

Resource Use Efficiency in Yam Production in Taraba State, Nigeria

Jonathan Reuben* and Anthony Danlami Barau

Department of Agricultural Economics and Extension, Taraba State University,
Jalingo, Nigeria

*E-mail: jonnyato4@yahoo.com

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ABSTRACT Yam (*Dioscorea* spp) is one of the major staple food crops grown in Nigeria. A number of previous studies have shown that resource-use in yam production in many parts of Nigeria have generally been inefficient. This study seeks to determine the resource use efficiency in yam production and profitability of the enterprise in Taraba State. Multistage, purposive and simple random sampling techniques were adopted in sampling the respondents. The Cobb- Douglas functional form was chosen as the lead equation in estimating the model. All inputs were found to be inefficiently utilized. Yam production in the State was, however, found to be highly profitable. Major constraints indicated were inadequate farm inputs, lack of improved yam setts and high cost of hired labour. The results suggest that farmers could increase outputs if assisted in accessing the limiting factors coupled with appropriate adjustments in level of inputs used.

INTRODUCTION

Yam (*Dioscorea* spp) is one of the major staple food crops grown in Nigeria, specifically in Taraba State. The common species grown in the country are *Dioscorea rotundata* (white yam) and *Dioscorea alata* (water yam). The crop is of great nutritional and economic importance to mankind. The tuber can be eaten boiled, roasted, fried, mashed or pounded (Osunde 2008). It is also acknowledged to provide some 200 calories of energy per capita daily in Nigerian and West African diet. According to Eka (1985), dioscorine which is the major alkaloid in yam is medicinally a heart stimulant. Moreover, yam is also a source of industrial starch, the quality of which varies with the species, with some of them producing starch with comparable quality to cereal starch (Osisiogu and Uzo 1973). Throughout Nigeria, yam is used in various aspects of the people's economic and socio-cultural activities. Identification and evaluation of the major inputs used in yam production is, thus, very relevant in order to sustain and increase the level of production and total output of this important staple food/emerging industrial crop.

NBS (2007, 2012) reports show that 27 States in Nigeria produce yam, with total area planted during the 2009/2010 season put at 3,236.16 ('000 ha). Of this, Benue State led with 396.45 ('000 ha) followed by Niger State with 367.16 ('000 ha) and Taraba State with 272.52 ('000 ha). The estimated corresponding total outputs

were 37,328.17('000 metric tons) for the country and 3,914.17; 3,166.12 and 2,854.95 ('000 metric tons) for Benue, Niger and Taraba States, respectively. The farm hectareage of yam production has been increasing over the years with corresponding increases in usage of inputs such as fertilizers, herbicides, yam seeds and other agro-chemical inputs (Table 1). Unfortunately, the increases in outputs seem not to have been commensurate with those in input usage. It would seem that whereas the inputs were used at an increasing rate, the resultant outputs were increasing at decreasing rate.

Several empirical studies have been carried out on determining the efficiency of resource use in yam production in Nigeria (Izekor and Olumese 2010; Shehu et al. 2010; Awoniyi et al. 2007; Ike and Inoni 2006). All these studies concluded that resources were not efficiently used in yam production in their respective study areas. This implies that if resources were efficiently used at optimal level, total outputs of yam and farmers' net earnings would have been greater in the study areas, *ceteris paribus*.

Are these findings applicable to Taraba State? This study sought to answer this question by addressing the following issues:

(i) How optimally are resources used in yam production in Taraba State? (ii) What is the profitability level of yam production in the state, and (iii) What are the needed adjustments in resource use if they are currently over-or under-utilized?

Table 1: Trend of outputs and resources used in yam production in Nigeria and Taraba State (all values in 10³ metric tons, except land = 10³ Ha)

Year	N / T*	Outputs			Inputs		
		Yam	Land	Fertilizer	Yam setts	Herbicide	Insecticide
1994/95	N	23395.75	2117.29	11212.80	4763.75	98.76	142.65
	T	1101.00	98.00	826.00	220.50	0.98	0.34
2004/05	N	25707.45	2165.75	76492.21	4872.94	179.98	178.12
	T	2694.00	204.00	1034.00	459.00	1.35	0.56
2009/10	N	37328.17	3236.16	98754.98	6786.78	114.34	182.17
	T	2854.95	272.52	1523.12	697.89	1.52	0.9

*Note: N= Nigeria, T= Taraba State

Source: Extracted from NBS Database (2007, 2012)

Objective of the Study

The specific objectives of the study are:

- (i) to determine the economic efficiency of resource use in yam production in the study area,
- (ii) to estimate the costs and returns to yam production in the State, and (iii) identify major constraints to yam production and proffer possible solutions.

MATERIAL AND METHODS

The Study Area

The study was conducted in Taraba State of Nigeria. The State had a population of about 2,300,736 people as at 2006 (NPC 2006). It has 16 Local Government Areas and one Special Development Area. It is divided into three Senatorial Districts: North, South and Central. It lies between latitudes 6° 30' N and 8° 30' N of the Equator and between longitudes 9° and 12° E of the Greenwich Meridian with a land mass of 54,426 km² (Oruonye and Bashir 2011). Taraba State shares boundaries with Bauchi and Gombe States in the North, Adamawa State in the East and Republic of Cameroun in the South and Nasarawa and Benue States in the South-West. It has a tropical wet and dry seasons, well drained alluvial soils and characterized by both savannah and rainforest vegetations. Its dry season lasts for a minimum of five months (November to March) while the wet season spans early March to late November in the south and early April to November in the north. The mean annual rainfall ranges from 1000mm in the northern part to over 1800mm in the extreme southern part and Mambila area (Oruonye and Bashir 2011).

Sampling Procedure and Data Collection

Multistage, purposive and simple random sampling techniques were adopted in sampling the respondents. In the first stage, six Local Government Areas were purposively picked because they were high yam-producing areas with large volumes of yam marketing activities. These Local Government Areas were: Bali and Gassol in the central zone, Ibi and Wukari in the southern zone, and Yororo and Zing in the northern zone. In the second stage, three villages were randomly selected from the lists of yam-producing villages in each Local Government Area, making a total number of 18 villages in the sample. In the last stage, 130 yam farmers were randomly selected from the sampled villages as follows: 25 farmers from the villages in Wukari and 21 farmers from each of the following Local Government Areas: Ibi, Gassol, Bali, Zing and Yororo. Data were collected from the yam farmers on their household's production activities during the 2010/2011 cropping season. The data were collected using structured interview schedules with the aid of questionnaires administered by experienced Taraba State Agricultural Development Project's (TADP) Extension Agents (EAs) in the various Local Government Areas. Information were collected from the sampled farmers on such parameters as inputs and their associated costs, level of outputs and prices as well as other socio-economic variables.

Data Analysis

Econometric and budgetary techniques were employed in achieving the objectives of the study. Multiple regression analytical technique was used to determine the effects of the speci-

fied socio-economic variables on the producers' outputs. Four functional forms were tried: Linear, Semi-log, Double-log and Exponential. The implicit form of the regression models used was:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \emptyset) \quad (1)$$

Where Y = Output of yam (Kg)
 X_1 = Quantity of fertilizer used in (kg)
 X_2 = Quantity of insecticides used in litres
 X_3 = Herbicides used in litres
 X_4 = Quantity of yam setts (seed) in (Kg)
 X_5 = Hired labour in man-days
 X_6 = Family labour in man-days
 X_7 = Farming experience (years)
 X_8 = Farm size in hectares, and
 $\emptyset$ = Error term

The explicit functional forms tried were as follows:

(a) Ordinary linear form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \dots + b_8 X_8 + \emptyset \quad (2)$$

(b) Semi-log form:

$$Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + \dots + b_8 \log X_8 + u \quad (3)$$

(c) Double-log form:

$$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + \dots + b_8 \log X_8 + \emptyset \quad (4)$$

(d) The exponential form:

$$\log Y = b_0 + b_1 X_1 + b_2 X_2 + \dots + b_8 X_8 + \log \emptyset \quad (5)$$

where, b_0 is a constant term and $b_1, \dots, b_n$ are estimated coefficients of the variables $X_1, \dots, X_n$ respectively, as defined in equation (1). The variables X_1 - X_n were expected to have positive causal relationships with Y and were added to the model to determine the extent to which each of them explained variation in total output. The estimation of the econometric models (2-5) was carried out using SPSS 11.0. Economic, statistical and econometric criteria were employed to choose the lead equation based on the estimated values of the adjusted coefficient-of-multiple determination ($\bar{R}^2$) and the standard error values as well as consistency with the *a priori* expectations consistent with agricultural production/economic theory.

The efficiency of resources used in production, denoted by r , was determined by using equation (6), following Vincent et.al. (2010) and Taiwo et al. (2011).

That is:

$$r = MVP/MFC \quad (6)$$

Where, MVP = marginal value product in the production process, obtained by multiplying marginal physical product (MPP_{xi}) by the unit price of output (P_y). That is: $MPP_{xi} \cdot P_y$. MFC

= marginal factor cost in resource application, obtained from the market price of input used. Use of the ratio was based on the assumption that the farmers operated in pure competitive input markets (Olukosi and Ogunbile 1989). The ratio has the following interpretation: For each resource used, if: (i) $r=1$, the yam producers were efficient in the use of the particular resource. That is, the cost of producing the last additional item just equals the additional income derived from that last item; (ii) $r < 1$, the yam producers were inefficient (over-utilizing resources) in the production process, and (iii) $r > 1$, the yam producers are also inefficient (under-utilizing resources) in the production process. More profit could still be made by employing additional input since each additional cost item incurred brings in more marginal revenue (MVP).

Similarly, the elasticity of production (E_p) was estimated using equation (7). The concept measures the degree of responsiveness of output to a given unit change in input.

$$E_p = \hat{b} \frac{\bar{X}}{\bar{Y}} \quad (7)$$

where, b = coefficient (productivity) of individual inputs (MPP),

$\bar{x}$ = mean of input; and

$\bar{Y}$ = mean of output

For the Cobb-Douglas functional form, the individual estimated coefficients ($\hat{b}_i$) are also elasticities and can be used to estimate returns to scale in the production process. That is, if $\sum \hat{b}_i$ is < 1 ; $= 1$, or > 1 , there is decreasing, constant or increasing returns to scale.

The farm budgetary technique, as used by Olukosi and Erhabor (1988), states that the gross margin is the difference between gross farm income and the total variable cost of production. It was used in this study to estimate the profitability level of yam production in the area. This tool was used because in subsistence farming the fixed cost is assumed to be negligible (Olukosi and Erhabor 1988). The model is specified as:

$$GM = GI - TVC \quad (8)$$

$$NFI = GM - TFC \quad (9)$$

where, GM = Gross margin per hectare (₦)

GI = Gross income per hectare (₦)

TVC = Total variable costs per hectare (₦)

NFI = Net farm income per hectare (₦)

TFC = Total fixed costs per hectare (₦)

RESULTS AND DISCUSSION

The econometric equations (2-5) were estimated and the Cobb-Douglas (Double-log) was chosen as the lead equation and used to determine resource-use efficiency. The choice was based on the high value of the adjusted R^2 (81%), conformity with *a priori* expectations in respect of the signs of the estimated coefficients of all, but one, of the explanatory variables in the model and finally, it had the least standard error of estimate value of 0.322. With the exception of herbicides and family labour, the coefficients of all the variables in the model were statistically significant indicating their individual contributions as determinants of yam production. This agrees with the findings of previous studies by Awoniye et al. (2006), Izekor and Olumese (2010) and Shehu et al. (2010) in Ekiti, Edo and Benue States respectively. Discussions with the farmers revealed that most of them deliberately adopted low usage of herbicides because of the beliefs that its application reduces yield of the tubers.

The non-significance of the herbicides and family labour variables in explaining variations in yam output in the study area can be attributed to their relatively low levels of usage by farmers. Herbicides were costly inputs and coupled with the belief of some farmers about its effects, resulted to very limited usage by them. Family labour input, on the other hand, had reduced greatly in the study area as most children were attending schools and the farmers were left with just one or two elderly persons as family labour hands in most households. The youths, who would have been the major source of family labour, had their own personal farms to attend to. Thus, the farmers depended predominantly on hired labour for most farm operations.

Given the non-significance of family labour as determinant of yam productivity in the study area, the selected (Cobb-Douglas) equation was re-run twice; firstly by dropping family labour as explanatory variable which gave an $\bar{R}^2$ value of 81% (same with the original model), and secondly by combining family and hired labour as one variable.

The latter model gave an $\bar{R}^2$ value of 80% but also resulted in a negative value for the herbicide Coefficient.

Arising from these two observed limitations, the model with family labour dropped was fi-

nally selected for the analysis. The results are presented in Table 2.

Table 2: Estimated parameters of the yam production function in Taraba State

Variable	Estimate	Std. error	t-value
Constant	1.46236	0.24660	5.930*
Fertilizer (X_1)	0.17781	0.04109	4.327*
Insecticides (X_2)	-0.0337	0.01857	-1.829NS
Herbicides (X_3)	-0.02661	0.04039	-0.659NS
Yam setts (X_4)	0.35631	0.03673	9.700*
Hired labour (X_5)	0.04609	0.01564	2.947*
Experience (X_6)	0.34801	0.07200	4.834*
Farm size (X_8)	0.25991	0.05846	4.446*
R^2	0.8185		
Adjusted R^2	0.8081		
F-Value	78.58		
Standard error of estimate	0.3205		

* Significant at 1%

Source: Field Survey (2011)

The negative sign for the insecticide coefficient indicates negative yam output response to its usage, which is normally associated with over-usage. But this was hardly the case in the study area. In fact most of the farmers barely used this input, except as seed dressings. Errors in data given/recorded might have contributed to the unexpected negative sign observed. This phenomenon, thus, requires further investigation in future studies on the crop in the area.

With respect to resource-use-efficiency, the results shown in Table 3 clearly indicate that farmers were inefficient in usage of their resources in yam production in the State. This finding too agrees with the findings by Ike and Inoni (2006), Awoniye et al. (2007), Izekor and Olumese (2010) and Shehu et al. (2010), that farmers were generally inefficient in resource-use in production of yam in their respective study areas. It was found that fertilizer (X_1), yam setts (X_4), and farm size (X_8) were under-utilized by the farmers in the production process in the State. This could be as a result of the high cost of fertilizer and yam setts, problems of yam setts storage, and lack of skills in yam-seed multiplication techniques thereby limiting supplies and hence under-utilization by farmers.

Information gathered from farmers showed that yam yielded more on virgin or new land relative to old or over-used land. Unfortunately, increases in farming population in the area coupled with competition from other crop enterprises meant that virgin (or long-rested un-

Table 3: Marginal physical products, marginal value products and the efficiency ratios in yam production in Taraba State

Variable	MPP	MVP	MFC	$r = MVP/MFC$
Fertilizer (X_1)	4.2	105	62	1.7
Insecticide (X_2)	-.027	-.43	1,000	-0.0004
Herbicides (X_3)	1.54	38.5	1200	0.043
Yam setts (X_4)	1.67	41.75	20	1.4
Hired labour (X_5)	0.81	20.13	250	0.04
Family labour (X_6)	0.09	2.32	200	0.0058
Farm size (X_7)	95770	394250	20,000	119.7

Source: Field Survey (2011)

cultivated) land were becoming harder to come by. Furthermore, the high labour requirement of the yam enterprise meant that farmers had to limit their scale of operation. This apparently explains the under-utilization of land for yam production as indicated in Table 3. On the other hand, hired labour, herbicides and insecticides were found to have been over-utilized by the farmers in the area. The over-utilization of labour in the production process could be as a result of the many cultural activities involved in yam production, ranging from land clearing, molding of heaps, wilting of trees, seed-dressing, planting, weeding/application of herbicides, application of fertilizers and staking through harvesting, sorting, cleaning and storage of the tubers. All these activities needed reasonable number of labourers to get done. Indication of herbicides over-utilization could be attributable to the sheer high prices of these chemicals relative to the mean unit price of yam produced and sold; especially as this input was found not to significantly contribute to yam output (Table 2). Wrong usage of the herbicides could also contribute to the poor input-output relationship as depicted in these findings. Similarly, volume of herbicides said to have been applied were often exaggerated by persons hired to spray on commercial basis just to make excess profit. Accordingly, volume stated was at variance with effect of the input on output as reflected in the regression and efficiency ratio results. The sum of the estimated coefficients, $\Sigma \hat{b}_i$, was slightly greater than 1 implying the farmers were operating at an increasing return to scale.

Table 4 shows the costs and returns in yam production in Taraba State. It was found that the cost of acquiring yam setts, and hired labour constituted almost 64% of the total costs of production. Yam production in the State was found to be highly profitable with a gross margin of ₦326,349.20 per hectare at the prevailing mean

output prices as at the time of the survey. It was also found that the return per Naira invested was ₦1.96. This implied that for each Naira invested in yam production by the selected farmers a return of ₦1.96 was obtained.

Table 4: Costs and returns analysis of yam production in Taraba State

Costs / Returns	Average value per hectare (₦)	Percentage
A = Variable Costs		
Yam setts	82,278.10	49.4
Hired labour	23,987.50	14.4
Family labour	14,604.50	8.8
Variable implements used	14,585.50	8.7
Fertilizer	10,804.50	6.5
Rent on land	9,790.00	5.9
Herbicides	7,267.50	4.4
Insecticides	769.50	0.5
Others	2,403.50	1.4
Total Variable Cost (TVC)	166,490.60	100
B = Gross Income (GI)	492,839.80	
C = Gross Margin (GI-TVC)	326,349.20	
D = Per Naira Invested (C/A)	1.96	

Note: 1Hectare = about 10,000 mould of planting heaps in the southern part of the State, but about only.

5,000 mould of heaps in the northern part of the State.

Source: Field Survey (2011)

Figure 1 illustrates the constraints to yam production in Taraba State. It indicates that inadequate farm inputs, lack of improved yam setts and high cost of hired labour were ranked first, second and third, with 22.3, 16.2 and 15.4 percent, respectively. This conforms to the findings of Ayanwuyi et al. (2011), which listed these same variables as constraints to yam production in Oyo State. Other constraints indicated by farmers included lack of effective extension services, lack of suitable land, inadequate fund to carry out farming activities, lack of storage facilities, problems of diseases and pests, amongst others.

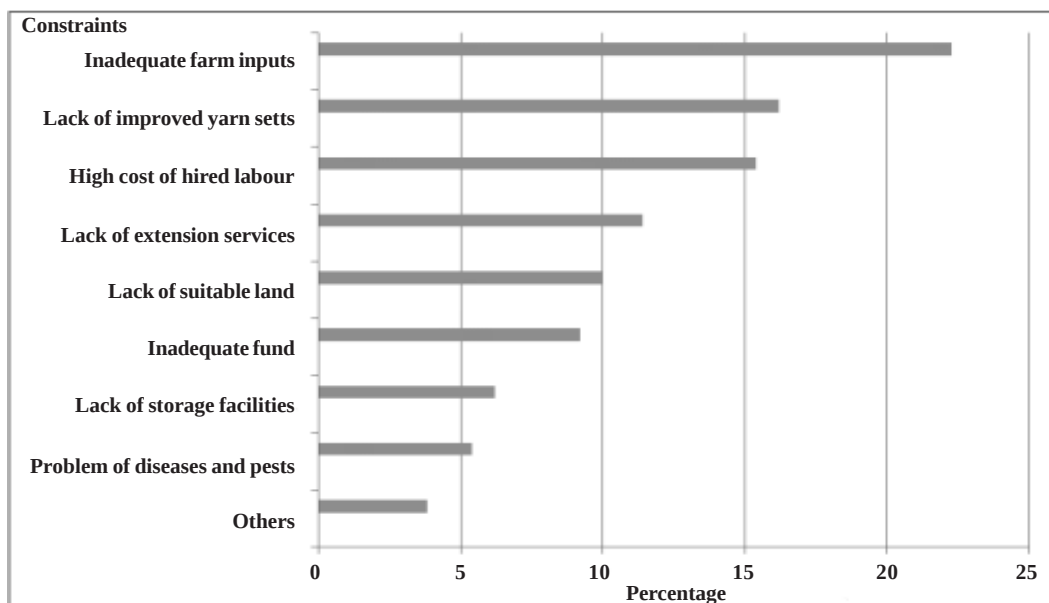


Fig. 1. A chart showing constraints to yam production in Taraba State

CONCLUSION

Based on the results of the study, it was concluded that (i) the major determinants of yam production in Taraba State were seed yam (36%), farming experience (35%) and farm size (26%). (ii) yam producers in the state were generally inefficient in their utilization of resources (iii) notwithstanding (ii) above, the yam production enterprise in the state was profitable, and (iv) productivity can be greatly enhanced if farmer are assisted to overcome the identified constraints.

RECOMMENDATIONS

It is recommended that efforts by government at various levels should be geared towards strengthening and broadening investment in timely inputs supply and availability at affordable prices as well as skill development and empowerment of farmers to adopt global best practices to attain greater efficiency in yam and other agricultural production in the State.

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