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Empirical Analysis of the Allocative Efficiency of Cashew Production in Oyo State, Nigeria

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Abstract

This study was carried out in Oyo State, Nigeria to determine the allocative efficiency of cashew production in the study area to solve the problem usually encountered by the cashew farmers on the allocation of farm inputs on the cashew farms. Therefore, in order to increase cashew production and farmers' income, efficient allocation of the farm inputs at the farmers' disposal is of necessity, hence this study. Multi-stage sampling procedure was used to sample sixty respondents. The first stage was the purposive selection of Ogbomoso zone, the second stage was the purposive selection of two local government areas due to their level of cashew production and the last stage involved the random selection of thirty cashew farmers from each of the local government areas. Data analysis was carried out using descriptive statistics and stochastic Frontier Production Function. The result showed that cost of fertilizer (₦9.05), cost of harvesting (₦0.03) and the cost of bagging (₦0.03) have significant effects (p >0.01) on the productivity of cashew farmers. The marginal analysis result showed that all the input variable costs are under-utilized given the fact that all the marginal value products are greater than the marginal factor cost of inputs considered. The study recommends that in order to improve efficiency in resource allocation in cashew production, more of the variable inputs needs to be allocated to bring about an increase in output of cashew and to generate more revenue for the cashew farmers in the study area.

Introduction

Cashew *(Anacardium occidentale* L.) is a member of the family Anacardiaceae, it is an evergreen tree with spreading large canopies which can attain the height of 9 - 13 metres. It was believed to have been introduced to Nigeria between 15th and 16th Centuries by Portuguese explorers. The tree was mainly used in afforestation schemes for the control of erosion most especially in the Eastern part of Nigeria (Salau *et al*., 2017). Large scale production of cashew however started in the early 1950s when 8,000 hectares of commercial plantations were established at Oghe, Oji in the present Anambra State, Mbano in lmo State, 824 hectares commercial plantation was established in Upper Ogun and other parts of Oyo State. Cashew grows in almost all the ecological zones of Nigeria on estimated hectares of about 40,000. Of this total hectare, about 24,000 ha, that is 60 percent, is owned by the peasant farmers, the rest by government agencies (Oluyole *et al*., 2016a).

Cashew is next to cocoa as export crop and a major source of cash income to many smallholder farmers in the central and northern parts of Nigeria (Adeigbe *et al*., 2015). Presently, like Cocoa, Cotton, Palm produce and Sesame; Cashew provides considerable contributions to Gross Domestic Product, National Income and generation of foreign exchange to the country. Among the tropical nuts, cashew has emerged as the most popular dry nut currently in the world (Malhotra *et al*., 2017). Consumption of cashew in the world rose by 25.70 percent between 2011 and 2015 for the top 20 consuming countries and is expected to continue with the increase due to the positive health reports and beneficial diets (International Nut and Dried Fruits Council (INC), 2017). Furthermore, according to Gro intelligence (2016), the emergence of new food types from tree crops (especially cashew) and the changing

consumer taste for dairy alternatives like cashew milk in the developed world accounts for why the world demand for cashew nuts has gone up.

Cashew production in Nigeria is mainly a smallholder activity and provides income to farmers and all other agents involved in its production and marketing. Resources used in any production activity are regarded as the inputs that drive the production process. In cashew farming, the resources required include the seeds, land, labour, capital, fertilizer and pesticides. The main technology applied is the traditional cutlass and hoe technology which has been blamed for the low output levels of farmers. A resource or input is said to be efficiently utilized when it is put to the best use possible and at minimum cost allowable. In a bid to help farmers increase productivity and income, the focus is usually on whether farmers are using better and improved technologies. It is however necessary to investigate whether these farmers are even making maximum use of what is available to them in terms of inputs so that the stakeholders involved in agriculture will be convinced that the new technologies they intend to introduce to farmers will be used efficiently and cost effective to boost output. Farmers might use resources rationally, but not at the economic optimal level. As the aim of every agribusiness firm is to maximize profit while minimizing cost, it is pertinent to determine the efficiency of resource allocation (Wongnaa and Ofori, 2012).

Allocative efficiency is a measure of how an enterprise uses production inputs optimally in the right combination to maximize profits (Inoni, 2007). Thus, the allocative efficient level of production is where the farm operates at the least-cost combination of inputs. According to Chiona (2011), allocative efficiency measures a firms' ability to choose inputs mix that reduces the cost of production given the best available technology. This implies that intensifying the use of inputs based on their prices will require accurate and timely information about the price movement or trend of that input to reduce or minimize inefficiencies that may arise from unobserved prices.

Most studies have been using gains obtained by varying the input ratios based on assumptions about the future price structure of products say maize output and factor markets. This study follows Chukwuji *et al*., (2006) reviewed assumptions used by farmers to allocate resources for profit maximization. Such assumptions included, farmers choose the best combination (low costs) of inputs to produce profit maximizing output level; there is perfect competition in input and output markets; producers are price takers and assumed to have perfect market information; all inputs are of the same quality from all producers in the market. Thus, for the farm to maximize profit, under perfectly competitive markets, which requires that the extra revenue (Marginal Value Product) generated from the employment of an extra unit of a resource must be equal to its unit cost (Marginal Cost = unit price of input) (Chukwuji, *et al*., 2006). In summary, if the farm is to allocate resources efficiently and maximize its profits, the condition of Marginal Value Product (MVP) = Marginal Cost (MC) should be achieved.

In Nigeria, due to the rise in population, the demand for agricultural products especially cashew is continually rising. This has resulted in the need to allocate resources efficiently in cashew production.

The objectives of the study were:

(i) describe the socio-economic characteristics of cashew farmers in the study area;
(ii) determine how efficiently resources are being allocated on the cashew farm;
(iii) determine the problems encountered by farmers in cashew production; and,
(iv) make policy recommendations.

Materials and Methods

Study area

This study was carried out in Oyo State, which is one of the 36 states in Nigeria. The state is located in Southwest Nigeria. Oyo State covers an area of approximately 35,743 square kilometers and occupies about 34% of the country's total land area of about 927,769 square kilometers. It lies between latitude 7º2' and 9º1' north and longitude 2º4' and 4º3' east of Osun State. It is bounded in the west by Republic of Benin, east by Osun State,

north by Kwara and Niger states and south by Ogun State (OYSADEP, 2019).

Oyo State enjoys a tropical climate with prominent wet and dry seasons. There are 33 local government areas in the state. The economy of the state is based on agriculture and the major occupation of the people is farming (OYSADEP, 2019). The climatic condition of the state is tropical and it favours the production of wide varieties of agricultural products. The wet season generally occurs between April and October, while the dry season occurs between November and March. Its vegetation is evergreen, which favours many food crops most especially cashew crop.

Sampling procedures or techniques

Multi-stage sampling procedure was used to sample the respondents from the agricultural zones in Oyo state. Oyo state has four (4) agricultural zones, namely Ibadan/Ibarapa zone, Oyo zone, Ogbomoso zone and Saki zone. In the first stage, Ogbomoso zone was purposely selected based on their highest intensity in cashew production. The second stage involved purposive selection of two local government areas (Surulere and Oriire) from Ogbomoso zone. The last stage involved the random selection of thirty cashew farmers from each of the local government areas giving a total of sixty (60) respondents that was used for the study.

Well-structured questionnaires were administered to the respondents in the study areas. Data collected were analysed using descriptive statistics and stochastic frontier production function (SFPF).

Method of data analysis

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 its price or marginal cost. The Average Physical Product APP is calculated by;

$$APP_i = \frac{Y}{X} \quad \text{.....(1)}$$

where Y and X are the mean of the output and inputs respectively.

The Marginal Physical Product MPP was given as;

$$MPP_{xi} = b_i \times APP_i \quad \text{.....(2)}$$

Where bi is the elasticity of the various inputs used

The Marginal Value Product (MVP) of production is given as:

$$MVP = MPP_{xi}.P_{yi} \quad \text{.....(3)}$$

P_{yi} is the output (cashew) price

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

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

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

Where: MVP = marginal value product

MFC = marginal factor cost

r = numerical constant

In a way to substitute the efficiency hypothesis, focus was based on the estimated value of r and its closeness to unity.

Allocative Efficiency is attained if:

$$MVP = MFC \quad \text{.....(5)}$$

The relative percentage change in MVP (Marginal Value Product adjustment) of each resource required in order to obtain optimal allocation of resources. i.e. $r = 1$ or $MVP = MFC$ which was estimated using equation below:

$$D = (I - \frac{MFC}{MVP}) X 100 \quad \text{.....(6)}$$

where: D = absolute value of percentage change in MVP of each resource. Economic optimum occurs where MVP=MFC. If r ≠ 1, it suggests that resources are not efficiently utilized. Adjustment could therefore be done in the quantity of inputs employed and costs in the production process to restore r = 1 (Abiola *et. al*., 2016).

Estimate of the parameters in the stochastic production frontier function

The maximum likelihood estimates (MLE) of the Cobb-Douglas Stochastic Production Frontier Model for cashew production are presented in equation (7). The result of the analysis are, however shown in equation (8) and explicitly shown in Table 2. Armah (2018) in his study also employed the use of Cobb-Douglas functional

form in the estimation of the Stochastic Production Frontier to find out the productivity and resource-use efficiency of cashew production in Ghana. This is because of its attractive feature of simplicity and its few restrictions.

$$LnY = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + \beta_6 LnX_6 + \beta_7 LnX_7 + V_i - U_i \ldots\ldots\ldots (7)$$

where: Ln= Natural logarithm to base 10

Y = Total cashew output of the farmer in kilogram per hectare (kg/ha)

B_s = The parameters to be estimated

X_1 = Cost of weeding

X_2 = Cost of fertilizer measured in kilogram per hectare (kg/ha)

X_3 = Cost of chemical used measured in litres per hectare (litres/ha)

X_4 = Cost of pruning

X_5 = Cost of harvesting

X_6 = Cost of transportation

X_7 = Cost of bagging

V_i = Random error which are assumed to be independently and identically distributed.

U_i = Non negative random variable associated with allocative inefficiency of production.

$$LnY = 11.40 + 0.02LnX_1 + 9.05LnX_2 + 0.03LnX_3 + 0.03LnX_4 + 0.03LnX_5 + 0.03LnX_6 + 0.03LnX_7 + 0.12 + 0.03 \ldots\ldots (8)$$

Results and Discussion

Table 1 below shows the socio-economic characteristics of the cashew farmers on gender, educational status, age, farming experience among others were analyzed as these variables to a large extent affect the farmers' level of how resources are allocated efficiently on the cashew farm**.**

The results analysis revealed that 68.30% which constitute the majority are male cashew farmers with females being 31.70%. Kuwornu *et al.* (2012) and Wongnaa and Ofori (2012) got similar results of male dominance in cashew farming in Ghana. This was because females were not able to cope with laborious activities involved in cashew farming. They are also responsible for detaching the nuts from the fruits.

Majority of them (36.70%) have primary education while 15.00% were university graduates of indicating that the farmers are fairly educated and hence the ability to understand and be trained on efficient resource allocation of inputs. The mean age of the farmers was 56 years and its standard deviation was 12.24, this implied that cashew farming is being practiced by middle age farmers who are still strong to carry out farming activities. This shows that cashew farmers belong to the middle age classes, who are physically fit to withstand the stress and risks involved in cashew production, and are more mentally alert to embrace new techniques of cashew production. The mean year of cashew farming experience was at 26 years and its standard deviation was 12.02.

Most (96.70%) of the farmers were married. This indicates a higher chance of involving family labour in cashew production. The mean household size is at 8.00 while its standard deviation was 3.49. The mean of household members assisting in farm work was 4.00, while its standard deviation was 1.76. Most (97.00%) of the farmers have between 1 - 10 hectares or more of cashew farm size while 3.30% of the farmers have less than 1 hectare of cashew farm size and its mean is 4.00. Only 23.30% of the farmers have cashew as their major occupation, 33.30% are involved in farming of another crops, 15.00% are livestock breeders, 25.00% are traders, 1.70% are salary workers and 25.00% are artisans. This implied that cashew farmers were people with high responsibility who needed income from other sources to meet up with their financial obligations.

The results presented on table 2 below shows a goodness-of–fit measure for linear regression models or the coefficient of determination, denoted R^2 of 74.64 which indicated that 74.64% of the variation in the dependent variable is explained by the independent variables included in the model. The result further shows an F-value which is significant at 1% level. This indicates that the model used is of a good fit. Critical input of importance to cashew production in the study area includes cost of fertilizer, cost of harvesting and cost of bagging of cashew. This shows that these inputs are important in cashew production and need to be efficiently allocated in order to generate more revenue in the study area.

The costs of weeding, cutlass and farm boot are not significant at 1% level, indicating that weeding, cutlass and farm boot are not critical factors in cashew production in the study area. However, the coefficients are positive meaning

Table 1: Socio-economic characteristics of cashew farmers in Surulere and Oriire LGA of Oyo State

Variables	Frequency	Percentage (%)	Mean	Standard Deviation
LGA				
Surulere	32	53.30		
Orire	28	46.70		
Total	60	100.00		
Gender				
Male	41	68.30		
Female	19	31.70		
Total	60	100.00		
Age (years)				
35 – 45	15	25.10		
46 - 56	14	23.30		
57 – 67	19	31.70	56	12.24
68 – 78	10	16.90		
79 – 89	2	3.00		
Total	60	100.00		
Years of cashew farming experience				
<10	1	1.70		
10 – 20	24	40.00		
21 – 30	18	30.00	26	12.02
31 – 40	9	15.00		
41 and above	8	13.30		
Total	60	100.00		
Marital Status				
Single	2	3.30		
Married	58	96.70		
Divorced	0	0.00		
Widowed	0	0.00		
Total	60	100.0		
Level of Education				
None	5	8.30		
Primary	22	36.70		
Junior High School	8	13.30		
Senior High School	15	25.00		
Tertiary	9	15.00		
Adult Education	1	1.70		
Total	60	100.00		
Household size (persons)				
<5	1	1.70		
5 – 9	51	84.90		
10 – 14	5	8.30	8	3.49
15 – 19	1	1.70		
20 -24	2	3.40		

Table 1 Contd.

Household members assisting in farm work (persons)				
1 – 3	24	40.00		
4 – 6	30	50.00	4	1.76
7 – 10	6	10.00		
Total	60	100.00		
Size of cashew farm (ha)				
<1	2	3.30		
1 – 2	8	13.30		
2 – 4	20	33.30	4	
4 – 6	11	18.30		
6 – 8	9	15.00		
8 – 10	3	5.00		
>10	7	11.70		
Total	60	100.00		
Cashew farming as major occupation				
Yes	14	23.30		
No	46	76.70		
Total	60	100.00		
Other major occupation apart from cashew farming				
Farming of another crop	20	33.30		
Livestock rearing	9	15.00		
Trade	15	25.00		
Salary work	1	1.70		
Artisans	15	25.00		
Total	60	100.00		

Source: Field survey, 2022

that there is a positive effect of weeding, the use of cutlass and farm boot on the yield of cashew.

Furthermore, the result of the analysis showed that the costs of chemical and pruning are not significant at 1% level and had negative coefficients on cashew production indicating that an increase in the cost of the two items will lead to a decrease in cashew output. They are not significant at 1% level due to the fact that the items (especially chemical) are not items that are constantly being used in the operation of cashew production.

The elasticity represents the ratio of the percentage change in cashew output to the percentage change in the respective level of the resource allocated in cashew production. The sum of the elasticity (when $b_1 + b_2 + \ldots + b_7$ equal one, there is constant return to scale, above one indicates increasing return to scale and less than one indicates decreasing return to scale).

The elasticity of production is given by the addition of all the coefficients. This sums up to 9.65 which shows that a 100.00% increase in the input used for cashew production has the capacity to increase cashew production by 9.65%. From the study, the elasticity is greater than one (9.65) implying that the production is in an increasing return to scale. Thus, the cashew farmers ought to allocate more inputs to their cashew farm for more productivity in Oyo State.

From table 3 below, the efficiency of resource allocation was obtained from the estimated

Table 2: Efficient allocation of resources on the cashew farm in Surulere and Oriire LGA of Oyo State calculated in cost (naira)

Output of farm	Coefficient	Standard Error	Z	P>|z|	[95% Confidence Interval]	
Cost of weeding	0.02	0.01	1.41	0.16	-0.01	0.04
Cost of fertilizer	9.05	0.14	65.66	0.00	8.78	9.32
Cost of chemical	-0.03	0.02	-1.52	0.13	-0.06	0.01
Cost of pruning	-0.03	0.02	-1.43	0.15	-0.07	0.01
Cost of harvesting	0.03	0.01	2.77	0.01	0.01	0.05
Cost of transport	0.03	0.02	1.18	0.24	-0.02	0.07
Cost of bagging	0.03	0.02	-2.66	0.01	-0.08	-0.01
Cost of cutlass	0.11	0.07	1.62	0.11	-0.02	0.25
Cost of farm boot	0.03	0.04	0.80	0.43	-0.04	0.09

Log likelihood = -228.42, Prob > Chi^2 = 0.00, R^2 = 74.64 *, ** and *** denote t-test significant at 1%, 5% and 10% levels respectively. Source: Field survey, 2022 (n = 60)

equation by comparing the Marginal Value Product (MVP) of a particular input with the Marginal Factor Cost (MFC) of that input. The MVP of an input was obtained by the following equation:. $MVP_{xi} = MPP_{xi}\ x\ P$

where MPP_{xi} is the Marginal Physical Product and P is the unit price of the output (Q). The output price of cashew was found to be ₦218 per kilogram as at the time of survey. The MFC for an input is defined as $MFC_{xi} = MPP\ x\ r_{xi}$

where r_{xi} is the unit price of input $x_{i.}$ The regression coefficients, which are equal to the elasticity coefficients in Cobb-Douglas production function, were used to measure the return-to-scale in the production of cashew. As regards the resource allocative efficiency, whenever $MVP_{xi} > MFC_{xi}$, there is under-utilization of resource $x_{i,}$ but when $MVP_{xi} < MFC_{xi}$, there is over-utilization of resource x_i. When $MVP_{xi} = MFC_{xi}$, there is optimum utilization of resource xi. Table 3 shows the analysis of how efficiently the resources are allocated among cashew farmers in the study area.

Table 3 shows the marginal value product and the marginal factor cost analysis of the study on input allocative efficiency in the study area. The analysis shows that all the input variable costs are under-utilized given the fact that all the marginal value products are greater than the marginal factor cost of inputs considered. Thus, these findings are in line with the study of Oluyole *et al*., (2016b) on economic analysis of the input use efficiency among cocoa farmers in Taraba State, Nigeria which shows that the inputs of cocoa farmers were under-utilized.

Also, Shanmugam and Venkataramani (2006) used the marginal analysis procedure to achieve their objectives in estimating the economic efficiency of the resource use. According to Oladeebo and Ezekiel (2006), estimating the resource efficiency using the marginal analysis procedure depends on a comparison between a computed MVP of the input variables and their respective acquisition cost or Marginal Factor Cost (MFC).

Table 4 below shows the distribution of respondents with regards to the constraints militating against cashew production in the study area shows that the major cashew production constraints faced by farmers in the study area were: inadequate credit (100.00%), land tenure problems (60.00%), lack of improved planting materials (91.70%), inadequate rainfall (40.00%), high cost of labour (95.00%), poor road network (80.00%), unstable price of produce (100.00%), high cost of fertilizer (63.30%), high cost of transportation (85.00%), difficulty in accessing extension services (86.70%) and skill acquisition (90.00%). This finding is in consonance with Oladejo (2015) and Pelemo *et al.*, (2019), who stated that inadequate capital and lack of good roads were some of the major problems faced by cashew marketers in Nigeria and Agbongiarhuoyi *et al*., (2008) who reported that insufficient price information, poor quality of nuts and inadequate

Table 3: Marginal value product and marginal factor cost for cashew farm in Surulere and Oriire LGA of Oyo State

Input	Input Price P_x	MPP/β_{xi}	MFC_{xi}	MVP_{xi}
Weeding	144.60	0.02	2.43	3.67
Fertilizer	105.35	9.05	953.06	1972.16
Chemical	87.70	-0.03	-2.45	-534.97
Pruning	74.20	-0.03	-2.21	-6.48
Harvesting	156.60	0.03	4.45	6.19
Transportation	107.70	0.03	2.81	5.69
Bagging	117.80	0.03	3.07	5.69
Cutlass	37.00	0.11	4.24	24.97
Farm boot	55.95	0.03	1.59	6.17

Source: Survey data, 2022

Table 4: Constraints Faced by Cashew Farmers in Surulere and Oriire LGA of Oyo State

Constraints	Frequency	Percentages	Ranking (%)
Inadequate credit	60	100.00	1
Unstable price of produce	60	100.00	2
High cost of labour	57	95.00	3
Lack of improved planting materials	55	91.70	4
Skill acquisition	54	90.00	5
Difficulty in accessing extension services	52	86.70	6
High cost of transportation	51	85.00	7
Poor road network	48	80.00	8
High cost of fertilizer	38	63.30	9
Land tenure problems	36	60.00	10
Inadequate rainfall	36	60.00	11

Source: Field survey, 2022

extension on cashew production were the major constraints faced by cashew producers in Kogi State.

Conclusion and Recommendation

This study concludes that the inputs used by the cashew farmers in Surulere and Oriire LGA of Oyo State, Nigeria are underutilized. Therefore, cashew farmers in the study area should continue to increase the use of variable inputs that will eventually bring about an increase in output of cashew thereby increasing farmers' income and hence the livelihood of the farmers.

It is thus recommended that government should provide access to credits facilities to the farmers, deploy more agricultural economists and extension agents to train cashew farmers on resource (inputs) allocation.

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