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Technical Efficiency of *Moringa oleifera* Production in Oshimili South Local Government Area of Delta State, Nigeria

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ABSTRACT

Technical efficiency is a prerequisite for allocative or economic efficiency. Economic efficiency is achieved if the highest possible level of satisfaction is obtained from a given resources. The level of technical efficiency of a particular firm is characterised by the relationship between observed production and some ideal or potential production. The moringa plant (*Moringa oleifera*) is known worldwide for its nutritional and medicinal benefits and industrial uses. Almost every part of the moringa plant has nutritional value. Specifically, the study estimated the profitability of moringa production in the study area; the productivity of the factors involved in moringa production as well as the technical efficiency (TE) of moringa production in the state. The area covered by this study is Oshimili South Local Government Area of Delta State from which six villages were randomly selected. The town and villages are Oko-amakom, Oko-anala, Oduke, Okwe, Asaba (Cable) and Anwai. Data obtained were statistically analyzed using descriptive and stochastic frontier analysis. Farmers can increase their efficiency level if they can source their inputs and information as regards farming directly from Delta State Agricultural Development Project. An entrepreneurial class of people well motivated and trained to employ an appropriate inputs use combination pattern in order to achieve the highest possible level of production from given resources will also lead to a high level of efficiency.

Keywords: Technical efficiency, *Moringa oleifera,* productivity, resource Use

INTRODUCTION

Technical efficiency means that natural resources are transformed into goods and services without waste that is producers are doing the best job possible of combining resources to make goods and services. There is no waste of material inputs. There are no workers standing idly around waiting for spare parts. The maximum amount of physical production is obtained from the given resource inputs. In essence, production is achieved at the lowest possible opportunity cost. Technical efficiency is a prerequisite for allocative or economic efficiency. Economic efficiency is achieved if the highest possible level of satisfaction is obtained from given resources. Because satisfaction is derived from consuming goods and services, economic efficiency requires the greatest possible level of production, that is, technical efficiency.

As technical efficiency is necessary for economic efficiency, it does not guarantee economic efficiency. While technical efficiency might be achieved in the production of purple spotted stuffed animals, allocative efficiency will not be achieved if no one actually wants purple spotted stuffed animals and they remain stored in a big purple warehouse. Technical efficiency is just one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (that is, be technically efficient), use the right mix of inputs in light of the relative price of each input (that is, be input allocative efficient) and produce the right mix of outputs given the set of prices (that is, be output allocative efficient) (Kumbhaker & Lovell, 2000).

The level of technical efficiency of a particular firm is characterized by the relationship between observed production and some ideal or potential production (Greene, 1993). The measurement of a firm specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier it is perfectly efficient. If it lies below the frontier then it is technically inefficient, with the ratio of the actual to potential production defining the level of efficiency of the individual firm.

Farrell's (1957) definition of technical efficiency led to the development of methods for estimating the relative technical efficiencies of firms. The common feature of these estimation techniques is that information is extracted from extreme observations from a body of data to determine the best practice production frontier (Lewin and Lovell (1990). From this the relative measure of technical efficiency for the individual firm can be derived. Despite this similarity the approaches for estimating technical efficiency can be generally categorized under the distinctly opposing techniques of parametric and non-parametric methods (Seiford and Thrall, 1990).

Stochastic estimations incorporate a measure of random error. This involves the estimation of a stochastic production frontier, where the output of a firm is a function of a set of inputs, inefficiency and random error. An often quoted disadvantage of the technique, however, is that they impose an explicit functional form and distribution assumption on the data. In contrast, the linear programming technique of data envelopment analysis (DEA) does not impose any assumptions about functional form, hence it is less prone to mis-specification. Further, DEA is a non-parametric approach and so does not take into account random error. Hence, it is not subsequently subject to the problems of assuming an underlying distribution about the error term. However, since DEA cannot take account of such statistical noise, the efficiency estimates may be biased if the production process is largely characterized by stochastic elements.

Moringa oleifera

Moringa pod is cooked as a vegetable in India and exported to many countries for Indian expatriates, fresh or canned. The root can be used as substitute for horseradish. Foliage is eaten green, boiled, fried, in soups or for seasoning. Dried leaf powder can be added to any kind of meal as a nutritional supplement. The seed can be roasted and eaten like a peanut. Seeds can also be used as a flocculent to clarify water as well as a source of non-drying and very stable oil, known as Ben oil. This oil, which was once used for lubricating watches and other delicate machinery, is clear, sweet and odourless, almost never going rancid. It is edible and is becoming increasingly popular in the cosmetics industry. Leaves and young branches are used as fodder. Moringa may also be used in fish and poultry feeds.

In tropical Africa, trees serve various traditional purposes such as source of food (leaves and fruits), timber, medicine, mulch, manure, firewood and livestock fodder. However, little attention has been paid to tree cultivation for livestock feeding in the region (Dicko & Siken, 1992). In the 1980s, the alley farming technology was introduced in Nigeria (Kang et al., 1990) with focus mainly on two exotic browse species, *Leucaena leucocephala* and *Gliricidia sepium* (Gutteridge and Shelton, 1993). Unfortunately, the adoption of these species by farmers has been faced with several challenges such as pests and diseases attack and presence of anti-nutritional factors. Therefore, the need to discover and recommend novel browse species with exceptional agronomic qualities which will be readily adopted by farmers.

The multiple uses and potentials of *Moringa oleifera* have attracted the attention of researchers in recent times. Although the plant is not completely strange in West Africa, it has been grossly underexploited as it is restricted to the arid northern zone where it is used mainly as live fence and as vegetable salad. Preliminary investigation showed that the plant grows fast, it has potentially high biomass production and exceptional biochemical properties, but there has been no systematic attempt to exploit *Moringa* either in terms of its agronomic or nutritive attributes (Akinbamijo et al., 2004).

Findings from this study will help to assess the impact of resources already committed to moringa production and the increased output that can be generated from such resources. It is in view of this that the study examines the productivity and the technical efficiency of moringa production in Oshimili South LGA of Delta State, Nigeria. Specifically, the study estimated the profitability of moringa production in the study area, the productivity of the factors involved in moringa production as well as the technical efficiency (TE) of moringa production in the state.

METHODOLOGY

Area of Study

The area covered by this study is Oshimili South Local Government Area of Delta State from which six villages were randomly selected. The town and villages are Oko-amakom, Oko-anala, Oduke, Okwe, Asaba (Cable) and Anwai. The area lies roughly between latitude $6^0$10'N and longitude $6^0$45′E. The area has an average annual rainfall of about 8667mm in the coastal area and 1905mm in the north area. The rainfall is heaviest in July with a short break in August. It has an average temperature range of 39 – 44^0C. Crops grown include Root and Tuber crops (cassava, yam, cocoyam), cereal (maize and swamp rice) like crops (palm and rubber) and a variety of vegetables.

Sources and method of data collection

Data for this study were collected from primary source. Primary data were collected using structured questionnaires personally administered with an assisting officer. The data collected include hectare of *Moringa oleifera* cultivated, quantity of fertilizer application of seed, quantity of pesticide applied and labour use in man day. Information on household characteristics such as educational status, farm size and farmers experience were also collected.

Sampling procedure

A two stage sampling procedure was adopted for this study. The first stage involves the random selection of six villages from the list of the villages in the local government area sourced from the LGA Secretariat .The second stage involves a random selection of an average of twenty farmers per village. A total of One Hundred and Twenty respondents were obtained.

Analytical techniques and model specification

Descriptive analysis was used to analyse and make comparison on the socio-economic characteristics of the combinations of both descriptive and analytical statistical tools employed. The descriptive analysis includes mean, frequency percentages, and average efficiency while the statistical tool is stochastic frontier analysis of farmers.

Stochastic production frontier

The study employed a variation of the stochastic production analysis by Coelli and Battese (1996). The empirical model of stochastic production and frontier applied to the analysis of efficiency to the production system of the moringa is specified as:

$L_n Y_{ij} = LnB_0 + B_1L_n X_{1ij} + B_2L_nX2_{ij} + B_3L_nX_3 + B_4L_nX_4 + B_5L_nX_5 + B_6L_nX_6 + V_{ij} U_{ij}$

Where the subscripts i and j refer to the ith moringa producer and jth input respectively

Y =Total output (kg)

X1 = farm in (ha)

X2 =Quantity of seed in (kg)

X3 =Amount spent on hired labour (N)

X4 =Family labour (man day)

X5 =Fertilizer (bags)

X6 =Pesticide (litres)

Vij are assumed to be independent and identically distributed normal random errors, having mean zero and variance (--), that is ,term Vij is the symmetric component and permit random variation output due to factors outside the of the farmers like fluctuation inputs,

Uij is the non-negative random variable call technical inefficiency effects associated with technical inefficiency of moringa production that is term Vij takes care of the variation noticed as a result of the following, family size, age, educational status, cooperative membership and years of experience, it is called a one-sided component (Uij >0), which reflects technical efficiency relative stochastic frontier. Thus Uij equals zero for any output lying on the frontier while Uij >0 for any lying below the frontier, hence the *equation* because, the output variable in the stochastic frontier production function is output in kg. In the measurement of the technical efficiencies of the moringa farmers, it is assumed that the inefficiencies effects are independently distributed and Uij arises by truncation at zero of the normal distribution with mean.

RESULTS AND DISCUSSION

Table 1 shows that the mean age of the farmers was 49.2. About 45% of the farmers were below 50 years of age. That is majority of the farmers are in their active age. The average technical efficient seem is not different across the age groups.

Marital status is directly linked with the farmers' performance in that it affects their level of productivity. Married farmers can engage the family labour in carrying out some of the farming operation. Table 1 shows the marital status of the sampled farmers which indicates that majority of the farmers are married. In fact, only 2 percent of the farmers are singles. This suggests that the farmers that are single are more technically efficient in their usage of resources than their married counterparts. This may be probably due to the fact that most married farmers engaged in more distractive family responsibilities that may led to their technical inefficiency

The Table also revealed that 15% of farmers were females while the remaining 85% were male. This means that most of the moringa farm owner were male and this may be due to the fact that women were generally treated as part of the labour available to the head of the household at a specify time such as during harvesting and processing. The result also revealed that male was efficient in input combination than female farmer in moringa production.

The Table revealed that moringa farmers that had primary education were more technically efficient in moringa production than those with no formal education. Farming experience can be said to measure the number of years of active participation in the cultivation of moringa with a view to determining how such experience has contributed to farmers' productivity in terms of yield and input use. Through experience, skills are developed. It was observed in the study area that more experienced farmers are better managers of farm resources than the less experienced ones. 55.8% of respondents have less than 1year of farming experience in moringa production and they have higher technical efficiency than those farmers between 1 – 4 years of experience in moringa production as shown in Table 1. The Table also showed that, about 41.7% of the farmers had their farm size between 0.11 – 0.30 and also had higher technical efficiency in moringa production.

It was observed from the Table that majority of the farmers (76.6%) obtain their land through family inheritance which had higher technical efficiency than other sources of land for production. This indicates that communal land tenure system is still operating in the area and among the problems associated with this system is that individual farmers have small fragmented farm holding which explains while they have small farm size as revealed in Table 1.

Table 1: Distribution of farmers according to their socio-economic characteristics

Age	**Frequency**	**Percentage (%)**	**Average efficiency level**
30-49	54	45.0	1.88
50-69	55	45.8	1.85
>= 70	11	9.2	1.11
Total	**120**	**100**	
Marital status			
Married	118	98.3	0.93
Single	2	1.7	0.96
Total	**120**	**100**	
Gender l			
Male	85.0	102	0.98
Female	15.0	18	0.82
Total	**100**	**120**	
Level of Education			
Primary education	68	56.6	0.98
No formal education	29		24.2
Tertiary education	23	19.2	0.91
Total	**120**	**100**	
Years of farming			
< 1	67	55.8	0.92
1-2	24	20.0	0.73
3-4	17	14.2	0.83
5 +	12	1.0	0.98
Total	**120**	**100**	
Farm size			
< 0.10 ha	25	20.8	93
0.11-0.30	50	41.7	98
0.31-0.50	30	25.0	93
0.51-0.80	15	12.5	92
Total	**120**	**100**	
Source of land			
Family	92	76.6	0.98
Leased	23	19	0.92
Rent	5	4.2	0.83Z
Total	120	100	

The regression equation is:

$E = 0.8952 + 0.0282X_1 + 0.0004402X_7 + 0.012X_8 + 0.000624X_9 + (0.0232)\ (0.0246)\ (0.000366)\ (0.0075)\ (0.009313)\ 0.01187X_{10} + 0.0051X_{11} + 0.0219X_{12} + 0.00167X_{13}\ (0.009892)\ (0.013077)\ (0.007449)\ (0.0005529)$

Results of regression analysis

$In\ Y = 4.4126 + 0.06593I_nX_1 + 0.0540I_nX_2 + 0.01843I_nX_3 + (0.0000251)\ (0.0000178)\ (0.0000199)\ (0.00000140)\ 0.1801I_nX_4 + 0.1087I_nX_5 + 0.0368I_nX_6$

$(0.0000633)\ (0.00000673)\ (0.0000)$

Table 2: Result of the determinant of efficiency

Coefficient	Standard Error	t-Value	
Constant	0.8952	0.0232	38.55
Farm size	0.0282	0.0246	1,44
Age	-0.00004402	0.000366	-1.20
Extension awareness	O.00624	0.009313	0.67
Primary education	0.01187	0.009892	1.20
Secondary education	0.0051	0.013077	0.39
Cooperative relationship	0.0219***	0.007449	2.94
Farming experience	0.00167***	0.0005529	3.02
Diagnostic statistics, log likelihood=211.35.			
Chi square =41.12.significant at1%, N=120			
Sex	0.012	0.0075	1.60

Source: Field Survey 2016.

***Indicate statistical significant of the coefficient at 1% level

From the result of the determination of efficiency factors above, 2 variables of cooperative membership and farming experience have significant coefficient at 1% level respectively. The coefficient of other independent variable (farm size, sex, primary education, secondary education, and extension awareness) were however not significant (p>0.10)

The coefficient of farming experience is estimated to be positive and statistically significant at 1% level. This indicates that a unit increase in farming experience leads to a better assessment of the important and complexities of good farming decision making including efficient use of input. The farming experience suggests that only farming background is an important positive determinant of a farmer's technical efficiency.

The coefficient of cooperative membership variable is estimated to be positive and statistically significant at 1% level. This suggests that cooperative membership has higher technical efficiency value than non membership in moringa production. That is cooperative membership is associated with higher level of technical efficiency in moringa production.

Table 3: Marginal value product and unit cost of each resource

Resources	MPP	Unit price input(#)	MVP	MFC(#)
Land	06503	10.000	30.6	10.000
Seed	0.5402	100	32.4	100
Hired labour	0.0843	150	5.06	150
Family labour	0.1087	150	10.81	150
Fertilizer	0.1087	900	6.52	000
Pesticide	0.0368	800	2.22	800

Source: Field Survey 2016

Resources use efficiency

In order to ascertain whether resources are efficiently put to use, the marginal value product (MVP) of land, seed, family labour were calculated and then compared with their input prices, since these variables are expressed in physical quantity in the function estimated, the MVP of such are compared with their unit prices to determine the degree of efficiency for their use.

The current farm gate price of moringa is N 60.00/kg. Given the levels of technology and prices of inputs and output, the marginal value productivity is the yardstick for judging the efficiency of resources use as a given resource is optimally allocated when there is no significance between MVP and its unit price. Thus, the marginal productivities of individual resource provides a frame work for policy decision on resource adjustment and the difference between the MPV and the unit cost indicates the scope of resource adjustment necessary to attain economic optimum.

As shown in Table 3, the marginal value products of all the resources (land, seed, hired labour, family labour, fertilizer and pesticide) are less than their unit prices (MVP<MFC). This implies that these resources are under utilized in the production. Thus there is resource use inefficiency. Therefore, there is need to cut down the level of resource use until the marginal value product and marginal factor cost of each resource are at equilibrium in order to attain optimal allocation of the resources in moringa production that is where MVP=MFC.

CONCLUSION

Based on the result of the study, the following conclusion and recommendations were made: Farmers can increase their efficiency level if they can source their inputs and information needed in farming directly from Delta State Agricultural Development project and if an entrepreneurial class of people are also well motivated and trained to employ an appropriate inputs use combination pattern in order to achieve the highest possible level of production from given resources as this will lead to a high level of efficiency.

RECOMMENDATIONS

1. There is need for the involvement of extension personnel in assisting moringa farmers in the area of improving their level of awareness especially to motivate the farmers to associate themselves with existing and organized cooperative society just as it's been shown in Table 2 shows cooperative membership has higher technical efficiency value than non membership in moringa production. In the same vein, distribution of credit facilities to such farmers should also be encourage and monitored by the government officials with existing co – operative groups, so as to ensure that the loan get to the proper hands (farmers) on time to procure necessary inputs at the appropriate time.
2. Improved seed variety should be distributed evenly among the farmers in order to increase the yield of farmers annually and also be able to withstand the damaged done by pests.
3. Government should also endeavor to provide machineries for potential farmers such as tractors, harrow, disc plough among other in order to enhance production activities

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