ECONOMIC EFFICIENCY AND INCOME EARNING POTENTIALS OF AGROFORESTRY FARMING SYSTEMS IN OGUN STATE, NIGERIA

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ABSTRACT

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This article investigated the economic efficiency and costs and returns on agroforestry and non-agroforestry farming systems in Ogun State. Primary data were collected from farmers that practiced agro-forestry and those that did not (those into arable crop production without integrating agroforestry) with the aid of interview guide. Descriptive statistics, budgetary techniques and data envelope non-parametric analytical tool were used for data analyses. The mean age of farmers that practice agroforestry and non-agroforestry farming was 41 and 46 years respectively, with more that more than 70% having access to formal education. The respective estimated economic efficiencies for agroforestry and non-agroforestry farmers is below unity, the maximum attainable level of economic efficiency. Although the returns to production (gross margin) of agroforestry and non-agro forestry farming systems are positive, the gross-margin of agroforestry farmers was significantly ($p<0.01$) higher than that of the non-agroforestry. It can be concluded that even though agroforestry farming practice is yet to achieve the highest level of economic efficiency, it can be a better option for raising farmers' earnings (income) than non-agroforestry farming systems in the study area.

Keywords*: Agroforestry, economic efficiency, farm earnings, crop production*

INTRODUCTION

Agricultural food production in Nigeria has not increased at the rate that can meet with the food demands of the population (Metu *et al*., 2016). Among the challenges facing food production and agricultural sustainability is the level of participation in agriculture, returns associated with farming and the environmental compatibility of various agricultural techniques. Agriculture is a fundamental instrument for sustainable development, poverty alleviation and enhanced food security in developing countries. It is a vital development tool for reducing the number of people suffering from extreme poverty and hunger. Despite the extensive role of the oil sector (World Bank, 2008), the agricultural sector still play a significant role in the Nigerian economy. In Africa, agriculture is a potent option for spurring growth and overcoming poverty. High agricultural productivity is imperative in stimulating growth in other sectors of the economy, the farming systems adopted by farmers is of interest, because it contributes to agricultural sustainability and human welfare. Farmers have shown great ingenuity in developing traditional farming practices to meet local needs and minimize risks. Among the farming techniques employ is Taungya farming, an agroforestry practice which has the potential of increasing food security than the Non-Taungya farming (Bashir *et al*., 2006). Agroforestry intentionally combines agriculture and forestry to create an integrated and sustainable land-use system which takes advantage of the interactive benefits from combining trees and shrubs with crops and/or livestock (Nair, 1993). The agroforestry production systems involve integration of trees and other large woody perennials into farming systems through the conservation of existing trees, active planting and tending, or the tolerance of spontaneous tree re-growth.

In Taungya farming, short duration crops are grown in the early years of the plantation of a woody perennials species in order to utilize the land in the control of weeds, reduce establishment costs, generate early and stimulate the development of the woody perennials species (Ehiagbonare, 2006; Edberg, 2015). Alley cropping is another form of agroforestry which involve the planting of rows of trees or shrubs (single or multiple) with wide spacing thus creating alleyways within which agricultural crops or horticultural crops are produced. The improvement in vegetative cover through agroforestry in the form of contour hedgerows is reported to be an appropriate innovation for reducing soil erosion on sloppy lands (Fujisaka, 1997). Complimentary, supplementary and competitive interactions exist between tress and crops in agroforestry and higher crop yields have been obtained when some agricultural crops are inter-planted near leguminous trees such as *Faidherbia albida*-Acacia (FAO, 1994). Taungya plantation development has been identified an agricultural practice that helps in meeting the wood demand by countries, with the rate of forest cover loss remains high at 1.7 percent per year since 1990 (FAO, 2000). In a study on costs and return under agroforestry farming (Adesiyan and Olagunju, 2007), it was observed that the farming practice was profitable when compared to the traditional slash and burn system. In Africa, poor functioning capital market, poor production technology, low income distribution have discouraged farmers, which have made them to leave farming for other occupations and this had grossly affected agricultural production over years and contributed to the gap between food demand and supply. Considering the return and higher crop yield associated with the cultivation of some crops under agroforestry system that has the ability of replenishing soil nutrient in the course of cultivation, there is tendency of making more income by farmer, thereby promoting agricultural investment and spurring growth in the economy. Against this background, the study attempts to estimate the cost and return associated with agroforestry and non-agroforestry farms, as well as economic efficiency of agroforestry and non-agroforestry farming.

MATERIALS AND METHODS

The study area

This study was conducted in three randomly selected forest reserves communities in Ogun State. The forest reserves are Omo, Aworo and Ohumbe forest. Omo forest reserve (OFR) is the largest forest reserve in Ogun State, Nigeria (Farinola *et al*., 2014) covering a land area of approximately 136,806 hectares. Aworo and Ohumbe forest reserves are located in Yewa North Local Government Area (LGA) and covers approximately 21,299 and 4,608 hectares respectively with the presence of both disturbed and undisturbed natural forest types. Most farmers in the study area are involved in agroforestry.

Sampling procedure and data collection

A multi stage sampling technique was used to select 240 farmers, comprising those that practiced agroforestry (120) and non-agroforestry (120). The first stage was a random selection of three forest reserves out of nine forest reserves in Ogun State (Faleyimu *et al*., 2013). The second stage featured a simple random selection of four villages from each of the selected forest communities to make a total of 12 villages. The third stage was a simple random selection of 10 farmers that embraced agroforestry from the list of farmers to which agroforestry has been introduced in each of the selected villages. The list was compiled with the assistance of forestry officers covering the study area. In addition to these, 10 farmers that do not practice agroforestry were also identified by snowball sampling from each of the selected forest villages. The process yielded a total of 120 agroforestry farmers and 120 Non-Agroforestry farmers that combined to form the study sample of 240 farmers. Primary data were used for this study. This involves data on socio-economic characteristics of the farmers, resource use and outputs as well as their agroforestry related activities. The data were collected with the aid of questionnaire as interview guide.

Analytical tools and model specification

Descriptive statistics, budgetary analysis, Student t-test and data envelope analysis were used for data analysis.

Budgetary analysis

Budgetary technique was used to estimate the profit earning potentials (gross margin) of agroforestry and non-agroforestry farms in the study area. The gross margin (GM) associated with an average agroforestry or non-agroforestry farm was calculated as shown in equation 1 and as the difference between the total revenue (TR) per hectare and the total variable cost (TVC) per hectare.

GM= TR-TVC

$GM = P_{ij}Q - C_{ij}X$

Where

i – Represent either agroforestry or non-agroforestry farmer

j – Represent individual farmer

P- Price of a particular farm output

C- Cost of input

X- Input Quantity

Q= Output quantity

Test of difference of means (independent sample t-test)

The difference of mean analysis was used to test the significant difference between the gross margin associated with agroforestry and non-agroforestry farm in the study area. The test statistic (t-test) was computed as follows:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\left(\frac{\partial_1^2}{n_1} + \frac{\partial_2^2}{n2}\right)}}$$

Where,

$\bar{X}_1$= Mean gross margin per hectare of agroforestry farms

$\bar{X}_2$= Mean gross margin per hectare of non agroforestry farms

∂_1^2= Sample estimate of the population variance of the test variable for agroforestry farms

∂_2^2= Sample estimate of the population variance of the test variable for non-agroforestry farms

n_1= sample size of agroforestry farm

n_2= sample size of agroforestry farm

Economic Efficiency (Data envelopment analysis)

Following Coelli (1995), Fletscher and Zepeda (2002), Coelli *et al*. (2005) and Wu and Prato (2006), in a data envelopment analysis, the Economic Efficiency (EE) score for a given field m (which in this study could either be agroforestry or non-agroforestry system) is obtained by first solving the cost minimizing linear programming model stated as:

$$Objective\ function = MC_m = Min_{\lambda_i X^*_{mj}} \sum_{j=1}^{J} P_{mj} X^*_{mj}$$

Subject to:

$$\sum_{i=1}^{I} \lambda_i X_{ij} - X^*_{mj} \le 0$$

$$\sum_{i=1}^{I} \lambda_i Y_{ik} - Y_{mk} \ge 0$$

$$\sum_{i=1}^{I} \lambda_i = 1$$

$$\lambda_i \ge 0$$

where MC_m is the minimum total cost for field m; P_{mj} is the price for input j on field m; and X^*_{mj} is the cost minimizing quantity of input j on field m (agroforestry or non-agroforestry) given its input price and output levels. The cost minimizing input level is estimated via the linear programming model. λ_i = the nonnegative weights for I fields. The constraint $\sum_{i=1}^{I} \lambda_i = 1$ helps to ascertain that the minimum total costs of production for the field are estimated under the assumption of variable return to scale (Fletscher and Zepeda, 2002; Wu and Prato, 2006). X_{ij} = the amount of input j utilized on field i; X_{mj} = the amount of input j used on field m. Y_{ik} is the amount of output k produced on field I; and Y_{mk} is the amount of output k generated on field m. Having obtained the cost minimizing The Economic efficiency (EE_m) for each field (agroforestry or non-agroforestry system) is then estimated using the following equation:

$$EE_m = \frac{\sum_{j=1}^{J} P_{mj} X^*_{mj}}{\sum_{j=1}^{J} P_{mj} X_{mj}}$$

The main component of the farm output are food crops, forest products and livestock while that of farm inputs are household labour, hired labour, agrochemicals, land size and planting materials. For a given farmer, food crops comprises of at least one of groundnut, beans, melon, palm oil, cocoa, rubber, cassava, yam, coconut, plantain, tomato and pepper, other activities wages, firewood, game, income from off farm activities, timber and others. Planting materials = sum of planting material cost / unit cost of maize) agrochemicals = (Sum of the cost of agrochemicals / Unit cost of herbicide).

RESULTS AND DISCUSSION

Socio-demographic characteristics of farmers

The results of the socio-demographic characteristics of agroforestry and non-agroforestry farmers are presented in Table 1. The mean age for non-agroforestry and agroforestry farmers is was 41 years and 46 years respectively. This implies that most of the farmers are still within their productive and economic active age and may be able to leverage of this to increase farm production (Oluwatusin and Shittu, 2014). Most of the farmers (60%) are males. Approximately 90% of the farmers are also married. The high percentage of married farmers may translate to a larger household size which could induce supply of household labour for farm production. The study revealed that more than 70% of the farmers have access to formal education with more than 20% attaining secondary school education and above. This is consistent with Idumah *et al.* (2014) in their work among farmers practicing agroforestry in Edo State, Nigeria. Generally, higher formal education is expected to increase farm output and productivity by enhancing ability to understand, evaluate and apply new production technologies or better farm practices (Okpachu *et al*., 2014).

The mean farm size of non-agroforestry farmers and agroforestry farmers were 2.4 ha and 3.37 ha respectively, indicating that most of the farmers in the study area are small scale farmers and it supports the work of (Mbanasor and Obioha, 2003).

Table 1: Distribution of farmers by socio-demographic characteristics

Variable	Non-Agroforestry		Agroforestry	
	Frequency	Percentage	Percentage	Percentage
Age group (Years)				
Below 40	30	25.00	22	18.33
41-60	72	60.00	76	63.33
Above 60	18	15.00	22	18.33
Mean	41		46	
Sex				
Male	69	57.50	74	61.67
Female	51	42.50	46	38.33
Marital status				
Married	110	91.67	105	87.50
Single	6	5.00	6	5.00
Widowed	4	3.33	9	7.50
Educational level				
Non Formal	32	24.40	34	28.33
Primary	56	43.90	59	49.17
Secondary	29	26.70	26	21.67
Tertiary	3	5.00	1	0.83
Farm size				
below 4	105	87.50	94	78.33
4-6	13	10.83	24	20.00
Above 6	2	1.67	2	1.67
Mean	2.4		3.37	
Total	120	100.0	120	100.0

Source: Field survey, 2014

Costs and returns of non-agroforestry and agroforestry farmers

The costs and returns associated with non-agroforestry and agroforestry farmers are presented in Table 2. The results showed that the estimated total variable cost for an average farmer per hectare for non-agroforestry and agroforestry farms was ₦91, 639.46 and ₦53, 616.52 while the total revenue per hectare was ₦209, 881.26 and ₦288, 349.28 for non-agroforestry and agroforestry farms respectively. The estimated gross margin was also ₦118, 187.80 and ₦234, 732.76 respectively. Although the positive gross margins are indicative of some profit earning potentials from the two farm systems, the test of difference of means show that the realized gross margin from agroforestry system is significantly higher than that of non-agroforestry system, suggesting that agroforestry system is potentially more profitable than non-agroforestry system. This finding is similar to Ekwugha (2016) who reported greater income earning capability for agroforestry system in Southeastern Nigeria.

Table 2: Costs and return analysis for agroforestry and non-agroforestry farm systems

Description	Non-agroforestry (₦ ha^{-1})	Agroforestry(₦ ha^{-1})
Sales of food crops (₦)	209,881.26	134,512.85
Sales of tree crops (₦)		93,781.90
Sales of forest products (₦)		60,054.53
Total revenue	209,881.26	288,349.28
Variable cost items		
Cost of planting material	21,111.11	15,069.24
cost of hiring tractor	12,500.00	
Cost of agrochemicals	27,484.70	16,822.81
Labour cost	27,000.88	19,295.98
Annual cost of leasing land	3,596.77	2,428.49
Total variable cost (₦)	91,693.46	53,616.52
Gross margin (₦)	118,187.80	234,732.76
$t_{(0.05)}$	6.69**	

Source: Field Survey Data, 2014. **=Significant at 5%

Economic efficiency of non-agroforestry and agroforestry farmers

The distributions of the non-agroforestry and agroforestry farmers based on their estimated results of the economic efficiencies are presented in Table 3. The results showed that 53.3% of Non-Agroforestry and 44.2% of agroforestry farmers have economic efficiency between 0.51 - 0.8. The mean economic efficiency for agroforestry farms is 0.599 and that of non-agroforestry farms is 0.526. The import of these findings is that both agroforestry and non-agroforestry farmers still have some spaces to allocate resources to enhance farm production and their levels of economic efficiencies since the estimated efficiencies values are still below unity.

Table 3: Economic efficiency of agroforestry and non-agroforestry farmers

	Non-agroforestry		Agroforestry	
	Frequency	Percentage	Frequency	Percentage
below 0.5	48	40.00	48	40.00
0.51-0.8	64	53.33	53	44.17
0.81-1.0	8	6.67	19	15.83
Total	120	100.0	120	
Mean	0.526		0.599	

Source: Field Survey, 2014.

CONCLUSION

The study examined the economic efficiency and costs and return of agroforestry and non-agroforestry farming systems in Ogun State. The majority of the farmers practicing agroforestry and non-agroforestry farming are in their productive age, with fairly high level of formal education. We found that although agroforestry farming practice is yet to be attain the highest level of efficiency in terms of economic performance, all the same, it is a better system of increasing farmers' income compared to non-agroforestry system.

REFERENCES

Adebola, O., Jimoh, S. and Agera, S. 2011. Agricultural productivity under Taungya and non Taungya land use options: a case study in Nigeria. International J*ournal of Biology and Chemistry Science* 5(6): 2343-2350.

Adesiyan, I., Olagunju, F. and Salako, B. 2007. Comparative study of taungya system and alley cropping. *Journal of Social Sciences* 4(2):261-265

Bashir, J. and Eyasu, E. 2006. Role of Agroforestry in improving food Security and Natural Resource Management in dry-lands: a Regional Overview. *Journal of Dry-lands, 1(2):206-211*

Coelli, T. J. 1995. Recent developments in frontier modeling and efficiency measurement. *Australian Journal of Agricultural Economics* 39:219-245.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J. and Battese, G. E. 2005 .An introduction to efficiency and productivity analysis. Second edition. New York: Springer Science and Business Media, Inc.

Edberg, S. 2015. Commercial eucalyptus plantations with taungya system in Lao PDR: analysis of tree root biomass. MSc Thesis in Forest Management, Swedish University of Agricultural Sciences

Ehiagbonare, J. E. 2006. Effect of taungya on regeneration of endemic forest tree species in Nigeria: Edo State Nigeria as a case study. *African Journal of Biotechnology* 5 (18):1608-1611

Ekwugha, U. E. 2016. Impacts of Agroforestry technologies on watershed management in Imo State, Southeastern Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 12(1):12-16

Faleyimu, O. I., Agbeja, B. O. and Akinyemi, O. 2013 State of forest regeneration in Southwest Nigeria. African Journal of Agricultural Research 8(26): 3381- 3383

FAO. 2000. Global forest resources assessment main report. FAO Forestry Paper 140: 479

FAO. 1994. Tropical soybeans: an improvement and production. Plant production and protection series; No 27, Rome

Farinola, L. A., Famuyide, O. O., Nosiru, M. O. and Ogunsola, A. J. 2014. Survey of identified non timber forest products and their role in the rural livelihood of inhabitants of Omo forest reserve, Ogun State. *International Journal of Agriculture and Forestry*, 4(4): 317- 324

Fletschner, D. K. and Zepeda, L. 2002. Efficiency of small landholders in eastern Paraguay. *Journal of Agricultural and Resource Economics* 27:554-572.

Fujisaka, S., 1997. Sense and nonsense: contour hedgerows for soil conservation. *Agroforestry Forum*, 8 (4), 8–10.

Idumah, F. O., Owombo, P. T. and Ighodaro, U. B. 2014. Economics of yam production under agroforestry system in Sapoba forest area, Edo State, Nigeria *International Journal of Agriculture and Forestry* 2014, 4(6): 440-445

Kesseba A. 1993. Strategies for developing a viable and sustainable agricultural sector in sub-Saharan Africa: Some issues and options. In: Technologies for sustainable agriculture in the tropics. ASA, Madison, Wisconsin, USA, pp. 21 1-243.

Mbanasor, J. and Obioha, L. 2003. Resource productivity under fadamas cropping system in Umuahia north local government area of Abia State, Nigeria. *Journal of Subtropical Agro-ecosystem*, 2(2):81-86

Metu, A. G., Okeyika, K. O. and Maduka, O. D. 2016 .Achieving sustainable food security in Nigeria: challenges and way forward. 3rd international conference on African development issues (CU-ICADI 2016). Covenant University Press

Nair, P. K. R. 1993. An introduction to agroforestry. The Netherlands. Kluwer Academic Publishers

Oluwatusin, F. and Shittu, G. 2014. Effect of socio-economic characteristics on the farm productivity performance of yam farmers in Nigeria. *Research on Humanities and Social Sciences* 4(6):31-37

Onyenweaku, C. E. and Okoye B. C. 2007.Technical efficiency of small holder cocoyam farmers in Anambra State, Nigeria. A translog stochastic frontier production function approach. *International Journal of Agriculture and Rural Development*, 9: 1-6

World Bank, 2008. World development report 2008: Agriculture for development. The World Bank, Washington, DC.

Wu, S. and Prato, T. 2006. Cost efficiency and scope economies of crop and livestock farms in Missouri. *Journal of Agricultural and Applied Economics* 38:539-553.