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DETERMINANTS OF NET RETURNS TO AGROFORESTRY IN THE HUMID RAIN FOREST BELT OF NIGERIA

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ABSTRACT: *The study analyzed the determinants of net returns to agroforestry in the humid rainforest belt of Nigeria. The multi-stage random sampling technique was used in selecting the sample. The sample size comprised 120 agroforestry practitioners who were selected from the list provided by the staff of the Imo state Agricultural Development Programme (ADP). The results of the ordinary least squares multiple regression analysis showed that farm size, years of farming experience, tree crop density, educational attainment, extension contact, type of soil fertility replacement materials used, and farmers age are the major determinants of net returns to agroforestry practice in the state. It was suggested that co-operative farming and communal system of land use could significantly enhance participation in agroforestry in Imo State, Nigeria.*

KEYWORDS: Determinants, Net Returns, Agroforestry, Humid Rainforest, Nigeria

INTRODUCTION

Agricultural production till date remains the mainstay of the Nigerian economy. Over the years the sector has witnessed tremendous decline in its contribution to national development. This is evident in the high incidence of poverty among the rural populace. The reasons for this widespread poverty in Sub Sahara Africa including Nigeria is the destruction of the natural forest leading to environmental degradation and reduced productivity besides small farmers usually farm on degraded lands with complex and diverse farming systems (Owese, 2009). Consequently, population pressures, deforestation and bush burning, farming and other forms of land use (Ekwebalam and Onyenwotu, 1989) are the bane of Nigerian Agriculture. Regrettably, the recent global economic crisis has made it increasingly difficult to generate enough resources required for sustainable economic growth without exerting much pressure on natural resources to generate more income and produce more food for household consumption (Akinyemi et al., 2009). Yudelman (1987) further explained that the further deterioration of the resource base in much of Sub Saharan Africa including Nigeria threatens to reduce production. The forest area of Nigeria has diminished from above 60million hectares in the 1990's to the current value of about 9.6million hectares, a current annual estimate of forest loss is about 300,000 hectares per annum (NEST, 2004). Loss of forest biodiversity can result from fragmentation, overharvesting of plant and animal species and intensification of arable farmlands. For instance, the land devoted to food crops alone rose from 7.6million hectares in 1970 to 35.5 million hectares in 1995 (Agboola, 1987; FORMECU, 1995). The implication is that more forest lands are subjected to ever increasing pressure by subsistence farmers and herders. This quest for maximum food production

for the masses has exerted a negative impact on some of the forest cover through bush clearing and burning. Agroforestry is the deliberate incorporation of trees and woody species of plants into other types of agricultural activities. It is a concept of combining crops, animals and trees on the same piece of land as maximum land use practice (Beetz, 2002). The technique offers solution to land shortage, poverty, food insecurity and environmental degradation (Lipper, 2002). Again, agroforestry techniques are designed to provide tree and other crop products and at the same time protect, conserve, diversify and sustain vital economic, environmental and natural resources (Kings, 1987; Baumer, 1990; Hawkins et al., 1990; Nair, 1991, 1993).The place of agroforestry in the productivity, sustainability, adaptability, prevention of soil erosion, poverty alleviation and social stability protection has been widely researched (Akpan et .al., 2009; Nair, 1988; Nair, 1993; Kio, 2000). However, there is limited information on the determinants of net returns from agroforestry in the study area. In an attempt to close the gap, the study set out to achieve the following objectives:

Objectives of the study

The broad objective of the study was to evaluate the determinants of net returns to agroforestry in the humid rain forest belt of Nigeria with a view to developing strategies for sustainable ecological conservation in Nigeria. The specific objectives are:

(i) to examine and identify the socio-economic characteristics of agroforestry practitioners in Imo State, Nigeria

(ii) to ascertain the level of participation of households and communities in agroforestry in the area

(iii) to identify the types of agroforestry practiced, and the species and varieties of crops planted in the area

(iv) to determine and isolate the main determinants of net returns to agroforestry in the area.

MATERIALS AND METHODS

Imo state is located in the humid south-eastern region of Nigeria with a total land mass of 7,689 square kilometers (UNTC, 1998). The state has a population of 3,934,899 people (NPC, 2006). The occupation of the people is mainly agriculture. The system of land use in the state can be grouped into forest land, wood land and agricultural land. The state is made up of twenty seven (27) local government areas divided into three (3) major agricultural zones for administrative convenience. The three agricultural zones are Owerri, Orlu and Okigwe respectively. The multi-stage stratified random sampling technique was used in selecting the respondents. Firstly, two local government areas were randomly selected from each of the three agricultural zones of the state. This gave a total of six local government areas. In the second stage, two autonomous communities were randomly selected from each of the six selected local government areas, giving a total of twelve communities. Thirdly, ten agroforestry practitioners were selected randomly from each of the twelve communities thus giving a sample size of one hundred and twenty (120) farmers. The list of agroforestry practitioners in the area was supplied by staff of the Imo state agricultural development programme (ADP).

Data for the study were collected mainly from a primary source. The primary data were obtained using structured questionnaire which was administered to the selected farmers through oral interview.

Data were analyzed using descriptive statistical tools such as means, frequencies and percentages.

The ordinary least squares multiple linear regression was used to analyze the factors affecting the returns to agroforestry in the state. The estimated model is expressed as:

$Y_t = b_0 + b_1x_{1t} + b_2x_{2t} + \cdots + b_8x_{8t} + e_t$ eqn.1

Where,

Y_t = returns to agroforestry production (₦)
X_{1t} = age of farmers (years)
X_{2t} = farm size (Ha)
X_{3t} = years of farming experience (years)
X_{4t} = tree crop density (number of stands)
X_{5t} = educational attainment (years)
X_{6t} = household size (persons)
X_{7t} = extension contact (dummy 1=yes, 0=otherwise)
X_{8t} = type of soil fertility enhancing material used (dummy, 1=organic manure; 0=otherwise)
e_t= error term

Different functional forms of the model were estimated and the one that gave the best fit based on apriori expectations was selected as the lead equation and used for further analysis of the data.

The viability of agroforestry practice in the state was measured using farm financial analytical techniques such as benefit cost ratio (BCR) and net present value (NPV). These are specified below:

Benefit Cost Ratio (BCR) = $\frac{total\ discounted\ benefits}{total\ discounted\ costs}$ eqn.2

$= \frac{\sum_{i=1}^{n} B_n(1+i)^n}{\sum_{i=1}^{n} C_n(1+i)^n}$ Eqn. 3

$NPV = cashflow_o + cashflow_1\ [1/(1+i)^1] + cashflow_2[1/(1+i)^2] + \ldots + cashflow_n[1/(1+i)^n]$ eqn. 4

Since $cashflow_0$ is not affected by the variability of the discount factor, it is moved to the other side of the equation.

$$NPV = cashflow\left[\sum_{t=1}^{n} \frac{1}{(1+i)^t}\right] \quad \text{eqn.5}$$

The cashflow is the annual equivalent value (AEV) that is being calculated.

$$Cashflow = \frac{NPV}{\sum_{t=1}^{n} \frac{1}{(1+i)^t}} \quad \text{eqn.6}$$

Simplifying equation (5) further, we obtain the series of annual equivalent values of the investment as

$$AEV = \sum_{t=1}^{n} \frac{1}{(1+i)^t} = \frac{1}{i} - \frac{1}{i(1+i)^n} \quad \text{eqn.7}$$

Where,

BC R = Benefit Cost Ratio

NPV = Net Present Value
Cash flow$_n$ = Net income or net loss for the year "n"
Cash flow$_1$= Net income from the first full year of production.
i = Discount rate or the opportunity cost of investing.
n = Number of years included in the budget.
Similarly, the net returns to agroforestry in the state was estimated using the equations (8 to 10)

$$TR_i = \sum_{i=1}^{n} P_q Q \qquad \text{eqn.8}$$

$$TVC_i = \sum_{i=1}^{n} P_i X_i \qquad \text{eqn.9}$$

Where,

TR = Total Revenue generated
TVC = Total Variable costs
P_q = Unit price of output
Q = Quantity produced
X = Quantity of the variable input

Net Returns = TR_{ij} - (TVC + TFC) eqn.10
TFC = Total fixed costs

RESULTS AND DISCUSSION

Socio-economic characteristics respondents.

Table 1. Distribution of agroforestry practitioners according to socio-economic characteristics

Socio-economic characteristics	Frequency	Relative Frequency
Gender		
Male	95	79.16
Female	25	20.83
Age (Years)		
≤ 30	2	1.67
31 – 40	6	5.00
41 – 50	62	51.67
51 – 60	28	23.33
61 – 70	12	10
71 – 80	7	5.83
81 and above	3	2.50
Mean age = 51years		
Marital status		3.33
Single	4	91.67
Married	110	5.00
Widowed	6	

Household size (persons)		22.50
≤ 5	27	56.67
6 – 10	68	16.67
11 – 15	20	4.17
16 aand above	5	
Mean household size = 8persons		
Educational attainment (years**)**		
(0) no formal education	8	6.67
6 – 10	28	33.33
11 -15	72	60
16 and above	12	10
Mean years of formal education = 7		
Farm size (Ha)		
≤ 1.0	34	28.33
1.1 – 2.0	62	51.67
2.1 – 3.0	16	13.33
3.1 – 4.0	4	3.33
4.1 – 5.0	2	1.67
5.1 and above	2	1.67
Mean farm size = 1.4 hectares		
Years of farming experience		
≤ 10	40	33.33
11 – 20	64	53.33
21 – 30	8	6.67
31 – 40	6	5.00
41 and above	2	1.67
Mean years of farming experience = 14		
Total	120	

Source: Survey data, 2010

Table 1 shows the distribution of respondents according to socio-economic charateristics. The Table shows that 79.16% of the sampled agroforestry practitioners are males while 20.83% are females. This suggests the involvement of more males in agroforestry practice in the area. With respect to age, the Table further show that the majority 51.7% are within the age bracket of 41 – 50 years. The mean age was 51 years. This may indicate that agroforestry in the state is practiced more by active middle aged men and women who could adopt new techniques in agroforestry farming. This has implications for high productivity. Apart from increase in labour supply, resspondents within the productive age bracket are likely to adopt innovation more than the aged farmers (Onyenweaku and Okoye, 2007). The Table further show that about 91.67% of the respondents are married, 3.33% are single, while 5.00% of the rest are widows. It could be deduced from the analysis that married people do readily engage in agroforestry practice than unmarried people. Furthermore, the Table showed that about 67.6% of the respondents have household sizes that range between 6 – 10 persons. The mean household size was 8 persons. With regard to educational attainment, the study showed thaat the farmers had a minimum of seven years of formaal education, while the highest percentage had between 7 – 12 years of

education, suggesting that majority of the farmers had secondary education. The level of education of a person not only increases his farm productivity but also enhances his ability to understand and evaluate new production technologies (Obasi, 1991). In addition to the above, the study further showed that about 53.3% of the respondents had spent between 11 – 12 years in agroforestry farming. The mean years of agroforestry farming was 13.8 years. Finally, about 51.67% of the respondents have farm sizes that range between 1.1 – 2.0 hectares. The mean farm size was 1.67 hectares. This implies that agroforestry in Imo State is practiced on a small scale which could be due to the fragmented nature of farmlands in the area brought about by high population pressure (Henri-Ukoha et al, 2010).

Participation in agroforestry

Table 2. Distribution of respondents by level of participation in agroforestry

Forestry activities*	**High**	**Moderate**	**Low/mild**	**No participation**
Nursery management	11 (09)	31 (26)	28 (23)	52 (43)
Home gardens	36 (30)	40 (33)	19 (16)	25 (21)
Alley cropping	01 (01)	07 (06)	19 (16)	91 (76)
Multipurpose trees	13 (11)	25 (21)	23 (19)	59 (49)
Crops/trees in rotation	16 (13)	31 (26)	24 (20)	49 (41)
Improved fallow	13 (11)	29 (24)	25 (21)	53 (44)
Shelterbelts/windbrakes	10 (08)	24 (20)	31 (26)	55 (46)
Trees and hedgerows	13 (11)	13 (11)	13 (11)	79 (66)
Plantation crops	24 (20)	41 (34)	17 (14)	40 (33)
Trees as live fences	18 (15)	29 (24)	24 (20)	49 (41)
Farm woodlots	18 (15)	40 (33)	16 (13)	48 (40)

* multiple response n = 120
Figures in parenthesis are percentages
Source: Field survey data, 2010.

Table 2 shows the distribution of respondents by level of participation in agroforestry. The Table shows that (9%) of the respondents actively participated in the management of nurseries, 26% moderately participated in nursery management, 23% did not actively participate, while 43% do not manage nurseries. Similarly, 30% highly participated in home gardening, 33% moderately grew home gardens, and 16% did not actively grow home gardens, while 21% do not grow home gardens at all. The Table also shows that 1% highly participated in alley cropping, 6% moderately participated in alley cropping, and 16% mildly participated in alley cropping, while 76% did not participate in alley cropping. Furthermore, 11% of the respondents actively grew multipurpose trees, 21% moderately grew multipurpose trees, and 19% did not actively grow multipurpose trees, while 49% did not grow multipurpose trees at all. Also, 13% actively practiced crops and trees in rotation, 26% moderately practiced crops and trees in rotation; 20% did not practice crops and trees in rotation, while 41% did not practice crops and trees in rotation at all.

The Table also shows that 8% actively grew shelterbelts and windbreaks, 20% moderately grew shelterbelts and windbreaks, 11% did not actively grow shelterbelts and windbreaks, while 66%

of the respondents did not grow shelterbelts and windbreaks at all. Similarly, 20% of the respondents actively grew plantation crops, 34% moderately grew plantation crops, and 14% did not actively grow plantation crops, while 33% did not grow plantation crops at all. Furthermore, 15% actively grew trees as live fences, 24% moderately grew trees as live fences, and 20% of the respondents did not actively grow trees as live fences, while 41% did not grow trees as live fences at all. Finally, 15% of the respondents were highly involved in growing farm woodlots, 33% are moderately involved in growing farm woodlots, 13% of the respondents were not actively involved in growing farm woodlots, while 40% were not involved in growing farm woodlots at all.

Types of agroforestry systems practiced

Table 3. Distribution of respondents according to types of agroforestry practiced

Type of agroforestry	Frequency*	Relative percentage
Plantation crops	35	29.17
Farmwood lots	12	10.00
Fruit trees and crops in combination	77	64.17
Trees as live fences	11	9.17
Trees and hedgerows	05	4.17
Multistory home gardening	13	10.83
Dispersed multipurpose trees	02	1.66
Improved fallow	10	8.33
Wildlife agroforestry	02	1.66
Amenity planting	04	3.33
Alley farming	01	0.83

Source: Field survey data, 2010

Table 3 shows the distribution of respondents according to types of agroforestry practiced. The Table shows that fruit trees and crops in combination (64.17%), and plantation trees (29.17%) were cultivated due to their roles in food security, the variety of crops obtained, logs and timber derived, and income generation. Other agroforestry practices in the area included trees and hedgerows,(4.12%), live fences (9.17%), farm woodlot (10.00%), and multistory home gardening (10.83%) were used mainly because of their roles in enhancement of aesthetic beauty, control of wind and water erosion, supply of fodder, fuel wood and soil fertility maintenance.

Types of soil fertility replacement materials used by Farmers

Table 4: Distribution of respondents according to type of soil fertility replacement materials used in Agroforestry practice

Soil fertility replacement material	Frequency*	Relative frequency
Animal waste	20	16.67
Green manures (mulching)	34	28.33
Household and kitchen waste	14	11.67
Inorganic fertilizers	74	61.67

Multiple response*

Source: Field survey data, 2010

Table 4 shows the distribution of respondents according to type of soil fertility replacement materials used in Agroforestry practice. The Table shows that 16.67% of the respondents used animal waste as soil fertility enhancement material, 28.33% used green manures, 11.67% used household and kitchen waste, while 61.67% used inorganic fertilizers as soil fertility replacement material. The result shows that majority of the respondents (61.67%) in the sampled area used inorganic fertilizer as soil fertility replacement material.

Determinants of net returns to agroforestry production in Imo State

Table 5: Results of the multiple regression analysis on the determinants of net returns to agroforestry in Imo State.

Variable	Coefficients	T-ratio
Age (X_1)	- 0.0743 (0.0614)	1.2101
Farm size (X_2)	0.0937 (0.0213)	4.3991*
Years of experience in agroforestry (X_3)	0.0742 (0.0169)	4.3905*
Tree crop density practiced (X_4)	0.0318 (0.0107)	2.9719*
Years of formal education (X_5)	0.0664 (0.0185)	3.5892*
Household size (X_6)	0.0903 (0.0817)	1.1053
Extension contact (X_7)	0.0885 (0.0307)	2.8827*
Type of soil fertility replacement material used (X_8)	0.0685 (0.0329)	2.2313**
Constant	73.4447 (0.0329)	
R^2 = 0.7142 F-Value = 34.3365		

Figures in parentheses are standard errors

* significant at 1% ** significant at 5%

Source: Field survey data, 2010

The double log function was chosen as the lead equation and used for further analysis of the data. The choice was based on the signs and size of the estimated coefficients, their statistical significance, and the magnitude of the coefficient of multiple determination (R^2) as they aid in the interpretation of the results. Farm size (X_2), years of farming experience (X_3), tree crop density (X_4), years of formal education (X_5), and extension contact (X_6) are statistically significant at 1% level directly related to net returns to agroforestry, while type of soil fertility replacement material used (X_8) is statistically significant at 5% and also positively related to net returns to agroforestry. This suggests that an increase in the levels used of these inputs will

significantly enhance net returns to agroforestry in the area. However, age (X_1) was found to be negatively related to net returns to agroforestry and statistically non significanly. This suggests that net returns to agroforestry reduce as the age of the practitioners increase. Finally, the coefficient for household size was found to be positively related to net returns to agroforestry, but statistically non significant.

Table 6**:** Discounted Benefits and Costs from agroforestry practice in Imo State

Year	Gross revenue	Discount factor (18%)	Present worth	Gross costs	Discount factor (18%)	Present worth
1	116895	0.848	99126.960	54197	0.848	45959.056
2	142529	0.718	102335.822	68583	0.718	49242.594
3	172729	0.609	105191.961	66013	0.609	40201.917
4	148300	0.516	76522.800	59648	0.516	30778.368
5	138033	0.437	60320.421	54750	0.437	23925.750
6	146935	0.370	54365.950	57329	0.370	21211.730
7	151841	0.314	47678.074	60789	0.314	19087.746
8	153518	0.266	40835.788	83963	0.266	22334.158
9	142770	0226	32266.020	53887	0.266	12178.462
10	114553	0.191	21879	41646	0.191	7954.386
TOTAL			640523.419			272874.167

BC Ratio = $\frac{present\ worth\ of\ benefits}{present\ worth\ of\ costs}$

$= \frac{640523.419}{272874.167}$

BC Ratio = 2.347

Since BC Ratio is greater than 1, the agroforestry enterprise is viable.

Table 7: Discounted cashflow from agroforestry practice in Imo State

Year	Gross revenue (1)	Gross costs (2)	Cash flows (1-2)	Discount factor (18%)	Present worth
1	116895	54197	62698	0.848	53167.904
2	142529	68583	73946	0.609	64990.044
3	172729	66013	106716	0.609	64990.044
4	148300	59648	88652	0.516	45744.432
5	138033	54750	83283	0.437	36394.671
6	146935	57329	89606	0.370	33154.220
7	151841	60789	91052	0.314	28590.328
8	153518	83963	69555	0.266	18501.630
9	142770	53887	88883	0.226	20087.558
10	114553	41646	72907	0.191	13932.528
TOTAL					=N=367,656.543

NPV = N367,656.543

Since NPV is positive, the agroforestry enterprise is economically viable.

Applying equation (6 and 7) to Table 7, we obtain
Where NPV = 367656.543
i = 18% (market interest rate)
t= 10 years (planning horizon)

Then, $\sum_{t=1}^{n} = \frac{1}{(1+i)^t} = \frac{1}{0.18} - \frac{1}{0.18(1+0.18)^{10}} = 5.55 - \frac{1}{0.94} = 4.49$

Therefore, cash flow (AEV) = $\frac{NPV}{4.49} = \frac{367656.543}{4.49}$ AEV = =N= 81,883.417

This result indicates that the series of cashflows expected from the agroforestry practice have the same net present value as an annuity that pays =N= 81,883.417 per year. This does not reflect the time it started generating positive cashflows. Therefore the practice of agroforestry in the state is economically viable.

Table 8: Net returns to agroforestry practice in Imo State.

Item	**Value (=N=** 1years)
Total revenue (TR)	142810.34
Variable cost (VC)	
Seed planting materials	17573.83
Chemical fertilizer	14505.25
Organic fertilizer	1042.00
Labour	22618.30
Agro-chemical	2745.50
Total variable cost (TVC)	58484.90
Fixed cost (FC)	
Depreciation on capital items	4574.69
Land rent	6425.71
Total fixed costs (TFC)	11000.40
Total costs (TC)	69485.30
Net revenue (TR-TC)	73325.04

BCR = 2.055 1 dollar = N145
Source: Field survey data, 2008

Table 8 shows a positive net returns of =N=73,325.04. Also the benefit-cost ratio was 2.10 implying that for every one naira (N1.00) spent in the agroforestry business, one naira ten kobo is returned (N1.10k).This result indicates the viability of agroforestry practices in Imo state.

CONCLUSION

Based on the results of this study, we hereby conclude that agroforestry practice in the humid rainforest belt of Nigeria is economically viable and should be invested upon.

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