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Technical Efficiency of Yam Production in Ukum Local Government Area, Benue State, Nigeria

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Abstract: *The study was undertaken to assess the technical efficiency of yam production efficiency in Ukum Local Government Area, Benue State. Primary data were collected from one hundred and one (101) yam farmers. Descriptive statistics, profitability (gross margin) analysis, stochastic frontier and student t-test were used as analytical tools. The result identified the most popular cultivar (68%) as white yam (Diosocrea rotundata) and majority (81.2%) grow local variety. The cost and returns analysis shows that yam production was profitable in the study area with the mean gross income of ₦318, 960.4 and a mean gross margin of about ₦3550.4/hectare with the capital turnover ratio of 6.86. The result of resource use shows that yam farmers in the study area were over-utilizing their resources. This implies that a proportionate increased in variable inputs would result in less than a proportionate increased in output level of yam (decreasing marginal returns to scale). The attainment of the average technical efficiency of 57% indicated that the technical efficiency of the farmers could be increased by 43% through efficient use of available resources. The result suggests that farmers could increase output through more intensive and efficient use of available resources (land, labour, seed yam, fertilizers and other inputs) given the current state of technology. The study also identified common problems of yam production in the study area as pests, inadequate storage facilities, inadequate improved varieties of yam, land tenure and high cost of inputs; of which pest constitute the greatest problem (93.1%) of yam production in the study area. Procurements of farm inputs (improved seed yam, pesticides, herbicides, fertilizer) by the Government, involvement of NGOs in provision and dissemination of adequate improved practices, storage facilities and technical research were therefore recommended.*

I. Introduction

Yam (*Dioscorea spp*) is among the oldest recorded crop (Orkwor, Asiedu and Ekanake 1998). Apart from cereals, yam is the most important staple food in West Africa. It is among the most valuable root tuber crops in the tropics. Yam is an annual tuber and monocot plant. The food plant comprises of 600 species outs of which ten species produce edible tubers and only six are cultivated in Africa. The commonest yam species widely grown in West Africa include: i. White yam (*Dioscorea rotundata*) ii. Water yam (*Dioscorea alata*) iii. Yellow yam (*Dioscorea cayanensis*) iv. Aerial yam (*Dioscorea bulbifera*) v. Chinese yam (*Dioscorea esculenta*) vi. Trifoliate yam (*Dioscorea dumetorum*). According to Onwueme and Havekort (1991) *Dioscorea rotundata* is grown on the greater acreage than any other species of yam in the world because of its storage ability, taste and the ability to mature faster than all other species. Yam tuber is a good source of energy mainly from their carbohydrate contents since it is low in fat and protein. The yam tuber is said to contain pharmacologically substances such as "dioscorine, saponin and sapogenin. Dioscorine which is the major alkaloid in yam is medicinally a heart stimulant. Also, it has been reported that yam is good source of industrial starch whose quality varies with species. Yam is consumed commonly in West Africa as pounded yam with soup, roasted, boiled or fried yam depending on the consumer's desire (Orkwor *et al.,* 1998). Yam can be processed into flour which can also be cooked as staple food and eaten with soup of different kinds.

Amegbeto and Asiedu (2000) reported that, the international trade of yam originates from Jamaica as the leading exporter in Central America, Brazil leads in South America while Japan leads the production in Asia. Asomugba and Ujoku (2007) stressed that, West and Central Africa accounts for about 93% of the world total production (38 million tons). The dominant yam production zones stretches from Cotedi'voire through Ghana, Togo, Benin, Nigeria, Cameroon, Gabon, Central African Republic and the Western part of the democratic republic of Congo. Ethiopia and Sudan are the major yam producers in East Africa. International Institute of Tropical Agriculture (IITA, 1991-1992) reported that, Nigerian remains the principal yam producer with the world production percentage of 71.9% in recent years. Cote d'ivore, the second largest producer had percentage increase from 9.3 to 10.6% from 1980 to 1992 with its yield increase by 7.6%. Ghana, the third largest yam producers increase its production almost by 20% (Asumugha and Njoku, 2007).

With growing demand, yam has assumed great importance in Nigeria. The nation produces about 31.5 million metric tons of yams annually (CBN, 2003) and FAO (2002) reported that Nigeria accounts for 71% (26 million tons) of the total world production of yam harvested from 2,760.00 hectares. In Nigeria, yam is becoming more expensive and relatively unaffordable in urban areas as production growth has not kept pace with population growth leading to demand exceeding supply (Kushwaba and Polycarp, 2000). Despite this importance of yam as staple food for rural and urban dwellers, its production in Nigeria has not been accorded the needed attention (Orkwor and Asiedu, 1999). This is reflected in the fall in output percentage growth rate of yam from 42% in 1990 to 16.3% in 2001 despite the increase in land devoted for the production of the crop from 1270 million hectares to 2742 million hectares in the same period (Federal Ministry of Agriculture (FMA), 2001).This notwithstanding, yam production in Nigeria is quite insufficient as compared to the growing population. Hence, there is a need to increase the production level by efficient use of resources.

Efficiency in the use of available resources determines the output realized in the business venture. It is achieved by maximizing the production inputs and ensuring that wastes are significantly minimized. Efficiency is concerned with the relative performance of the processes used in transferring given input into outputs. Farrel, (1957) identifies three types of efficiency – technical, allocation and economic efficiency. Since increase in productivity is directly related to production efficiency, it is imperative to raise productivity of the farmers by helping them reduce technical inefficiencies. An important assumption relating to efficiency measurement is that, firms operate on the outer bound production function, that is, on the efficiency frontier. When firms fail to operate on the outer bound production function, they are said to be technically inefficient.

The most recent food crisis in Nigeria needs serious attention most especially problems affecting the production of staple food crops. Although, some research work on efficiency have been done by other researchers from different areas in Nigeria. For instance, Ayinde, *et al.,* (2005) examined insecticide use efficiency in cowpea production in Kano and Ogun States; Adejumolu (2006) studied the resource-use efficiency in yam-based cropping system in Ekiti State; Musa, Onu, Vosanka and Anonguku (2011) carried out an empirical study on the production efficiency of yam in Zing Local Government Area of Taraba State. The application of stochastic frontier production function in efficiency analysis has been employed by Battese and Coelli (2004), Amaza (2005), Umoh (2006), to mention a few. However, little or no work has been done on the technical efficiency of yam production in Ukum LGA of Benue State, Nigeria. It has thus, become necessary to know the existing efficiency level of farmers in using the inputs to increase yam production up to the maximum level. The objectives of the study were to:

1. identify the existing varieties (cultivars) of yam grown among the farmers in the study area;
2. assess the costs and returns in yam production;
3. determine the technical efficiency of yam production; and
4. identify the major problems associated with yam production in the study area.

II. Methodology

The Study area is Ukum Local Government Area of Benue State in Nigeria. Ukum Local Government was carved out of Katsina-Ala Local Government Area in 1991. It has a total land mass of 1810.99 square kilometers (BNARDA, 1998). Ukum Local Government Area is located at Northern part of Makurdi, the State capital. It borders to the East by Wukari Local Government Area of Taraba State and to the South East and West by Katsina-Ala and Logo Local Government Area respectively. The Local Government Area has thirteen council wards and its headquarters is Sankera. The council wards include: Aterayange, Azendeshi, Boikyo, Kundav, Kendev, Lumbur, Mbatiam, Mbayenge, Mbazum, Tsaav, Tyuluv, Ugbaam and Uyam.

There are two distinct climatic seasons in this area; rainy season from March to October and dry season from November to February. Because of abundant rainfall experienced in this area coupled with the fertile soil available, farming is the predominant occupation of the people living in the area. Agricultural crops such as yam, cassava, groundnut, sorghum, sweet potatoes, cowpea, tomatoes, bananas, citrus, mangoes are produced in the study area. Available statistics shows that yam is produced in Ukum LGA more than any other Local Government in Benue State and this informed its choice as the study area. Livestock such as sheep and goats, swine as well as poultry are also reared there.

Yam farmers in Ukum LGA formed the population from which the sample was drawn. A multi-stage sampling technique was used to select respondents for the study. In the first stage, all the thirteen (13) council wards in the Local Government Area were considered on their relative importance in yam production. Secondly, two (2) villages were purposively selected from each council wards giving a total number of twenty six (26) villages. The final stage in the sampling exercise was selection of farmers from the selected villages. 10% of farmers in each of the selected villages were drawn using simple random sampling technique to give a total of one hundred and one (101) respondents. Primary data were collected through the use of a well- structured questionnaire. Descriptive statistics, profitability/gross margin analysis, stochastic frontier and t-test analysis were used to analyze the data.

Model Specification
Stochastic Frontier Model
Technical efficiency is derived analytically and defined as follows:

$$\text{Log}\, Y_1 = \beta_0 + \beta_1 logX_{1_i} + \beta_2 logX_{2_i} + \beta_3 logX_{3_i} + \beta_4 logX_{4_i} + \beta_5 logX_{5_i} + (V_i - U_i)$$

where:
Y_1= Total farm output of ith farmer (kg);
X_1=farm size (ha);
X_2 =Labour (man-days);
X_3 =quantity of fertilizer used (kg);
X4=quantity of seed yam planted (kg);
X5=quantity of herbicides used (Litres);
B=coefficient;
V_i= random error that assumed to be normally distributed with zero mean and constant Variance ($\delta^2 v_i$) and
U_i= technical in-efficiency effects independent of Vi and have half normal distribution with mean zero and constant Variance ($\delta^2 U_i$).

Inefficiency model
Following Battese and Coelli (1995) model, the mean of farm-specific technical inefficiency model (Ui) was defined as:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6$$

where:
Ui= Inefficiency effect;
Z_1=Age of the respondent (years);
Z_2=Farming experience (years);
Z_3= Years of education;
Z_4=Family size;
Z_5 =Yam variety used (improved variety =1, Local variety =0);
Z_6 =Number of extension contact;
Z_7 =Annual income (₦);
δ_o=constant term;
δ_1-δ_7 =Coefficient.

III. Results And Discussion

Varieties (Cultivars) of yam grown in the study area
The summary of the results on the varieties of yam grown by the respondents is presented in Table 2. The result shows that 81.2 percent of the respondents cultivated local varieties of yam while only 18.8 percent grew improved varieties. While 52.5 percent of the respondents grew white yam, 32, 7 percent planted water yam, while 14.9 percent cultivated yellow yam. This indicates that yam farmers in the study area engage in the production of three main varieties of yam and white yam is the most common variety of interest to farmers in the study area. The result agrees with Onwueme and Havekort (1991), who found that white yam is grown on greater acreage than any other species of yam in the world because of its high storage ability taste and the its ability to mature faster than other varieties.

Costs and returns in yam production
The result of the costs and returns in yam production in the study area is shown in Table 4. The result shows that agrochemical had the highest cost with a mean cost of ₦82,816.34 which represents 29% of the total variable cost. While staking had the least cost which ranged from ₦100 and ₦2500 with a mean cost of ₦246.54 which represents 0.09% of the total variable costs. The total variable cost of yam production ranged between ₦194,000 and ₦578,000 and a mean cost of ₦283,460 which represents about 88.87% of the gross farm income. While the gross farm income ranged between ₦100,000 and 585,000 with a mean of ₦318,960.4. The gross margin for yam production ranged between ₦195,000 and ₦281,000 and a mean of ₦3,550.4/ha which represented about 1.11% of the gross farm income. This result shows that yam production in the study area was relatively profitable.

The result also shows the profitability analysis of yam production using ratio analysis. The analysis shows that yam production in the study area had a mean total turnover of 6.86. This means that for every one Naira invested in yam enterprise, there was a return of 86 kobo to the farmer. Also, the mean ratio of net profit to variable cost and the mean return was found as 13% and 1.02%, respectively all pointing to the profitability of the enterprise. In addition, the result shows that the mean of the net farm income of the respondents

(₦34,433.17) is positive indicating that yam production is profitable in the study area. Similarly, the result of the profitability shows that the gross farm income was significantly higher ($t=2.83$; $P \leq 0.05$) than total variable cost. This means that the difference between total variable cost and gross farm income was not by chance; hence yam production in the study is profitable.

Estimates of Cobb-Douglas frontier production

The maximum livelihood estimates of the parameters of the model were obtained using computer program FRONTIER (Version 4.Ic). The result is presented in Tables 5 and 6, the result in Table 5 shows that at 5% level of significance, labour (0.27) quantity of fertilizer (0.26) quantity of seed (0.28) and quantity of herbicides (0.06) had significant influence on the output of yam. The output elasticity of all the parameters used were less than unity and the sum of the coefficients (input elasticity) of the variables of the Cobb Douglas stochastic frontier production model was 0.89 which also was less than unity, thus indicating decreasing marginal returns to scale. This meant that a proportionate increase in all the variable inputs used in yam production would lead to a less than proportional increase in yam outputs in the study area. The implication of this is that, the expansion of yam production in the study area would result in less output. Policies that would enhance the technical use of more production inputs by yam farmers would lead to decrease in yam output level. In addition, the magnitude of variable ratio gamma (Y) was found to be at 0.99; suggesting that the systematic influences were unexplained by the production function were the dominant sources of errors. This means that 99% of the variations in output of yam farmers were explained by the model. The estimate of sigma square was also significant at 1%.

Results of inefficiency model

The result in Table 5 shows that majority (37.6%) of the respondents operated at a technical efficiency level of 0.4 < 0.6; 26.7% operated within 0.6 < 0.8; 22.8% operated within 0.17 <0.4, while only 12.9% of the respondents operated within the technical efficiency level of 0.8-1.0. The result shows that technical efficiency of yam farmers in the study area ranged between 0.17 and 1.00 with a mean of 0.57. The result suggests that, technical efficiency in yam production in the study area could be increased by 43% to attain maximum output. This means that, the farmers could increase outputs through more efficient use of the available resources given the current state of technology.

Furthermore, the result shows that the estimated coefficient of age (0.43), farming experience (-0.17) and variety of seed yam (0.31) were significant. The result therefore suggests that, technical inefficiency effects in yam production in the study area decline with increase in farming experience; increase with use of improved yam varieties and age of the farmers. This means that, farming experience, use of improved yam varieties and age were the critical determinants of technical efficiency in yam production. In other words, decrease in age, increase in farming experience and the use of local varieties increases technical efficiency of farmers. The implication of this is that farming experience, improved varieties and age were very important in reducing inefficiency in utilization of inputs in yam production. In other words, young farmers with relatively long farming experience who planted local varieties achieved higher level of technical efficiency in yam production. The implication is that policies that would encourage young farmers with long farming experience in yam production and as well increased their access to indigenous/local varieties would ensure efficient use of resources in production. This would also improve profitability of yam production in the study area, as the efficient use of available resources would lead to maximization of profit.

Major Constraints in yam production

The result showing the constraints in yam production is presented in Table 7. This result shows that pests constituted the major problem (93%) of yam production in the study area. This was followed by inadequate storage (92%), 91 percent of the respondents in the study area were constrained by inadequate farming inputs and land tenure respectively. And 81.2 percent of the respondents were constrained by high cost of inputs and poor road facilities. While a good number of farmers, (84.2%) faced the problem of inadequate extension services. The result suggests that, the problems of yam farmers were those of inadequate supply of inputs, including; inadequate knowledge of new farming techniques, storage, improved varieties of yam, capital, and a host of others. Generally, appropriate technology induces increase in the production of staple food by reducing the cost and increasing returns of producers while consumers ultimately benefit through low and stable food prices.

IV. Conclusion And Recommendations

The study showed that yam production was profitable in the study area with the average revenue of ₦318,960.4 and a mean gross margin of about ₦3,550.4/hectare with the capital turnover ratio of 6.86. The sum of elasticity of production is less than one (1) depicting dereasing returns to scale. The result of resource use shows that the resources of yam farmers in the study area were being over-utilized. This implies that a proportionate increased in variable input would result in less than a proportionate increased in output level of yam (decreasing returns to scale). The attainment of the average technical efficiency of 57% indicated that the technical efficiency of the farmers could be increased by 43% through efficient use of inputs. The result suggests that farmers could increase output through more efficient use of available resources (land, labour, seed yam, fertilizers and other inputs) given the current state of technology. The major determinants of technical efficiency in yam production in the study area were age, farming experience and variety. If the problem of pest, storage facilities and other farming inputs were tackled, yam productivity will sustantially improve.

Young farmers with high education and long farming experience should be motivated through a sustained and adequate system that would provide financial support to yam farmers to enable them increase production in the study area. It was also recommended that, farmers in the study area could increase their technical efficiency by 43%, through efficient use of available resources to attain maximum output. Government should take absolute control in the procurement and supply of production inputs (fertilizer, herbicides, and pesticides) to yam farmers to ensure timely delivery of inputs to yam farmers and at the affordable and stable prices. Finally, yam farmer should be encouraged to form co-operative societies through which they can get financial, material and moral aids from government and Non Governmental Organization (NGO) to boost yam production in the area. This will make dissemination of information on yam production and provision of credit facilities easy.

Tables:

Table 1: Varieties of yam grown in the study area

Variables	Frequency	Percentage
Yam varieties		
Local varieties	82	81.2
Improved varieties	19	18.8
Specific varieties		
White yam (*Dioscorea rotundata*)	65	68
Water yam (*D. alata*)	45	44.5
Yellow yam (*D. cayenensis*)	30	29.7

Source: field survey, 2012

Table 2: Cost and returns in yam production

Variables	Minim. Cost	Max. Cost	Mean cost	S/Deviation
Agro-chem.	49,500.00	98,500.00	82,816.34	11,037.72
Tillage	10,000.00	352,000.00	51,438.61	37,830.35
Labour	12,800.00	14,500.00	48,437.62	18,486.86
Transports	14,500.00	85,700.00	34861.68	14,447.70
Weeding	5,500.00	65,500.00	25061.32	25,061.32
Land clearing	1,500.00	5000.00	21562.38	11,360.94
Storage	000.00	26,700.00	10091.89	9,016.80
Planting	3,400.00	16,000.00	8,942.57	8,942.57
Staking	000.00	2,500.00	246.54	620.41
Total Variable Cost	19400	57,800	283,460	54,593
Gross Farm Income	100,000.00	585,000.00	318960.4	113,451
Gross margin	195,000.00	281,000.00	3550.4	108,862
Net Farm income	-198,020.00	281,300.00	34433.17	108,992
Return on cap. Emp.	0.48%	2.61%	1.02%	0.44
Capital turnover ratio	-732.71	88.29	6.86	74.11

Table 3: Maximum likelihood estimates of Cobb-Douglas frontier production function

Parameter		Coefficient	t-ratio
Constant	β_0	3.85	3.93**
X_1 Farm Size (ha)	β_1	0.02	0.59
X_2 Labour (manday)	β_2	0.27	1.79**
X_3 Quantity of fertilizer (Kg)	β_3	0.26	6.16**
X_4 Quantity of seed yam	β_4	0.28	3.48**
X_5 Quantity of herbicides (L)	β_5	0.06	1.04**
Inefficiency model			
Constant	δ_0	-0.50	-0.57**
Z_1 Age (years)	δ_1	0.43	2.72*
Z_2 Farming experience	δ_2	-0.17	3.08**
Z_3 Years of Education	δ_3	0.05	0.47
Z_4 Family Size	δ_4	0.02	0.12
Z_5 Yam variety used	δ_5	0.31	1.93*
Z_6 Number of extension Contact	δ_6	-0.10	-0.52
Z_7 Annual Income	δ_7	-0.03	-0.30

Variance of parameters			
Sigma squared	δ^2	0.19	4.23
Gamma	γ	0.99	5276180.8
Log Livelihood function		-33.57	

* - Significant at 1 percent, ** - Significant at 5 percent

Source: Field survey data, 2012

Table 4: Profitability of Yam production

Variable	Mean (₦)	Mean difference	t-value	df	Sign. (2tailled)
Total revenue	318960	35500.29	2.83**	200	0.005
Total variable cost	283460				

** - Significant at 5 percent

Source: Field survey data, 2012

Table 5: Distribution of respondents according to technical efficiency estimates

TECHNICAL EFF. RANGE	FREQUENCY	PERCENTAGE
0.17 < 0.40	23	22.8
0.4 < 0.60	38	37.6
0.6 < 0.80	27	26.7
0.8 < 1.0	13	12.9
Total	101	100

Mean = 0.57; Minimum = 0.17; Maximum = 1.00

Source: Analysis of field data, 2012

Table 6: Major problems of yam production

Variables	Frequency	Percentage
Pests	94	93.1
Inadequate storage facilities	93	92.1
Inadequate improved inputs	92	91.1
Land tenure	92	91.1
Inadequate extension services	85	84.2
High cost of inputs	82	81.2
Poor road facilities	82	81.2

Source: Field survey, 2012

Multiple responses recorded.

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