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ECONOMIC EVALUATION OF SOURSOP FRUIT BASED AGROFORESTRY SYSTEMS ESTABLISHED IN FORESTRY RESEARCH INSTITUTE OF NIGERIA (FRIN), IBADAN

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ABSTRACT

Agroforestry has been extensively publicized to diversify farm produce, enhance livelihood and environmental sustainability. However, smallholder farmers are reluctant to engage in such practices due to the long gestation period of the trees and their negative effects on the annual crops when the canopy closes. Intercropping plays a significant role in tree production by smallholder farmers. This study therefore, evaluated the economics of soursop fruit based agroforestry systems established in Forestry Research Institute of Nigeria (FRIN). The treatment consisted of soursop planted as sole crop, soursop intercrop with pineapple and soursop intercrop with corn. The experiment was a 3x3 factorial arranged in Completely Randomized Design (CRD) and replicated three (3) times. Data were collected on the yield and the cost and returns of each plot. Data were analysed using budgeting techniques. The test of differences was achieved using analysis of variance. The result obtained indicated that the revenue from soursop intercrop with pineapple (₦2,539,790/ha) was significantly higher ($P<0.01$) compared to sole cropping (₦1,320,000)/ha) and soursop intercrop with corn (₦1,45388/ha). Similarly, the Gross Margin (₦1,653,490/ha) estimated for soursop-pineapple intercrop was significantly higher ($P<0.01$) compared to other two treatments. The rate of return on investments was 1.42, 1.86 and 0.68 for soursp sole cropping, soursop intercrop with pineapple and soursop intercrop with corn respectively. The study therefore, concluded that the agroforestry based system is viable and gives positive returns on investment and can therefore be recommended for the poor resource farmers. Also, its adoption and practice on a large scale can enhance food security and improve the livelihood of the populace.

Keywords: Soursop, Agroforestry system, pineapple, maize, intercropping, gross margin

Introduction

In Nigeria, smallholder farmers may not want to engage in tree planting due to the long term gain involved in timber production as a result of the protracted gestation period and the underutilized vast inter row spacing of such trees (Anegbeh *et al*., 2017). Planting of timber trees in association with light demanding crops often leads to a drastic

suppression in crop production as a result of competition for both above and below ground resources. Therefore, concerns have been raised over the sustainability and suitability of tree farming for resource-poor farmers. However, different techniques and tending operations are being developed for annual intercrops and tree growth improvement (Bertomeu and Roshetko, 2007).

Intercropping reduces weeding cost in tree plantation establishment. The cropped alleys between the tree lines function as effective firebreaks (Bertomeu and Roshetko, 2007). Branch pruning effectively reduces light interception by the tree canopy, and thus prolong the number of years that annual crop production can be practiced (Bertomeu and Roshetko, 2007). Intensive pruning even though helps maximize crop yield but it is incompatible with commercial timber production because the growth rate and quality of the over storey timber trees are severely reduced (Bertomeu and Roshetko, 2007; Saptoro and Ernawati, 2001). There is therefore the need for complementary and/or alternative practices or technologies such as inclusion of integrated cropping systems into such Agroforestry tree based systems**.**

At the Forestry Research Institute of Nigeria (FRIN), Agroforestry systems were developed through the integration of economically important tree species into crop farming systems. The incorporation of such diverse variety of trees into agricultural systems will help increase crop productivity, food security and the incomes of smallholder farmers as well as improve nutrition, health and sustainable livelihood especially among the rural poor farmers. Such fruit trees include *Mangnifera indica, Chrysophyllum albidum, Annona muricata, Irvingia wombulu, Parkia biglobosa*; fruit crops like pineapple, plantain and annual crops like maize and cassava that have been proved to have the highest potential of reducing poverty in Nigeria (IFAD, 2010; Aminu and Okeowo, 2016). The objectives of this study were to determine the productivity of the integration of fruit crop (Pineapple) intercropped with maize in an *Annona muricata* fruit tree based Agroforestry systems and to evaluate the viability and gross margin of such mixed cropping practices.

Several benefits varying from food security, nutritional, medicinal, environmental to livelihood sustainability are being attributed to Agroforestry practices. However, farmers are reluctant to engage in Agroforestry practices due to the aforementioned reasons in the first paragraph of the introduction. There is therefore the need to develop profitable, sustainable and economical Agroforestry systems for resource-poor farmers using fruit trees due to their nutritional, medicinal and economic importance. Inclusion of such complementary and/or alternative practices or technologies will help maximize and enhance the productivity, sustainability and profitability of the various components of the tree based Agroforestry systems.

Materials and Methods

Study area

The experiment was conducted in Forestry Research Institute of Nigeria, Ibadan. The Institute is located on the longitude 07°23'18"N to 07 ° 23'43"N and latitude 03 ° 51'20"E to 03 ° 51'43"E.

Preparation of the experimental site and planting procedure

Recognisance Survey of the land was carried out in March, 2017. Land preparation practices such as stumping, cutting, clearing of shrubs and packing of the debris were done

in the second week of the month. Lining out, pegging and digging activities were also carried out manually. The experimental was a 3x3 factorial consisting of three treatments (soursop sole cropping, soursop intercrop with pineapple and soursop intercrop with maize) and three replicates arranged in Completely Randomized Design (CRD) giving a total number of nine plots. Grafted *Annona muricata* (Soursop) seedlings were used to reduce gestation periods and planted at 6m by 6m. In May, suckers of pineapple (Sweet cayenne) were purchased and planted at spacing of 1.5m by 1.5m in the alleys of the Soursop seedlings. Early maturing maize variety seeds (BR 9928DMR SR-Y) collected from International Institute of Tropical Agriculture (IITA), Ibadan were planted at 50cm within and between rows of the pineapple stands. Maize plants were thinned to 2 plants per stand at 2 weeks after planting.

Maintenance and Management of the Experimental Plots

Proper maintenance activities such as pest control, weeding and fertilizer applications were carried out to ensure optimum output. Pest control exercise was carried out on corn thrice to prevent the invading insects, also, DD Force and Cypermethrin (insecticides) were applied periodically to the soursop trees. In the second year, maize was again planted on the existing soursop and pineapple plot. Both manual and chemical weeding activities were carried out when necessary using selective herbicides (Atrazine and Diuron).

Organic fertilizer, DI Growth (N2.35%, P4.44%, K1.75%); a foliar organic fertilizer was applied to the trees and pineapple at the appropriate time to enhance their productivity. Compound fertilizer (NPK 15-15-15) at the recommended rate of 60 kg N/ha, 60 kg P_2 O_5 /ha and 60 kg K2O/ha was applied at 3 WAP and Urea, (46:0%N) was applied at the rate of 60 kg N /ha at 6 WAP as side dress to maize plants.

Data Collection

Data were collected on the yield of the three crops. The fruits and the maize cobs were harvested at maturity and sold. Soursop fruit was sold at ₦500 per kg, pineapple was sold at ₦150 per kg and maize were sold at ₦20 per cob. Data was also collected on the cost and returns of each plot.

Analytical technique

Gross margin analysis was carried out to determine the gross margin from the soursop sole cropping, soursop intercropped with maize and pineapple.

GM = TR – TVC

Where;

GM = Gross margin,
TR = Total revenue and
TVC = Total variable cost.

Test of significant of the variables such as total revenue, gross margin and rate of return were achieved using one way analysis of variance.

Results and Discussion

Cost and Returns of soursop production

The results presented in Table 1 reveals the estimate obtains from soursop farm established in the study area. The total quantity of soursop harvested was 2640 kg/hectare This quantity was less than the expected average yield of 5000 to 8000kg/ha reported by Tripathi *et al*. (2014). The Total revenue and total cost of production were ₦1,320,000 and ₦544100 respectively. The estimated gross margin was ₦775900. The

positive gross margin value is an indication that soursop farming is a veritable venture. The rate of return on investment was 1.42. This is the ratio of gross margin and total variable cost. The implication of this is that for every naira invested in soursop farm, one naira forty-two kobo will be realized

Table 1: Cost and returns analysis of a hectare soursop sole cropping system

S/N	Items	Quantity	Unit price (₦)	Total (₦)
A	**REVENUE**			
	Revenue from soursop (kg)	2640	500	1,320,000
C	**VARIABLE COST**			
I	Land clearing(1ha)			
	Ploughing(1ha)	1	50,000	50,000
	Stumping(1ha)	1	30,000	30,000
	Total cost of land clearing			80,000
	Soursop seedling (unit)	278	200	55,600
Ii	Fertilizer			
	NPK (bag)	3	6,500	19,500
	Organic fertilizer (litre)	12	6,000	72,000
	Urea (bag)	1	7,000	7,000
	Total cost of fertilizer			98,500
iv	Herbicides/insecticide			
	Diuron (litre)	6	3,800	22,800
	Atrazin (litre)	6	1,200	7,200
	DDT insecticide	1	10,000	10,000
	Total cost of herbicides			40,000
V	Labour			
	Weeding (time)	3	30,000	90,000
	Harvesting (time)	3	20000	60000
	Herbicides and fertilizer application	6	20,000	120,000
	Total cost of labour			270000
D	**TOTAL VARIABLE COST**			**544100**
E	**GROSS MARGIN**			**775900**
F	**Rate of return**			**1.42**

Cost and Returns of soursop intercrop with pineapple

The results in Table 2 revealed that the total cost of producing soursop intercrop with pineapple in the study area is ₦886,300 while the total revenue from the sale of soursop and pineapple fruit was ₦2,539,790. The estimated gross margin was ₦1,653,490. This indicates that production of soursop with pineapple on the same plot is a good enterprise. This support the fact that agroforestry is a sustainable resource management that can provide stable incomes and other benefits to human welfare (Brown *et al.*, 2018). Abadi (2003) reported that alley

farming consisting of interacting tree with agricultural crops in the inter-rows can make a positive economic return. The estimated rate of return on investment was 1.86. This is the ratio of gross margin and total variable cost. The implication of this is that for every ₦1 invested in the production of soursop intercrop with pineapple, one naira eighty six kobo will be realized.

Table 2: Cost and return analysis of soursop intercrop with pineapple

S/N	Items	Quantity	Unit price (₦)	Total (₦)
A	**REVENUE**			
I	Revenue from pineapple (kg)	13,998.60	150	2,099,790
ii	Revenue from soursop (kg)	880	500	440,000
	Total Revenue			2,539,790
C	**VARIABLE COST**			
I	Land clearing			
	Ploughing	1	50,000	50,000
	Stumping	1	30,000	30,000
	Total cost of land clearing			80,000
Ii	Seed/seedling			
	Soursop seedling (unit)	278	200	55,600
	Pineapple sucker (unit)	4444	50	222,200
	Total cost of seed/seedling			277800
iii	Fertilizer			
	NPK (bag)	3	6,500	19,500
	Organic fertilizer (litre)	12	6,000	72,000
	Urea (bag)	1	7,000	7,000
	Total cost of fertilizer			98,500
Iv	Herbicides/insecticide			
	Diuron (litre)	6	3,800	22,800
	Atrazin (litre)	6	1,200	7,200
	DDT insecticide	1	10,000	10,000
	Total cost of herbicides			40,000
V	Labour			
	Weeding (time)	3	30,000	90,000
	Harvesting (time)	6	13000	180,000
	Herbicides and fertilizerd application	6	20,000	120,000
	Total cost of labour			390,000
D	**TOTAL VARIABLE COST**			**886,300**
E	**GROSS MARGIN**			**1,653,490**
F	**Rate of return on investment**			**1.86**

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Cost and Returns of soursop intercrop with maize

As shown in Table 3, the cost of producing soursop intercrop with maize include cost of land clearing, ploughing, stumping, cost of seedling, fertilizer, agrochemicals, weeding, harvesting and so on. The total cost incurred in the establishment of soursop-maize intercrop was ₦827,800 while the revenue was ₦1,453,880/hectare. The gross margin was ₦566,080/hectare. This implied that soursop intercropped with maize is profitable. The estimated rate of return was 0.68. This is the ratio of gross margin and total variable cost. This indicates that there is 68% return on the amount of initial investment.

Table 3: Cost and return analysis of soursop intercrop with maize

S/N	Items	Quantity	Unit price (₦)	Total (₦)
A	**REVENUE**			
I	Revenue from maize (cob)	6694	20	133,880
ii	Revenue from soursop (kg)	2420	500	132000
B	**TOTAL REVENUE**			**1,453,880**
C	**VARIABLE COST**			
i	Land clearing			
	Ploughing	1	50,000	50,000
	Stumping	1	30,000	30,000
	Total cost of land clearing			80,000
iii	Seed/seedling			
	Soursop seedling (unit)	278	200	55,600
	Maize seed (kg)	3	500	1,500
	Total cost of seed/seedling			279,300
iii	Fertilizer			
	NPK (bag)	3	6,500	19,500
	Organic fertilizer (litre)	12	6,000	72,000
	Urea (bag)	1	7,000	7,000
	Total cost of fertilizer			98,500
iv	Herbicides/insecticide			
	Diuron (litre)	6	3,800	22,800
	Atrazin (litre)	6	1,200	7,200
	DDT insecticide	1	10,000	10,000
	Total cost of herbicides			40,000
v	Labour			
	Weeding (time)	3	30,000	90,000
	Harvesting (time)	6	20,000	120,000
	Herbicides and fertilizerd application	6	20,000	120,000
	Total cost of labour			330,000

D	**TOTAL VARIABLE COST**	**827,800**
E	**GROSS MARGIN**	**566080**
F	**Rate of returns on investment**	**0.68**

Differences between costs and returns of soursop agroforestry farm

The results presented in Table 4 revealed a higher return (₦1653490) on soursop intercropped with pineapple. This indicates that multiple intercropping of crops with tree crop based systems generated more profits than sole cropping. This result is in agreement with Esekhade *et al*., (2003); Esekhade *et al*., (2014); Anegbeh *et al*., (2017), who also found that farmers made positive and higher returns on capital invested for different combinations of tree crops based cropping systems. Obasi *et al*., (2016) also reported that mixed farming is profitable farm enterprise that can give high productivity index value.

Table 4: Differences between costs and returns of soursop agroforestry farm

Variables	Sole cropping (soursop)	Soursop intercrop with pineapple	Soursop intercrop with maize	F-value	Remark
Total Revenue	13200000	2539790	1453880	15922.86	P<0.01
Total cost	544100	886300	827800	644.22	P<0.01
Gross Margin	775900	1653490	566080	9983.25	P<0.01
Rate of returns	1.42	1.86	0.68	5334.00	P<0.01

Conclusion and recommendation

From the results of this experiment, it can be concluded that the *Annona muricata* fruit based Agroforestry system with the mixed cropping practice is highly viable and gives positive returns on investment. The practice of intercropping is environmentally sustainable, reduces costs of inputs because the cost of production is borne by all the crops in the system. Adoption and practice of this system in a large scale can enhance food security and improve the livelihood of the populace, especially those in the rural areas whose livelihood is based primarily on farming and farming related activities. This study therefore, recommends adoption of agroforestry based cropping for improved livelihood among farmers.

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