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Cobb-douglas stochastic frontier production approach on technical efficiency of small-scale cassava production in Delta State, Nigeria

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Abstract

This survey was conducted to analysed the status of technical efficiency of small-scale cassava farmers in Delta State. A multistage sampling technique was employed to select a total of 240 respondents. Data collected with aids of questionnaire were analysed using descriptive and inferential statistics. The study exposed that the respondents were in their active age of production who were mostly married female households. The educational qualification of farmers was primary school with moderate family size having wealth of farming experiences. Access to farm credit was a major problem with lack of extension service contact and indigenous stem cuttings as against improved varieties stems. The survey results demonstrated that fertilizer, family labour, and herbicides had negative statistically significant with cassava technical efficiency and education had positively statistically significant at 10% level indicating that education positively influenced the farmers‘ technical efficiency in resource utilization. The result exposed that the mean technical efficiency of the cassava farmers was 0.72 (72%). This infers cassava farmers could raise their efficiency by 28% revealing that farmers were operating a little below the Frontier level and could be enhanced through resource use optimization. The study suggest that farmers expand their scope of production and improve productivity by enhancing their resource use optimization.

Keywords: Cassava; Cobb-Douglas; Efficiency; Stochastic; Production

1. Introduction

Cassava (*Manihot esculenta*) is a vital staple crop in many developing countries, particularly in sub-Saharan Africa, where it serves as a primary source of food and income for smallholder farmers. In Nigeria, cassava cultivation is widespread, with small-scale farmers accounting for a significant portion of production. Despite its importance, the technical efficiency of small-scale cassava farming remains a critical concern, as it directly influences productivity, profitability, and food security. The research of Oluwaseun *et al.* (2020) examined the trends and instability in cassava production in Nigeria from 1970 to 2018. The study found that while cassava production increased, yield per hectare remained inconsistent. The decomposition analysis revealed that the increase in production was primarily due to the expansion of harvested area rather than improvements in yield. A study conducted in Anambra State, Nigeria, utilized a stochastic production frontier approach to analyze the technical efficiency of small-scale cassava farmers. The findings revealed a mean technical efficiency of 89%, indicating that there is substantial potential to improve productivity with the current resource base and available technology. The study also identified factors such as age, education, family size, farming experience, and farm size as significant determinants of technical efficiency among the farmers (Okeke, and Emaziye, 2017). Technical efficiency refers to the ability of a farm to maximize output from a given set of inputs. Poverty alleviation recorded by IFAD (2004) can be accomplished in sub-Saharan Africa by enhancing the economic and technical efficiencies of arable crops production such as cassava. Assessing the technical efficiency of small-scale cassava

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farmers is essential for identifying resource utilization patterns, understanding productivity disparities, and formulating policies aimed at enhancing agricultural performance. The researcher Akinmoladun (2019) revealed that technical efficiency potential means for the improvement in resource utilization. The study highlighted the importance of factors such as farm size, education, and access to credit in enhancing technical efficiency. The critical need to assess and improve the technical efficiency of small-scale cassava farmers is by identifying the factors that influence efficiency, stakeholders can develop targeted interventions to optimize resource use, increase productivity, and ultimately improve the livelihoods of smallholder farmers.

The objective of the study were to:

- examine the socio-economic characteristics of cassava farmers
- identify maximum likelihood estimates outcome of the inefficiency parameters of Cobb-Douglas frontier production function.
- analyse the distribution of resource use efficiency of the small-scale cassava farmers

2. Material and methods

The study area Delta State was selected because of its sizable local population that relies on businesses related to arable crop cultivation for their livelihood. It is lies between latitudes 502859.7 N and longitude 5044.04.60 E, with a projected land area of 1,722 km2 with a population of about 4 million persons (NPC, 2016). Multistage sampling system was used in collecting data from oil palm producers. The first stage involved random selection of six Local Government Areas (LGAs). The second stage involve four communities selected randomly from each of the eight (LGAs) selected amounting to 48 communities while the third stage involved random selection of ten farmers resulting to 240 respondents. Survey data were obtained with supports of questionnaire and analyzed using inferential and descriptive statistics.

2.1. Stochastic Frontier

The stochastic frontier model was used to determine the technical efficiency level of the cassava farmers in the study area. The model is expressed as

$$Y = F(X : B) \exp (Vi - Ui),\ i = 1, 2, \ldots\ldots, N \ldots\ldots (1)$$

Where:

Y = output of the ith farm
X = vector of input quantities of the ith farm
B = represent an appropriate function
Vi = assumed to account for factors beyond the farmers control-weather, diseases etc.
Ui = error due to technical inefficiency

The production technology of the farm was assumed to be specified by the Cobb-Douglass Production Function (CDPF).

Hence, Ui = 0 for any farms output lying on the frontier and, positive for any output below the frontier. The empirical stochastic production frontier model used was specified as:

$$Ln\ Yi = B_0 + B_1LnX1i + B_2LnX2i + B_3LnX3i + B_4LnX4i + \ldots B_7LnX7i + Vi - Ui \ldots (2)$$

Where:

Ln = denotes natural logarithm to base e Y_1 = represents output of the ith farm (in kg)

B_0, B_1 ………..Bn are parameters to be estimated

Yi	=	Output in tons
X_1	=	Farm size in ha
X_2	=	Cassava cuttings in bundles
X_3	=	Family labour (mandays)
X_4	=	Fertilizer used (kg)

X_5 = Hired labour used in production (mandays)
X_6 = Capital inputs depreciated (Naira)
X_7 = Herbicides in litres Vi and Ui as in equ (1)

The inefficiency model is defined by

$$Ui = B + B_1 Z_1 + B_2Z_2 + B_3Z_3 + B_8Z_8$$

Where
U_1 = inefficiency effect
Z_1 = Age of the farmer in years
Z_2 = Sex of the farmer (dummy variable; 1=male, 0=female)
Z_3 = Education status (years)
Z_4 = Farming experience (years)
Z_5 = Household size (No. of persons)
Z_6 = Credit Access (dummy variable; 1=yes, 0=No)
Z_7 = Improved Variety use (dummy variable; 1=yes, 0=No)
Z_8 = Extension contact (dummy variable; 1=yes, 0=No)

3. Results and discussion

Table 1 shows that the mean age of respondents was 42 years active age of production who were mostly married female households. The educational qualification of farmers was primary school confirming that they were no too literate farmers were literate with family size of 8 persons having 18 years farming experiences. Access to farm credit was a major problem with lack of extension service contact and indigenous stem cuttings as against improved varieties stems. This is in line with Emaziye et al, (2022a, 2022b and 2022c), who noted that most arable crops farmers have a wealth of experience in farming with low educational qualification.

Table 1 Socio-Economic Characteristics of Farmers

Variable	**Frequency**	**Percentage**	**Mean/Mode**
Age in Years			
21 – 32	47	19.6	
33 – 44	95	39.6	42 years
45 – 56	64	26.7	
57 - 68	34	14.2	
Total	240	100	
Gender			
Male	96	40	
Female	144	60	Female
Total	240	100	
Marital Status			
Married	128	53.3	Married
Single	47	19.6	
Widow	65	27.1	
Total	240	100	
Educational status			
No formal Education	61	25.4	
Primary School education	107	44.6	Primary school
Secondary School education	48	20	

Tertiary education	24	10	
Total	240	100	
Farming Experience (Years)			
1 – 6	22	9.2	
7 – 12	42	17.5	
13 – 18	86	35.8	18 years
19 – 24	93	38.8	
Total	240	100	
Family Size (persons)			
1 – 3	67	27.9	
4 – 6	34	14.2	
7 – 9	102	42.5	8 persons
10 – 12	37	15.4	
Total	240	100	
Access to credit			
Access	51	21.3	
No access	189	78.8	No credits
Total	240	100	
Improved Variety use			
Improved cuttings	70	29.2	
Indigenous cuttings	170	70.8	Indigenous cuttings
Total	240	100	
Extension Contact			
Yes	67	27.9	
No	173	72.1	No contact
Total	240	100	

Source: Field Data

Maximum Likelihood Estimates Outcome of the Inefficiency Parameters of Cobb-Douglas Frontier Production Function.

The maximum-likelihood estimates for the parameters of the Cobb-Douglas stochastic frontier model for the cassava farmers revealed that estimated coefficients of hired labour and farm size were positive statistically significant at 1% level. The insinuation was that the variables exert positive statistically significant influence on the farmers yield. The outcome also displays that fertilizer, family labour, and herbicides had negative statistically significant relationship with technical efficiency of cassava farmers while education, credit access and improved cuttings were positive statistically significant relationship with technical efficiency of cassava farmers at 10% level. This implies that the farmer‘s credit access and education will enhance their production through provision of the needed input as at when due. It will also lead to increased productivity, scale and efficiency. This is in line with Emaziye and Emaziye (2023) that, availability of fund and literacy level of the farmer will positively influence his production techniques and yield. The result in Table 2 exposed that the mean technical efficiency of the cassava farmers was 0.72. This infers cassava farmers could raise their efficiency by 28% through enhanced resource use. This exposed that the mean farm technical efficiency was about 72%, proposing that farmers could increase profitability by resource use optimization. The scholar Oguejiofor (2021) findings indicated that fertilizer price, farm size, education level, age of household heads, and farming experience statistically significant influence on profit efficiency. The work of Alabi (2023) evaluated the technical efficiency and profitability of cassava production among small-scale farmers in the Federal Capital Territory. The findings revealed that the average technical efficiency score was 79%, indicating a 21% gap from maximum production potential. Socioeconomic factors such as age, education, and farming experience were found to significantly influence technical efficiency.

Table 2 Maximum Likelihood Estimates Result of the Inefficiency Parameters of Cobb-Douglas Frontier Production Function

Variables	Parameter	Coefficient	Standard	T values	Errors
Stochastic Frontier	Constant term	B0	2.1034	0.7534	2.1321
Size of Farm		B1	0.5642	0.0753	6.0312**
Cassava Stem cuttings		B2	0.7217	0.0573	4.3256
Household labour		B3	-0.8034	0.3122	0.6652
Fertilizer		B4	-6.4231	-6.4537	-6.5643
Hired Labour		B5	0.6652	1.2034	0.4410
Capital Use		B6	0.3342	0.5984	0.0244
Herbicides		B7	0.2620	0.0583	-3.5856**
Inefficiency Factors					
Age		X1	-0.0473	0.0962	-0.2685
Gender		X2	0.3281	0.3643	0.1638
Educational level		X3	1.0425	0.6876	1.9382*
Experience in Farming		X4	2.3464	0.0234	-3.8471
Family size		X5	0.3145	0.6875	-4.0365
Credit Access		X6	0.0760	0.1038	7.0427**
Improve Variety		X7	0.0865	0.0456	4.1384**
Extension Contact		X8	0.0103	0.7158	0.0103
Mean Technical Efficiency			0.7241		

Note: Significant level at 5% * and Significant level at 1% = **,

3.1. Distribution of Resource use Efficiency of the Small-Scale Cassava Farmers

The result of the technical efficiency analysis of the farmers as shown Table 3 indicated 52.1% respondents had the highest technical efficiency level of 0.70 – 0.79 while the least technical efficiency level (1.2%) fall within the range of 0.01 – 0.39. However, the result further shows a mean technical efficiency level of 0.72 which implies that the farmers were producing at 72% of the potential frontier production status with respect to their production methods, existing resource base and technology usage. This also collaborated the findings of Okeke and Emaziye (2017) who stated that farmers average technical efficiency of 80%, signifying improvement in yield and resource use.

Table 3 Distribution of Resource use Efficiency of the Small-Scale Cassava Farmers

0.01 – 0.39	3	1.2	
0.40 – 0.49	5	2.1	
0.50 – 0.59	11	4.6	
0.60 – 0.69	43	7.9	
0.70 – 0.79	125	52.1	0.72
0.80 – 0.89	53	22.1	
0.90 – 1.00	19	7.9	

4. Conclusion and Recommendation

The study exposed that the respondents were in their active age of production who were mostly married female households. The educational qualification of farmers was primary school confirming that they were no too literate farmers were literate with moderate family size having wealth of farming experiences. Access to farm credit was a major problem with lack of extension service contact and indigenous stem cuttings as against improved varieties stems. This study analysed the efficiency of input utilization by cassava farmers in Delta State. The maximum-likelihood estimates for the parameters of the Cobb-Douglas stochastic frontier model for the cassava farmers revealed that estimated coefficients of hired labour and farm size were positive statistically significant at 1% level. The insinuation was that the variables exert positive statistically significant influence on the farmers yield. The outcome also displays that fertilizer, family labour, and herbicides had negative statistically significant relationship with technical efficiency of cassava farmers while education, credit access and improved cuttings were positive statistically significant relationship with technical efficiency of cassava farmers at 10% level. This implies that the farmer‘s credit access and education will enhance their production through provision of the needed input as at when due. It will also lead to increased productivity, scale and efficiency. The result exposed that the mean technical efficiency of the cassava farmers was 0.72. This infers cassava farmers could raise their efficiency by 28% through enhanced resource use. The exposed that the mean farm technical efficiency was about 72%, proposing that farmers could increase profitability by resource use optimization. results show that the farmers are operating a little below the Frontier. The study recommends that Cassava farmers should be availed opportunity to credit access to help them expand their scope of operation and productivity which will enhance their resource use efficiency and reduce poverty thereby resulting to improved living standard for the rural farmers in cassava production.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Akinmoladun, O.A., Akinmoladun, O.A., Akinmoladun, O.A. (2019) Assessment the Technical Efficiency of Smallholder Cassava Farmers in Benue State using a Stochastic Frontier Production Function. Journal of Agricultural Sciences, 3(2): 67-77

[2] Alabi, O.O., Musa, A.S., Ibrahim, M., Aluwong, S.J. (2023) 'Technical Efficiency and Profitability Analysis of Cassava Production in Federal Capital Territory, Nigeria

[3] IFAD (2004). International Fund for Agricultural Development The Global Cassava Development strategy.

[4] Emaziye, P O; Okpara, O; Emaziye, O (2022a). Cost benefits analysis of broiler production in Delta State, Nigeria: Implication for livelihood sustainability. *Scientific Papers Series Management, Economic Engineering in Agriculture & Rural Development* . Vol. 22 : 211-214.

[5] Emaziye PO. (2013) Food security index and socio economic effects of climate change on rural faring households in Delta State, Nigeria. Asian Journal of Agriculture and Rural Development. 3(393):193 – 198.

[6] Emaziye P.O., Emaziye O. and O. Okpara (2022b) Job Motivation and Satisfaction among Piggery Farm Employees in Niger Delta Area Nigeria *International Journal of* Research and Review 9(8):193-199

[7] Emaziye PO, Emaziye O and Udonadi IJ (2022c). Economics Implications of Insecurity on Food Crop Production in Delta State Nigeria Journal of Basic and Applied Research International.28 (3):44-50.

[8] Emaziye O. and P. E. Okoro (2023) 'Assessment of Marketing Skills Possessed by Final Year Business Education Students for Self-sufficiency at River State University, Port Harcourt, River State 17(2):48-55

[9] Emaziye PO, Ureigho NU, Emaziye O and Ovharhe OJ. (2022d) Evaluation of economic implications of forest products utilization on rural households in south west Nigeria. International Journal of Biosciences (IJB) 21(2):43-50.

[10] Emaziye P.O. and O. Emaziye (2022) Savings and Constraints among Rural Farming Households in Delta State, Nigeria: Implications for Agricultural Development. Journal of Economics and Trade 7(1): 26-32

[11] NPC (2016). National Population Commission Year Book of Nigeria Population Data, National Population Commission, Nigeria

[12] Okeke DC and Emaziye PO. (2017) Technical efficiency of small holder cassava production in Anambra state Nigeria. A Cobb-Douglas stochastic frontier production approach. Nigeria Agricultural Journal. 48(1):66-71.

[13] Oguejiofor J. Okorie, Ubokudom E. Okon, Anselm A. Enete (2021) Profit Efficiency Analysis of Cassava Production in Enugu State, Nigeria Journal for the Advancement of Developing Economies 5(2):32-43

[14] Oluwaseun A. Akinmoladun, Olufemi A. Akinmoladun, Olufemi A. Akinmoladun (2020) Cassava Production in Nigeria: Trends, Instability, and Decomposition Agricultural and Food Economics 2(1):54-61