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SHORT NOTE [NOTA CORTA]

ECONOMIC EFFICIENCY OF COMMERCIAL VEGETABLE PRODUCTION SYSTEM IN AKWA IBOM STATE, NIGERIA: A TRANSLOG STOCHASTIC FRONTIER COST FUNCTION APPROACH.

[EVALUACIÓN DE LA EFICIENCIA ECONÓMICA DE LA PRODUCCIÓN COMERCIAL DE VEGETALES EN NIGERIA]

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SUMMARY

This study employed a translog stochastic frontier cost function to measure the level of economic efficiency and its determinants in commercial vegetable production Systems. A multi-stage random sampling technique was used to select 150 vegetable farmers from whom input-output data and their prices were obtained using the cost-route approach. The results of the analysis showed that the mean farm level economic efficiency was about 61%. The study found level of education and household size to be negatively and significant at 10% and 1 % respectively while age, farm experience, extension visit and access to credit were significant and directly related to economic efficiency at 1.0% and 5% levels of probability respectively. No significant relationship was found between economic efficiency and membership of cooperative organization and farm size.

Key words: Economic analysis, efficiency, productivity, vegetable.

RESUMEN

Se evaluó la eficiencia económica de sistemas de producción comercial de vegetales en Nigeria. Se realizó un muestreo aleatorio multi etapa para seleccionar 150 agricultores de los cuales se obtuvo información de ingresos, egresos y costos. Se encontró que el promedio de eficiencia fue de 61%. Se encontró un relación negativa del nivel educativo y tamaño de la familia (P=0.1 y 0.01 respectivamente), mientras que edad, experiencia agrícola, visitas de agentes de extensión y acceso al crédito estuvieron positivamente relacionadas con la eficiencia (P=0.01 y 0.05). No se encontró relación entre eficiencia económica y pertenencia a alguna asociación y tamaños del sistema de producción

Palabras clave. Análisis económico, eficiencia, productividad, hortalizas.

INTRODUCTION

Vegetables, supply essential micro-nutrient in human nutrition that act as preventive agents to several ailments. Increased vegetable production may improve food security and offer employment opportunities to the populace, especially women who form a substantial proportion (Mlozi, 2003).

For sub-Saharan African population, the attention on vegetables as vital dietary components is significant, as leafy and fruit vegetables have long been known to be indispensable ingredients in traditional sauces that accompany carbohydrate staples. (Francisca and Eyzaguirre, 2006)

In Akwa Ibom State specifically, vegetable production is very popular due to its high consumption. Waterleaf (Talinum triangulare) and pumpkin (Telferia occidentalis) are among the major leafy vegetables grown by farmers in this area.

Evidence of low productivity in vegetable production was observed because of inefficiency in resource use (Abang et al., 2004).

Farm efficiency no doubt is an important subject in developing countries agriculture (Parikh, et al., 1995, Hazarika and Subramanian, 1999).

Farrell 1975 provided the impetus for developing the literature on empirical estimation of technical, allocative and economic efficiency.

Among the approaches used in measuring efficiency stochastic frontier approach has been used extensively in measuring the level of inefficiency/ efficiency. Early studies focused primarily on efficiency using deterministic production function with parameters computed using mathematical programming techniques. However, with inadequate characteristics of the assumed error term, this approach has an inherent limitation of the statistical inference on the parameters and resulting efficiency estimates. Aigne et al. (1977) and Meeusen and Van den Broech (1977) independently developed the stochastic frontier production function to overcome this deficiency.

The objective of this study is therefore to measure the level of economic efficiency and its determinants in commercial vegetable production in Akwa Ibom State, Nigeria using the stochastic frontier translog cost function approach. The cost function approach combines the concepts of technical and allocative efficiency in cost relationship. Technical and allocative efficiencies are necessary and when they occur together, are sufficient conditions for achieving economic efficiency (Yokopoulous and Lau, 1973) Economic efficiency is the ability of farms to maximize profit (Adeniji, 1988). It is also described as the product of technical and allocative efficiency (Okoye and Onyenweaku, 2007)

MATERIAL AND METHODS

The theoretical model

The stochastic frontier cost function is defined by:

$$C_i = f(y_i, \beta I, \alpha) + \varepsilon_i \quad (1)$$

$i = 1, 2, \ldots, n$
where
C = Total production cost in naira (₦)
y = Output produced in kg
p_i = Vector of input prices
α = parameter of cost function
ε_i = Composite error term (v_i-u_i)

Using Sheppard's Lemma we obtain

$$\frac{dC}{dp_i} = x_i(W, Y, \alpha) \quad (2)$$

This is a system of minimum cost input demand equations (Bravo-Ureta and Pinheiro, 1997). Substituting a farm's input prices and quantity of output in Equation 2 yields the economically efficient input vector X_c. with observed levels of output given, the corresponding technically and economically efficiency costs of production will be equal to $X_{ii}p$ X_{ie}, respectively. While the actual operating input combination of the farm is X_ip. The cost measures can then be used to compute the economic efficiency indices as follows:

$$EE = (X_{ie}.p)/(X_i.p) \quad (3)$$

However the efficient production is represented by an index value of 1.0 while the lower values indicate a greater degree of inefficiency.

The empirical model

In this study, the stochastic frontier translog cost function was estimated for commercial vegetable farmers using the maximum likelihood method.The model is specified as follows:

$$\begin{aligned} lnC_i = {} & \alpha_0+\alpha_1 lnp_1 + \alpha_2 lnp_2 + \alpha_3 lnp_3 + \alpha_4 lnp_4+ \\ & \alpha_5 lnp_5+\alpha_6 lnp_6+\alpha_7 lny_7^2+0.5\alpha_8 lnp_1^2+ \\ & 0.5\alpha_9 lnp_2^2+0.5\alpha_{10} lnp_3^2+0.5\alpha_{11} lnp_4^2+ \\ & 0.5\alpha_{12} lnp_5+0.5\alpha_{13} lnp_6+0.5\alpha_{14} lny_7+ \\ & \alpha_{15} lnp_1 lnp_2+\alpha_{16} lnp_1 lnp_3+\alpha_{17} lnp_1 lnp_4+ \\ & \alpha_{18} lnp_1 lnp_5+\alpha_{19} lnp_1 lnp_6+\alpha_{20} lnp_1 lny_7+ \\ & \alpha_{21} lnp_2 lnp_3+\alpha_{22} lnp_2 lnp_4+\alpha_{23} lnp_2 lnp_5+ \\ & \alpha_{24} lnp_2 lnp_6+\alpha_{25} lnp_2 lny_7+\alpha_{26} lnp_3 lnp_4+ \\ & \alpha_{27} lnp_3 lnp_5+\alpha_{28} lnp_3 lnp_6+\alpha_{29} lnp_3 lny_7+ \\ & \alpha_{30} lnp_4 lnp_5+\alpha_{31} lnp_4 lnp_6+\alpha_{32} lnp_4 lny_7+ \\ & \alpha_{33} lnp_5 lnp_6+\alpha_{34} lnp_5 lny_7+\alpha_{35} lnp_6 lny_7+ \\ & v_i - u_i \end{aligned} \quad (4)$$

where lnC_i represents total input cost of the i^{th} farm, p_1 is land rent in naira per hectare, p_2 is price of planting materials in naira per kg, p_3 is average daily wage rate per manday, p_4 is price of agro chemical (fertilizer) in naira per kg, p_5 is price of other inputs (pesticides and herbicides) in naira per litre, p_6 is capital input in naira made up of depreciation charges on farm tools and equipment, interest on borrowed capital, y is output of vegetable in kg adjusted for statistical noise, α_0, α_1, α_2, …, α_{35} are regression parameters to be estimated while u_i and v_i are as defined earlier.

Determinants of Economic efficiency

The determinants of economic efficiency were modeled in terms of socio-economic variables of the farmers and other factors. The economic efficiency in the model was simultaneously estimated with their determinants $Exp(-\mu_i)$, defined by

$$Exp(-\mu_i) = b_o + b_1z_1 + b_2z_2 + b_3z_3 + b_4z_4 + b_5z_5 + b_6z_6 + b_7z_7 + b_8z_8 + b_9z_9 + b_{10}z_{10} + \varepsilon_i \quad (5)$$

Where $Exp(-\mu_i)$ is the economic efficiency of the i-th farmer, z_i is the age of the farmer in years, z_2 is farmers level of education, z_3 is gender, a dummy variable, 1 for male and 0 for female, z_4 is farmer's farming experience in years, z_5 is number of times visited by an extension agent, z_6 is credit availability access is 1, No access is 0, z_7 is membership of cooperative societies, z_8 is Household size in number, z_9 is production system dummy variable zero for sole cropping and mixed cropping is 1, z_{10} is farm size in hectare while $b_0, \ldots, b_{10}$ are regression parameters to be estimated.

Data

The study was conducted in Akwa Ibom State. The State is comprised of thirty-one (31) Local Government Area, six (6) Agricultural Zones namely Oron, Eket, Abak, Ikot Ekpene, Etinan and Uyo. Akwa Ibom State is located on the South Eastern part and on the rain forest zone of Nigeria. It lies between $4^0 33^I$ and $5^0 33^I$ North and longitude $7^0 25^I$ and $8^0 25^I$ East. The ecological condition in the State is conducive for an impressive distribution of livestock such as goat, cattle, sheep, pig, fish poultry and others. Agriculture is the major occupation of the people. They produce both food and cash crops. Vegetable is seen among the major crops as they cultivate it for commercial purpose and for home consumption (Policon 1996). The state has a population of 2,359,736 people (NPC, 2006).

Multistage sampling technique was used for the study. The six agricultural zones were purposively selected for the study. They are Abak, Eket, Oron, Etinan, Ikot Ekpene and Uyo zones. The second stage involved a simple random selection of thirty (30) farmers from each agricultural zone. However, due to inconsistency in data from some of the farmers, some copies of the questionnaires were rejected. Data gotten on which the analysis was done were sixty (60) waterleaf, sixty (60) pumpkin and thirty (30) garden egg.

RESULTS AND DISCUSSION

Estimation of economic efficiency: Table 1 shows the maximum likelihood estimates of the cost frontier for commercial vegetable production in Akwa Ibom State. The sigma (σ^2 = 2.787) and the gamma (γ = 0.99) are quite high and significant at 1.0% level of probability. The high and significant value of the sigma square (σ^2) indicates the goodness of fit and the correctiveness of the specified assumption of the composite error term distribution (Okoye and Onyenweaku, 2007). The gamma (γ = 0.99) shows that 99 percent variation in the total production cost is due to differences in their cost efficiencies.

The coefficients of the variables (land rent, price of planting materials, wage rate, price of agro chemical, price of other inputs, depreciation and output), all have desired positive sign, which agrees with a priori expectations. All the first order coefficients were highly significant at 99% confidence level. This implies that increasing land rent, price of other input, price of planting materials, wage rate, price of agro chemical and depreciation by 1.0% would increase total cost of production by 22.06, 2.72, 1.80, 7.92, 16.38 and 8.72 respectively. The high value of these coefficients indicates the importance of these variables in the cost structure of the farmers. Studies consistent with the result are (Ogundari and Ojo, 2006) and Okoye and Onyenweaku, 2006).

Most of the interaction terms (2[nd] order coefficients) were statistically significant at the conventional significance levels, implying the suitability of the translog function (Okoye and Onyenweaku, 2007). Among the second order terms, the coefficients of the square term for land rent, price of planting material and those of interactions of land rent and depreciation, wage rate and depreciation, price of agrochemical and output, price of other input and depreciation and depreciation and output are positively and highly significant at 1.0% levels of probability, showing a direct relationship with total cost. Coefficient of square term for price of agrochemicals, depreciation and interaction between wage rate x output are significant at 5% level of probability and have a direct relationship while interaction between price of planting material x wage rate, price of planting material x price of agrochemical and price of planting material x output shows direct relationship with total cost and are significant at 10% level of probability.

Table 1. Maximum likelihood estimates of the stochastic cost function (translog) for commercial vegetable production system.

Production factor	Parameter	Coefficient	Standard error	t-value
Constant term	a_0	4.8348	0.9896	4.8856
Land rent	a_1	22.0582	2.0320	10.8556***
Price of planting material	a_2	1.7963	0.8712	2.0619***
Wage rate	a_3	7.9166	4.5405	1.7436**
Price of agro chemical	a_4	16.3793	1.9878	8.2400***
Price of other input(s)	a_5	2.7236	0.9043	3.0119***

Production factor	Parameter	Coefficient	Standard error	t-value
Depreciation	a_6	8.7154	0.7630	11.4220***
Output (y^*)	a_7	2.5499	0.7785	3.2755***
Land rent^2	a_8	4.3513	1.6909	2.5733***
Price of planting material^2	a_9	0.1175	-4.4749	2.6263***
Wage rate^2	a_{10}	-1.1560	0.3181	-3.6336***
Price of agro chemical^2	a_{11}	0.8072	0.4701	1.7170**
Price of other input(s)^2	a_{12}	0.0627	0.4552	0.1378
Depreciation ^{2}	a_{13}	0.3243	0.1655	1.9589**
Output^2 (y^*)	a_{14}	-0.5671	0.7382	-0.7682
Land rent x price of planting material	a_{15}	-0.5972	0.07507	-7.9550***
Land rent x wage rate	a_{16}	-0.1233	0.2126	-0.5799
Land rent x price of agro chemical	a_{17}	-1.5719	0.3347	-4.6970***
Land rent x price of other input(s)	a_{18}	-0.6404	0.2292	-2.7936***
Land rent x depreciation	a_{19}	0.3913	0.0298	13.1312***
Land rent x output (y^*)	a_{20}	-0.4723	0.2202	-0.2145
Price of planting material x wage rate	a_{21}	0.01089	0.0739	1.4739*
Price of planting material x price of agro chemical	a_{22}	0.1901	0.1358	1.400*
Price of planting material x price of other input(s)	a_{23}	-4.3113	0.1066	0.4044
Price of planting material x Depreciation	a_{24}	-19.4326	-4.4794	-4.3381***
Price of planting material x Output (y^*)	a_{25}	0.1510	-0.9969	1.5149*
Wage rate x price of agro chemical	a_{26}	-1.2029	0.4556	-2.6403***
Wage rate x price of other inputs	a_{27}	-0.0563	0.3986	-0.1412
Wage rate x depreciation	a_{28}	0.9112	0.1550	5.8771***
Wage rate x Output (y^*)	a_{29}	0.7919	0.3989	1.9851**
Price of agro chemical x price of other inputs	a_{30}	0.1686	0.3813	0.4421
Price of agro chemical x Depreciation	a_{31}	-0.5645	0.2424	-2.3292***
Price of agro chemical x Output (y^*)	a_{32}	0.4476	0.2095	2.1367***
Price of other inputs x depreciation	a_{33}	0.0446	0.0219	2.0369***
Price of other inputs x Output (y^*)	a_{34}	2.3738	0.3784	6.2726***
Depreciation x Output (y^*)	a_{35}	0.0388	0.2266	0.1715
Diagnostic statistics				
Log-likelihood function	33.5128			
Total Variance	σ^2	2.7822	0.1797	15.4845***
Variance ratio	γ	0.9999	1.5400	2.1646***
LR Test				

Source: Computed from frontier 4.1c MLE results/Survey data 2007

Table 2. Frequency distribution of economic efficiency indices.

Economic Efficiency Index	Frequency	Percentage (%)
<0.50	5	3.33
0.51-0.60	10	6.67
0.61-0.70	13	8.67
0.71-0.80	34	22.67
0.81-0.90	46	30.66
0.91-1.00	42	28.00
Total	150	100
Maximum Economic Efficiency	0.99	
Minimum Economic Efficiency	0.13	
Mean Economic Efficiency	0.61	

Source: Computed from output of computer programme frontier version 4.1c

Table 3. Maximum likelihood estimates of the determinants of economic efficiency in commercial vegetable production system.

Variable	Parameter	Coefficient	Standard Error	t-value
Constant term	Z_0	-12.4354	0.5296	-23.4829
Age	Z_1	0.2600	0.0253	10.2796***
Education	Z_2	-0.0528	0.0366	-1.4419*
Gender	Z_3	1.8927	0.3388	5.5865***
Farm experience	Z_4	0.1532	0.0337	4.5514***
Extension visit	Z_5	0.3047	0.0354	8.6170***
Access to credit	Z_6	0.8287	0.4235	1.9567**
Membership of cooperative	Z_7	-0.3850	0.5757	-0.6688
Household size	Z_8	-0.8295	0.1363	-6.0868***
Production system	Z_9	-4.2018	0.6140	-6.8436***
Farm size	Z_{10}	-0.0089	0.3723	-0.0239

Source: Computed from frontier version 4.1c MLE/Survey data 200

The results of the frequency distribution of economic efficiency estimates are shown in Table 2. The result indicates that it ranged from 0.13-0.99. The mean economic efficiency was 0.61. The estimates show that for the average vegetable farmer to attain the level of the most economically efficient farmer in the sample, he or she would experience a cost savings of 38.38 (1 – 0.61/0.99%).

The least economically efficient farmer will have an efficiency gain of 13.13% (1 – 0.13/0.99%) in vegetable production if he or she is to attain the efficiency level of most economically efficient farmer in the State. The vegetable farmers in the sample were economically inefficient as a result of allocative inefficiency.

Sources of economic efficiency

Table 3 shows the results of the factors influencing economic efficiency of commercial vegetable farmers in Akwa Ibom State. The coefficients of farm experience and extension visit were positive and are significant at 1.0% level of probability. This implies that farm experience and number of visit by an extension agent has a positive influence on economic efficiency among the farmers sampled. The coefficient of age is positive and significant at 99% confidence level. This implies that the older the farmer the more efficient he or she becomes. This goes against the findings of Idiong (2005) who reported that the older a farmer becomes, the more he or she is unable to combine the available technology. Coefficient of the variable of access to credit was positive and significant at 5% level of probability which implies farmer who have access to credit are more economically efficient than farmer who does not have, coefficient of education have negative sign and is significant at 10%. It could be because most farmers rely on their years of experience to attain economic efficiency other than education. Lack of education might not be regarded as a facto causing inefficiency (Okoye and Onyenweaku, 2007) Lau and Yotopoulos (1971) found out that smaller farms were economically more efficient than larger farms within the range of output studied.

Family size has a negative coefficient and is highly significant at 1.0% level of probability. Effiong (2005) and Idiong (2006) reported that a relatively large household size enhance the availability of labour though large household sizes may not guarantee for increased efficiency since family labour which comprises mostly children of school age are always in school.

Gender is positively signed and highly significant at 1.0% level of probability which implies that male farmers' sole cropping production system has a positive influence on efficiency.

CONCLUSION

The study has indicated that commercial vegetable production system was not fully economically efficient. Individual levels of economic efficiencies range between 0.13 – 0.99 with a mean of 0.61, which reveal substantial economic inefficiencies hence considerable potential for enhanced profitability by reducing cost through improved efficiency. On average, by operating at full economic efficiency levels vegetable production entrepreneurs would be able to reduce their cost by 38.38% depending on the method employed.

Important factors directly related to economic efficiency are farm experience, extension visit, and access to credit. These results call for policies aimed at encouraging new entrants to cultivate vegetable and the experienced ones to remain in farming. Micro-credit from governmental and non governmental agencies should be made available to rural farmers, for this will go a long way in addressing their inefficiency problems.

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