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Technical Efficiency of Turmeric (*Curcuma Longa L.*) Production in Kaduna State, Nigeria

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ABSTRACT

Purpose: *The study analyzed the technical efficiency of turmeric production in Kaduna State, Nigeria.*

Methodology: *Data for the study were collected with the aid of structured questionnaire from 33 turmeric farmers from Jabba, Kachia, Jama'a, and KagarkoLocal Government Areas of Kaduna State. The collected data were analyzed using descriptive statistics and stochastic frontier production function.*

Findings: *Analysis of the results revealed that the mean technical efficiency of turmeric farmers in the study area was 28% with majority (66.7%) having technical efficiency level of ≤0.303. Also, analysis of the stochastic frontier production function revealed that the socio-economic characteristics of turmeric farmers in the State significantly influenced their technical efficiency.*

Unique contribution to theory, practice, and policy: *It was recommended that campaigns aimed encouraging more youths into turmeric production as well as discouraging large household size among turmeric farmers should be promoted in the study area; and policies aimed at increasing the resource use efficiency of turmeric farmers in the State and hence their farm output should include the farmers' specific efficiency factors in their formulation.*

Key words: *Turmeric, Technical Efficiency, Production, Stochastic Production Function, Kaduna State, Nigeria*

INTRODUCTION

Turmeric (*Curcuma longa L.*) commonly referred to as 'Queen of Spices' is a spice made from the roots of turmeric plant. According to Nwaekpe*et al*. (2015), turmeric is also known as 'the golden spice of life' and is one of the most essential spice used as an important ingredient in culinary all over the world.

Turmeric major active ingredients oleoresin and turmeric oil according to Amadi*et al*. (2017), are used for a wide range of culinary, confectionary, and pharmaceutical purposes. Globally, the world production level for turmeric is between 11-16 tonnes annually (Uchechukwu, 2020) with Nigeria accounting for about 3% of this global annual production and occupying the position of the fourth largest producer of the crop (Uchechukwu, 2020).

Though Nigeria can play a leading role in the production of turmeric considering the prevailing favourable soil and climatic conditions in the country, India still maintains the largest producer of the crop accounting for over 78% of the annual production for turmeric (Uchechukwu, 2020). Studies on inefficiency in resource use can help boost turmeric production in Nigeria as such estimates on the extent of inefficiency can help to decide whether to improve efficiency or to develop new technology.

Several studies have emerged in the country to estimate the efficiency of agricultural production at the farm level, no attempt has been made to measure the efficiency of turmeric crop. It is with this backdrop that a stochastic production frontier with a technical inefficiency model was applied to investigate the technical efficiency and the factors affecting production inefficiency of turmeric farming in Kaduna State, Nigeria.

The study specifically aimed to:

i. describe the technical efficiency level of small-scale turmeric farmers in the study area; and
ii. estimate the determinants of technical inefficiency among small scale turmeric producers in the study area.

METHODOLOGY

The Study Area: The study was conducted in Kaduna State, Nigeria. The State has four agricultural zones namely: Samaru, Lere, BirninGwari and Maigana zones. Samaruagricultural zone comprises of seven Local Government Areas (L.G.As) namely: Jema'a, Zango-Kataf, Sanga, Kaura, Kagarko, Kachia and Jaba. Samaru agricultural zone was chosen for the study. The choice of Samaruagricultural zone was essentially on the basis of its high potentials for turmeric production, processing and marketing (KADP, 2010).

Kaduna State which has 23 LGAs and a land area of about 7,627.20sqkm is located in the northern part of Nigeria and is located between latitudes 100211N to 10.330N and longitudes 70451 to 7.750E (Wikipedia, 2008). It shares common borders with Abuja in the South-East and six other states namely: Katsina, Kano, Zamfara in the North, Nasarawa and Plateau in the North-East and Niger in the North-West. The hottest months are March-April while the coldest are December-January. Rainfall is heaviest in the south and decreases northwards with an annual mean rainfall varying between 942mm and 1000mm which lasts from May till October (National Agricultural Extension and Research Liaison Services (NAERLS, 2002).

The vegetation in the State is divided into Northern Guinea Savannah in the North and Southern Guinea Savannah in the South. In the south, savannah woodland with trees like shear butter and locust bean predominate, while in the north, Baobab, silk cotton and date palm are predominant (Wikipedia, 2010). The people of the State are engaged in agricultural production activities. The main crops which are grown in the state include Maize, Sorghum, Soya bean, Millet, Rice, Groundnut, Yam, Sugar cane, ginger, and turmeric. By the 2006 census of the National Population Commission, Kaduna State had a population of 6,113,443 people and a projected population of 7,030,469 people in the year 2011, using the stipulated growth rate of 2.5% per annum (Indexmundi, 2012).

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Sampling Technique and Data Collection: The multi-stage sampling technique was employed to select a sample size of 33 turmeric farmers. In the first stage, four Local Government Areas namely Jabba, Kachia, Jama'a, and Kagarko were purposively selected due to the intensity of turmeric activities in them. The second stage involved the random selection of turmeric producing farm households.

The data for the study were collected with the aid of a well-structured questionnaire. The questionnaire was designed to provide answers on the socio-economic characteristics of turmeric producers, the quantity and cost of inputs used, as well as their farm output. Due to the low level of literacy among the farmers in the study area, trained enumerators were sourced among the extension staff of the Agricultural Development Project (ADP) in the State, to administer the questionnaire to the farmers.

Analytical Technique: The collected data were analyze using descriptive and stochastic production function. Objective (i) was achieved using descriptive statistics such as frequency table, percentage, and mean; objective (ii) was achieved using stochastic production function.

Stochastic Frontier Model

In order to achieve objective ii, Cobb-Douglas production frontier function was estimated using the Maximum Likelihood Techniques. From the production frontier, the corresponding dual cost frontier was determined. These two frontiers are the basis for deriving farm level efficiency measures. The stochastic production frontier was written as:

$\ln Y_i = \ln\beta_0 + \beta_j \ln X_{ij} + V_i - U_i$ ……. (1)

Where:

ln = the natural logarithm

Y_i = Farm output (kg)

X_{ij} = Vector of farm inputs (X1 – X5) used

X_1 = Farm Size (hectares)

X_2 = Quantity of seeds (kg)

X_3 = Fertilizer (kg)

X_4 = Total Labour used (man hours) and

v = random variability in the production that cannot be influenced by the farmer;

μ = deviation from maximum potential output attributable to technical inefficiency.

β_o = intercept;

βi= vector of production function parameters to be estimated;

i = 1, 2, 3, n farms;

j = 1, 2, 3, m inputs.

***A priori* expectation** was that $b_{1,}$ $b_{2,}$ $b_{3,}$ $b_4 > 0$ while $b_5, < 0$

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The inefficiency model was used to achieve objective (ii). It was specified as:

$\mu_i = \delta_o+\delta_1Z_1+\delta_2Z_2+\delta_3Z_3+\delta_4Z_4+\delta_5Z_5+\delta_6Z_6+\delta_6Z_6+\delta_6Z_6+\delta_7Z_7$ …….. (2)

Where,

u_i= technical inefficiency effect of the ith farm;

Z_1 = age of farmer in years;

Z_2 = sex (single 1, other =0)

Z_3= marital status (married 1, other 0)

Z_4= educational level of farmer in years of formal education completed;

Z_5 = major occupation (farming =1, other 0)

Z_6 = household size (no.);

Z_7 = membership of cooperative society (member=1, non-member=0)

δ_0 = constant

$\delta_1 – \delta_6$ = parameters to be estimated.

These socio-economic characteristics are included in the model to investigate their influences on the technical efficiency of resources employed by participating entrepreneurs. The ß and δ coefficients are un-known parameters to be estimated along with the variance parameters δ2 and γ. Aigner*et al.* (1977), Jondrow*et al.* (1982), and Green (1993) defined δ2 and λ as:

$\delta_2 = \delta_2v + \delta_2u$ and $\lambda = \delta u/ \delta v$

Battese and Corra (1977) defined γ as total variation of actual output towards its frontier such that $\gamma = \delta_2u/ \delta_2$

Consequently, $0< \gamma <1$ and one may obtain the estimated value of γ

The δ_2, and γ, coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumptions made on the distribution form of the error term. The δ_2 indicates the goodness of fit and the correctness of the distributional form assumed for the composite error term. The γ, indicates that the systematic influences that are unexplained by the production function are the dominant sources of random errors.

In the context of the stochastic frontier production function, the technical efficiency of an individual farmers is defined as the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by the farmers. Thus, the technical efficiency of farmers i is: TEi = exp (-µi), that is

$TE_i = Y_i/Y_i^* = f(X_i; \beta) \exp(V_i – \mu_i) / f(X_i; \beta) \exp(V_i) \exp(-U_i)$ …… (3)

Where

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TE_i = Technical efficiency of farmer i; Y_i = observed output and; Y_i* = frontier output. The technical efficiency of a farmer ranges from 0 to 1. Maximum efficiency in production has a value of 1.0. Lower values represent less than maximum efficiency in production.

V_i = is independently and identically distributed random errors, having N (0, σ^2) distribution.

U_i= allocative inefficiency

Technical efficiency= 1- TE_i.

RESULTS AND DISCUSSION

TECHNICAL EFFICIENCY ESTIMATES OF TURMERIC FARMERS IN KADUNA STATE

The technical efficiency estimates summarized in Table 1 indicate that small-scale turmeric farmers in Kaduna State had technical efficiencies varying from 10 to 99 percent with a mean of 28 percent.

The wide range of values indicates large variation in performance across farms. The implication of this result is that turmeric farmers in the study area were not utilizing their production resources efficiently.

Table 1: Distribution of Respondents by Technical Efficiency in Kaduna State

Technical Efficiency	Frequency	Percentage (%)
< = .303	22	66.7
0.31 – 0.60	7	21.2
0.61 – 0.90	3	9.1
0.91+	1	3.0
Total	33	100
Maximum	0.99	
Minimum	0.01	
Mean	0.28	

Source: Field Survey (2020)

The foregoing result suggest that most of the turmeric farmers in the study area had not yet reached the production frontier, indicating that they were not obtaining maximum output possible from their given quantum of inputs. In other words, technical efficiency among the respondents could be increased by 72 percent in the study area through better use of available resources given the current state of technology. This would enable the farmers obtain maximum

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output possible from their given quantum of inputs and hence increase their farm incomes, thereby facilitating expansion in turmeric production in the study area.

The implication of the foregoing result is that if the average turmeric farmer in the sample were to achieve the technical efficiency level of his or her most efficient counterpart, he or she would realize only 1 percent more productivity. By using simple analogy, this implies that turmeric productivity in the study area could be greatly enhanced using current production technology, if key factors that currently constrain production efficiency are adequately addressed. Specifically 66.7% of turmeric farmers have technical efficiency of < = .30, 21.2% of turmeric farmers had technical efficiency of 0.31 - 0.60, 9.1% had technical efficiency of 0.61 – 0.90 and 3.0% of turmeric farmers had technical efficiency of 0.91+. None of the farmers attained the frontier efficiency. The most efficient farmer had technical efficiency of 99 percent. The respondent was a male, 52 years, married with 2 years of farming experience in the business of turmeric. The farmer also had household size of 9 persons and had only primary education. Turmeric production was his secondary occupation since he was involved in other businesses. The least efficient farmer had technical efficiency of 0.1 they both require 0.10 and 0.99 more efforts to get to the frontier efficiency respectively.

Determinant of Technical Inefficiency of Turmeric Farmers in Kaduna State.

Result of the diagnostics statistics presented in Table 2 indicated that there was technical inefficiency in turmeric production in the study area. This was confirmed by the significant value of the gamma coefficient. A gamma (γ) value of 0.999 indicates that 99.9% of the variation in the output of turmeric production by the respondents was attributed to technical inefficient effects alone, while 0.1% was due to random effects. In addition the generalized likelihood ratio was significant at 1% level, suggesting the presence of one sided error component. This means that inefficiency factors were significant in the stochastic frontier model. As indicated in Table 2, the estimated sigma square (σ^2) was significant at 1 percent level of probability indicating goodness of fit and correctness of the specified distribution assumption of the composite error terms.

The estimated coefficients of the technical inefficient effects model indicated that age, education and household size, had positive significant influence on technical inefficiency of turmeric production in Kaduna State. Sex, farm experience and membership of organization reduced significantly the effect of technical inefficiency of small-scale turmeric production in the study area. The coefficient of sex, farm experience and membership of organization were negative implying that technical inefficiency effect in turmeric production in Kaduna State will decline with increase in the variables. Inevitably, age, education, household size had negative effect on technical efficiency of small-scale turmeric production in the study area. This is important for achieving effective utilization of inputs in small-scale turmeric production. This finding disagrees with those of Karthick, Alagumani and Amarnath (2013) who reported that education and farm experience are negative and significantly reduce technical inefficiency of turmeric production in the study area.

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This means that educated farmers may be able to make national decision concerning production of turmeric since they are skilled and stand a better chance than the unskilled farmers. This finding is not in consonance with the study by Abate *et al*. (2019) who found a negative coefficient for age, education, household size in Ambara regional State, Ethiopia.

Table 2: Maximum likelihood estimates for parameters of the stochastic frontier production model for turmeric production in Kaduna State.

Variable	Parameters	Estimates	t-ratio
Stochastic frontier			
constant	β_0	2.111	1.053
Quantity of seeds	β_1	1.041	4.235***
Farm size	β_2	0.324	1.288*
Fertilizer	β_3	0.020	1.000*
Labour	β_4	-0.015	-0.457
Inefficiency model			
Constant	δ_0	3.212	1.589*
Age	δ_1	0.005	-0.198
Sex	δ_2	-0.919	-1.602*
Education	δ_3	0.044	0.062
Farm experience	δ_4	-0.033	-0.446
Household size	δ_5	0.36	1.663*
Membership of organization	δ_6	-0.096	-1.084
Variance parameters			
Sigma squared	σ^2	1.036	3.446***
Gamma	γ	0.999	74324.25***
Log likelihood ratio		-40.753***	

Source: field survey (2020)

*** t – ratio is significant at 1% level of significance

** t – ratio is significant at 5% level of significance

* t – ratio is significant at 10% level of significance

CONCLUSION AND POLICY IMPLICATIONS

Evidence from the study showed that:

- Technical efficiency levels of turmeric farmers ranged from 10 to 99%. Thus, there was a vast difference between technical efficiency levels of farmers even if they used the same level of inputs.
- The mean technical efficiency level of turmeric farmers in the study area was 28% implying that a substantial 72% of the potential output from the farming system can be recovered by eliminating inefficiency with the present technology (technique) itself.
- Socio-economic characteristics of turmeric farmers in the study area significantly influenced their level of technical inefficiency.

Based on the findings from this study, the following recommendations were made:

- Campaigns aimed at encouraging more youths into turmeric production as well as discouraging large household size among turmeric farmers should be promoted in the study area.
- Policies aimed at increasing the resource use efficiency of turmeric farmers in the State and hence their farm output should include the farmers' specific efficiency factors in their formulation.

REFERENCES

Abate, T.M., Dessie, A.B. andMekie, T.M. (2019). Technical Efficiency of Smallholder Farmers in Red Pepper Production in North Gondar Zone AmharaRegional State, *Ethiopia. Economic Structures*, 8 (2): 18 – 24

Amadi, P.O.E., Ibe, M.N. and Kalu, C.I. (2017). Turmeric Research in Nigeria: Challenges and Prospects for Economic Growth. *Proceeding of the 51st Annual Conference of the Agricultural Society of Nigeria, Abuja 2017*. Pp.19-21

Greene, W.H. (1993). The Economic Approach to Efficiency Analysis. *In* H.O. Fried, C.A.K Lovell, and S.S. Schmidt (Eds.). The Measurement of Production Efficiency. Oxford University Press, New York.

Indexmundi (2012). Nigeria Population growth rate.

Jondrow, J., Lovell, C.A.K., Materov, I.S. and Schmidt, P. (1982). On Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. *J. Econometrics* 19:233-238.

KADP (2010). Agricultural Commodities Produced and their Major Areas of Production in Kaduna State, Nigeria.

Karthick, V., Alagumani, T. and Amamath, J.S. (2013). Resource Use Efficiency and Technical Efficiency of Turmeric Production in Family Nadu. *Journal Agricultural Economics Research,* 26(1)109 – 114.

Nwaekpe, J., Anyaegbulam, H., Okoye, B.C. and Asumugha, G.N. (2015). Promotion of Turmeric for the Food/Pharmaceutical Industry in Nigeria. American Journal of Experimental Agriculture, 8(6): 335-341

Uchechukwu, N.U. (2020). Turmeric Research in Nigeria: Challenges and Prospects for Food Security. *Direct Research Journal of Agriculture and Food Science*, 8(8): 278-282