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Economic Analysis of Yam Production under The Taungya Agroforestry System with Cost Analysis

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ABSTRACT

The study was carried out to investigate the economic analysis of yam production under the taungya agroforestry system in some selected Local Government Areas in Oyo State. A multistage sampling procedure was used to select 80 farmers producing yam under the taungya agroforestry system in the study area and structured questionnaires were administered based on the objectives of the study. Descriptive statistics, gross margin, and regression analysis were used to analyze the data collected. The gross margin of the yam farmers in the study area was #337,013.00. This implies that yam production under the taungya agroforestry system was profitable in the study area. The results of regression analysis reveal that household size, years of experience in the taungya agroforestry system, farm size, and level of farming were statistically significant in determining the output of yam in the study area. The study also revealed that there are a lot of benefits and challenges associated with practicing yam production under the taungya agroforestry system. Therefore, the study recommended that the government at all levels should provide commodity exchange arrangements that will see to the regulation of yam price market price, provision of basic infrastructural amenities, and provision of loans to farmers. Lastly, the government should ensure adequate security against theft.

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1. INTRODUCTION

Crop production comes under different agricultural farming system which includes agroforestry (Nath et al., 2020; Ivezić *et al*., 2021). The need to protect and manage natural resources, particularly the forest, therefore, brings the idea of crop production under taungya forestry which encourages a deliberate integration of woody perennials (trees, shrubs, palms, and bamboo among others) with crops on the same land management unit in form of spatial arrangement or time to enhance soil fertility and increase farmers income with the use of economic trees (Akinbile *et al*., 2007). Taungya agroforestry produces benefits to the environment by controlling wind erosion, improvements, in internal drainage, reduction of run-off and infiltration, and enhancement of aquatic and terrestrial habitats (Barbieri & Valdivia, 2010; Paudel and Yadav, 2021). In agroforestry, sustainable management is required in the harnessing and programmed tapping of natural, physical, social human, and financial capital resources available in the forest enterprises through various structures and processes (law, rules, regulations, programs, policies, etc.) to increase the wealth and productive capacity of a defined group of people now and in future. These practices include; tree planting multiple cropping, zero tillage, and alley cropping (Morugán-Coronado *et al*., 2020).

Taungya agroforestry is best practiced in agricultural land outside forest reserves when the principal need is food crop production (Osikabor and Oyelami, 2022). Tree crops play only a secondary though important role (Akinsanmi, 2004). If the tree used is legumes or other species able to fix nitrogen, there is an increase in soil fertility. Forest crops may be raised with both food crops and farm animals. Trees are planted for fodder, shade, or as live fences. Root and tuber crops are staple food drops, being the source of daily carbohydrate intake for the large populace of the world. The term refers to any growing plant that stores edible materials in subterranean root, corn, or tuber (Oke, 2002).

Yam is among one of the major food crops usually cultivated under taungya agroforestry (Ahmed *et al*., 2021; Dania *et al*., 2020). In West Africa, yam (Dioscorea spp.) is a food and cash crop. It is cultivated mostly in the derived, humid, and southern Guinea savanna agroecologies. About 48 million tons of yams (95% of the global supply) are produced on 4 million hectares annually in the region, mainly in five countries: Benin, Cote 'Divore, Ghana, Nigeria, and Togo. Nigeria alone accounts for 70% of global yam supply. Yam has the potential for livestock feed and industrial starch production (Ayanwuyi *et al*., 2001). It is one of the principal tuber crops in the Nigerian economy in terms of land under cultivation and the volume and value of production (Bamise & Amujoyegbe, 2005).

One of the challenges facing Nigeria is the production of sufficient food and fiber to meet the needs of its ever-increasing population. With rapid population increase and land use pressure, natural fallows, and shifting cultivation have been reduced to below the minimum threshold required for the system to sustain itself. These have led to land shortages and continuous arable cultivation without fallowing. As a result of this, land does not have enough time to replenish its fertility. However, attempts to resuscitate land and hence promote yield with the use of chemical fertilizers have resulted in soul toxicity and environmental pollution.

Taungya agroforestry has considerable potential to contribute towards solving some of the major agricultural problems. Nitrogen-fixing trees, serve as substitutes for fertilizers (Akinbile *et al*., 2007) and can increase smallholder incomes, conserve foreign exchange, and improve regional food security. By supplying fuel wood from the farm, agroforestry can help reduce pressure on forests and communal woodlands. Moreover, agroforestry trees can supply farm households with a wide range of non-timber products including food, medicine and livestock feed, honey, bush meat for home use and sales.

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Taungya agroforestry provides raw materials for many types of industries such as the pulp and paper industry, and furniture industry as well as poles of trees of certain species of Tectona grandis used as poles for electricity transmission (Edberg *et al*., 2022; Dhyani & Handa, 2013). The cost of weeding is often low in taungya farms here the number of times for weeding is usually fewer than when the system is not adopted. Taungya also helps in the better utilization of land.

The integration of trees into the farming system could go a long way to help ameliorate environmental problems and can help protect against soil erosion and moderate extreme temperatures. Under the taungya farming system, farmers spend less on staking, pruned branches of trees can be used as stakes for yam plants to allow maximum sunlight interception for plant photosynthesis, thus obtaining high-yielding tubers and also reducing the spread of soil-borne diseases from attacking the growing plant parts (Tsonkova *et al*., 2018). This study was therefore carried out to investigate the profitability or otherwise of yam production under taungya agroforestry in some selected local government areas of Oyo State.

2. METHODS

The study was carried out in the four Local Government Areas in Oyo metropolis, Oyo State, which are four of the thirty-three Local Government Areas in Oyo State, Nigeria. The LGAs witness two distinct seasons which are the dry and the rainy seasons with the average wind speed in the area at 10km/h. The current estimated population of Oyo Local Government Areas is put at 428,798 as of the 2006 census (National Population Commission (NPC). The Local Government Areas Agrarian Local Government Areas, food, and cash crops are grown in the Local Government Area.

The main cash crops are palm produce (oil and kernel), cashew, and tobacco. Among the food crops are yam, cassava, tomatoes, maize, pepper, and all other varieties of green vegetables. The data for this study were collected from primary sources using a well-structured questionnaire and through personal communications with selected small-scale farmers. Data were collected on the socio-economic characteristics of the respondents and their level of production. In addition, data on yam output, farm size, family labor input use, the number of fertilizers, seed yam, and the prices of various inputs. Other questions like the type and number of trees on the farm, sources, cost of seedlings, benefits, and constraints faced by the farmers in the study area were also collected.

Multi-staged sampling procedure was used in selecting the farmers. The first stage of the sampling technique was the purposive selection of Oyo State from South West Nigeria because the state is one of the major producers of yam and also practices the taungya system in Southwest, Nigeria. The second stage was the purposive selection of Oyo town and the four local government areas therein because they are easily accessible and also, and most of its local government areas are agricultural zones. The third stage was the purposive selection of communities that are known for yam production under the taungya agroforestry system through the assistance of the Agricultural Development Programme (OYSADEP) extension officer in the LGA. 20 farmers under taungya agroforestry were then selected in each of the four local government areas based on the available number of farmers in the communities. This brought the sample population to 80 farmers.

Descriptive statistics such as frequency distribution, mean and percentages were used to describe the socio-economic characteristics of the respondents, the method used in the production, and problems and benefits faced by various farmers practicing the taungya system with yam production. Gross margin analysis was used to determine the cost and returns of yam production in the study area.

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Multiple regression analysis was used to assess the main determinants of yam production in the study area. Gross margin analysis was employed to estimate the cost and returns of yam production under the taungya system in the study area. Gross Margin (GM) is defined as the difference between total revenue and total variable cost. The profitability ratio which measures the ratio of revenue to expense and gives room for comparison between two or more firms was used to determine the performance of yam production in the study area. Thus; we can write equations (1) and (2):

$$Profitability\ ratio = \frac{GM}{TC} \quad (1)$$

$$Efficiency\ ratio = \frac{TR}{TC} \quad (2)$$

Where, *GM* is the Gross margin, *TC* is the Total Cost, *TR* is the Total Revenue, *GM* is the *TR-TVC* and *TVC* is the Total Variable Cost.

Multiple regression analysis was used to assess the main determinants of yam production under the taungya farming system in the study area. Mathematically, it is usually expressed as in equation (3):

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, \mu i) \quad (3)$$

Where, *a* is the constant, *Y* is the Gross Margin in Naira, X_1 is the Age (years), X_2 is the Gender, X_3 is the Presence of trees on farmland, X_4 is the Major occupation, X_5 is the Household size, X_6 is the Level of education, X_7 is the Farming experience (years), X_8 is the Farm size, X_9 is the Level of farming, and μi is the Stochastic error term.

3. RESULTS

3.1. Descriptive Analysis

Table 1 shows the socio-demographic characteristics of yam farmers under the taungya agroforestry system. The study revealed that the middle-aged group of 31-40 years was the dominant age group in the study. This is evident that yam production under taungya agroforestry is an energy-demanding venture to have involved people belonging to this age group. The study also revealed that 95% of the respondents were male while 5% were female. This revealed that there are more males in yam production than females. The majority of the respondents (63.80%) are Muslims followed by Christians (35%) while traditional worshippers account for 1% of the yam farmers in the study area (see **Table 1**).

The study also revealed that 76.30% of the respondents are married, forming the majority; 8.80% single, 7.50% divorced and 7.50% widowed. The majority of the respondents (66.30%) are farmers by primary occupation and engagement while others take yam production as a secondary business. Also, 66.30% of the respondents have a household size between 4-6people while 17.50% and 16.30% have household sizes between 1-3 and 7-9 people respectively (see **Table 1**). In addition, all the respondents had at least primary education but the majority of the respondents have secondary education (56.30%). This is an indication that all respondents are knowledgeable enough to give the appropriate aid needed for this research. The majority of the respondents have between 1 and to 3years of experience while 38.8% have more than 3 years of experience in yam production under the taungya agroforestry system. In **Table 1**, 79% of respondents indicated that 98.80% have farm sizes between 1-5 hectares while 1.20% have greater than 5 hectares of land for yam production. This indicates that yam is produced on a large scale for commercial production and as a cast crop (see **Table 1**).

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Table 1. Descriptive analysis of yam farmers' socio-economic characteristics.

Variables	Frequency	Percentage
AGE (years)		
20-30	11	13-80
31-40	35	43-80
41-50	25	31-30
>50	09	11-30
Total	80	100.0
GENDER		
Male	76	95.00
Female	04	5.00
Total	80	100.0
RELIGION		
Christianity	28	35.00
Islam	51	63.80
Traditional	01	1.30
Total	80	100.00
MARITAL STATUS		
Single	07	8.80
Married	61	76.30
Divorced	06	7.50
Widowed	06	7.50
Total	80	100.00
MAJOR OCCUPATION		
Farming	53	66.30
Civil Servant	08	10.00
Trader	19	23.80
Total	80	100.00
HOUSELHOD SIZE		
1-3	14	17.50
4-6	53	66.30
7-9	13	16.30
Total	80	100.00
LEVEL OF EDUCATION		
Primary	23	28.80
Secondary	45	56.30
Tertiary	12	15.00
Total	80	100.00
YEARS OF EXPERIENCE IN TAUNGYA		
1-3	49	61.30
4-6	10	12.50
7-9	12	15.00
>9	09	11.30
Total	80	100.00
FARM SIZE (Hectares)		
1-5	79	98.80
>5	01	1.20
Total	80	100.00
LEVEL OF FARMING		
Subsistence	07	8.80
Semi-commercial	62	77.50
Commercial	11	13.80
Total	80	100.00

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3.2. Cost Analysis

Table 2 revealed that transportation cost constituted the largest part of the variable cost followed by tillage cost. It was evident that the labor cost of carrying out these processes was outrageous. Machinery and associated costs accounted for the largest percentage under the fixed cost of production followed by the cost of land. Total revenue was due to sales of yam, firewood, and cashew nuts which implies that aside from returns from yam production, there are other sources of income for farmers who had practiced or are practicing the taungya agroforestry system.

The gross margin was ₦337,013.00, the net farm income was ₦327,479.73, and the return per naira invested was ₦2.69. Other financial measures included are operating ratio, fixed ratio, and gross ratio with 0.35, 0.02, and 0.37 respectively. These results revealed that yam production under the taungya agroforestry system is profitable despite the production challenges encountered by the farmers.

Table 2. Cost and return analysis.

Items of Cost	Value (₦/Ha)	Percentage
Tillage cost	42,550.00	22.02
Yam setts	17,589.00	9.10
Tree seeds/seedlings	0.00	0.00
Fertilizer cost	20,275.00	10.49
Weeding	12,487.50	6.46
Staking	4,881.25	2.52
Harvesting	30,187.50	15.62
Transportation	44,687.50	23.12
Total Variable Costs	183,730.75	100.0
Fixed Costs		
Land	4308.91	2.23
Implements/machineries	5224.36	2.70
Total fixed cost	9,533.27	
Total Cost = (TUC + TFC)	193,264.02	100.00
Return		
Yam sales	512,812.50	
Fuel wood sales	3,456.25	
Cashew nut sales	4,475.00	
Total Returns (TR)	520,743.75	
Gross Margin (TR-TVC)	337,013.00	
Net Farm Income (TR-TC)	327,479.73	
Return Per Naira Invested (TR/TC)	2.69	
Operating Ration OR=TVC/TR	0.35	
Fixed Ratio FR=TFC/TR	0.02	
Gross Ratio GR=TC/TR	0.37	

3.3. Yam Output Determinates Under Taungya Agroforestry

The estimated parameters and the relevant statistical test results obtained from the analysis are presented in **Table 3**. It had an adjusted R2 value of 0.631. This implies that about 63.1% of the variation in (Y) is accounted for by the variables ($X_1 – X_9$) included in the model while the remaining 36.9% is a result of the non-inclusion of other explanatory variables in the model. The F-value is positive and statistically significant at 0.01 indicating that the

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variables included in the model adequately explain the net income in the study area (see **Table 3**).

Out of the 9 variables modeled, only the presence of trees on farmland, household size and years of experience in the taungya agroforestry system, farm size, and level of farming are statistically significant in determining the output of yam in the study area. This implies that the significant variables have a positive relationship with yam output and experience, household size, farm size and level of farming will increase the output of the respondents in the study area.

Table 3. Regression analysis of yam production output under Taungya Agroforestry.

Variables	Coefficients	T	Sig.
(Constant)	438,089.48	2.198	0.031
Age	-0.320	-1.884	0.064
Gender	-0.043	-0.322	0.749
Presence of trees on farm	-0.059	-0.399	0.011
Major Occupation	0.064	0.520	0.104
Household size	0.130*	0.858	0.039
Education level	-0.118	-0.980	0.331
Years of experience in Taungya	0.088*	0.656	0.338
Farm size	-0.090*	-0.757	0.043
Level of farming	0.145*	1.192	0.021
F	1.171		
R Square	0.631		
Adjusted R Square	0.190		

4. DISCUSSION

This section discusses the socio-economic characteristics of the farmers which are known to influence resource productivity and returns on the farms. The summary of the demographic and socio-economic variables considered includes age, gender of farmers, household size, marital status, years of farming, and level of education. The study revealed that the middle-aged group 31-40 years was the dominant age group in the study and this implies that the farmers were still in their active age which could result in a positive effect on production. The result agrees with the findings of Idumah and Owombo (2019) who observed that farmers' age has a great influence on yam production with younger farmers producing more than the old ones possibly because of their flexibility to new ideas and risk (Akingbile *et al*., 2007).

The study also revealed that all the respondents had at least primary education but the majority had secondary education (56.30%). Formal education has a positive influence on the acquisition and utilization of information on improved technology by the farmers.

This study shows how profitable yam production is under taungya agroforestry. The gross margin was ₦337,013.00, the net farm income was ₦327,479.73, and the return per naira invested was ₦2.69. Other financial measures included are operating ratio, fixed ratio, and gross ratio with 0.35, 0.02, and 0.37 respectively.

Total revenue was due to sales of yam, firewood, and cashew nuts which implies that aside from returns from yam production, there are other sources of income for farmers who had practiced or are practicing the taungya agroforestry system. This agrees with literature who opined that taungya systems in Nigeria have directly provided enough food for about 900,000

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people, constituting about 1 percent of the country's food needs and also sales of surplus to the community which serves as a source of income to the farmers (Reuben & Barau, 2012).

5. CONCLUSION

This study examined yam production under taungya agroforestry in Oyo Local Government Areas of Oyo State. The study was based on primary data obtained in a cross-section survey of 80 rural farm households drawn by multi-stage random sampling across farming communities in the study area. Trained enumerators, who personally administered questionnaires/interview schedules, were employed in collecting the study data.

The findings of this study revealed that there was a positive relationship between the presence of trees on farmland, experience, household size, farm size, and level of farming, and the total output of the respondents in the study area.

It can however be concluded from the findings of this study that yam production under the taungya agroforestry system is profitable despite production challenges encountered by the farmers and that taungya agroforestry helps in minimizing the cost of production.

Based on the results of this research the following policy measures, as suggested below would assist yam farmers immensely:

(i) Provision of commodity exchange arrangement that will see to the regulation of yam market price. Also, the board will be able to enact laws that would guide proper marketing of yam.
(ii) Provision of basic infrastructural amenities such as good roads that lead to the farm gate, which would reduce the cost of transportation and facilitate easy access to the farms and farming households.
(iii) Also, loans should be granted to farmers to enable them to be more efficient and effective in the production business.
(iv) The government should help to provide tree seeds and seedlings to farmers.
(v) Lastly, there should be enactment of laws that guide against illegal land tenure systems.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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