Determinants of Yam Production and Resource use Efficiency under Agroforestry System in Edo State, Nigeria

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Abstract

This study was carried to determine the economics of yam production under agroforestry system in Sapoba forest area, Edo State, Nigeria. A two-stage sampling procedure was used to purposively select five villages and 12 respondents from each village engaged in food crop production under agroforestry system. About 60 farmers were thus selected from the area. Structured questionnaires were administered on the respondents to elicit answers on their socioeconomic characteristics and food production operations. Sixty farmers were selected in all. Data collected were analyzed with the aid of descriptive statistics, Cobb-Douglas production function was used to estimate the coefficients of the various variables analyzed. MPP, MVP and allocative efficiency index were used to estimate the efficiency of resource use in the study area. The results showed that farm size, yam seed and years of farming were significantly positive to yam production in the area. The results of the efficiency estimation, however, indicated that farm size (1.55), yam seed (1.5) were underutilized while hired labour (0.24), hoes (0.46) and machetes (0.32) were over-utilized. The regression also showed that the farmers were in the first stage of production which is increasing return to scale (using the elasticities). The study therefore recommends that to ensure the restoration of our forest, farmers should be encouraged to adopt agroforestry as a farming system. Farmers should also be encouraged to increase their productivity and, by extension, profit through the provision of improved yam seeds and given the opportunity for plot expansion. They should also maximize the utilization of the farm land by increasing the number of yam sett planted per hectare.

Keywords: Efficiency, agroforestry, yam, production function, Sapoba forest area,

Introduction

Food crop production remains a major component of all production activities in the agricultural sub-sector in Nigeria. Food crop production comes under different agricultural farming systems which include agroforestry. With increasing need to conserve natural resources particularly the forests, there was an introduction of agroforestry systems which permits the cultivation of food crops alongside tree crops. Agroforestry is a land use management system in which woody perennials are grown with food crops and or livestock leading to many beneficial, ecological and economic interactions between trees and non-tree components (FAO, 2015). It is one of the methods designed to create a climate-smart agriculture, increase food security, alleviate rural poverty and achieve a truly sustainable development (Garrity and Stapleton, 2011). Lambert and Ozioma (2011) stated that agroforestry combines agriculture and forestry technology to create a more integrated, diverse, productive, profitable healthy and sustainable land use system.

Some of the benefits of agroforestry are direct provision of food thereby supporting food nutrition and raising farmers' income, providing fuel for cooking etc. Agroforestry has the advantage of mitigating change in climate, enhancing soil fertility as well as enhancing

farmers' revenue through income from fuel wood (Bifarin *et al.,* 2013). Some studies have been carried to estimate the adoption of agroforestry technologies in Nigeria (Owombo *et al.,* 2017; Bifarin *et al.,* 2013)

One of the major food crops usually cultivated under that agroforestry farming system is yam. Yam belongs to the genus "Dioscorea" and family "Dioscoreaceae". It is an important tuber crop of the tropics and some other countries in East Asia, South America and India (Iwueke *et al,* 2003). Yam (*Dioscorea* spp.) is among the oldest recorded food crops and ranked second after cassava in the study of carbohydrates in West Africa (Agwu and Alu, 2005). Yam is one of the major staple food in Nigeria and has potential for livestock feed and industrial starch production (Ayanwuyi *et al,* 2011). It is one of the principal tuber crops in the Nigeria economy, in terms of land under cultivation and in the volume and value of production (Bamire and Amujoyegbe, 2005).

Nigeria is the largest producer of the crop, producing about 38.92 million metric tonnes annually (FAO, 2008). There has, however, been a general decline in yam production in Nigeria over years. Madukwe *et al.* (2000); Agwu and Alu (2005) and International Institute of Tropical Agricultural [2009] reported that both area under yam cultivation and total yam output were declining. The decline in average yield per hectare has been more drastic, as it dropped from 14.9% in 1986-1990 to 2.5% in 1996-1999 (CBN, 2002; Agbaje *et al,* 2005 and FAO, 2007). This declining trend may not be unconnected with the type of operating farming system and inefficiency of resource use and allocation (Nwosu and Okoli, 2010).

Efficiency is a very important factor for productivity growth. In an economy where resources are scarce and opportunities to use new technologies are limited, inefficiency studies indicate the potential possibility to raise productivity by improving efficiency without necessarily developing new technologies or increasing the resource base (Bifarin *et. al.* (2010). International Atomic Energy Agency (2009), highlighted that agroforestry which is the integration of trees and crops can increase resource use efficiency but that the management and design of the system must be such that are compatible with the local climate and soil conditions so as to avoid competition and the resultant decrease in crop yields.

Several studies have been carried out to determine the efficiency of resource use in yam production in Nigeria (Izekor and Olumese, 2010; Shehu *et al.* 2010; Awoniyi *et al.* 2010; Rueben and Barau, 2012). All these studies reported that farmers were inefficient in the use of resources in yam production. No known study has been carried out to determine the efficiency of farmers in yam production under agroforestry farming system. This study is, therefore, carried out to determine the efficiency of farmers in the production of yam under agroforestry by asking the following question:

i. How optimally are resources used in yam production under agroforestry in Edo State?
ii. What are the factors that influence the efficiency of farmers in yam production under agroforestry?
iii. What are the needed adjustments in resource use if they are not optimally utilized?

Objectives of this study

The study was carried out to

1. Identify the factors that determine the efficiency of yam farmers under agroforestry enterprise
2. Describe the socio-economic characteristics of the yam farmers;
3. Identify the problems faced by farmers in yam production

Methodology

Study area

This study was carried out in Sapoba Forest Area in Orhionmwon Local Government Area of Edo state. Edo state is located between latitude 5°51N -7°33[i] N and longitudes 5°E-6°40[i]E. It shares common boundary with Ondo state in the west, Delta State in the east and Kogi state in the north. The vegetation of the state is moist rain forest in the south and derived savanna in the north. Sakpoba Forest Reserve lies between

latitudes 4°-4° 30' and longitudes 6°- 6°5'E. It is bounded on the south by Delta State, on the East by Urhonigbe Forest Reserve and on the West by Free Area. It is located in Orhionmwon Local Government Area, about 30 kilometers South-East of Benin City. Some of the major villages located within and around the reserve are Ugo, Ikobi, Oben, Iguelaba and Amaladi in Area, and Ugboko-Niro, Iguere, Idunmwowina, Evbarhue, Idu, Evbueka, Iguomokhua, Ona, Abe, Igbakele, Adeyanba, Evbuosa in Area.

Orhionmwon LGA has a population of about 182,717 according to 2006 census with a land area of 2.382km^2 (NPC, 2006). The people of the area are farmers and traders. Crops grown in the area include: yam, cassava, maize, plantain, and cocoyam interplant with some trees like *Tectona grandis* (teak) *Gmelina arborea, Terminalia ivorenisis, Khaya ivorensis* etc.

Sampling technique and data

A two-stage sampling procedure was used to select respondents for the study. In the first stage, 5 villages namely: Ageka, Evbuosa, Ona, Iguomokhua and FRIN Camp were purposively selected because of the predominance of agroforestry farming in the area. In the second stage, 12 respondents per village were purposively selected for the study. A total of 60 respondents were used for the study. Data collected include the socio-economic characteristics of respondents and the input-out factors of farm enterprise.

Analytical Technique

Data were analyzed with the aid of descriptive statistics and multiple log-linear regression. Descriptive statistics was employed to describe the socio-economic characteristics of respondents. It employed simple percentage, means and standard deviation.

The multiple log-linear regression model was used to determine quantitatively the socio-economic factors that influence the efficiency of yam farmers under agroforestry system. This is specified as follows:

Multiple log-linear Regression Model specification

The empirical specification of the model is of the form shown below:

$$Y = \beta oXi^{\beta i}\varepsilon i \quad (1)$$

where Y = output
βo = intercept of the function
Xi = explanatory variable (i= 1-----n)
εi = error term

The error term is assumed to be log normally distributed with mean 1 and contains among other things, differences in efficiency between farms. The explicit form of the equation is as stated below

$$Log\ Y = \beta o + \beta_1 \log X_1 + \beta_2 \log x_2 + \beta_3 \log x_3 + \beta_4 \log x_4 + \varepsilon i \quad (2)$$

Where
Y = yam output in kilograms
X1= land (farm size in hectares)
X2 = hired labour(man days)
X3 = value of capital used (hoes, matchete)
X4 = quantity of seed yam
εi = error term.
β0 and βi are the constant and the regression coefficients respectively

From the Cobb-Douglas production function, the output elasticity of each production input was determined. This is equal to the value of the coefficient of the input. Also derived from the log-linear production function is the ratio of the marginal value product (MVP) of the various production inputs to the respective acquisition costs. This is done to examine the marginal returns to the agroforestry farm. This is an indication of efficiency in production.

Efficiency Model

The marginal physical product MPP was given as

$$MPPi = bi \times APPi \quad (3)$$

where:
bi = elasticity of the various inputs.

$$APPi = \frac{y}{x} \quad (4)$$

Where y is the mean of the output and x is the mean of the factor.

Using the above specification and the output and input prices, the marginal value products (MVPs) and allocative efficiency index (AEI) were computed as follows:

$$MVPi = MPPi \times Py \quad 5$$

$$AEI = \frac{MVPi}{MFCi} \quad 6$$

where Py and MFC are the unit prices of output and factor input respectively.

The decision of whether a resource is used efficiently or not thus allocative efficient is basically on the value of AEI (Nimoh, *et al.,* 2012). If AEI is equal to one (AEI=1) the factor input is efficiently utilized, hence the farmer is considered allocative efficient. The factor is over-utilized if AEI is less than one (AEI<1) and underutilized if AEI is greater than unity (AEI>1).

Results and Discussion

This section discusses the socio-economic characteristics of farmers which are known to influence resource productivity and returns on the farms. The summary of the demographic and socio-economic characteristics of farmers is presented in Table 1. The demographic and socio economic variables considered include age, gender of farmers, household size, farm size, years of farming, level of education and marital status. About 63.3 % of the sampled farmers were between the age bracket 20 -50 years. This shows that majority of the farmers were middle aged and this implies that the farmers were still in their economic active age which could result in a positive effect on production. This result agrees with the findings of Alabi *et al* (2005) who observed that farmer's age has great influence on maize production in Kaduna state with younger farmers producing more than the older ones plausibly because of their flexibility to new ideas and risk.

Furthermore 83.3% of the sampled respondents had one form of formal education or the other. Onyenweaku *et al*. (2005) and Idiong *et al*. (2006) observed that formal education has positive influence on the acquisition and utilization of information on improved technology by the farmers as well as their innovativeness adoption of innovations. Majority of the farmers (73.3%) have over 5 years farming experience in agroforestry. This means that they must have acquired good experience in agroforestry farming. Rahman *et al* (2005) indicated that the length of time in farming business can be linked to age. Age, access to capital and experiences in farming may explain the tendency to adopt innovation and new technology.

Results of the Regression Analysis

The results of the production function that was used to determine the nature of the relationship between the inputs and output in food production are shown in Table 2. The results in the table showed that the coefficient of multiple determinations (R^2) and adjusted R were 0.7111 and 0.6784, respectively. This implies that 67.84 percent variation in the output of yam in the area is accounted for by the specified independent variables. The F-ratio (21.75) which was significant at 1 per cent level of probability indicates the overall significance and fitness of the model.

The results further showed that year of farming and seed yam (X_4) were positive and significantly influenced yam production in the study area. Years of experience and seed yam were both significant at 1% level of probability. Farm size was positively significant at 10% and influenced yam production in the study area; it equally conformed to the expected sign of the study. The quality and, to some extent, the quantity of seed yam greatly influenced yam output under agroforestry enterprise. In addition, the quality and fertility of the soil although not accounted for in our estimation has great effect on output especially since the soil under which the farmers were farming was an undisturbed high forest area. The elasticities of production (EP) with respect to the inputs were 1.0580, 1.0771, and 0.6498 for years of farming, farm size and seed yam, respectively. From the regression analysis, the sum of the elasticities of the various variables equal to 2.0836 indicating

Table 1: Demography and Socioeconomic characteristics of sampled farmers (N=60)

Variables	Respondents	Percentage	Cumulative Percentage
Age in Years			
21-30	12	20	20
31-40	12	20	40
41-50	14	23.3	63.3
51-60	09	15	78.3
61-70	03	5	83.3
71-80	04	6.7	90
Above 80	06	10	100
Total	**60**	**100**	
Level of Education			
Informal	10	16.7	16.7
Primary	23	38.3	55
Secondary	22	36.7	91.7
Vocational	3	5	96.7
Tertiary	2	3.3	100
Total	**60**	**100**	
Marital status			
Single	4	6.6	6.6
Married	46	76.7	83.3
Divorced/widow/widower	10	16.7	100
Total	**60**	**100**	
Year of farming experience			
1-5	16	26.7	26.7
6-10	8	13.3	40
11-15	7	11.7	51.7
16 and above	29	48.3	100
Total	**60**	**100**	
Household size			
1-5	15	25	25
6-10 above	45	75	100
Total	**60**	**100**	
Gender			
Male	50	83.3	83.3
Female	10	16.7	100 aw
Total	**60**	**100**	
Farm size (Ha)			
0-5-1.0	6	10	10
1.5-2.0	19	31.7	41.7
2.5-3.0	11	18.3	60
3.5-4.0	2	3.3	63.3
Above 4.0	22	36.7	100
Total	**60**	**100**	

Source: *Field Survey 2012*

that the farmers were operating at the region of increasing returns to scales which suggests that they are still in stage one of the production process.

labour, hoe and matchete suggesting that these inputs were over utilized in yam production in the study area. It is therefore expected that more yam would be produced if more hectares

Table 2: Estimates of the Cobb-Douglas Production Function

Variable	Coefficient	Standard error	t-value
Constant	-0.0197	2.0488	-0.01***
Years of farming	1.0580	0.3873	2.73***
Farm size	1.0771	0.6287	1.71*
Hired labour	0.4297	0.1960	0.22*
Hoes	0.8568	0.6371	1.34
Matchete	-0.9298	0.6329	-1.47
Seed yam	0.6498	0.0769	8.44***
R^2	0.7111		
R^2(Adj.)	0.6784		
F	21.75		

Source: *Field Data analysis (2012)*

Table 3 shows the estimates of allocative efficiency (AE) of inputs used by yam farmers in the study area. The allocative efficiency indices were 1.55, 0.24, 0.46, 0.32 and 1.5

of land are cultivated and the quantity of seed yam is increased. Also, improved return on yam production can be recorded and achieved by reducing the over used resources in the area.

Table 3: Estimated resource use efficiency

Resources	Coefficient	APP	MPP	EP	MVP	MFC	AEI
Farm size	1.0771	24.01	25.86	1.08	3,103.2	2000	1.55
Hired Labour	0.4297	7.00	3.01	0.43	361.2	1,500	0.24
Hoes	0.8568	3.10	2.66	0.86	392.2	700	0.46
Matchete	-0.9298	3.45	3.21	0.93	385.2	1,200	0.32
Seed yam	0.6498	1.30	0.85	0.65	102	68	1.5

Source: *Field survey (2012)*

for farm size, hired labour, hoe, matchete and seed yam respectively. The results showed that farmers were inefficient in their resource use. This finding corroborates the findings of Ike and Inoni (2006); Izekor and Olumese (2010); Shehu *et al* (2012) and Rueben and Barau (2012) that farmers were equally inefficient in resource use in their respective studies. The indices revealed that MVP exceeds the MFC in the cases of farm size and seed yam respectively. This implies that farm size and seed yam were underutilized in the production of yam in the study area. However, MVP was lesser than MFC in the case of hired

Constraints to Yam Production

The problems faced by farmers in yam production in the area include lack of adequate farm inputs (50%), high costs of hired labour (83.3%) and lack of improved seed yam (66.7%). This conforms with the findings of Rueben and Barau (2012) and Sanusi and Salimonu (2006) which listed the same variables as constraints to yam production in Taraba and Oyo States respectively. Other constraints faced by the farmers are lack of extension services (100%), inadequate fund (95%) and the problems of diseases and pests among others.

Table 4: Constraints in Yam Production

Problems encountered	Number of farmers	Percentage
Lack of inadequate inputs	30	50
High cost labour cost	50	83.3
Inadequate Fund	57	95
Weather (climate)	45	75
Lack of improved seed yam	40	66.7
Problems of pest and diseases	30	50
Lack of extension services	60	100

Note: *Multiple responses from the respondents*

Conclusion

This study revealed that yam production in the study area is profitable. Among the variables that contribute to production include farm size, seed yam and labour. Analysis of the efficiency of yam production, however, revealed that farmers in the area are inefficient in the use of their resources hence there is the need to reduce the use of those resources that reinforce inefficiency especially hired labour to the level where the marginal value products of the resources equal their acquisition costs. Farmers can also increase their productivity and, by extension, profit by the use of improved seed yam as well as maximize the utilization of the farm land by increasing the number of seed yam planted per hectare.

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