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Determinants of Technical Efficiency in Irrigated Ornamental Plants Production System of Akwa Ibom State, Nigeria

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Abstract
There are obvious cases of low agricultural production and sluggish economic growth begging for immediate intervention in Nigeria. One of such is irrigated agriculture which is a catalyst of transformation, changing agriculture from subsistence level to commercial lines and giving substantial returns to farmers. The determinants of technical efficiency in irrigated floriculture were investigated. A total of 90 respondents/floriculturists were randomly selected from the six agricultural zones that make up the study area. Descriptive statistics and the stochastic production frontier function were the tools of analyses. More than 70.2% of the respondents are males in their very youthful age of between 21 and 50years. A total of 72.2% are graduates having between 5 and 10 years of farming experience. It is also revealed that farm size, capital, irrigation, fertilizer and planting materials were all positively and significantly related to technical efficiency. The variations among the respondents were largely influenced by age, level of education, farming experience and extension contacts. All the production resources were used below their economic optimum levels and floriculturists were producing below the maximum frontier, having their efficiency index between 0.10 and 0.98 with 0.86 as the mean. It is observed that there are potentials for improvement with high level of technical efficiency. Thus, increased farm size, more capital investment and more extension contacts are strongly advocated.
Keywords: Farmers efficiency, irrigated production system, floriculture, economic growth, Nigeria

INTRODUCTION

There is increasing concern for agricultural advancement in sub-Sahara Africa especially Nigeria because the region is pre-eminently tropical. This is a fact which creates major obstacles and constraints to agricultural development and economic growth. Most African soils and farmlands are moderately fertile, delicate and deficient in organic materials. The rains are inadequate in volume and varies in time. Well watered areas are only about one quarter of the total land area of 98.3million hectares with 71.2million hectares cultivable land (Udom, 1991). The absence of frost, scanty mineral deposits and tropical climate also create conducive habitation for weeds, pests, bacterial and parasitic diseases which adversely affect the level of agricultural production including floriculture. Also, environmental degradation is a very sensitive issue receiving global attention today. The scourge of environmental degradation ranging from drought, soil erosion, flooding, pollution, oil spillage, gas flaring, deforestation, desertification and climate change; and its attendant consequences such as low and sluggish agricultural production and development, poverty and impoverishment of quality of life poses one of the most critical challenges and constraints in recent times. Hence, the concern of this study has become more important for floriculturists to meet basic objectives and improve upon the performance of the farm business in the Nigerian economy.

Furthermore, it is worth mentioning that the agribusiness sector has shifted from mere food production to farming systems incorporated to foster all round development. Diversifying, protecting the environment and meeting the various social and hospitality needs of the people have become the present day emphasis in agricultural development in Nigeria. Most of these basic food crop production systems are not on their own capable of ensuring increased and sustained levels of production with little or no degradation of the soil resource base (Clearfield and Osgood, 2006). Reversing the present trend of declining agricultural production and economic growth in Nigeria, therefore, should not depend solely on the development of improved and high-yielding crop varieties but also diversifying into other areas of agriculture like floriculture. The development and incorporating sustainable approach into various farming and production systems are necessary to foster and maintain advantages derived from such improved varieties (Atta-Krah and Kang, 2000).

Floriculture/ornamental plants production is a foremost and a major component of urban farming system in Nigeria. More than 75% of urban dwellers globally are involved either in commercial or subsistence level as a business or for home beautification and environmental protection (Smit, 1996). Floriculture involves the science and practice of growing, harvesting, storing, designing and marketing of shrubs, potted plants and cut-flowers (Muthoka and Murithi,2008). It is a major and specialized area of horticulture involved in the production of cut flowers, potted plants and greenery otherwise. Others are production of bulbs, rose plants, ground covers, trees and shrubs (landscape) and production of seeds and sods referred to as turf (Hodder, 1994).

The production and marketing of ornamental plants have potentials for income and employment generation, foster hospitality and social needs of the people, protect and enhance the aesthetics of the environment, foreign exchange earnings and of course poverty reduction in many developing economies. According to Okigbo (2000) trees including ornamental plants have long been recognized as essential both for the stability of the environment and for maintenance of soil fertility for crop production and quite useful in solving emotional, psychological and mental problems. Baiyewu et al; (2005) and Fakayode et al; (2008) revealed that ornamental plants do arrest dust, supplies oxygen and help as windbreaks. They also help in reducing heat build-up, air and noise pollution apart from checking erosion, flooding and deforestation.

In Nigeria, the business of floriculture is contributing positively to the economic growth of the nation and Akwa Ibom State in particular. The demand for ornamental plants has been reported to be increasing in most Nigerian urban centres at a faster rate than the level of production (Baiyewu et al,2005). Environmental degradation especially drought and uncontrolled urban population among other factors are the major factors that exert pressure and has created a wide disparity between level of production, population growth and increased demand. Production has remained very low and far below average. Consequently, local production has not been able to meet up with the domestic demand creating a problem of how to increase domestic production. Floriculture in Nigeria and other developing economies is still at infancy in contrast to what is obtained in the developed nations. Production is still in a developing state (Adeoye et al 1996; Ezedinma et al 1999). According to Fawusi (1996), though the business is flourishing in many urban centers in Nigeria, their production and awareness still remain a serious problem. There is that problem of not fully discovering the potentials which in the near future may create a wide gap between supply and demand. Again the efficiency of the utilization of production resources in ornamental plants production especially during off season in the study area has not been empirically ascertained. The potentials for accelerated and increased production could be fully realized through sound empirical studies such as this.

Every aspect of ornamental plants production is characterized by intensive care during production, controlled growing conditions, dedication and innovation on the part of the farmers, it is stimulating, satisfying and provides relative good income and it requires a substantial investment. For it to flourish, there must be a concentration of favourable growing conditions and efficient resource use (Sim and Kwack, 1995).

Top on the list of growing conditions is the availability and efficient use of water and other production resources especially during off-season. As put by Hsiao (1993), one of the most limiting environmental factors for crop production worldwide is lack of water. Ornamental plants require a reasonable amount of water to produce their biomass and maintain their inherent fragile and perishable nature even after harvesting and marketing. Water stress elicits a number of negative responses from the plants especially during dry season.

The availability of water/irrigation facilities in dry season production of ornamental plants cannot be compromised. Irrigation will not only make water available for the plants but will help in transforming the business from subsistence to commercial giving substantial returns to farmer and ensure the welfare of producing households through increased farmland productivity (Sikka and Vaidya, 1994). Cropping pattern will equally change from traditional food crops to cash crops with high yielding varieties and high level of efficiency in the business.

Farmers' technical efficiency is the ability to produce the highest level of output with a minimum amount of production resources under a given technology. It indicates the gains that can be obtained by improving resource management. A measure of how close a firm is to the maximum output level as defined by the frontier is a measure of its technical efficiency (Farrel, 1957). It is the success of producing a large amount of output as possible from a given set of inputs (Adeoti, 2006). Inefficient use of production resources especially in developing nations including Nigeria has been the greatest constraint to increased agricultural productivity. In the mist of frightening risks and uncertainties, farmers scarce and expensive resources need to be better organized and use efficiently for maximum output. Increased efficiency is imperative for maximum production which will offer solution to the present economic problems.

Thus, this study seeks to empirically provide an insight into the determining factors to increased technical efficiency. Specifically, it will identify the socio-economic attributes of the farmers influencing production, examine how efficiently floriculturists are using the production resources, identify the constraints and offer policy recommendations for increased profitable and sustainable ornamental plants production business in the study area and beyond especially during offseason.

STUDY METHODOLOGY

The study area and data collection procedures: Akwa Ibom State of Nigeria with six (6) agricultural zones is located in the South South region of Nigeria. It lies between latitudes 4°31"N and 5°31" N and longitudes 7°35"E and 8°35" E and has a population of over 3.92 million (NPC; 2006). It occupies a total land area of 7,245,935 square kilometers. The State is a foremost producer of petroleum resources and with two distinct ecological seasons the wet and the dry seasons. The rains are evenly distributed throughout the year and decrease from about 3,000mm in the South to about 2700mm in the North. The soil is generally sandy, easily drained with high absorptive capacity. The South has swampy coasts and creeks with salt and fresh water mangrove and up North is the rainforest belt. The people are predominantly farmers producing rain fed trees and food crops, including ornamental plants. Other farming activities such as fishing and livestock rearing including poultry, piggery, goats etc. are also carried out by them.

The study used well structured and pre-tested questionnaire to collect relevant primary data from 90 practicing floriculturists identified through a reconnaissance survey using simple random sampling technique to select from the six agricultural zones of the state.

Data on ornamental plants production activities in terms of inputs, outputs, socio-economic attributes of the farmers and business locations were collected for analyses.

Statistical Models and Data Analyses

Descriptive statistics such as means, percentages and frequency counts were used in the analysis of the data. To ascertain the determinants of production efficiency in the study area the following models were applied.

The Stochastic Production Frontier as specified by Aigner et al (1977), then Meeusen and Van den Broeck (1977) has been widely used in past production studies by Etim et al (2005); Hamidu et al (2003); Onu et al (2000) and several others. A major feature of the Stochastic Production Frontier is that the disturbance term is composed of two parts, a symmetric and a one-sided component. The Symmetric (normal) component V captures the random effects due to measurement error, statistical noise and other factors outside the farmers' control such as diseases and weather. It is assumed to be normally, independently and identically distributed as N ~ (O, δ^2V). The one sided component U; non negative (≤ 0) reflects technical inefficiency relative to the stochastic frontier and captures the randomness under the control of the firm. Its distribution is assumed to be half normal or exponential. The frontier is stochastic because its placement is allowed to vary randomly across firms (Adeoti, 2006).

The stochastic frontier approach is generally preferred for agricultural research for the following reasons: the inherent variability of agricultural production due to interplay of weather, soil, pests, diseases and environmental failures and many firms are small family owned enterprises where keeping of accurate records is not always a priority hence available data on production are subject to measurement errors. The Stochastic Frontier model used in this study is a linearized version of Cobb-Douglas production function. The production function and the inefficiency model were simultaneously estimated as proposed by Battese et al (1996).

The Stochastic Frontier Model was specified and estimated as follows:

$$\mathbf{LnY = ð_0 + ð_1 LnX_{1ij} + ð_2 LnX_{2ij} + ð_3 LnX_{3ij} + ð_4 LnX_{4ij} + ð_5 LnX_{5ij} + ð_6 LnX_{6ij} + v - \mu_i}$$

where subscripts ij refer to the ith observation on the jth farmer

Ln = denotes logarithm to base e
Y = Total Revenue in Naira
$ð_0$ = A constant Parameter
$ð_1$ - $ð_6$ = Regression Parameters
X_1 = Farm Size in hectares
X_2 = Labour in mandays
X_3 = Manure in kg
X_4 = Fertilizer in Kg
X_5 = Planting materials in kg
X_6 = Volume of Irrigation water in Litres
v = A random error term or white noise assumed to be independent of μ_1 identical and normally distributed with zero mean and constant variance N (0, δ^2v), intended to capture events beyond the control of the farmers, like topography, weather, uncertainties etc
μ = Disturbance term or technical inefficiency effects, which are assumed to be independent of V_i. They are non negative truncations at zero or half normal distribution with N(0, δ^2v). if μ_1, is zero, no allocative inefficiency occurs, the production lies on the stochastic frontier. If P is greater than zero, the production lies below the frontier and is inefficient.

i = 1. 2, 3, N, 1 (where, i =……..7) δ^2v, $\delta^2\mu$. δ^2 are unknown parameters to be estimated.

To account for the technical inefficiency the model below was estimated:

$$\mu ij = \boldsymbol{\beta_0 + \beta_1\, {}_{Ln}Z_{1ij} + \beta_2\, {}_{Ln}Z_{2ij} + \beta_3\, {}_{Ln}Z_{3ij} + \beta_4\, {}_{Ln}Z_{4ij} + \beta_5\, {}_{Ln}Z_{5ij}\, \beta_5}$$

where

μij = Technical inefficiency of the ith floriculturists
$\boldsymbol{\beta_0}$ = Intercept
$\boldsymbol{\beta_1 - \beta_5}$ = Regression coefficients
$\mathbf{Z_1 - Z_5}$ = Explanatory Variables which are
Z_1 = Gender (male= 1; female= 0)
Z_2 = Age of respondent
Z_3 = Years of formal education
Z_2 = Household size in numbers

Z_4 = Years of farming experience
Z_5 = Number of Extension contacts

The parameters of the stochastic production function are estimated by the method of maximum likelihood using FRONTIER 4.1 (Coelli, 1994). The maximum likelihood estimation (MLE) procedure is used because it is asymptotically efficient; consistent and normally distributed.

The above linear production function has been widely used in past production studies by Mailumo et al (2005). Etim et al (2005); Helfand (2003) Hamidu et al (2003) Onu et al (2000) Appleton et al 1996, then Ali and Byerlee (1991).

To determine the efficiency of each production resource the Efficiency Ratio given as

$$\textbf{E.R.} = \frac{\textbf{MVP}}{\textbf{MFC}}$$

was equally adopted.

Where

E.R. - Efficiency Ratio
MVP - Marginal Value Product of a Variable Input
MFC - Marginal Factor Cost of a Variable Input

The MVP is estimated using

$MVPx_1$ - $b_1(Y/x_1)p_y$

Where

$MVPX_1$ - Marginal Value Product of Input x_1
b_1 - Co-efficient of input x_1
y - Mean of the total revenue
X_1 - Mean of total production inputs
P_y - Unit price of output (y) in Naira

The MVP could also be estimated as MVP = MPP. P_y which is the profit maximizing point (Adegeye and Dittoh, 1982).

Where

MVP - Marginal Value Product
MPP - Marginal Physical Product
P_y - Unit price of output in Naira

Conventionally, if the efficiency ratio is unity i.e. 1(One) then production resources are used efficiently, if greater than 1(one) then production resources are over utilized (Alabi et al, 1998, Baba and Etuk 1991, Onyenweaku and Ukaegbu 1988).

RESULTS AND DISCUSSION

Ornamental plants production in the study area is dominated by the males. It is revealed that more than 70.2% of the floriculturists are males. A significant number of the floriculturists are between the age bracket of 21 and fifty years. A total of 72.2% of them are highly educated while 50.6% have between 5 and 10 years of farming experience. Very few had a reasonable number of extension contacts as 46.7% had non at all. In spite of many years of promoting modern and commercial agriculture, floriculture in Akwa Ibom State is still in the small-scale category as all the cultivated farmland were less than one (1) hectare. Production targeted more at plants suitable for aesthetics and environmental protection as desired by buyers in a mixed cropping system. Land, labour, capital and market situations were the major factors directing the level and pattern of production adopted by the floriculturists in the state.

Respondents identified income generation (33.7%), environmental protection(26.5%) and employment(25.5%) as major reasons for going into floriculture. Major buyers of farm output included Event Managers/decorators(23.4%), Hotels/clubs and restaurants(22.4%), Banks/corporate and government establishments(20.8%), politicians and experttraites(19.5%).

The result of the statistical analysis of the frontier production function as displayed by table I shows that the estimate of gamma (γ) is large and significantly different from zero, indicating a perfect fit and correctness of the distributional assumption which is statistically significant at one per cent level. The gamma (γ) estimate of 0.9782 implies that more than 97 percent of the revenue variation among the farmers is due to differences in technical efficiency. However, the variance parameters of the inefficiency model frontier are statistically significant at 1% level which indicated that the inefficiency variables are significant in explaining the technical inefficiencies of the farmers. The estimated coefficient of all the production inputs are all positive which shows that increase in input will lead to increase in revenue and vice versa.

The estimated coefficients of farms size, capital, planting materials and irrigation water are highly significant at 1% level. This finding agrees with that of Amaza et al (2005) and Onyenweaku et al (2005) whose results showed a positive and significant relationships between these variables and technical efficiency in Nigerian Agricultural production systems. That of labour and inorganic fertilizer though positive but are not significant at any level and this may be attributed to the scarcity and high cost of these inputs which restricts their uses. However, the positive relationship between these two variables and technical efficiency shows their relevance in enhancing the level of production output.

The estimated coefficient of the inefficiency variables of age, level of education, farming experiences and extension contacts are statistically significant at 1% level of significance showing that farmers that are highly educated, aged with many years of farming experiences and many extension contacts are more efficient in their production. The positive and the significance of household size at 1% level implies that increase in the number of persons per farm household per farm unit could lead to increase in technical inefficiency thus reducing productivity. The frequency distribution of technical efficiency in the study area is presented in table 2 which clearly indicates that none of the farms has efficiency index of one implying that no farm operates on the efficiency frontier leaving a gap for technical inefficiency.

Table 1 Socio-Economic Attributes of Floriculturists/ Respondents in the Study Area

Socio-economic attributes	Frequency	Percentage
Gender		
Male	63	70.2
Female	27	29.8
Age groupings (Years)		
Less than 20	6	2.5
21-30	18	23.2
31-40	29	39.7
41-50	32	28.3
> 50	15	6.3
Household Size		
1-5	74	56.1
6-10	26	42.6
11-15	-	-
Farm Size (ha)		
Less than 1	90	100
1-2	-	-
>3	-	-
Educational level		
No formal education	0	0
Primary	0	5.1
Secondary	24	22.8
Tertiary (OND)/NCE/HND/BSc and above)	76	72.2
Years of farming Experience		
Less than 5	21	27.0
5-10	42	50.6
11-15	27	14.8
Extension contacts		
1-3	23	25.6
4-6	18	20.0
>6	7	7.7
None	42	46.7

Table 2. Maximum Llikelihood Estimates of the parameters of the Stochastic Frontier Production function for irrigated ornamental plants production system.

VARIABLES	PARAMETERS	STD. COEF	STD. ERROR	T. VALUE
Production Factors				
Constant	$ð_0$	170.1885	2.3058	73.809***
Farm Size	$ð_1$	98.9872	2.3805	41.583***
Labour	$ð_2$	2.5206	12.9212	0.1951**
Capital	$ð_3$	0.2205	0.0164	13.4451***
Fertilizer	$ð_4$	0.9054	0.5519	1.6405
Planting Materials	$ð_5$	6.5891	2.6785	2.4600***
Irrigation Water	$ð_6$	7.6529	2.5691	2.9788***
Inefficiency Effects				
Constant	β_0	0.9472	1.5012	0.6310
Age	β_1	-7.3460	1.0861	-6.7636***
Level of education	β_2	-128.8268	15.1679	-8.4934***
Household Size	β_3	38.2134	3.8497	9.9263***
Farming Experience	β_4	-99.82156	12.3727	-8.0679***
Extension Contacts	β_5	-9.8555	2.5218	-3.9081***
Likelihood Ratio Test		-48.6861		
Variance Parameters				
Sigma Squared ($\boldsymbol{\delta}^2$)		2.8790	2.9875	0.9637
Gamma (γ)		0.9782	0.0429	22.8017***
Sample Size	90			

*** ($p<0.01$) ** ($p<0.05$)

Table 3. Technical efficiency of respondents.

Technical Efficiency Interval	**Frequency**	**Percentage**
0.00 – 0.10	6	5.40
0.11 – 0.20	3	2.70
0.21 – 0.30	6	5.40
0.31 – 0.40	4	3.60
0.41 – 0.50	2	1.80
0.51 – 0.60	2	1.80
0.61 – 0.70	5	4.50
0.71 – 0.80	16	14.40
0.81 – 0.90	28	25.20
0.91 – 1.00	18	16.20
TOTAL	90	100
Minimum value	**38**	
Maximum value	**96**	
Mean value	**86**	

Most of the floriculturists in the study area (i.e. 62.10%) produce above 0.50 efficiency index indicating that a large percentage of them are technically efficient. The distribution of the technical efficiency of farms shows a wide gap between the most efficient farm (0.98) and the least efficient (0.10) with a mean of 0.86 which is an indication of a high inter farm variation. Again, the potential gains or benefits among the sampled floriculturists are not reasonable enough. Everything being equal, if the technology and technique used by the best practice floriculturists are adopted there is hope of increased production in the short –run with a reasonable level of technical efficiency.

Table 4. Marginal Value products and acquisition costs of production inputs in irrigated ornamental plants production in the study area.

Production Inputs	Marginal Value Products (MVP)	Acquisition Cost (₦)
Farm land (X1	120,880.40	96,220.00
Labour (X2)	18,203.00	10,102.26
Capital (X3)	6,245.59	2,100.00
Planting Materials (X4)	28,426.00	12,450.50
Manure (X5)	16,202.45	7,080.00
Fertilizer (X6)	4,005.15	800.00
Irrigation Water (X7)	48,420.25	16,200.65

Table 4 indicates that all the production inputs had their marginal value productivities higher than their acquisition costs per unit of the inputs. Implying that the resources were used below their economic optimum levels in the study area. For instance, labour and irrigation water had their MVP at ₦18, 203.00 and ₦48,420.25 respectively, it means to achieve efficiency, a 1% increase in any of the two inputs holding other inputs constant will significantly increase total value product by ₦18,203.00 and ₦48,420.25 respectively. However, floriculturists in the study area can raise their production efficiency and of course their revenue by increasing the use of labour and irrigation water especially during off season.

CONCLUSION

More than 70.2% of the ornamental plants farmers in the study area are males who are experienced and educated cultivating various varieties of ornamental plants in less than 1ha. The result of the study revealed that farm size, capital, planting materials and irrigation water were the major determinants of technical efficiency of the floriculturists in the study area with farm size, capital and irrigation water as the most outstanding. It means that increases in the above production resources will increase output and revenue levels.

It was observed that the level of technical efficiency varies among the farmers with a mean technical efficiency of 86. The variation according to the results is largely due to the influence of age of the farmers, level of education, farming experience and the number of extension contacts.

The policy thrust of this investigation is that more farmland, fertilizer and irrigation water should be increased to encourage commercial production while enhancing farm families income and welfare. More extension contacts to create awareness on contemporary farming technologies especially during off season and subsidies on farm inputs should be encouraged.

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