the area and determine the technical efficiency of resources used in cocoyam production in the area.

Primary data were used to conduct the study, obtained through structured questionaire. Statistical tools used to realize the objectives of the study included allocative efficiency index (AEI) and stochastic frontier production function (SFPF) were used study. Result of the allocative efficiency index showed that farm size (x_1), fertilizer (x_3) and herbicide (x_5) were all found to be grossly underutilized since their allocative efficiency index were greater than one (1) and their marginal value product (MVP) were greater than their marginal factor cost (MFC). However, Labour (x_2) alone was over-utilized. The following were recommended cocoyam farmers are advised to improve on their use of farm resources like land, fertilizer, herbicide and seeds as they were found to be under-utilized and labour should be controlled in such a way that it can be used in other farm enterprises.

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