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# Measuring Technical Efficiency of Urban Farms in Uyo Metropolis

NSIKAK-ABASI A. ETIM , EDET J. UDOH and T. T. AWOYEMI

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## ABSTRACT

This study assesses the socio-economic characteristics of urban farmers and determines efficiency of resources of urban farms in Akwa Ibom State. Data for the study were collected from 80 urban farmers using questionnaire and personal interview. The study utilized descriptive statistical tools and Cobb-Douglas production function based on stochastic frontier to assess the resource use efficiency in urban farms respectively. Empirical result reveals the mean level technical efficiency of 69.47 percent implying that there exists scope for increasing output. The result further reveals that except for capital resource, the coefficients of land ( $\beta_1$ ), Labour ( $\beta_2$ ), Fertilizer ( $\beta_4$ ), and plantlings ( $\beta_5$ ) have positive signs and were significant at five and one percent level of significance. Their elasticities of production were 0.1767, 9.4431, 0.1354 and 0.7578 respectively.

**KEYWORDS:** Urban farming, technical efficiency, stochastic frontier, population pressure.

## INTRODUCTION

Before now, Agriculture was primarily practised in the rural areas. Most people think of farming as an activity occurring almost exclusively on rural land. (Kaufman and Bailkey, 2002). The increasing demand for food caused by population pressure in urban areas has driven many households to cultivate vacant lands. When population grows rapidly, it demands more and more from nature – more food, more water, more energy (Green, 1992). Food produced from city farms are usually used to augment family food supply and income. In most cases, food produced from urban farms are consumed at home. Mougeot (2002) reported that the great majority of urban farmers are still poor and grow food mainly for their own subsistence with little support or protection, on small plots that they do not own. Nigeria's population with a growth rate of 2.8 percent is on the increase. According to population reference Bureau (2000) cited in (Hinrichsen and Robey, 2000), Nigeria has a population of 123.3 million and it is projected that by 2050, the country's population will be 303.6 Million. Pressure on population does not only increase food demand but influences resource use and indirectly decreases food supply. The high population density in urban areas results in more intensive use of resources, and the increase in population in course of time tends to outpace the increase in food supply. (UNDP, 1996; Sundharam and Vaish, 1973).

Akwa Ibom State which is fast on the ladder of urbanization may not be food secured in the nearest future. With a population of over 2.4 million (FOS, 1999), the pressure does not only limit land for agricultural purposes but also a decline in food supply. Rural – peri-urban – urban drift is on the rise as more and more people migrate from the hinterland to urban areas of the state in search of skilled jobs and quality education. With the influx of people into urban areas of the state without corresponding measures to keep pace with the high population densities, many city dwellers are still malnourished. While poverty and food shortage remain predominantly rural problems, the proportion of undernourished people living in cities is on the rise due to rural-urban migration (Von Braun, 1997). A more worrisome aspect is the industrial and real estate which have taken over agricultural lands.

In reaction to the persistent food inadequacies caused by urban population pressure and in a bid to balance food supply with population growth while circumventing the problem of food deficit in urban households within the state, urban dwellers have been involved in farming around their homesteads. Different types of gardens are cultivated and managed. Besides, it is increasingly common to see micro-ruminants and poultry and other non-ruminants in many compounds. These activities are evolving and to a considerable extent becoming phenomenal economic ventures.

Urban agriculture uses resources, products and services found in and around the urban areas and in turn, often supplies resources, products and services to that area (Mougeot, 2002). Farming in general, have to use available inputs as efficiently as possible to achieve optimum production (Udoh and Akintola, 2001). Inefficient use of inputs can jeopardize food availability and security. Thus an index of resource-use productivity measurement constitutes important empirical consideration. This study, therefore, aims at measuring farm level technical efficiency effects, and relating the estimated technical efficiencies to socio-economic characteristics of the urban farming households.

## METHODOLOGY

### The Study area, sampling and Data collection.

This study was conducted in Uyo Local Government Area of Akwa Ibom State in 2001 cropping season. Uyo is situated 55 kilometers inland from the coastal plain of southeast Nigeria. It covers an area of approximately 35km<sup>2</sup> and comprises four

**NSIKAK-ABASI A. ETIM**, Department of Agric. Economics and Extension University of Uyo, Uyo, Nigeria.

**EDET J. UDOH**, Department of Agric. Economics and Extension University of Uyo, Uyo, Nigeria.

**T. T. AWOYEMI** Department of Agric. Economics, University of Ibadan, Ibadan, Nigeria.

clans- Oku, Etoi, Offot and Ikono Uyo. It is a fast evolving metropolis with considerably governmental, civil and commercial activities. Farm-level intensive itinerary survey provided the basic primary cross-sectional data from 80 urban farms (20 from each clan); these were randomly collected with the aid of structured questionnaires. The baseline information on input use, socio-economics characteristics, output levels, units prices, etc were collected and analyzed.

#### The Analytical Techniques

Beside the descriptive statistics that were employed to present exploratory information of the socio-economic characteristics of the farming households, the study ultimately utilized multiple regression based on stochastic production frontier to determine resource use efficiency in the urban farms.

#### The Empirical Model

We specified a stochastic production frontier that allows for estimation of individual farm efficiency levels with both time variations and cross sectional data. The stochastic frontier production function is defined as:

$$Y_i = F(X_i, \beta) \exp(V_i - U_i) \quad i=1,2,\dots,N \quad (1)$$

Where:  $Y$  is the output of  $i^{\text{th}}$  farm;  $X_i$  is the corresponding (MxZ) vector of inputs;

$\beta$  is a vector of unknown parameter to be estimated;  $F(\cdot)$  denotes an appropriate functional form;  $V$  is a symmetric error component that accounts for random effects and exogenous shock; and  $U \leq 0$  is a one-sided error component that measures technical inefficiency

To develop a model that is flexible and can envelop the data, we specified a Cobb-Douglas production function that is expressed as:

$$\ln(\text{Qty}) = \beta_0 + \beta_1 \ln(\text{LA}) + \beta_2 \ln(\text{LAB}) + \beta_3 \ln(\text{CAP}) + \beta_4 \ln(\text{FERT}) + \beta_5 \ln(\text{P.MAT}) + U_i + V_i \quad (2)$$

Where: Qty is the grain equivalent (kg); LA is farm size (ha); LAB is labour (mandays); CAP is capital (naira); FERT is fertilizer (kg); P.MAT is cost of planting material (naira);  $U$  and  $V$  are as previously defined in equation 1. The term  $U_i$  that represents technical inefficiency is assumed to arise from a normal distribution with  $\mu$  mean and variance  $\sigma^2 u$ , which is truncated at zero. In this study, estimated technical inefficiency is related to certain variables as defined in the following expression:

$$e^{-u_i} = \delta_0 + \delta_1 (\text{Age}) + \delta_2 (\text{Exp.}) + \delta_3 (\text{Edu}) + \delta_4 (\text{Sex}) + \delta_5 (\text{Ext}) + \delta_6 (\text{Pur}) + Z_i \quad (3)$$

Where Age is the age of the farmer (Years), Exp is the years of farming experience, Edu is the educational level of the farmer in years, Sex is the sex of the farmer (dummy), Ext is extension service (dummy), Pur is purpose of farming (dummy).

The values of the unknown coefficients in equation (2) and (3) are jointly estimated by maximizing the likelihood function (Yao and Liu, 1998; Udoh and Akintola, 2001b).

## RESULTS AND DISCUSSION

### ML ESTIMATES AND INEFFICIENCY ESTIMATES RESULTS

The model specified is estimated by maximum likelihood method using a FRONTIER 4.1 software developed by Coelli (1995). The results are presented in table 1. According to the table which shows ML estimates and inefficiency determinant of the sigma square (0.0132) is statistically significant and different from zero at  $\alpha = 0.01$ . This indicates a good fit and the correctness of the specified distribution assumption of the composite error term.

Moreover, the variance ratio, defined as  $\lambda$  is estimated to be as high as 52.49 percent, suggesting that the systematic influences that are unexplained by the production function are relatively dominant sources of random errors. Thus, the existence of technical inefficiency among the urban farmers accounts for about 53 percent of the variation in the output level of the crops grown. In a nutshell, the diagnostic statistics confirm the relevance of the specified stochastic production function and maximum likelihood estimation.

Table 1 further shows likelihood parameter estimates of the stochastic production frontier for urban farms in the study area. The production function estimate indicates the relevance of resources in urban farming. Except for capital use, the coefficients of other factors have the expected signs and magnitude; labour appears to be the most important input in the area with an elasticity of (9.4431). The implication is that, increasing labour use by 10 percent, output level would increase more than proportionate by a margin of 94.431 percent. The estimated co-efficients of the inefficiency variables are highly significant except

Age, Sex and Purpose. It therefore follows that educational level of urban farmers, years of experience in farming and access to extension services positively affect the farm level technical efficiency. This implies that as an urban farmer advances in education, inefficiency in resource use decreases and technical efficiency increases. As an urban farmer acquires more experience in farming, technical efficiency increases and inefficiency of resource use decreases. Furthermore, an urban farmer who has access to extension services is likely to be more efficient in use of resources.

TABLE 1: ML ESTIMATES &amp; INEFFICIENCY FUNCTION

Variables	Coefficients	Asymptotic T-Value
Constant term ( $\beta_0$ )	1.2978	2.5120**
Land (ha) $\beta_1$	0.1767	2.2854**
Labour (Mandays) ( $\beta_2$ )	9.4431	2.6173***
Capital (N. K) ( $\beta_3$ )	-0.0121	-0.7896
Fertilizer (k.g) ( $\beta_4$ )	0.1354	2.744***
Plantlings (N. K) ( $\beta_5$ )	0.7578	14.0848***
<b>Inefficiency Model</b>		
Intercept $\delta_0$	1.0491	1.6757*
Age (yrs) $\delta_1$	-0.1192	-0.8879
Experience (yrs) $\delta_2$	-0.1216	-2.5413***
Education (yrs) $\delta_3$	-0.2504	-2.2365**
Sex (Dummy) $\delta_4$	0.0355	0.6302
Extension (Dummy) $\delta_5$	-0.1237	1.7124*
Purpose (Dummy) $\delta_6$	-0.0068	-0.110
<b>Diagnosis Statistics</b>		
Sigma-square $\sigma^2_s$	0.0132	5.222***
Gamma $\lambda$	0.5249	2.8991***
Ln (Likelihood)	547.970	
LR Test	160.417	

Source: Computer Print out of Frontier 4.1.

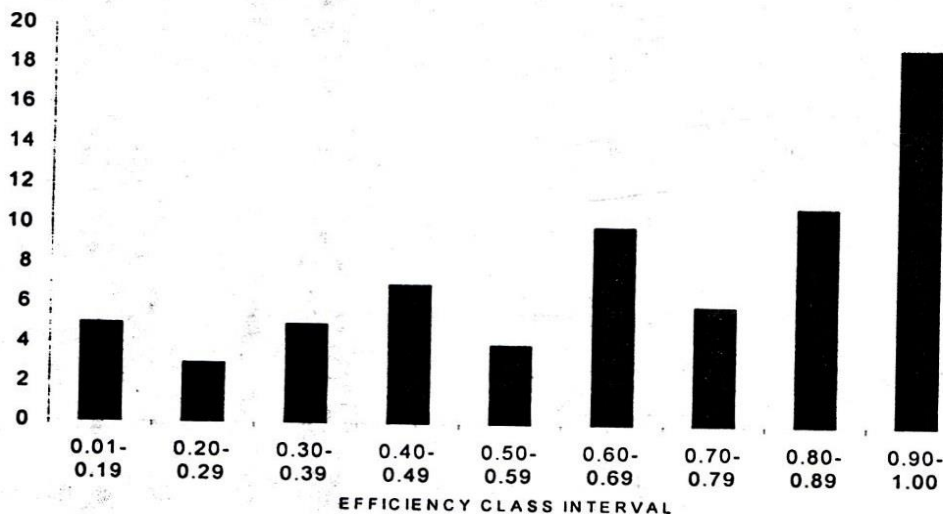
NOTE: All Explanatory variables are in natural logarithms. A negative sign of the parameters in the inefficiency function means that the associated variables have a positive effect on technical efficiency and a positive sign indicates the reverse is true. Asterisks indicate significance \*\*\* 1%, \*\* 5%, \* 10%

#### Resource-Use Efficiency Distribution

Farm-specific resource use efficiency indices are presented in Table 2.

Efficiency class	Frequency	Percentage
0.01-0.19	5	7
0.20-0.29	3	4
0.30-0.39	5	7
0.40-0.49	7	10
0.50-0.59	4	6
0.60-0.69	10	14
0.70-0.79	6	9
0.80-0.89	11	16
0.90-1.00	19	27
Mean= 69.47	Minimum= 0.01	Maximum= 0.98

Graphically, these distributions are shown in figure 1:



**DISTRIBUTION OF FARM-SPECIFIC TECHNICAL EFFICIENCY INDICIES AMONG URBAN FARMERS**

The distribution as shown on both table 2 and figure 1 indicate a rather wide variation of efficiency index across the farms. The distribution spreads from left to right at different intervals with the mean value being 0.69. However, larger percentage of the farms have efficiency value greater than 0.60, indicating negatively skewed distribution.

The observed distribution suggests that little marketable outputs are wasted due to inefficient use of farm resources. However, none of the farms was on the frontier of production, which suggests that each urban farm was confronted with multifaceted production problems. These problems range from technical production constraints and socio-economic factors to environmental factors. Specifically, in subsistence farming as in the case of urban farming, resources are mostly allocated to various uses on the basis of their marginal shadow values thereby preventing the farmers from reaching the efficiency frontier (Udoh and Akintola, 2001a). On this premise, Parikh *et al.* (1995) noted that marginal shadow values and marginal value productivities could differ for each of the inputs so that inefficiency may result.

#### SUMMARY AND CONCLUSION

The study centred on farm-level estimation of technical efficiency and related determinants through stochastic parametric estimation methods. A Cobb-Douglas production frontier was estimated by maximum likelihood estimation procedure to obtain ML estimates and inefficiency determinants. The parameters obtained were asymptotically efficient, unbiased and consistent. The diagnostic statistics confirmed the relevance of the stochastic function and the maximum likelihood estimation method against ordinary least squares estimation method.

With a mean efficiency value of about 69 percent, the analysis revealed that production has not reached frontier threshold. As such, within the context of efficient production, crop production can still be increased by about 31 percent using available technology. In conclusion, there is no doubt that urban farming is providing food and income to millions of city inhabitants. To ensure the sustainable use of productive resources, it becomes pertinent for the efficient use of such resources in the face of increasing urbanization. With the expansion of urban lands and subsequent replacement with industrial development, cultivation of the limited spaces available with short cycle crops and raising of micro-livestock is the panacea for persistent food paucity in populous urban areas.

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