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IDENTIFYING SOURCES OF EFFICIENCY AMONG RESOURCE POOR INDIGENOUS VEGETABLE FARMERS IN UYO, NIGERIA

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Abstract

Indigenous vegetables have historically played an important role in farming and consumption systems in Nigeria. Vegetable production like any other farming activity requires the use of inputs as efficiently as possible to optimize production. To identify the sources of efficiency among indigenous vegetable farmers, the stochastic frontier production function which incorporates a model for the technical efficiency effect was employed. Data from 100 indigenous vegetable (waterleaf) producers were obtained through two-stage sampling procedure with the aid of questionnaire. Using the maximum likelihood estimation analysis, asymptotic parameter estimates were evaluated to describe efficiency sources. Results revealed that the average resource use efficiency is 0.81 (81%) leaving an inefficiency gap of 0.19 (19%), indicating that about 19% higher production could be achieved using the same input mix. Land, labour, waterleaf cuttings were evaluated and identified as the most critical efficiency sources. Age, access to credit facilities, and market were identified as the most important explainers of inefficiency. To derive the benefits of economies of scale, indigenous waterleaf producers should increase their farm sizes devoted to waterleaf cultivation either by land consolidation or acquiring new farm plots.

Keywords: *Sources, efficiency, indigenous, waterleaf, Nigeria.*

1. Introduction

Indigenous vegetables are significant component of the diet of households throughout sub-Saharan Africa (SSA) (FAO, 1988; Grubben & Denton, 2004; Oluoch, Pichop, Sihie, Abukutsa-Onyango, Diouf & Shackleton, 2009). Hundreds, if not thousands, of species are used, many as daily components of the diet. For example, Vainio-Mattila (2000) found that the samba people in Tanzania consume 73 species of wild plant foods, most of which are ruderals growing by the roadsides or in arable lands. Ogle and Grivetti (1985) identified more than 200 wild edible species used by the Swazi of Swaziland, most of which were collected on a daily basis, by women, just before the preparation of meals. These were sourced from agricultural fields (56%) as well as other disturbed environments that include "near home" (18%), cattle or goat kraal (2%), or from household garden (1%). Many others are used less frequently, and some only in times of drought or as famine foods (see Zinyama, Matiza & Campbell, 1990). Regardless, there is little doubt that these species and varieties are extremely important for food security, nutrition, culture and poverty alleviation throughout Africa. One of such indigenous vegetables which is the daily components of diets in Akwa Ibom State and which is widely cultivated and consumed in Southern Nigeria is waterleaf (*Talinum triangulare*).

Water leaf (*Talinum triangulare* (Jacq.) wild) is an erect, fleshy, annual herb cultivated in West Africa and used as a cooked vegetable (Akobundu & Agyakwa, 1998; Udoh & Etim, 2006a; Udoh & Etim, 2006b; Udoh & Etim, 2011). It has swollen taproot and can be reproduced from seed, or vegetatively from stem cuttings. Waterleaf is used in combination with other indigenous vegetables such as African jointfir (*Gnetum africanum welw.*) Bush apple (*Heinsia crinata* (Afzel) G. Taylor), Bitter leaf *(Vernonia amygdalina)* and fluted pumpkin (*Telferia occidentalis* Hook F) (Udoh & Etim, 2006a; Udoh & Etim, 2011). In 100 grams of fresh materials, waterleaf contains protein (2.4g), fats (0.04g), carbohydrates (40g), fibre (1.0g), calcium (121mg), phosphorus (67mg), iron (5mg), thiamine (0.08mg), riboflavin (0.18mg), niacin (0.30mg), and ascorbic acid (31mg) (Ekpenyong, 1989; Eyo, Ekpe & Ogban, 2001; Udoh & Etim, 2006; Udoh & Etim, 2011). There has been a wide gap between the demand for waterleaf and its supply particularly during the peak of rainy season and dry seasons. This is evidenced in astronomical rise in price of waterleaf and therefore greatly implied in food security. Indigenous vegetable production like any other farming activity utilizes resources. Recent and empirical studies by Udoh and Etim (2006a, 2006b, 2011) document that for farmers to optimize production, available resources must be utilized as efficiently as possible and being managers of land, farmers need to manage problems arising from deteriorating natural resources (Rosegrant, Cline, Li, Sulser & Valmonte-Santos, 2005; Udoh & Etim, 2011). Information on sources of efficiency of indigenous vegetables are limited. This study however attempts to fill this knowledge gap by identifying the sources of farm level efficiency among resource poor indigenous vegetable producers.

2. Methodology

2.1. The Study Area, Sampling and Data Collection Procedure

The study was conducted in Uyo Local Government Area, the capital city of Akwa Ibom State, Nigeria. Uyo is situated 55 kilometers inland from the coastal plain of South-East Nigeria. The area lies within the humid tropical rainforest zone with two distinct seasons – the rainy and short dry season. The annual precipitation ranges from 2000 – 3000mm per annum. According to Etim & Ofem (2005), this rainfall regime received in most parts of the State encourages farming throughout the year. The area is located between latitude $5^0 17^1$ and $5^0 27^1$N and longitude $7^0 27^1$ and $7^0 58^1$ and covers an area of approximately 35 square kilometers. The occupation of the inhabitants reflects the economic activity of the residents. The settlement pattern in Uyo is nucleated and being an administrative headquarters, majority of civil and public servants and political office holders reside there. Etim, Azeez & Asa (2006) noted that these people engage in part-time farming activities and other commercial ventures within and around their homes as a way of augmenting and supplementing family income and food supplies.

Data used for this study are mainly primary and were obtained from the waterleaf farmers using questionnaire during 2012 farming season. Two stage sampling procedure was employed. The first stage involved the random selection of two peri-urban areas viz: Mbiabong and Idoro. The second stage involved the selection of 50 farmers to make a total of 100 farmers. Baseline information on socio-economic characteristics, input use and output levels were collected and analyzed.

2.2. The Empirical Model

The study utilized stochastic production frontier, which builds hypothesized efficiency determinants into the inefficiency error components (Coelli & Battese, 1996). Assuming we specified a Cobb-Douglas functional form as:

$$Ln\ (Qty) = \beta_o + \beta_1 Ln\ (Land) + \beta_2 Ln(Labour) + \beta_3 Ln(Organic\ fertilizer) + \beta_4 Ln\ (Cuttings) + \beta_5 Ln(Capital) + Vi - Ui \qquad (1)$$

Where Qty is the quantity harvested measured in kg; Land is the farm size measured in square meters; Labour is the labour employed in farm operations measured in mandays; inorganic fertilizer is fertilizer applied on the soil measured in kg; organic fertilizer is farm yard manure applied on the soil measured in kg; planting materials is waterleaf cuttings measured in naira; Capital is the depreciation value of the implement used measured in naira. With Vi N $(0, v^2)$; and

$$e^{-ui} = \alpha_o + \alpha_1\ (Tech) + \alpha_2(Age)\ \alpha_3(Hhs) + \alpha_4(Sex) + \alpha_5(Cred) + \alpha_6(Mkt) + Zi \qquad (2)$$

Where Tech is access to extension contact (dummy), Age is the age of the farmer (years); Hhs is the number of persons in a household who share the same dwelling and meals; Sex is the sex of the farmer (dummy); Credit is access to credit facilities (dummy); and Mkt is access to market (dummy); Zi is an error term assumed to be randomly and normally distributed. The value of the unknown coefficients in equations (1) and (2) are jointly estimated by maximizing the likelihood function (Yao & Liu, 1998; Udoh & Akintola, 2001b).

3. Results and Discussion

Table 1. Summary Statistics of Output and some explanatory variables for a Sample of Waterleaf Farms Variables

Variables	Unit	Mean Value	Range
Output	Kilogram	2908.31	221-4303
Land	Square meters	71.09	49.37-92.82
Labour	Mandays	124.28	26.27 – 188.90
Organic Fertilizer	Kilogram	12.75	8.11 – 20.57
Planting Materials	Naira	2800	1600 – 5200
Capital	Naira	400.40	82.20 – 540.60
Household size	Number	8	2 – 14
Age	Years	38	18 – 52

Results for the variables were summarized (Table 1). The average production area was $71.09m^2$, indicating that waterleaf is cultivated on small holdings. This small farm size could either be due to the labour-intensive nature of the cultural practices involved or because the farmers cannot acquire, or cultivate large hectares. Production practices include land clearing, construction of beds, planting, weeding, fertilizer application, deflowering and harvesting. All these practices require substantial amounts of labour 124.28 mandays. Results are synonymous with earlier findings by (Udoh & Etim, 2006a, 2006b, 2011). The statistics of age is an indication that the producers are within an active and productive age group.

The LAND variable is aimed at capturing the effect of scale production on the technical efficiency of the farm. A study by Lundval and Battese (2000) established a varied relationship between farm size and technical inefficiency in developing countries using the frontier production function. The sign of the land variable in this study was negative-significant in the model. This can be explained by the fact that increased farm size diminishes the timeliness of input use thus leading to decline in technical efficiency. The inverse relationship confirms the findings of Msuya, Hisano and Nariu (2008) and Aye and Mungatana (2010). Results underscore the need to formulate policies that encourage small holder waterleaf farmers to continue in production as they are the backbone of agricultural production and growth in developing countries.

LABOUR variable refers to the family labour provided for farming operations. In this study, labour appears to be the most important production resources with an elasticity of 2.0982. The relative large coefficient for labour is an indication that cultivation of waterleaf is labour intensive particularly during deflowering and weeding.

Cuttings are the waterleaf stems used for planting. The variable is positively significant as expected. Result however stresses the need to encourage proper storage and preservation of seeds for use by local farmers. This will not only ensure timely availability of planting materials to farmers but will reduce the additional cost which would have been incurred in purchasing these seeds or planting materials.

The variable AGE could have either positive or negative effect on technical efficiency. Older farmers are more experienced and would be more technically efficient that younger farmers. However, regarding innovations and agricultural methods, older farmers are less likely to adopt innovations and thus would be less technically efficient than younger farmers. In this study, age has a positive sign and significantly impacts on technical efficiency in the model thus, the variable age indexes experiences and serves as a proxy for human capital revealing that farmers with more years of experience in farming will have more technical skills in management and thus higher efficiency than younger farmers. Increased experience in cultivation may also enhance critical evaluation of the relevance of better production decisions, including utilization of productive resources.

The variable CREDIT was positive as expected. Result implies that accessibility to and availability of credit to farmers eliminates the production constraints hence make it easier for timely purchase of resources thereby increasing productivity through efficiency. Results are synonymous with findings of Muhammed (2009); Aye and Mungatana (2010) and Etim, Thompson and Onyenweaku (2013). Access to agricultural credit has been positively linked to agricultural productivity and yet this vital input has eluded small holder farmers in Nigeria (Philip, 2009). One other key problem associated with small holder access to agricultural credit is that agricultural loans are often short-term with fixed repayment periods; and may not suit annual cropping, especially when loan release is not in time with growing cycle of crops.

MARKET variable captures farmers' access to market and serves as a proxy for development. The variable was correctly signed. Farms located farther to and from the market are believed to be less technically efficient than the farms closer to the market. Farms located farer from the market will not only add to production and marketing cost but also impacts on various operations on the farm particularly accurate timing of resources use. Etim and Okon (2013) reported similar findings in identifying sources of technical efficiency among subsistence maize farmers in Nigeria.

4. Resource-Use Efficiency Distribution

An important feature of the stochastic production frontier is its ability to estimate individual, farm-specific technical, allocative and economic efficiencies. Table 2 shows farm specific resource use efficiency indices.

Table 2. Maximum Likelihood Estimates and Inefficiency Function

Variable	Coefficients	Asymptotic t-value
Production Function		
Constant term (β_o)	0.5988	1.6813*
Land (β_1)	1.0257	2.0136**
Labour (β_2)	2.0982	1.9477*
Organic Fertilizer (β_3)	0.0157	1.0735
Waterleaf Cuttings (β_4)	0.0836	2.2510**
Capital (β_5)	1.0067	1.5821
Explainers of Inefficiency		
Intercept (α_0)	-6.0310	-2.9210***
Technical Assistance (α_1)	1.3651	1.2520
Age (α_2)	0.9310	1.9838*
Household size (α_3)	0.0520	0.6772
Sex (α_4)	0.0139	1.4078
Credit (α_5)	1.0677	1.8351*
Market (α_6)	0.0259	1.7634*
Diagnostic Statistics		
Sigma-square (s^2)	0.0831	2.5731**
Gamma (λ)	0.7481	1.6702*
Ln (Likelihood)	16.3817	
LR Test	7.8721	
Quasi function	1.4311	
Number of observations	100	

The efficiency indices across farms show considerable variation, as the technical efficiencies of all the sampled farms are less than one. This implies that no farm reached the frontier threshold and therefore has the potential to increase efficiency. With a mean technical efficiency index of 0.81, there is still scope for increasing farm input. The observed distribution suggests that little marketable product are wasted due to inefficient use of resource inputs. However, none of the farmers reached the frontier of production which according to Etim, Udoh and Awoyemi (2005) such farms are confronted with multifaceted production challenges ranging from technical production constraints, socio-economic factors to environmental factors.

Table 3. Farm Specific Technical Efficiency

Efficiency Class	Frequency	Percentage
< 0.13	12	12
0.14 – 0.49	22	22
0.50 – 0.69	38	38
0.70 – 0.95	20	20
>0.96	8	8
Mean Efficiency = 0.81		
Minimum = 0.02		
Maximum = 0.97		

5. Conclusion

The study measured the farm level efficiency and its determinants using stochastic parametric estimation techniques. The parameters of the ML estimates and inefficiency determinants obtained using Cobb-Douglas Production Function estimated by maximum likelihood estimation technique were asymptotically efficient, unbiased and consistent. The important resource inputs that increased output from the water-leaf farms are land, labour, organic fertilizer and capital. The distribution of farm-specific technical efficiency shows that the waterleaf farmers were operating below the frontier threshold. Thus, within the context of efficient agricultural production, waterleaf out put can still be increased by 19 percent using available imputer and technology. In order to meet the nutritional needs of the increasing population, adequate credit should be made accessible to farmers and the development of road infrastructure should be of priority to ensure easy movement of inputs and products in and out of the farm.

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