



Determinant of Technical, Allocative and Economic Efficiencies in Plantain Production Industry, Ondo State, Nigeria



- **Nigeria is the largest producer of plantain in West Africa with annual production of 2.4 million metric tonnes mostly obtained from the southern states (Ogazi, 1996).**
- **Plantain is a primary food crop in West Africa and the gross value of its annual production in sub-Saharan Africa exceeds that of each of the food crops such as maize (*Zea mays*), rice (*Oriza sativa*), cassava (*Manihot spp*) and sweet potato (*Hypomea batatas*) (Ortiz and Vulylsteke, 1995).**

- **makes it possible for the crop to contribute to an all year-round food security or income generation among small holder producers.**
- **The Objectives of the study are to;**
 - (i) assess the technical, allocative and economic efficiencies of plantain production, and**
 - (ii) identify the factors that influence efficiency in the plantain production industry.**

- **The concept of efficiency is concerned with the relative performance of the processes used in transforming given inputs into outputs. Economic theory identifies at least three types of efficiency. These are technical, allocative and economic efficiencies. Allocative efficiency refers to the choice of an optimum combination of inputs consistent with the relative factor prices.**

- **Technical efficiency** shows to the ability of firms to employ the “best practice” in an industry so that not more than the necessary amount of a given sets of inputs is used in producing the “best level of output (Carlson, 1972).
- **Economic efficiency** is the product of technical and allocative efficiencies

- **Thus, economic efficiency is defined as the capacity of a firm to produce a predetermined quantity of output at minimum cost for a given level of technology (Farrell 1957; Kopp and Diewert 1982).**
- **An economically efficient input-output combination would be on both the frontier function and the expansion path.**

- **Efficiency is a very important factor of productivity growth especially in developing agricultural economies, where resources are meager and opportunities for developing and adopting better technologies are dwindling (Ali and Chaudhry, 1990).**
- **For efficient production, non-physical inputs like experience, information and supervision might influence the ability of a producer to use the available technology efficiently.**

- **Each type of inefficiency is costly to a firm, in the sense that each causes a reduction in profit beneath the maximum value attainable under full efficiency. The cost of each type of inefficiency depends on the magnitude of the inefficiency and the structure of the underlying production technology.**

- **The two most popular methods of measuring efficiency that assumes the presence of inefficiency effects in the production system are Data Envelopment Analysis (DEA) and the Stochastic Frontier method. DEA is a non-parametric method while stochastic frontier method is parametric.**

- **Coelli (1995) compared the two methods and submitted that the main strengths of stochastic frontier approach are in its ability to deal with stochastic noise and permits statistical tests of hypotheses pertaining to production structure and the degree of inefficiency.**

- **However, because DEA is deterministic and attributes all the deviations from the frontier to inefficiencies, a frontier estimated by DEA is likely to be sensitive to measurement errors or other noise in the data.**

- **Most studies that had measured technical efficiency use the stochastic frontier method because of the above stated disadvantages. (Ajibefun and Abdulkadri, (1999), Ajibefun *et al*, (2002); Ajibefun and Daramola, (1999)**

- **Bravo-Ureta and Pinheiro, (1993), Parikh and Shah, (1994), and Sharma *et al*, (1999) had used stochastic parametric model to measure the technical, allocative and economic efficiencies in recent agricultural production efficiency studies.**

- **The stochastic frontier method was also employed in this study.**
- **Investigating the relationship between the farm/farmer characteristics and the computed technical or allocative or economic efficiency indices in a single step could achieve this.**

- **The two-stage estimation procedure is unlikely to provide estimates, which are as efficient as those that could be obtained using a single-stage estimation procedure (Coelli, 1995).**

- The stochastic frontier production function assumes the presence of technical inefficiency of production. Hence the function is defined by,

$$Y_i = f(X_i, a_i) \text{Exp}(V_i - U_i) \quad i = 1, 2, \dots, n \dots (1)$$

Where

Y_i is the output of farmer i ,

X_i is the input variables,

a_i are production coefficients, the

V_i is a random error, which is associated with random factors not under the control of the farmers, while

U_i is the efficiency measure.

- This model is such that the possible production Y_i is bounded above by the stochastic quantity, $f(X_i, a) \exp(V_i)$, hence the term stochastic frontier. V_i is assumed to be independently and identically distributed $N(0, \sigma_v^2)$ random error, independent of the U_i s; and the U_i s are non-negative random variables, associated with technical inefficiency in production, which are assumed to be independently and identically distributed as either half normal, truncated normal and two-gamma distribution and truncations (at zero) of the normal distribution with mean, μ , and variance, $\sigma_u^2 \left(N(\mu, \sigma_u^2) \right)$.

- **Technical efficiency**

$$TE = \frac{Y_i}{Y_i^*} \dots \dots (2)$$

$$= \frac{f(X_i, a) \exp(V_i - U_i)}{f(X_i, a) \exp(V_i)} = \exp(-U_i)$$

- To calculate the allocative efficiency, stochastic frontier cost function will be specified by altering the error term in the above specification from $(V_i - U_i)$ to $(V_i + U_i)$. Thus transforming the production function specified above into cost function

$$Y_i = X_i\beta + (V_i + U_i) \quad i = 1 \dots n \quad (3)$$

- **The study area is Ondo State, Nigeria. The state is made up of 18 Local Government Areas (LGAs) The state is one of the major agricultural producers in Nigeria because of the vibrant and favourable climate.**

- **A multistage sampling technique was employed.**
- **The list of plantain farmers in each selected LGA was collected and 50% of the farmers were chosen using simple random sampling technique and a total of 276 farmers in all. The questionnaires for the study were drawn and tested.**

- **Cobb-Douglas form has been used in many empirical studies, particularly those relating to developing agriculture (Battese, 1992).**

- The Cobb-Douglas function used is as stated below

$$Y = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} e^{V_i - U_i} \dots \dots \dots (4)$$

which when linearised becomes

$$\log Y_i = \log \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + (V_i - U_i) \dots (5)$$

β_0 = intercept

X_1 = labour (family and hired labour in man/days)

X_2 = other variable cost (N) (cost of herbicide, insecticide, fertilizer etc.)

X_3 = capital (N) (credit used)

X_4 = farm size (hectares)

U_i = farm specific technical efficiency related factor which are assumed to be independently and identically distributed as truncations (at zero) of the normal distribution with mean, μ , and variance, $\sigma_u^2 \left(N(\mu, \sigma_u^2) \right)$

V_i = random variable

The model used for allocative efficiency was

$$Y = \alpha_0 X_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3} X_4^{\alpha_4} e^{V_i + U_i} \dots \dots \dots (6)$$

which when linearised becomes

$$\log Y_i = \log \alpha_0 + \alpha_1 \log W_1 + \alpha_2 \log W_2 + \alpha_3 \log W_3 + \alpha_4 \log W_4 + (V_i + U_i) \dots (19)$$

α_0 = intercept

W_1 = expenses on labour (N)

W_2 = other costs (N)

W_3 = cost of depreciation on equipment (N)

W_4 = expenses on land (N)

U_i = farm specific allocative efficiency related factor and

- Where the technical, allocative and economic inefficiencies are assumed to be explained by:

$$m_i = \delta_0 + \delta_1 X_5 + \delta_2 X_6 + \delta_3 X_7 + \delta_4 X_8 \dots (7)$$

where,

m_i = inefficiency effects

X_5 = farmers education (years)

X_6 = extension visit

X_7 = access to credit

X_8 = age of farmers (years)

- **Table 1**
- **Cobb Douglas frontier production function for plantain production industry in Ondo State.**

Variable	Parameter	Coefficient	Std error
Constant	β_0	2.592	1.040
ln (labour)	β_1	0.284*	0.087
ln (other variable costs)	β_2	0.279*	0.097
ln (capital assets)	β_3	0.0349	0.047
ln (farm size)	β_4	0.122*	0.078
variance ratio	σ^2	0.465	0.630
Total variance	γ	0.650*	0.255
Log likelihood function	-	- 300.512	

Source: Data analysis, 2004

- **These coefficients represent percentages changes in the dependent variable as a result of percentage change in independent variables. In the plantain production industry in Ondo State, labour has the highest coefficient with a value of 0.284 while capital coefficient had the lowest of 0.0349. This value shows the relative importance of these variables to plantain output in the State.**

Table2

- **Cobb Douglas frontier cost functions in the plantain production industry in Ondo State**

Variable	Parameter	Coefficient	Std error
Constant	α_0	2.760	1.410
ln (W1)	α_1	0.164*	0.094
ln (W2)	α_2	0.084*	0.060
ln (W3)	α_3	0.261*	0.080
ln (W4)	α_4	0.361*	0.094
variance ratio	σ^2	0.999*	0.00000153
Total variance	γ	0.568*	0.021
Log likelihood function	-	- 0.97	

- **Source: Data analysis, 2004**

- **For the estimated Cobb-Douglas cost frontier model, the coefficient of expenses on land has the highest coefficient (0.361) while all the coefficients has positive values. Predicted technical, allocative and economic efficiencies of farmers are presented in Tables 3 to 5**

Table 3

- **Distribution of technical efficiency in the plantain production industry in Ondo State**

Technical Efficiency	Percentage	Cumulative percentage
11-20	0.4	0.4
21-30	2.2	2.6
31-40	4.8	7.4
41-50	15.9	23.3
51-60	20.4	43.7
61-70	25.4	69.1
71-80	27.9	97.0
81-90	3.0	100.0
	100.0	

Source: Estimated from the study, 2004

- **A large proportion (76.7%) of the respondents had an efficiency index of between 51% and 90%, while 20.7% and 2.6% operated between 30% and 50%, and less than 30%, respectively. It should be observed that none of the respondents achieved a technical efficiency index of 1.00 i.e. 100%.**

- **Allocative efficiency varied from 14% to 83% with the average being 57% (Table 4). A large proportion (68.2%) had allocative efficiency of above 50%. About 29% of the respondents operated at between 31% and 50% efficiency and 2.89% below 30%, respectively. However, none of the respondents had a 100% efficiency index. This implied that resources were not allocated to their best alternative uses and prices were not allowed to perform their allocative functions in the use of inputs.**

Table 4

- **Distribution of allocative efficiency in the plantain production industry in Ondo State**

Allocative efficiency percentage	Percentage frequency	Cumulative Frequency
11-20	1.08	1.08
21-30	1.8	2.88
31-40	10.14	13.02
41-50	18.8	31.82
51-60	27.2	59.02
61-70	22.8	81.82
71-80	17.0	98.82
81-90	1.08	100.0
	100.0	

- **Source:** Estimated from the study, 2004

Table 5

- **Economic efficiency distribution among respondents**

Economic Efficiency Percentage	Percentage frequency	Cumulative frequency
1-10	1.4	1.4
11-20	15.6	17.0
21-30	23.2	40.2
31-40	22.4	62.6
41-50	17.0	79.6
51-60	15.6	95.2
61-70	4.0	99.2
71-80	0.4	99.6
281-90	0.4	100.0
	100.0	

Source: Estimated from the study, 2004

Table 6

• **Factors affecting efficiencies among plantain farmers in Ondo State**

Parameters		Technical efficiency (s.e)	Allocative Efficiency (s.e)	Economic Efficiency (s.e)
Constant	Z ₀	0.192 (0.100)	0.164 (0.944)	0.421 (0.971)
Farmers' education	Z ₁	0.0000167* (0.00000938)	-0.0249 (0.0241)	-0.0195 (0.0169)
Extension visit	Z ₂	-0.0000435 (0.0000323)	0.0109 (0.121)	-0.080* (0.0171)
Age	Z ₃	-0.783* (0.538)	0.2016 (0.216)	-0.080* (0.0171)
Access to credit	Z ₄	0.0118* (0.0069)	0.112* (0.00778)	0.00386 (0.00703)
R ²		0.74	0.65	0.43

• **Source:** Estimated from the study, 2004

- **Farmers' Education**
- **The coefficient of farmers' years of exposure to education had positive estimated coefficients that were significantly different from zero at 10% level of significance for technical efficiency.**

- **In respect of allocative and economic efficiencies, farmers' education had a negative estimated coefficient but these were not significant. The negative sign of the estimates implied that allocative and economic efficiencies increased as this factor increased in value.**

- **Extension Visit**

- The estimated coefficient for extension visit had negative sign for both technical and economic efficiencies but it was only significant at the 10% level of probability with respect to technical efficiency. The negative sign of the coefficients implied that extension visit contributed negatively to inefficiency in both cases. In terms of allocative efficiency, extension visit was not significant at 10% level and it had a positive coefficient, which implied that extension visit contributed positively to allocative inefficiency.

- **Age**

- **The estimated coefficients for age with respect to technical and economic efficiencies had a negative sign and were both significant at the 10% level. This implied that age contributed negatively to inefficiency i.e. the older the farmer, the more technically and economically efficient he became. This may be because of the accumulated experiences that had been gathered over time. For allocative efficiency the sign of the coefficient was positive, showing that the older the farmer the more allocatively inefficient he becomes.**

- **Access to Credit**

- **The estimated coefficients of access to credit (Z_4) had positive signs for technical, allocative and economic efficiencies but were significant for both technical and allocative efficiency. This showed that credit was a strong factor in determining both technical and allocative efficiency in the study area.**

- **The explanatory variables included in these models have been commonly used in estimating agricultural production frontiers for developing countries (Kalirajan (1981); Kalirayan and Flinn (1983); Kalirayan and Shand (1985)).**

Conclusion

- **The results of the inefficiency models reveal that farmer education and access to credit contributed significantly and positively to technical inefficiency while extension visit was significant but had an inverse relationship with technical inefficiency. In terms of allocative efficiency only access to credit was significant but contributed positively to allocative inefficiency. The coefficient of age was negative for technical and allocative efficiencies, which implied that the older the farmer the more efficient he becomes but the age factor contributed significantly only to economic efficiency.**

- **The policy implication of the findings is that there are ample opportunities to raise the present level of efficiencies of plantain production in the study area since extension education has a direct relationship with efficiency therefore government policy should address ways of liberalizing access to extension services to meet the needs of the farmers.**

**THANKS FOR
YOUR
ATTENTION**