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Measuring Technical Efficiency of Water Leaf (*Talinum triangulare*) Production in Akwa Ibom State, Nigeria

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Abstract: Output-oriented technical efficiency indices were estimated by stochastic production frontier functions to survey data collected from 60 waterleaf farmers in Uyo, Akwa Ibom State with the aid of structured questionnaire. Using the maximum likelihood estimation technique, asymptotic parameter estimates were evaluated to describe efficiency determinants. Specifically, farm size, planting materials, labour, fertilizer and farmyard manure were estimated to be major determinants in waterleaf production. In this regard, a unit increase in any of the factors would result to less than proportionate increase in the output of waterleaf harvested. With regards to inefficiency model specified, the finding revealed the relative importance of farmers' ages, household size and contact with extension agents in explaining the observed distribution of the farm level inefficiency indices. Findings also revealed a mean efficiency index of 0.65 implying that output from maize production could be increased by 35 percent using available technology.

Key words: Technical efficiency · *Talinum triangulare* · Stochastic frontier · Nigeria

INTRODUCTION

Vegetable is one of the staple food component that it production has continue to increase in most countries of the world. For instance, in Nigeria, vegetable production growth rate stood at 2.18% between 1970 and 1974. It however decreased to about 5.7% between 1975 and 1979. Between 1990 and 1994 about 14.0% growth rate was recorded in the sub-sector. Vegetable production constitutes about 4.64% of the total staple food production between 1970 and 2003 in Nigeria [1].

In Akwa Ibom State specifically, vegetable production is very popular due to it high consumption. Though its production is seasonal and the produce high perishability, the cost per unit output is low as compare to other consuming items [2, 3]. In the State alone, about 150,000 tons of leafy vegetable was produced in 1992 [4]. Water leaf (*Talinum triangulare*), is one of the major leafy vegetable grown by farmers in Akwa Ibom State and widely consumed by every household in the State.

Waterleaf belongs to the plant family *Portulaceae*. It is a short –lived perennial herb, growing to 30-60cm in height. The leaf is greenish in colour with succulent stem and alternate leaf arrangement. The crop is believed to have originated from tropical Central Africa or South America [5]. In Nigeria, it wide acceptance across various ethnic groups has earned it several local names, such as *"gare*" in Yoruba, *mmon-mmong ikong* in Efik/Ibibio among others, which is consistent with it high water content. The crop is propagated mostly by stem cutting and rarely by seed. It has a short maturity period of 35-45 days. The yield is higher when propagated by stem cutting as compare to seed planting [6]. The short maturity period of waterleaf is an added advantage as compare to other vegetable. Hence, the turnover is rapid and farmers make quick returns in a short period [3, 7].

Agricultural production requires resources that are limited in supply [8]. Udoh [7] asserted that labour, planting materials and manure were the must important inputs influencing waterleaf production in Calabar area. The availability of these resources and various combinations determine the quantity of output (waterleaf) produced [9]. The cost-revenue relationship of the entire production process is influenced by how technically efficient the resources are utilized.

Efficient use of farm resources is an important part of agricultural sustainability. One way peasant farmers can achieve sustainability in agricultural production is to raise

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the productivity of their farms, by improving efficiency within the limit of existing resource base and technology [2, 9]. To cope with the predominant menace of poverty and unemployment in the rural area, small–scale waterleaf producers emerge thus employing various combinations of limited resources in their production [10, 11]. Efficient use of resources is a prerequisite for optimum farm production since inefficiency in resource use, can distort food availability and security [11, 12].

Owing to the socio-economic importance of this evolving enterprise in Akwa Ibom State, there is therefore the need to analyze the technical efficiency of resource utilization and also determined factor(s) contributing to inefficient use of resources among waterleaf producers in the study area. Then the pertinent questions concerning rural waterleaf farming therefore becomes; Are these resources used productively?, How statistically significant are these resources (inputs) to waterleaf output? and if these inputs are available, are they technically efficient in their use?

Conceptual framework/literature review: The conceptual framework for the study is based on the concept of the technical efficiency of resource utilization and the concept of production frontier proposed by Farrell [13]. Technical efficiency shows the success of a farm enterprise, as it indicates an ability of a farm to produce maximum output from a set of input mix [14, 15]. From Farrell analysis, a farm that is technically efficiency in resource use operates on a production frontier, while a technically inefficient farm in resources use operates below the production frontier. Hence, the position of individual farm relative to the frontier could be influenced by factors ranging from climatic, socio-economic and marketing etc. Sail [16], Hoppe *et al*. [17].

Mathematically, Farrell's production frontier function begins by considering a stochastic production function with a multiplicative disturbance term of the farm.

$$Y = f(X_a,; \beta)\, e^{E} \quad (1)$$

Where y = output; X = vector of input, β = vector of parameter, e = error term; E is stochastic disturbance term consisting two independent element "V" and "U". Hence.

$$E = U + V \quad (2)$$

The symmetric element V account for random variation in output quantity attributed to factors outside the farmer's control (such as disease, weather). A one – sided component $U \leq O$ reflects technical inefficiency relative to the stochastic frontier. Thus U = O for farm output that lie on the frontier (i.e. 100% technical efficiency in resource use) and U < O for farm output below the frontier as $N \sim (o, \delta_u^2\ v)$. Thus equation (1) becomes

$$Y = f(X_a;, \beta)\, e^{u + v} \quad (3)$$

Resource use efficiency: Empirical analysis of technical efficiency of farms in Nigeria has always shown a considerably value of efficiency [2, 11, 18, 19], on their work used stochastic production frontier to estimate the technical efficiency of urban farms in different areas. The result showed a mean efficiency value of about 69%, meaning that production can still be increased by 31% using the available technology. Udoudo [20] uses the stochastic cost function to study resource-use inefficiency among waterleaf farmers in Uyo, Akwa Ibom State. The study revealed that about 99% of inefficiency was accounted for by the explanatory variables. Udoh and Akintola [12] measured the technical efficiency of crop farms in the southeastern Nigeria using a restricted translog production frontier. Empirical result showed a mean technical efficiency of 77% achieved by farmers in the area indicating that crop production can still be increased by 23% using available technology Ajibefun and Abdulkadri [21] using stochastic frontier approach found out that technical efficiency vary widely across farms participating in the National Directorate of employment (NDE) program in Ondo State ranging between 21.7 and 87.8% with an average of 67%, showing an average technical inefficiency of 33%.

Some related work by authors from different countries had also reported a technical efficiency of farms ranging between 60 – 90% such as Yao and Liu [22], Garete [23] and Krishmamorthy and Radesse [24].

Methodology

The study area, Data collection and sampling technique: The study was conducted in *Nsit –Ibom* local government area of Akwa Ibom State, Nigeria. Primary data were collected with the aid of a well structure questionnaire and personal interview. Sixty (60) waterleaf farmers were randomly selected from areas of intensive waterleaf cultivation. Baseline information on socio-economic characteristics, input use and output levels as well as their unit prices were collected and analyzed.

Empirical model: Descriptive statistic is used to explore the socio-economics characteristics of the respondent and multiple regression model based on stochastic production frontier that assume a Cobb-Douglas form is employ to determine resource use efficiency in the study area. Hence;

$$\text{Ln (Qty)} = \beta_0 + \beta_1 \text{ In (FS)} + \beta_2 \text{ In (PM)} + \beta_3 \text{ In (LO)} + \beta_4 \text{ In (CP)} + \beta_5 \text{ In (FR)} + \beta_6 \text{ In (MA)} + V_1 - U_1 \quad (4)$$

Where Qty = Output of waterleaf harvested (kg); FS = Farm size (ha); PM = Planting Material (waterleaf cutting) in kg; LO = Labour (mandays); CP = Capital (N/k); FR = Inorganic fertilizer (kg); MA = Organic manure (kg); V and U are as previously defined in equation (2). Estimated technical inefficiency model is presented as thus:

$$e^{-ui} = \alpha_0 + \alpha_1, \text{(Edu)} + \alpha_2 \text{ (Age)} + \alpha_3 \text{ (HHS)} + \alpha_4 \text{ (Ext)} + Zi \quad (5)$$

where;
Edu = Educational level of farms in (Yrs); Age = Age of farmers (Yrs); HHS = Household Size (dummy) ; Ext = Contact with an extension agent (dummy)

Equation (4) and (5) are jointly estimated by maximizing the likelihood function [12].

RESULTS AND DISCUSSION

MI estimates: The sigma square coefficient of 0.3253 is statistically significant and different from zero at 1%. This indicates a good fit and the correctness of the specified distributed assumption of the composite error term. The variance ratio of the 67.28% significant at 1% is high; meaning that the systematic effect that are unaccounted for, by the production frontier function are the dominant sources of stochastic random errors. Hence, the occurrence of technical inefficiency among waterleaf farmers in the study area account for about 67% of the variation in the output level of the crop grown. The diagnostic results therefore confirm the relevance of the stochastic production frontier and maximum likelihood estimation.

The estimated production frontier shows a perfect combination of resources in waterleaf production in the rural area. All coefficients of explanatory variables (inputs) exhibit expected sign and magnitude except for capital and all are significant at either 1% or 5%. Planting material, labour, inorganic fertilizer and organic manure seem to be the most important inputs in the rural area with an elasticity of (0.9890), (0.9850), (0.8569) and (0.4360) respectively. This implies that, a unit percent increase in these inputs quantities will increase output by 0.9890, 0.9850, 0.8569 and 0.4360 kg, respectively.

Table 1: Output of vegetable in Nigeria (1970-2003)

Years	Average output '000 tons	Growth rate %
1970 - 1974	1175.8	2.18
1975 - 1979	1073.8	-5.70
1980 - 1984	1007.0	4.40
1985 - 1989	1324.4	5.90
1990 - 1994	2273.2	14.00
1995 - 1999	2932.8	8.70
2000 - 2003	4753.3	6.40

Source: CBN, 2003

Table 2: ML Estimates and inefficiency estimates result.

Variable	Coefficient	Standard error	Asymptotic
Constant term β_0	0.21812	0.5165	0.4223
Farm size (ha) β_1	0.40020	0.1544	2.5920 **
Planting M. (kg) β_2	0.98900	0.4524	2.1861 **
Labour (mandays) β_3	0.98500	0.2274	4.3320 ***
Capital (N/K) β_4	0.16330	0.3407	0.4793
Inorganic fertilizer (kg) β_5	0.85690	0.3603	2.3783 **
Organic manure (kg) β_6	0.43600	0.1231	3.5420 ***
Diagnosis statistics			
Sigma – square δ	0.3253	0.1144	2.8440 ***
Gamma	0.6728	0.1872	3.5940 ***
Inefficiency model			
Intercept α_0	-0.1754	0.4921	-0.3564
Education (yrs) α_1	0.5746	0.7721	0.7441
Age (yrs) α_2	-0.5008	0.1969	2.5434 ***
Household size (dummy) α_3	0.5219	0.2763	1.8889 **
Extension (dummy) α_4	0.5354	0.1974	2.7123 ***

Source: Derived from data analysis.
Note: The model is estimate by ML using a frontier 4.1 software developed by Coelli [25].
Asterisks indicate significance, *** 1%, ** 5% and * 10%

Table 3: Waterleaf farm specific resource use efficiency indices

Efficiency Class	Frequency	Percentage
0.01 – 0.19	5	8.3
0.20 – 0.29	5	8.3
0.30 – 0.39	6	10.0
0.40 – 0.99	10	16.7
0.50 – 0.59	8	13.3
0.60 – 0.69	13	21.7
0.70 – 0.79	5	8.3
0.80 – 0.89	4	6.7
0.90 – 1.00	4	6.7

Mean value = 0.65; minimum value = 0.01; maximum value = 0.97; mode value = 0.67

Similar results had been reported by Udoh [26]; Eyo *et al*. [27] and Amaza and Olayemi [28].

Inefficiency model: The estimated coefficients of the inefficiency variables are significant at 5% for family size and 1% for extension contact and for Age. Since the dependent variable of inefficiency function represents the mode of inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency and a negative sign indicates that the reverse is true. It therefore, follows that only age of farmers positively affects the farm level of technical efficiency. This implies, as rural waterleaf farmers advance in age, inefficiency in resource use decreases and technical efficiency increases and their output will be closer to the production frontier. Contrary, as farmers' family sizes increase and their access to extension services increases too; technical efficiency in resource use will decrease while inefficiency increase.

The resource use efficiency indices as shown in Table 3 exhibit rather minimal dispersion of efficiency index across the farms. Larger proportion (about 21.7%) of the farms have efficiency value around the mean value of 0.65. About 13.3% of the farms have their efficiency value range between 0.50 and 0.59.

However, the observed distribution predict that only a small fraction of output (waterleaf) is not produced because of inefficient use of identified farm resources in the rural area. Very few farms were close to the production frontier, thus indicating that the waterleaf farms are faced with multifarious production problems. Empirical explorations identify these constraints to include environmental, socio-economic and production constraints. In a subsistence farming, as in the case of waterleaf farming in *Nsit-Ibom*, farm resources are mostly allocated to multiple uses on the basis of their marginal shadow value thereby preventing the farmers from reaching the production efficiency frontier [12].

SUMMARY AND CONCLUSIONS

The research focused on the farm-level determination of technical efficiency through the application of stochastic parametric estimation method. ML- estimates and inefficiency coefficients were derives from a specified Cobb-Douglas production frontier estimated by maximum likelihood estimation procedure. The estimated parameters were unbiased, efficient and consistent. The diagnostic statistics confirmed the superiority of stochastic production frontier and the ML estimation method over OLS estimation method.

The study revealed a mean technical efficiency value of 65% for the rural waterleaf producers. This implies that farm output has not reached the production frontier. Hence, the crop production can still be increased by about 35% using available technology. In conclusion, waterleaf production in the rural area, though practice in a subsistence level can be a good source of rural employment, income source and even a means to engineer other sub-sectors of agriculture for increased productivity, if resources are efficiently utilized. Therefore within the scope of this research; it is recommended that private investment in the crop production should be advocated with an intention of parachuting the present status of peasant system of cultivation of the crop to market – oriented production that will even better the lives of an urban dwellers.

REFERENCES

1. CBN., 2003. Statistical Bulletin (December).
2. Udoh, E.J., 2005. Technical Inefficiency in Vegetable Farms of Humid Region: An Analysis of Dry Season Farming by Urban Women in South-South Zone, Nigeria. J. Agric. & Social Sci., 1: 80-85.
3. Umoren, E.J., 1998. The Marketing of perishable farm produce in Akwa Ibom State Unpublished B.Sc. Project, University of Calabar.
4. CBN., Annual Report and Statement of Account, 1994.
5. Tindall, H.D., 1983. Vegetables in the tropics. The Macmillian press Ltd. UK., pp: 102-106.
6. Grubban, G.H., 1977. Tropical vegetables and their genetic resources. International Board for plant genetic resources, FAO., Rome, pp: 18-20.
7. Udoh, E.J., 1993, Economics of Waterleaf production in Calabar Municipality Cross River State, University of Calabar, Unpublished B.Sc. project.
8. Adegeye, A.J. and J.S. Dittoh, 1982. Essentials of Agricultural Economics: University of Ibadan Press, Nigeria.
9. Harwood, R.R., 1987. Low Input Technologies for Sustainable Agricultural System. Westview Press Boulder, Col. London.
10. Mougeot, L.J.A., 2002. Achieving Urban Food and Nutrition Security in the Developing world. Ph action news. The News letter of the Global post Harvest forum No. 5, pp: 16.
11. Etim, N.A., E.J. Udoh and T.T. Awoyemi, 2005. Measuring Technical efficiency of urban farms in Uyo Metropolis; Global Journal of Agricultural Science, 4: 19-95.

12. Udoh, E.J. and J.O. Akintola, 2001. Technical efficiency of crop farms in the south eastern region of Nigeria, Nigerian Journal of Economic and Social Studies, 42: 93-104.
13. Farrell, M., 1957. The Measurement of Productive Efficiency, J. Royal Statistical Society, ACXX part 3: 253-90.
14. Coelli, T.J., 1995. Recent development in frontier modeling and efficiency measurement, Australian Journal of Agricultural Economics, 39: 219-245.
15. Coelli, T.J, D.S. Rao and G.E. Battese, 1998. An Introduction to efficiency and Productivity analysis, Kluver Academic publishers, Norwell, MC.
16. Sall, S., 1997. A Characteristic – Approach to Adoption: The Case of improved Rice varieties in southern Senegal. Ph.D Dissertation, Department of Agricultural Economics, Kanas State University Manhattan Ks, pp: 20-30.
17. Hoppe, R.A, J. Tames, J.E. Perry, K. Penni, E.J. and J. Momke., 2001 Structural and Financial Characteristics of US Farms, Family farm Report. ERS, USDA, AIB No. 768.
18. Ajibefun, J.A., 2003. Determinants of Technical efficiency and policy implication in traditional agricultural production. Empirical study of Nigerian food crops farmers. A Final Research Reports, submitted to African Economic Research Consortium Nairobi.
19. Udoh, E.J., 2006. Modelling Indices of Efficiency and Sustainable Land Use and Management among Migrant Farmers in a Farm Settlement of Cross River State, Nigeria, Journal of Agriculture and Social Sciences, 2: 67-71.
20. Udoudo, M., 2000. Resource use inefficiency among waterleaf farmers in Uyo, Aks. Unpublished B.Sc. project, University of Uyo.
21. Ajibefun, I.A. and O.A. Abdulkadri, 1999. An investigation of technical inefficiency of production of farmers under the natural directorate of employment Ondo State, Nigeria. Applied Economics Letter, 6: 111-4.
22. Yao, S. and Z. Liu., 1998. Determinant of grain production and Technical efficiency in China: Journal of Agric. Econs, 49: 171-84.
23. Garate, M.P. and B.I. Apezteguia, 1997. Technical Efficiency in the Spanish Agrofood Industry, Agric. Econ., 16: 185-92.
24. Krishnamorthy, S. and B. Radesse, 1997. Technical Efficiency in paddy farms of Tamil Nadu: an Analysis Based on Farm Size Ecological Zone, Agricultural Economics, 16: 185-92.
25. Coelli, T.J., 1994. A guide to frontier 4.1: a computer program for stochastic frontier production and cost function estimation, Department of Econometric, University of New England Armidale, NSW, 235L, Australia
26. Udoh, E.J., 1999. Commercial Production of waterleaf among urban women: A Case of Calabar Municipality of Cross River State in poverty alleviation and food security in Nigeria. Edited by Fabiyi, Y.L. and E.O. Idowu Published by Nigerian Association of Agricultural Economists (NAAE).
27. Eyo, E.O., E.O. Ekpe and P.I. Ogban, 2000. Waterleaf (Talinum triangular-wild) production in south eastern Nigeria: Existing practices, suggestions for increased productivity and profit, Global Journal of Pure and Applied Sciences, 7: 421-426.
28. Amaza, P.S. and J.K. Olayemi, 2000. The influence of education and extension services on food crop production in Gombe State, Nigeria, Journal of Agribusiness and Rural Development, 1: 80-92.