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ALLOCATIVE EFFICIENCY: A CASE STUDY OF SMALL-SCALE DATE PALM FARMERS IN DUTSE AND KIYAWA LGA OF JIGAWA STATE, NIGERIA

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ABSTRACT

The study aimed at determining the allocative efficiency of small-scale date palm farmers in Dutse and Kiyawa LGA of Jigawa State, Nigeria. A multi-stage sampling procedure was employed to a total of one hundred and thirteen (113) small-scale date **palm** farmers. Data were collected using a structured questionnaire and analysed using Frequency and percentages, and stochastic frontier Cobb-Douglas cost function. The result from the stochastic frontier cost function reveals the gamma (γ) parameter as 0.994, this implies that about 99.4% of the variation in output among date palm farmers in the study area was due to cost inefficiencies. The estimated elasticity for the number of trees and quantity of pollen were significant at 0.01% probability level. The mean allocative efficiency was 0.50 this shows that 50% of the farmers are allocative efficient. The result revealed that years of experience is the only variable that does not contribute to allocative inefficiency. It was concluded that date palm production is a profitable enterprise, but 50% of the small-scale date palm farmers are allocative inefficient. The study recommends that government should enact a policy to attract youth into date palm production and the government should give farmer's education high consideration for efficiency in date production.

Keywords: Allocative, Date-palm, Efficiency, Farmers and Stochastic

INTRODUCTION

For a country of over 200 million citizens striving to grow economically and to meet its quest for food sufficiency, lot of efforts are put in research to increase agricultural production and productivity. Date palm provides food and raw materials for domestic use, livestock supplements, building materials, and also has a lot of industrial potential. The date palm tree tolerates relatively harsh climatic and soil conditions under which no other crop could give a reasonable return (Chukwuemeka, 2013). Date fruits were the dried fruits most producing globally, in 2020/2021 and on average over the last 5 years Saudi Arabia was the leading producer of dates, accounting for 21% of global production (INC statistics, 2020-2021). Iraq was the leading exporter in 2019 with 62% of the country share destined to India and 32% to the United Arab Emirates. According to Ataga *et al.* (2012) in Nigeria a female date tree if matured can produce 10 to 75kg of date fruits per year. Thus, date palm will provide income and improve livelihood to growers and enhance rural transformation with an expected increase in demand for food resulting from a population exceeding 200 million inhabitants.

According to AbdulQadir *et al.* (2011), Nigerian annual production of date palm was 21,000MT with Kano and Jigawa States as the major producers of date palm. The national consumption of dates in 2009 was estimated at 89,580 metric tonnes which placed the country among the world top consumers of date palm fruit (Sani *et al.*, 2010). The expenses incurred in farm production for the input and labour employed is the cost of production, Cost efficiency is the ability of a farmer to produce the maximum level of output possible at a minimum cost outlay under a given

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technology. The *allocative efficiency* in economic theory measures a firm's success in choosing an optimal set of inputs with a given set of input prices; this is distinguished from the technical efficiency concept associated with the production frontier, which measures the firm's success in producing maximum output from a given set of inputs.

Nigeria has the advantage of two fruiting season per year and the high rate of production has not yet been sustained. The cultivation of date is still at the subsistence level, with farmers having few tree-stands on their farms and two or more stands in their homesteads. However, due to dearth of information, the production and productivity of date palm in Nigeria is not captured in any literature recently. The date palm farmers are not aware of the cost implications of growing date palm, this brought about the need for measuring cost efficiency in date palm farming, to find out whether the farmers are allocatively efficient or allocatively inefficient. Therefore, Stochastic Frontier Analysis (SFA) methodology was chosen for the estimation of a costs efficiency frontier to provide an individual efficiency analysis of small-scale date palm production. This study, therefore, sets to address the gap in the cost or allocative efficiency among small-scale date producers.

MATERIALS AND METHODS

The Study Area

Dutse and Kiyawa L.G.A. are situated in Jigawa State Nigeria latitude $11^0$42'04"North - $11^0$47'05"North and longitude $9^0$20'31"East - $9^0$36'30"East (Jigawa State, 2017). Dutse and Kiyawa share a border, as well as an inter-state border with Kano and Bauchi state. This provides a unique opportunity for inter-state trading in date palm fruit produced in the area and other surrounding states Annual rainfall is estimated to be between 600mm - 1,000mm with an average of about 650mm over the last few years. Temperature ranges from 10^0C during the harmattan season to about 42^0C during the dry season and annual mean relative humidity of 30.8%.

Sampling Procedure

A multi-stage sampling technique was used in this study. In stage one, two wards were purposively selected from Dutse and Kiyawa local government area due to concentration of date palm farmers, in the stage two, three villages were purposively selected from each ward. A simple random sampling technique was employed to select 113 for small-scale date palm producers.

Data analysis

Simple descriptive statistical (frequency and percentages) were used to describe the allocative efficiency level of the farmers. The stochastic frontier cost function was used to determine the cost efficiency and inefficiency among small scale date palm producers.

Model specification

Measures of efficiency: Stochastic frontier functions (SFF) was used. All of the specifications have been expressed in terms of production function, with the U_i as technical inefficiency effects, which cause the firm to operate below the production frontier. If we wish to specify stochastic frontier cost function, we simply alter the error term specification from (V_i - U_i) to (V_i + U_i). for example, this substitution would transform the production function defined by Cobb-Douglas into the cost function. i.e.

$$Y_i = X_i\beta + (V_i + U_i), i = 1,\ldots N, \quad \ldots(1)$$

Where; Y_i is the (logarithm of the) cost of production of the i-th firm;

x_i is a k X 1 vector of (transformation of the) input prices and output of the i-th firm;

β = is a vector of unknown parameters;

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the V_i are random variables which are assumed to be iidN($0,\sigma v^2$), and independent of the U_i which are non-negative random variables which are assumed to account for the cost inefficiency in production, which are often assumed to be iidN ($0,\sigma u^2$).

In this cost function U_i now defines how far the firm operates above the cost frontier. If allocative efficiency is assumed, the U_i is closely related to the cost of inefficiency. The corresponding cost frontier of Cobb- Douglass functional form was used as the basis for estimating the allocative efficiencies of the small-scale date palm farmers in Jigawa State. The explicit form of the cost frontier production form is specified as follows;

$$\ln C_{ij} = \alpha_0 + \alpha_1 \ln P_{1i} + \alpha_2 \ln P_{2i} + \alpha_3 \ln P_{3i} + \alpha_4 \ln P_{4i} + (V_{ij} + U_{ij}) \quad \text{... (2)}$$

Where;

C = Production cost (₦), P1 =average price of trees (₦/stand), P2 = Labour (₦/man-days), P3 =Cost of organic fertilizer (₦), P4 = Cost of Pollen (₦).

The allocative efficiency of individual farmers is defined in terms of the ratio of the predicted minimum cost (Ci) to observed cost (Ci*). That is AE = Ci*/Ci = exp (Ui)

$$AE = C_i/C_i^{*} = (U) = e^U \quad \text{...(3)}$$

Allocative Inefficiency

Allocative inefficiency will be estimated with the secondary variables as the independent variables;

$$\mu_{ij} = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 \quad \text{... (4)}$$

μ_{ij} = denotes the Allocative inefficiency of the ith farmer, Z_1 = denotes age of date palm farmers (years), Z_2 = represent house hold size of date palm farmers (number), Z_3 = represent educational status (formal =1, otherwise = 0), Z_4 = denotes years of farming experience of the ith farmer (years), Z_5 = represent member of association (member = 1, otherwise =0) Z_6 = represent access to land (purchase = 1, otherwise =0) δ_o = constant term δ_1 to δ_1 = unknown parameter to be estimated.

RESULT AND DISCUSSION

Stochastic Frontier Cost Function

The cost function is the same as that of the production function, but the cost function Ui defines how far the farm operates above the cost frontier. Also, Schmidt and Lovell note that the log-likelihood functions for the cost function are the same as that of the production frontier except for a few sign changes (Frontier 4.1). The result of the analysis for the cost function of the small-scale date palm production is presented in Table 1. The maximum likelihood estimates (MLE) of the stochastic frontier Cobb-Douglas cost function presented in Table 1 revealed that the coefficient for Sigma-square (δ^2) is positive but not significant and its estimated coefficient is 0.302, this depicts the goodness of fit and correctness of the distributional form assumed for the composite error term in the model. The gamma (γ) coefficient estimate was significant at 1% level of significance. This shows that 99.4% of the total variations in the date palm output encountered by the respondents that are unexplained by the cost function are due to the cost inefficiencies. The result revealed that the estimated coefficients of the parameters for the cost function are all positive except for the cost of date palm trees which is negative and not significant. The labour cost, cost of organic fertilizer and cost of pollen have a direct and positive relationship with the total cost of production. The coefficient of labour cost and cost of pollen are statistically significant at 1%, this implies that labour cost and cost of pollen are the important components of the date palm production that determine the cost of production.

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Table 1: Estimation of the stochastic frontier cost function for date palm production

Variables	Coefficient	Sd. Error	T-values
Constant	0.468	0.321	1.46
Cost of Tree (₦)	-0.018	0.068	-0.271
Labour cost (₦)	0.767	0.029	25.8***
Cost of Org. Fertilizer (₦)	0.012	0.025	0.468
Cost of Pollen (₦)	0.218	0.029	7.49***
Gamma	0.994	0.007	14.7***
Sigma-Square	0.302	0.253	1.190
log-likelihood function	91.9		
LR test	52.5		

$\sigma^2 = \sigma_v^2 + \sigma_u^2$, $\gamma = \sigma_u^2 / \sigma^2$Significant levels: ***=1%, **=5%, *=10%

Allocative Efficiency

Allocative efficiency is concerned with choosing optimal sets of inputs. A firm is allocative efficient when production occurs at a point where the marginal value product is equal to the marginal factor cost. In the cost function, the efficiency estimate is taking a value between zero (0) and one (1) and infinity. The Allocative efficiency indices measure the rate at which resources are allocated in optional proportion is presented in Figure 1. The result shows that 70% of the of small-scale date palm farmers fall within 1.00 – 1.04 efficiency level which is very close to the efficiency frontier. The small-scale date palm farmers have a minimum allocative efficiency of 1.00 and a maximum of 1.19, while the mean allocative efficiency was 1.04, this implies that the majority of the small-scale date palm producers in the study area are allocatively efficient and this could be because most of the small-scale date palm producers possesses matured trees and matured trees required less maintenance cost and also the farmers had certain level of farming years of experience in date palm, which may influence the possible combination of cost minimisation in date palm production. These may include using the necessary inputs for managing the date palm trees.

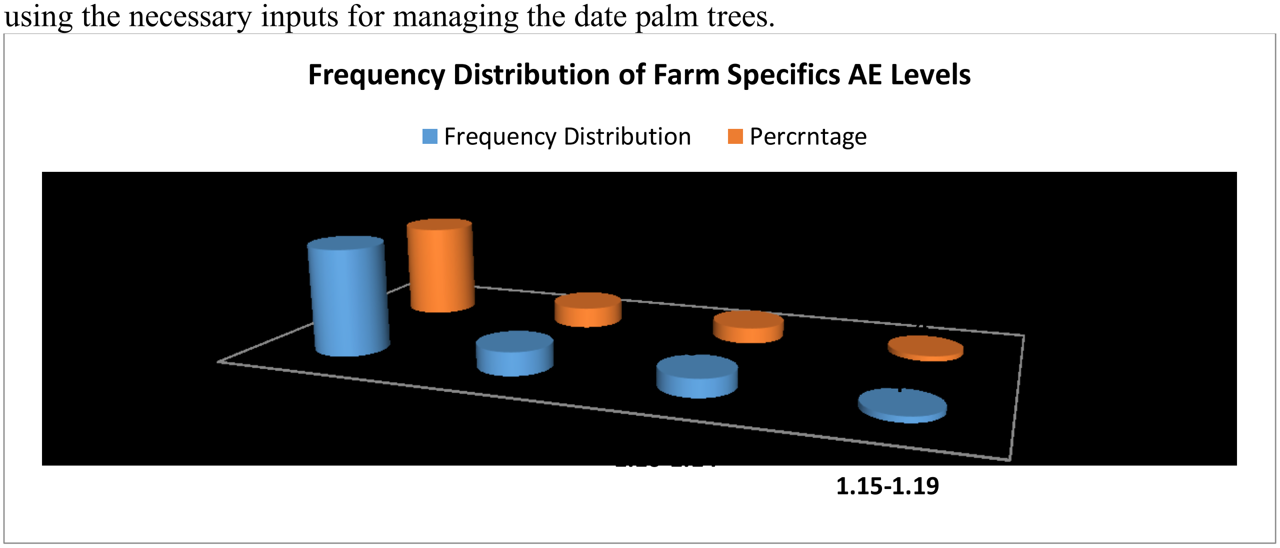

Figure 1: *Frequency Distribution of Farm Specifics AE Levels*

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Allocative Inefficiency Estimates for Small-Scale Date Palm Production

Allocative inefficiency was estimated using secondary variables as the independent variables. The positive sign shows that the variable contributes to Allocative inefficiency while the negative sign indicates that the variable contributes to allocative efficiency. The estimated result of the inefficiency model depicts that all the variables included are positive except for years of experience, therefore all contributed to the allocative inefficiency and reduces allocative efficiency among small scale date palm producers, and this conforms to the *a priori* expectation. The farmers' years of experience were negative, and this shows that, this variable is not negatively contributing to allocative efficiency among date producers. The coefficients of the positive variables were both non-significant. This indicates that they have a negative non-significant influence in the date palm production in the study area, this finding conforms to that of Mounir and Mohamed (2006) and Girei *et al.* (2013).

The expectation is that allocative efficiency would increase with the increase in the level of formal education, farmers group membership, years of experience and access to land as these could have helped the farmers in sourcing information on new technologies and adoption of such technologies, (Iwala *et al.,* 2006).

Table 3: Estimation of inefficiency in date palm production

Variables	Coefficient	Sd. Error	T-values
Constant	-8.279	7.385	-1.121
Farmers' Age (years)	0.035	0.029	1.176
Household Size (No.)	0.058	0.043	1.330
Level of Educational	0.074	0.062	1.188
Experience (years)	-0.003	-0.005	-0.670
Group Membership	1.453	1.317	1.103
Mode of access to land	0.383	0.326	1.174

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study it could be concluded that most of the small-scale date palm farmers in the study area are allocative efficient which affirms their level of enthusiasm in the date production with a good level of cost minimization. In light of the findings of this research, the following recommendations were made to encourage small-scale date palm farmers to increase their income from date palm production.

The result reveals that age is a factor that can significantly influence the allocative inefficiency in date palm production. Hence, it is recommended that policy should be provided to empower more youth into date palm production for sustainability and adaptation of new technologies. New technologies and resources should therefore be channelled toward the youth who are engaged in date palm farming or are willing to go into date palm production. Hence, farmers should look for good agricultural practices in date palm production to reduce the over-utilization of inputs in date palm farming, as this will improve their allocative efficiency.

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