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Full Length Research Paper

Resource use efficiency in yam production among Rubber Research Institute of Nigeria staff farmers in Iyanomo, Benin City, Edo State, Nigeria

Ogwuche P., *Mkor, T., Igbinosa, O.F., and Ogieriakhi, S.N.

Rubber Research Institute of Nigeria, Benin City, Nigeria

*Corresponding author: mkortoryila@gmai.com

Abstract

Yam is rightly regarded as a staple food crop in Africa and not only serve as an integral vehicle for food security but also as a source of income and good employer of labour in the Yam producing areas of Nigeria. Therefore, the study seeks to determine the resource use efficiency in Yam production and profitability of the enterprise among Rubber Research Institute of Nigeria staff farmers in Iyanomo, Benin City, Edo State, Nigeria. A multi-stage, purposive, and simple random sampling techniques were used in sampling the respondents. The Cobb-Douglas functional form was chosen as a lead equation in estimating the model. All inputs were found to be inefficiently utilized. However, Yam production among Rubber Research Institute of Nigeria staff farmers in Iyanomo, Benin City, Edo State, Nigeria was found to be highly profitable. Some major constraints identified were inadequate farm inputs, lack of improved Yam setts and the cost of obtaining them, and high cost of labour. The results suggest that Yam farmers could increase outputs if assisted in accessing the limiting factors apart from their meagre salary coupled with appropriate adjustments in the level of inputs used.

Introduction

Yam (Dioscorea spp) are annual root tubers-bearing plants with more than 600 species of which 6 are socially and economically important in terms of food, cash, and medicine (International Institute for Tropical Agriculture, IITA, 2001).The common species grown in Nigeria especially in Rubber Research Institute of Nigeria, among the farmers is the White Yam (Dioscorea *rotundata*) and Water Yam (Dioscorea *alata*). The crop is of great nutritional and economic value to mankind. The tuber can be eaten boiled, roasted, mashed or pounded (Osunde, 2008). It has been acknowledged that Yam can provide some 200 Calories of energy per capita daily in Nigeria and West African diet. Eka (1985) reported that Dioscorine which is the major alkaloid in Yam is medicinally a Heart stimulant. This crop is grown in Latin America and The Caribbean countries like Columbia, Brazil, Haiti, Cuba, and Jamaica (FAO, 2013).

Nigeria is the largest producer of Yam in the world, followed by Ghana, Cote d'Ivoire, Benin Republic,Togo, and Cameroun (FAO, 2013). Yam is also a source of industrial Starch, the quality which varies with the species, with some of them producing Starch comparable to the quality of cereal Starch (Osisiogu and Uzo, 1973). Yam is the fifth most harvested crops in Nigeria, following after Cassava, Maize, Guinea Corn, and Beans/Cowpeas. More so, after Cassava, Yam is the most commonly harvested tuber crops in the country (National Bureau of Statistics, 2012). Yam does not only serve as the main source of earnings and food consumption, but also as a major employer of labour in Nigeria. Despite the importance of Yam to people, the attention to its full potential production is still questionable (Verter and Becvarova, 2014).

Throughout Nigeria, Yam is used in various aspects of people's economic and socio-cultural activities. The aspect of identification and evaluation of the major inputs used in Yam production becomes 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 a total area planted during 2009/2010 planting season put at 3,236.16 hectares (ha). Of this, Benue State led with 396.45ha followed by Niger State with 367.16ha, and Taraba State with 272.52ha. The

estimated corresponding total output were 37,328.17metric tonnes (mt) for the country, and 3,914.17mt, 3,166.12mt, and 2,854.95mt for Benue, Niger, and Taraba States respectively. The farm hectarage of Yam production in Nigeria has been increasing over the years with corresponding increases in the usage of the various inputs such as fertilizers, herbicides, Yam seeds or setts, and other agro-chemical inputs as shown in Table 1.

However, it is quite unfortunate that the increase in output seems not to have been commensurate with those in inputs usage. It would seem that whereas the inputs were used at an increasing rate, the resultant outputs were increasing at a decreasing rate. Izekor and Olumese 2010; Shehu et al 2010; Awoniyi et al 2007, and Ike and Inoni 2006 carried out several empirical studies on determining the efficiency of resource-use in Yam production in Nigeria. All these were carried out concluded that resources were not efficiently used in Yam production in their respective study areas. This implies that if resources were efficiently used at an optimal level, the total output of Yam and farmers' net earnings would have been greater in the study areas, ceteris paribus.

Are these findings applicable to Iyanomo, Benin City,Edo State where Rubber Research Institute of Nigeria is located? This study sought to answer the question above by addressing the following issues:

i. How optimally are resources used in Yam production among Rubber Research Institute of Nigeria staff farmers?
ii. What is the profitability level of Yam production among Rubber Research Institute of Nigeria staff farmers?, and
iii. What are the needed adjustments in resources use if they are currently over or under-utilized?

Table 1: Trends of outputs and resources used in Yam production in Nigeria and Yam producers of Research Institutes (all values in 10^3 metric tonnes, except Land=10^3ha)

Year	NIR	Outputs	Inputs				
		Yam	Land	Fertilizer	Yam Setts	Herbicide	Insecticide
1994/1995	N	2339.75	2117.29	11212.80	4763.75	98.76	142.65
	RRIN	65.02	22	NIL	2.1	NIL	NIL
2004/2005	N	25707.45	2165.75	76492.21	4872.94	179.98	178.12
	RRIN	65.21	31	NIL	3.5	NIL	NIL
2009/2010	N	37328.17	3236.16	98754.98	6786.78	114.34	182.17
	RRIN	78	41	NIL	7.2	2.5	1.0
2010/2011	RRIN	81	62	NIL	8.2	4.5	2.1
2011/2012	RRIN	91	68	NIL	10.2	5.1	2.5
2012/2013	RRIN	102	69.5	NIL	12.2	6.7	3.1
2013/2014	RRIN	115	71.7	NIL	14.2	8.1	4.1
2014/2015	RRIN	127	82.5	NIL	16.1	10.5	4.7
2015/2016	RRIN	135	86.8	NIL	18.5	15.5	5.2

Note: N= Nigeria, RRIN=Rubber Research Institute of Nigeria

Source: 1994/1995, 2004/2005, 2009/2010- Extracted from NBS Database (2007-2012) while 2010-2016 data from RRIN were obtained from Field Survey

Objective of the Study

The broad objective of this study is to determine the economic efficiency of resource use in Yam production among Rubber Research Institute of Nigeria (RRIN) Yam farmers. While specific objectives include:

i. To estimate the costs and returns to Yam producers in RRIN, and
ii. To identify some major constraints in Yam production among Yam producers in RRIN and proffer possible solutions.

Methodology

Study Area

The study was conducted in Rubber Research Institute of Nigeria (RRIN) main station, Iyanomo, Benin City, Edo State, Nigeria with 2,078ha, a sub-station at Akwette, Abia State with 324ha, and experimental out-stations at Manchok, Kaduna State, and Igbotako, Ondo State with 12ha. Edo State is located in the South-south geopolitical zone of Nigeria and shares boundary with Kogi and Anambra States in the North and East, Delta State in the South, and Ondo State in the North and West respectively. The State is divided into 18 Local Government Areas. The vegetation of the area is predominantly Rainforest and Mangrove Swamp characterized by a tropical climate which ranges from humid to sub-humid at different parts of the year. The total land area of Edo State is 17,902Km^2 (NPC, 2006) with food and tree crops such as Cassava, Yam, Maize, Plantain, Oil Palm, Cocoa, and Natural rubber predominantly cultivated. Majority of farmers in Edo State where the study area is located grow other crops such as Cassava,Yam, Pineapple, and Plantain. Yam was significantly picked in the study area because of the serious interest developed by RRIN Yam farmers.

Sampling Procedure and Data Collection

Multi-stage, purposive, and simple random sampling techniques were used in selecting the respondents for this study in the order outlined below:

Stage 1: 6 zones (Obuakpe, Obagie Nosa, Old Quarters, New Quarters, After Gate, and Iyanomo) were purposively picked because they were the high yam-producing areas with large volumes of yam marketing activities.

Stage 2: 3 villages or areas were randomly selected from the list of yam-producing areas in each of the 6 zones (Stage 1) making 18 areas in the sample.

Stage 3: 130 Yam farmers of RRIN were randomly selected from the sampled 18 areas (Stage 2)

Data were collected from Yam farmers using structured questionnaire coupled with interview schedules on their household production activities during the 2010/2011 cropping season, and repeated in the 2012/2013, and finally through interview schedule conducted in the 2014/2015 cropping season.

Data Analysis

In achieving the objectives of the study, econometric and budgetary techniques were used. Multiple Regression analysis was used to determine the effects of the specified socioeconomic variables on the producers' outputs. Four functional forms were tried: Linear, Semi-Log, Double Log, and Exponential.

The implicit form of the Regression Model used was:

$$Y= f (x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, u_i) \quad \text{.....(1)}$$

where:

Y= Output of Yam (Kg)
f = Function of
x_1 = Quantity of fertilizer used (Kg)
x_2 = Quantity of insecticide used (Litres)
x_3 = Quantity of herbicide used (Litres)
x_4 = Quantity of Yam setts used (Kg)
x_5 = Hired Labour (Man-Days)
x_6 = Family Labour (Man-Days)
x_7= Farming Experience (Years)
x_8 = Farm Size (Hectares)
u_i = Error Term

Below are the explicit functional forms tried:

(a) Ordinary Linear Form:
$$Y= bo+b_1x_1+b_2x_2+b_3x_3+.....+ b_8x_8+u_i) \quad \text{.....(2)}$$
(b) Semi-Log Form:
$$Y= bo+b_1\log x_1+b\log x_2+b_3\log x_3+.....+ b_8\log x_8+u_i) \quad \text{.....(3)}$$
(c) Double-Log Form:
$$\text{Log } Y= bo+b_1\log x_1+b\log x_2+b_3\log x_3+.....+ b_8\log x_8+u_i) \quad \text{.....(4)}$$
(d) Exponential Form:
$$\text{Log } Y= bo+b_1x_1+b_2x_2+b_3x_3+.....+ b_8x_8+\log u_i) \quad \text{.....(5)}$$

where:

bo = Constant Term
x_1-x_n = Independent variables measured in relation to the dependent variable (Y)
b_1-b_n = Estimated Coefficients of the Independent Variables
n = 1, 2, 3,……..n^{th}

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 variations in the total output. The estimation of the econometric models (2-5) as 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 (R^2) and the Standard Error (SE) values as well as consistency with apriori expectations consistent with agricultural production/economic theory.

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

$$r = MVP/MFC \quad \text{.....(6)}$$

where:

MVP= Marginal Value Product in the production process ($MVP=MPP_{x1}.P_y$)
MPP= Marginal Physical Product
P_y= Unit Price of Output Y

MFC= Marginal Factor Cost in resource application obtained from market price of inputs used

The use of the ratio was based on the assumption that the farmers operated in pure competitive input markets (Olukosi and Ogungbile, 1989).The ratio has the following interpretation for each resource used. If:

i. r=1, the Yam producers were efficient in the use of a 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 (under-utilization of resources) in the production process.
iii. r>1, The Yam producers were inefficient (over-utilization of resources) in the production process.

More profit could still be made by employing additional inputs since each of the additional cost item incurred brings in more Marginal Revenue (MVP).

Similarly, the Elasticity of Production (Ep) was estimated using equation (7) below. The concept measures the degree of responsiveness of output to a given unit change in input.

$$Ep= b\frac{X}{Y} \quad \text{.....(7)}$$

where

b= Coefficient (Productivity) of individual inputs (MPP)
X= Mean of Input, and
Y= Mean of Output

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

Olukosi and Erhabor (1988) reported the use of farm budgetary technique which states that the Gross Margin (GM) is the difference between Gross farm income (GI) and the Total Variable Cost (TVC) of production. In this study, it was used to estimate the profitability level of Yam production in the study area. This tool was used because in subsistence farming, the fixed cost (FC) is assumed to be negligible. The model is specified below:

GM = GI - TVC……....(8)

NPI = GM – TFC……..……(9)

Where:

GM = Gross Margin per Hectare (₦)
GI = Gross Income per Hectare (₦)
NPI = Net Farm Income per Hectare (₦)
TFC = Total Fixed Cost per Hectare (₦)
TVC = Total Variable Cost 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 apriori expectations in respect of the estimated coefficients of all, but one of the explanatory variables in the model and finally, it had the least Standard Error of the estimated value of 0.322.The coefficients of all the variables in the model were statistically significant except 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. The findings from previous studies conducted by Awoniyi et al (2007), Izekor and Olumese (2010), and Shehu et al (2010) in Ekiti, Edo, and Benue States respectively. Discussions carried out by the researcher with the Yam farmers in the study area 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.The cost of herbicides coupled with the belief of some farmers about its effects resulted to very limited usage by them. Family labour, 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. Most of the youths in the study area who would have been the major source of family labour, had their own personal farms and other youthful commitments. Thus, the farmers depended predominantly on hired labour for most farm operations.

Given the non-significance of the 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 R^2 of 81% (same with the original model) and secondly by combining family labour and hired labour as one variable.

The latter model gave an R^2 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 finally selected for the analysis and the results presented in Table 2 below.

Table 2: Estimated parameters of the Yam production function in RRIN, Edo State

Variable	Estimate	Standard Error (SE)	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)	-0.026661	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_7)	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		
SE of Estimate	0.3205		

* Significant at 1%
Source: Field Survey 2010-2015

The negative sign for insecticide and herbicide coefficients indicate negative Yam output response to their usage which is normally associated with over-usage. But this was hardly the case in the study area. In fact, most of the farmers rarely used this input, except as seed dressings. Errors in data provided or recorded might have contributed

to the unexpected negative signs observed. Thus, this phenomenon requires further investigation in future studies on the crop in the study area.

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

The crucial information gathered from farmers showed that Yam yielded more on virgin or new land relative to old or over-used land. Unfortunately, the recent increases in farming population in the study area coupled with competition from other crop enterprises meant that virgin or long-rested cultivated land were becoming harder to come by.

Table 3: Marginal Physical Product (MPP), Marginal Value Product (MVP), and Efficiency Ratios in Yam production in RRIN, Edo State

Variable	MPP	MVP	MFC	r=MVP/MFC
Fertilizer (X_1)	4.2	105	62	1.7
Insecticides (X_2)	-0.27	-0.43	1,000	-0.0004
Herbicides (X_3)	1.54	38.5	1,200	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_5)	0.09	2.32	200	0.0058
Farm Size (X_8)	95770	394250	20000	119.7

Source: Field Survey, 2011-2015

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, $\sum bi$, 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 among RRIN Yam staff farmers in RRIN, Iyanomo, Benin City. It was found that the cost of acquiring yam setts, and hired labour constituted almost 64% of the total costs of production. Yam production by RRIN staff Yam farmers was found to be highly profitable with a Gross Margin (GM) 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 RRIN by staff farmers

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 holes in the study area
I acre= about 4540 planting holes in the study area
Source: Field Survey, 2010-2015

Figure 1 illustrates the constraints to Yam production among RRIN staff Yam farmers in RRIN, Iyanomo, Benin City. 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.

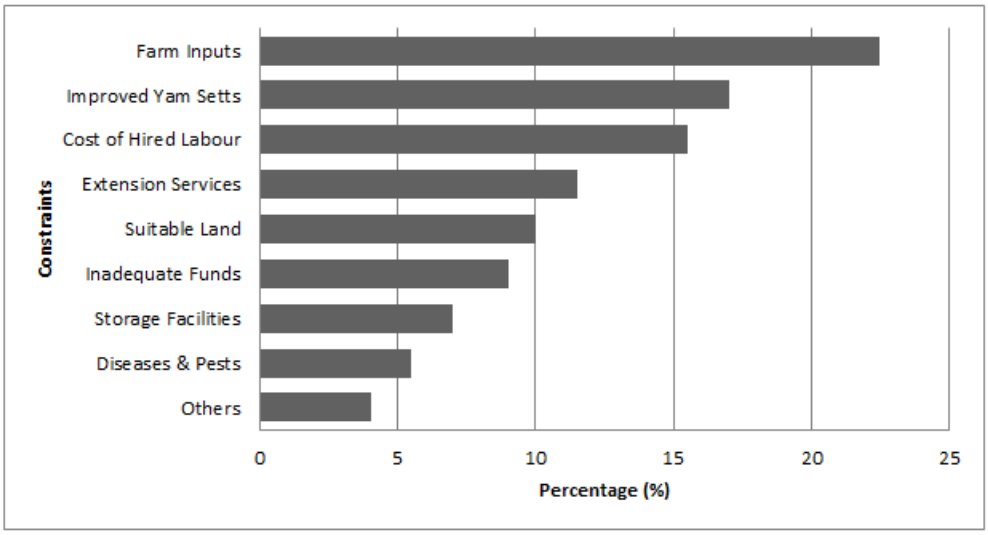

Fig.1: Constraints to Yam Production among RRIN Staff Yam farmers, Iyanomo

Conclusion

Based on the results of the study, it was concluded that

i. the major determinants of Yam production in RRIN Staff Yam farmers were Yam Setts (36%), farming experience (35%) and farm size (26%).
ii. Yam producers in RRIN were generally inefficient in their utilization of resources.
iii. notwithstanding (ii) above, the Yam production enterprise among RRIN Staff farmers 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 boosting 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 apart from Natural Rubber. This will further enhance low income earners

among the staff Yam farmers to earn more income which will improve their standard of living and also alleviate poverty.

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