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Determinants of Technical Efficiency of Urban Farming in Uyo Metropolis of Akwa Ibom State, Nigeria

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ABSTRACT

This study investigated the determinants of technical efficiency of urban farming in Uyo metropolis of Akwa Ibom State, Nigeria using a stochastic frontier production function. Structured questionnaires were used to collect cost-route data from 75 respondents randomly selected from four designated locations in the project area. The findings revealed that the co-efficient of farm size, capital, manures and planting materials were all positively and significantly related to the technical efficiency. For the in-efficiency function, the variation in the level of technical efficiency among the sampled farmers was largely influenced by age, farming experience, level of education, extension contract, crop diversification and household size. All the farmers were producing below the maximum efficiency frontier. The farmers's pacific technical efficiency index varied between 0.10 and 0.95 with a mean 0.81. Thus, in the short-run, there is a scope to increase output of the urban farming by 19% by adopting the technology used by the best practice farmer. Technical efficiency could be increased with more use of fertilizer, family labor, consolidation of small farm holdings and policies aimed at reducing household size.

Key Words: Determinants; Technical efficiency; Urban farming; Uyo metropolis; Akwa ibom state; Nigeria

INTRODUCTION

Nigeria has been faced with food supply deficit in the past decades. This food crisis has almost become an intractable problem (Umoh & Atobatele, 1998). This situation is even more pronounced in urban areas due to high population density. In Nigeria, urban farming is practiced in many cities across the country. In Akwa Ibom State in general and Uyo Metropolis in particular, many households embarked on urban farming as a source of income and food for the family.

Urban farming has been defined as an industry that produces processes and markets food and fuel largely in response to the daily demand of consumers within a town. It applies intensive production method using and re-using of natural resources and urban waste to yield a diversity of crops and livestock (Timothy, 1994; UNDP, 1996). Urban farming contributes significantly to the socioeconomic development of town and cities through out the world. In several economies, particularly developing ones, it is one of the largest urban productive industries and a prime generation of jobs for low income earner (Freeman, 1991). It offers opportunities for better diet and a chance to shift household spending toward other non-farm needs such as health care and housing (Robinoxitich & Schemetzer, 1997).

Despite the numerous advantages of urban farming advantageous level of output is a function of urban resources use efficiency and hence technical efficiency. Technical efficiency, which this study is designated to measures and its determinants, refers to the ability to produce the highest level of output with a given bundle of resources (Onyenweaku *et al.,* 2005). Past studies have pointed to the low resource productivity and efficiency in crop production (Diehl, 1982; Nweke & Akorhe, 1983; Onyenweaku & Kuaegbu, 1988). However, these studies did not provide numerical measures of technical efficiency the gap, which the present study is expected to fill.

MATERIALS AND METHODS

The study area. The study was conducted in Uyo Metropolis of Akwa Ibom State Nigeria. Uyo is the capital city of Akwa Ibom State and situates at about 55 km inland from the coastal plain of South-Eastern Nigeria. Uyo Local Government Area has an estimated population of 309,573 million people (NPC, 2006). The Metropolis is bordered within the following geographical co-ordinate, North 50^o4^1 N, East 70^o59^1 E and West $70^0 53^1$ E (NPC, 2006). There are basically two distinct seasons. The rainy season begins from April to October, while the dry season starts from November to March. Uyo Metropolis falls within the tropical zone with a dominant vegetation of green foliage of trees, shrubs and oil palm trees. The commonly grown crops by the people include cassava, yam, cocoyam, plantain, maize and vegetables, while livestock such as goats, sheep,

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pig, rabbit and poultry are also reared. The land holds promise of exciting people, splendid opportunities for leisure investment and wealth creation.

Data source and sampling technique. The study used mainly primary data. The relevant primary data were obtained on the urban farming activities in terms of inputs, outputs and their prices using the limited cost route approach from April to October, 2007 and also on the socio economic characteristics of the farmers such as age, farming experience, level of education, gender, extension contact, family size and crop diversification. The main instrument for the data collection was well structured questionnaires administered on the sampled farmers. A simple random sampling procedure was employed in the selection of 75 urban farmers from the four designated locations of brook street, Ukana Offot Street, Eka Street and Ufe Street.

Data analysis. The study utilized stochastic production frontier function with multiplicative disturbance term following Aigner *et al.* (1977) and Meeusen and Van De Broeck (1977) to analyze the data. This was further improved and used by Batteses and Coeli (1995); Amaza and Olayemi (2002); Helfand (2003) and Maurice (2004). The model used for the study is specified as follows:

$$Y = f(X_{a,\ldots}\ \beta)e^{\varepsilon} \quad \ldots\ldots(1)$$

Where, Y is the quantity of output in kg; Xa is the vector of input quantities; β is the Vector of parameters and e is the error term. ε is a stochastic disturbance term consisting of two independent elements u and v as:

$$\varepsilon = u + v \quad \ldots\ldots(2)$$

The symmetric component, v, account for the random variation in output due to factors outside the farmers control such as weather and diseases. It is assumed to be normally, independently and identically distributed as $N \sim (O, \delta^2 V)$. A one - sided component $U \leq O$ reflects technical in-efficiency relative to the stochastic frontier, F (Xa: β) e^{ε}. Thus U = O for a farm output, which lies on the frontier and U < O for one, which is below the frontier. Thus the distribution of U is half - normal.

The technical efficiency of an individual farmer is defined as the ratio of the observed output to the corresponding frontier output, given the available technology.

$$TE = yi/yi^* = \exp.\ \varepsilon\ (U/\varepsilon) \quad \ldots\ldots(3)$$

Where, TE is the technical efficiency for each farm, Yi is the observed output and yi* is the frontier output.

It is assumed that the inefficiency factors are independently distributed and that U arises by the truncated of the normal distribution with mean u and variance δ 2, where u in equation 3 is defined as:

$$U = f(Z, \delta) \quad \ldots\ldots(4)$$

Where, Z is the vector of farm - specific factors and δ is the vector of parameters.

The empirical model for this study is assumed to be specified by the Cobb Douglas frontier production function and defined as follows:

$$\ln Y = bo + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_4 \ln X_5 + b_6 \ln X_6 + V - U \ldots\ldots (5)$$

Where, Y, X_1, X_2, X_3, X_4, X_5 and X_6 are total output of crops in kg, X_1 farm size in hectares, labor inputs in man days, X_3 Capital input in naira, Inorganic fertilizer in kg, X_5 manure per kitchen waste in kg and cost of planting materials in naira, respectively. The b_o is a constant parameter and b_1 - b_6 are the regression parameters to be estimated, while v and u are as earlier defined.

In order to determine the factors contributing to the observed technical efficiency, the following model was formulated and estimated jointly with the stochastic frontier model in the singe stage maximum likelihood estimation (MLE) procedure using frontier version 4.1 designed by Coelli, 1996.

$$TE = \partial_o = \partial_1 Z_1 + \partial_2 Z_2 + \partial_3 Z + \partial_4 Z_4 + \partial_5 Z_5 + \partial_6 Z_6 + \partial_7 Z_7 + e \ldots\ldots (6)$$

Where, TE, Z_1, Z_2, Z_3, Z_4, Z_5, Z_6 and Z_7 are technical efficiency of each farmer, age of the farmer (yrs), farming experience in years, farmers years of formal education, farmers sex expressed in gender, number of extension contact during the 2006/2007 cropping season, crop diversification expressed in number of crops planted by a farmer in a farm unit and farmers household size. ∂_o is a constant parameter, while ∂_1 - ∂_7 are un-known parameters to be estimated and e is an error term.

RESULTS AND DISCUSSION

The estimated parameters of the frontier production function equation and related statistical test result obtained from the analysis are presented in Table I. It is evident from the table that the estimate of gamma (ɣ) is large and significantly different from zero, indicating a good fit and the correctness of the specified distributional assumption. Moreover, the estimate of ɣ, which is the ratio of the variance output was 0.8762. This means that more than 87% of the variation in output among the urban farmers is due to differences in technical efficiency. The generalized likelihood ratio test is highly significant at 1% indicating that the in-efficiency effects are significant in the stochastic frontier model and suggest the suitability of it than the ordinary least square (OLS) estimation technique in the traditional production function model.

The estimated co-efficients of farm size, capital and manure are all positive and highly significant at 1%, while planting material is also positive and significant at 5%. This observation is in line with the a priori expectation and implies that the output of the urban farmers in the study area would be expected to increases with the increasing use of such production inputs as farm size, capital, manure and planting materials. Amaza and Olayemi (2000), Amaza *et al.* (2005), Ebong (2005) and Onyenweaku *et al.* (2005) also

Table I. Maximum likelihood estimates of the parameters of the stochastic frontier production function

Variables	Parameters	Coefficient	Standard error	T-ratio
Production Factors				
Constant	b_o	150.0694	1.0066	149.0854***
Farm size, X_1	b_1	83.9672	1.1107	75.5985***
Labor, X_2	b_2	1.8759	9.2921	0.2019
Capital, X_3	b_3	1.0516	0.0125	84.1280***
Inorganic fertilizer, X_4	b_4	1.1721	1.2499	0.9378
Manures, X_5	b_5	4.0394	1.5073	2.6799***
Planting materials, X_6	b_6	4.3206	2.1152	2.0427**
Inefficiency effects				
Constant	∂_o	0.9471	1.0125	0.9354
Age, Z_1	∂_1	-38.5146	13.2857	-10.4258***
Farming experience, Z_2	∂_2	-88.4060	10.7237	8.2439***
Level of education Z_3	∂_3	-112,6971	13.1667	-8.5592***
Gender, Z_4	∂_4	0.8994	1.0092	0.8912
Extension contact, Z_5	∂_5	-7.2490	1.2758	-5.6819***
Crop diversification, Z_6	∂_6	13.9326	1.8985	7.3389***
Household size, Z_7	∂_7	21.3104	2.7394	7.7791***
Diagnostic statistics				
Likelihood ratio test	-32.7251			
Sigma -sguared (δ^2)		1.5970	1.7690	0.9020
Gamma(γ)		0.8762	0.0275	31.8618***
Sample size	75			

*** (O <0.01) ** (P<0.05) * (P<0.10); summarized from computer output (2007)

Table II. Frequency distribution of Technical Efficiency of Urban Farmers

Efficiency Index	Frequency	Percent of Farmers
0.00 - 0.10	3	4.00
0.11 0.20–	1	1.33
0.21 - 0.30	2	2.67
0.31 - 0.40	3	4.00
0.41 - 0.50	4	5.33
0.51 - 0.60	2	2.67
0.61 - 0.70	6	8.00
0.71 - 0.80	14	18.67
0.81 - 0.90	32	42.67
0.91 0 1.00	8	10.67
Total	**75**	**100**
Mean	0.81	
Maximum	0.95	
Minimum	0.10	

Source: Computed from MLE Result

reported a positive and significant relationship between these variables and technical efficiency in Nigeria.

However, the estimated co-efficient of labor and inorganic fertilizer, although positively signed are not significant at any level of significant. The positive relationship between these variables and technical efficiency of the urban farming shows the importance of these inputs in enhancing the increasing level of output in the study area. The statistical in-significance of labor and inorganic fertilizer may be attributed to the high cost of these inputs in the urban area, which limited their uses. The high cost and scarcity of fertilizer result in the alternative use of manure, which gives its high significance in the model.

The source of inefficiency is examined by using the estimated δ co-efficient in Table I associated with the in-efficiency variables in equation 4. The co-efficient of age, farming experience, level of education and extension contract were estimated to be negative and statistically significant at 1% and therefore conforms to prior expectations. The implication is that urban farmers that are aged, experienced with high level of education and have more extension contact tend to be more efficient in urban farming and hence increase in the output level. This result conforms to the earlier studies conducted by Soyoum *et al.* (1998), Onu *et al.* (2000) and Amaza and Olayemi (2000). There is a positive relationship between ages of farmers with farming experience. Thus, farmers with more years of farming experience are more efficient, presumably due to their ability to acquire technical knowledge through learning on the job.

The co-efficients of the variables associated with crop diversification and household size are positives and statistically significant at 1%. This implies that increase in the number of crops grown in a farm unit and household size could lead to increase in the technical in-efficiency of the urban farming and hence a decrease in the technical efficiency of the farmers. This result is inconsistent with the findings of Ebong (2005) and Onyenweaku *et al.* (2005), which identified a positive relationship between household size and technical efficiency among crop farmers.

The distribution of the farmer's technical efficiency is provided in Table II. The technical efficiency of the sampled farmers is less than one (i.e., 100%) indicating that all the farmers are producing below the maximum efficiency frontier. The farmer's technical efficiency varied between 0.10 and 0.95 with a mean of 0.81. The picture that emerges from the analysis is one of a generally high technical efficiency in urban farming in the study area as most of the farmers (82.68%) produce above 0.50 efficiency index. However, 53.34% of the crops farmers in the study area produce above the estimated average technical efficiency index of 0.81. The distribution of technical efficiency suggests that potential gain among the sample farmers is not much. Thus, in the short-run, there is a scope of increasing crop production in the urban farming by 19% by adopting the technology and technique used by the best-practice farmer. The result of this study, however deviates from the earlir studies conducted by Ali and Byerlee (1991), Onyenweaku *et al.* (2005) and Amaza *et al*. (2005), which indicated a wide gap between the maximum and the average technically efficient farmer on food crop production.

CONCLUSION

The results of the study revealed that the important factors directly and significantly related to technical efficiency are farm size, capital inputs, manure and planting materials. The contribution of the farm size (land) and capital in increasing production are more prominent.

A significant variation was observed in the level of technical efficiency achieved by farmers in urban farming.

The technical efficiency in urban farming in the study area could be increased and farmer's income improved through application of fertilizer, use of family labor and consolidation of small holder farms through formation of farmer's co-operatives and policies aimed at reducing household size.

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