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Willingness to pay for ecosystem benefits of Agroforestry driven green growth in Ogun State, Nigeria

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ABSTRACT

This paper investigates the Willingness To Pay (WTP) for ecosystem benefits derivable from Agroforestry (AF) driven green growth practice in Ogun state, Nigeria. The environmental service functions of AF were valued. Multi-stage sampling procedure involving purposive and simple random sampling was adopted in deriving a sample size of 160 households from a sampling proportion of 65 % of the study area. The methodology involved descriptive statistics, contingent valuation method and the binary choice logit model. The mean WTP for AF ecosystem benefits is ₦ 84.67/month. With a population of 1,295,648 people in the two zones considered, the total WTP/year is ₦1,316,430,193.92 and for the whole study area, it is ₦3,811,308,285.60. The log of bid offered had a negative and significant effect (p< 0.05) while income and contact with extension agents had positive and significant effects (p<0.10) on the likelihood of the bid acceptance in the WTP for the ecosystem benefits of AF. That the international community should share from the cost for the promotion of green growth through AF was highly accepted by 70 % of the respondents as they believed environmental benefits have no international boundary. There is therefore a need to put ecosystem services payment policy in place to sustain benefits derivable from AF systems. Dialogues that emphasize 70 % cost appropriation to the developed economies for green growth infrastructures that act as "sinks" in the developing countries to their industrial carbon emissions need to be fostered and protocols endorsed for green growth promotion. These will enhance the derivable ecosystem benefits of AF that transcends beyond international borders.

Keywords: Ecosystem benefits, green growth, cost sharing, bid, Willingness To pay.

INTRODUCTION

Green growth can be defined as a means to foster economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies on (OECD 2011). The concept of green growth has become an issue of policy debate in recent years. During the recent global financial crisis, the United Nations (UN) General Assembly and its several agencies underscored that the crisis represented an opportunity to promote green economy initiatives which include using AF strategy as part of the stimulus packages being put in place to support the recovery (UNCSD 2012). AF is a component of green growth practices. Agroforestry (AF) is a concept of integrated land use that combines elements of agriculture and forestry in a sustainable production system (Noble and Dirzo 1997). The integration of trees, agricultural crops, and animals into an agro forestry system has the potential to enhance soil fertility, reduce erosion, improve water quality, enhance biodiversity, increase aesthetics, and sequester carbon (Garrett and McGraw

2000). The organic matter derivable from AF practice through the cultivation of annual agricultural crops along with forest tree species can help to minimize pollution through minimal fertilizer usage, while enhancing farm output (Organic Research Centre 2010). The source adds that green growth drivers of AF such as crop rotation, conservation tillage, raising animals on pasture and natural fertilization, raising agricultural crops with forest plantations, help to sustain farm productivity without having a negative effect on the environment. AF in this sense improves and preserves the land and so ensures ecological stability necessary for enhanced food security and farmers' wellbeing.

In Nigeria, several studies have been carried out to evaluate the various land use practices in order to determine the agro forestry models suitable for each geo-political zone. Adesina (1999) estimated the potentials of AF in the mitigation of CO_2 emission in the country. Farmers in Urhobo land area of the Niger Delta practice integrated farming that uses palm trees alongside other crops to maintain soil fertility (Aweto 2000). Odurukwe (2004) asserted that a large majority of households in Abia State, Nigeria were aware on the environmental benefits of cultivating annual agricultural crops along with forest tree species. These results justified AF functions of "carbon sinks", soil fertility enhancement and the benefits derived from other environmental services. They did not however touch on "monetizing" these benefits by valuing what the respondents stood to gain or lose with or without AF practice in their respective study areas as is done in this paper.

The important roles that agro forestry strategy plays in driving green growth manifests through the cultivation of agricultural crops with protected forest crops to conserve biodiversity. Extensive review of literature from Africa and Asia, have shown that the use of AF green growth drivers such as alley-cropping and taungya have resulted in productivity increases of 59 to 179 %, and for every 10 % increase in farm yields, there is a 7 % reduction in poverty in Africa; and more than 5 % in Asia (Pretty *et al*. 2006). In addition, AF provides connectivity by creating corridors between habitat remnants which may support the integrity of these remnants and the conservation of area-sensitive flora and fauna species. AF helps in this biological diversity by providing ecosystem services such as erosion control and water recharge, soil improvement and nutrient recycling and in this direction; it helps in preventing the degradation and loss of surrounding habitat (Organic Research Centre 2010). AF in the greening process plays a global function of sequestering carbon. Several studies have been made along this line to quantify the global carbon sequestration rate of AF ecosystems. Dixon (1995) estimated a total of 585 – 1,215 million ha of land in Africa, Asia and the Americas under AF and a global potential to sequester 1.1–2.2 Pg of carbon (vegetation and soil) over 50 years. This finding still falls short of showing the monetary implication of such a benefit implying that society's willingness to pay for AF ecosystem services is yet to be fully explored. There is a need therefore for adequate information and data gathering on the economic and monetary values of the environmental benefits of AF in its green growth driving process. This will serve as an input to developing an appropriate payment schemes for the environmental benefits of AF towards achieving a green economy.

The complexity of the current threats to AF notwithstanding, the use of innovative market and policy mechanisms can internalize the true economic and monetary value of the ecosystem as a productive natural asset that provides goods and services at different levels to promote sustainable development and investment. Mechanisms that combine social, economic and environmental benefits are necessary to encourage sustained investment for the success of a green economy. AF in promoting green growth readily falls among these mechanisms. It is in this perspective that this paper seeks to investigate the following objectives:

(i) Determine the willingness to pay associated with the ecosystem benefits of Agroforestry driven green growth practice in the study area.
(ii) Establish a relationship between the willingness to pay and the factors that affect it.

MATERIALS AND METHODS

Study area

The study area is Ogun State in South Western Nigeria. It is neighbored by Oyo, Ondo, Lagos, Edo and Delta States. It is situated within the tropics and derives its name from the River.

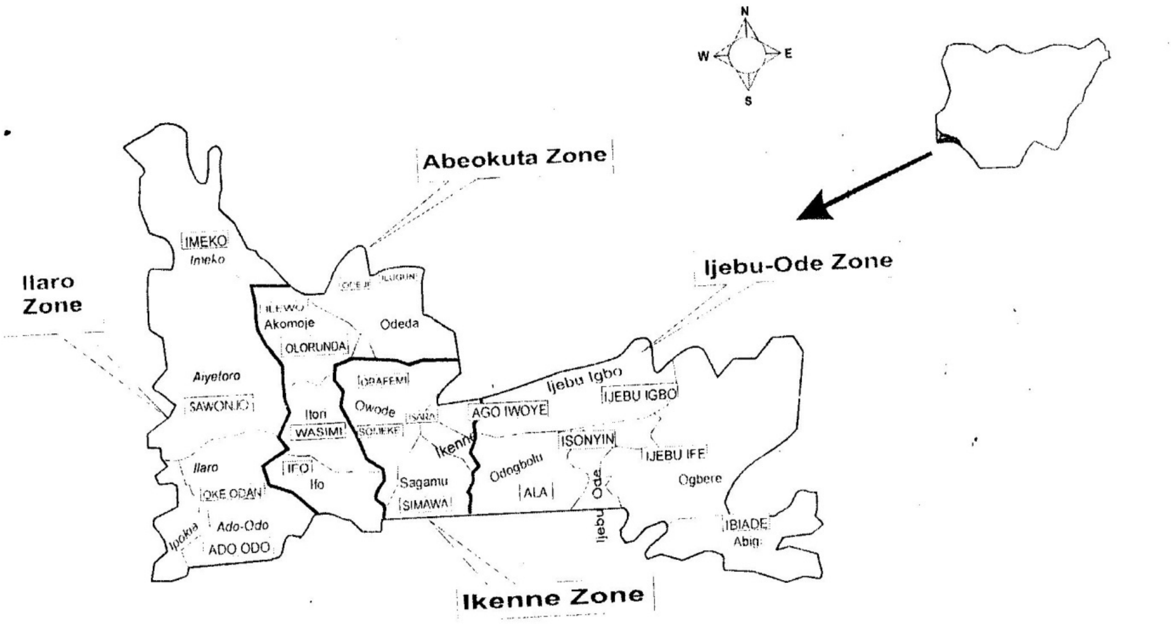

Figure 1: Map of Ogun State showing the Study Zones

The state lies between longitude $2^0 2'$ and $3^0 55'$ and latitude $7^0 0'$ and $7^0 18'$. It is approximately 1.9 % (16,762 $km^{2)}$ of Nigeria's 923,219 km^2 land area of which over 70 % is suitable for arable crop production. It is located in the moderately hot, humid tropical climatic zone of south western Nigeria. It has a tropical climate with two distinct seasons - the rainy and the dry season. The three main vegetation types in the study area are the tropical rainforest, guinea and derived savannah. It is made up of 20 Local Government Areas spread across the four main agricultural zones of the state - Abeokuta, Ijebu, Ikenne and Ilaro. The overall population of the state is 3,728,098 (National Population Commission 2006). The people are predominantly farmers and they mostly engage in AF practices in the government forest reserves as departmental taungya and non departmental taungya. The departmental taungya is where the forestry departments invite the farmers to raise agricultural and forest crops on behalf of the forest department for the first three years. The farmers are paid for their services while the harvested crops are owned and sold by the forest department. The non departmental type is where the farmers own their own food crops but help in the first three years to plant and raise forest tree crops for the forest department in return for the offer of the use of the forest land. Many farmers also in recent years have started to own their private taungya farms where they own the forest tree and food crops themselves. Other major AF practice in the area is agrisilvopastoral system where some domestic animals are kept along the raising of tree and food crops.

Data collection
The research data were obtained through primary source with the aid of a well-structured questionnaire from the sampled respondents. A pre-test open ended format contingent valuation survey was carried out in the study area to work out the optimal bid amounts that would be elicited in the dichotomous-choice contingent valuation method cross sectional survey. Data were collected on the socio-economic characteristics of the respondents and the willingness to pay of the respondents for the composite ecosystem benefits of the AF with respect to carbon sequestration, clean air, reduction of downstream flooding, and maintenance of the soil fertility.

Sampling procedure and size
The sample size used for this study was 160 households. Multistage sampling technique involving purposive and simple random sampling was used for the selection. At stage one, two Agricultural Development Programme Zones representing 65 % of the study area - Ijebu and Ilaro Agroforestry taungya sites were purposively selected out of the four ADP zones in Ogun State. At stage two, 50% of the blocks were randomly selected from each zone i.e. three blocks from Ijebu and two blocks from Ilaro to give a total of five blocks. At stage three, four cells each per block were randomly selected to give twenty cells. At stage four, eight households were randomly selected from each cell, which gave a total of one hundred and sixty (160) households from the study area

Data analysis
A combination of analytical tools was employed during the course of this study. These included descriptive statistics, the dichotomous-choice contingent valuation method, and the binary choice logit regression model. The descriptive analysis was used to depict the socio-economic characteristics and it involved the use of tables, frequency and %age proportions while the dichotomous-choice contingent valuation method that terminated into the logit model was used to assess the willingness to pay for the AF environmental benefits derived by the respondents. The maximum likelihood estimate of the logit regression model provided the coefficients necessary to compute the monetary value of the environmental benefits as expressed by the WTP. The covariates were cleared of the numerical problem of multicollinearity by checking that the standard errors of each of their coefficients were not more than 2. The logit regression model is based on Hanemann (1984). Approach as used by Cooper and Loomis (1992), Turcin and Giraud (2001) and Okojie (2007) and it is as follows:

$$P_i = \frac{1}{[1+e^{-(\alpha+\beta xi)}]} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Pi = Respondents acceptance probability to the bid offered.

B*i* = Vector representing the coefficients of all covariates including that of the bid (B*i*)

X*i* = Vector representing all covariates including that of the bid (X_1)

X_1 = Bid offered to the respondents, which is what they are willing to pay (naira)

X_2 = Respondents Income (Naira)

X_3 = Educational level attained (Years)

X_4 = Household size (No)

X_5 = Sex dummy (1 = if male, 0 = female)

X_6 = Cost sharing dummy (1 = Support for developed countries sharing from the cost of green growth practices in developing countries, 0 = If not)

X_7 = Farmers years of experience (1 =If less than 10 years, 0 = If more than 10 years)

X_8 = Contact with extension agent (1 = If yes, 0 = If not)

X_9 = Immigrant status dummy (1 = If migrant, 0 = non migrant)

The coefficient of the bids offered (X_1) was expected to be negative as the higher the bid, the less was expected to be the likelihood in the respondents' WTP for AF taungya ecosystem benefits. X_2 (income) was expected to be positive as the higher the income; the more would be the likelihood in the WTP. This was equally expected for X_3 (educational level attained), X_7 (Farmers experience), X_8 (contact with extension agents) and X_9 (immigrant status) as migrants being non-natives were expected to be less ethnocentric or less committed to whatever environmental damage inflicted as a result of improper use of the resources in the area they are temporarily domiciled. The signs of the household size, sex and cost sharing dummy could not be determined as they were expected to go either ways.

The environmental benefits derivation was computed based on the restricted mean WTP following Cooper and Loomis (1992). The procedure is as follows:

$$P^{-} = 1/|\beta| * \ln(1+ \exp^{a}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:

P^{-} = restricted mean WTP

a = intercept

β = coefficient of bid

The determinants of the WTP for the environmental benefits of AF were established from the logit regression from where relevant coefficients were estimated from the maximum likelihood procedure.

RESULTS

Socio-economic characteristics of respondents considered were gender, age, income, educational level and their WTP for the derived environmental benefits of AF. The respondents were predominantly male (75%). The proportion of farmers between the ages of 40-49 years was 42.5% which constituted the largest % (Table 1). The proportion of respondents earning between ₦10000 – ₦30000 per month was 33.7%. The respondents consisted of 29.3% that had primary education, 30.6% secondary education, and 18.1% tertiary level education. Farmers without formal education were 21.8%. Furthermore, 68.75% of the respondents were willing to pay for the derived environmental benefits of AF elicited through the optimal bids, while 31.25% were not willing to pay.

The DC-CVM analytical tool was used to derive the value of the ecosystem benefits of AF as a driver for green growth. The composite ecosystem service functions of AF so valued were carbon sequestration, clean air, reduction of downstream flooding, and maintenance of soil fertility. The actual Dichotomous-Choice Contingent Valuation Method (DC – CVM) that terminated into the logit regression was used to assess the ecosystem benefits of AF driven green growth from the people living in the catchment areas of the taungya plantations in the study area. The ecosystem benefits include carbon sequestration, reduction of downstream flooding, maintenance of the soil fertility and clean air. The relationship between the acceptance probabilities to the bid offered (WTP) for attaining the environmental benefits derivable from AF and the covariates were examined (Table 2). Five significant variables were the bid offered, household size, contact with extension agents, income and the cost sharing dummy. The likelihood ratio was 58.91 and the mean WTP value computed was ₦84.67/month. With the population of 1,295,648 people in the two ADP Zones considered in the study, the total WTP/year for these benefits is ₦1,316,430,193.92. For the whole study area – Ogun State, this is ₦3,811,308,285.60/year

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Table 1: Socio-economic characteristics of the respondents.

Variables	Frequency	%
Gender		
Male	120	75
Female	40	25
	160	10000p
Age		
Less than 30	23	14.375
30 – 39	35	21.875
40 – 49	68	42.5
50 – 59	30	18.75
60 and above	4	2.5
	160	100
Income		
Less than 10000	31	19.375
10000 – 30000	54	33.75
31000 – 50000	37	23.125
51000 – 70000	25	15.625
71000 and above	13	8.125
	160	100
Educational Level		
No formal	35	21.875
Primary	47	29.375
Secondary	49	30.625
Tertiary	29	18.125
	160	100

Source: Computed from Field Survey Data, 2013

The log of the offered bid had a negative and significant effect ($p < 0.05$) on the likelihood of the bid acceptance for environmental benefits of AF. The household size had a negative and significant ($p < 0.01$) relationship with the likelihood in the WTP for AF ecosystem services. Income of respondents had a positive and significant ($p < 0.01$) on the likelihood of bid acceptance for the environmental benefits of AF. The contact with extension agents (dummy) had a positive and significant relationship ($p < 0.01$) on the likelihood in the WTP for the benefits of ecosystem in the study area.

The cost sharing dummy had a positive and significant ($p < 0.05$) relationship with the likelihood of bid acceptance in the international community's sharing in the cost of sustaining AF systems to offer ecosystem beneficial functions. It was accepted that the international developed economies should be apportioned 70 % of the share as much of the forests in the developing countries act as "sinks" to their industrial carbon emissions.

Table 2: Maximum likelihood estimations of responses to willingness-to-pay (WTP) questions and estimation of mean willingness-to-pay (WTP)

Variables	Coefficient	T-ratio	Standard error	Marginal effect
Constant	-1.0701	-1.2526	0.85433	
Bid	-0.095**	-2.36	-0.39450	
Household size	-0.21301***	-4.4297	0.48086E-01	-0.46759E-01
Gender	0.51002	1.0163	0.50182	0.11196
Education	0.17963	0.72422	0.24804	0.39433E-01
Contact with extension agent	1.2902***	2.6078	0.49473	0.28322
Income	0.32254E-05*	1.8936	0.17033E-05	0.70803E-06
Cost sharing	1.1337**	2.4731	0.45840	0.24887
Farming experience	-0.32162E-02	-0.16336	0.19688E-01	0.70602E-03
Immigrant status	-1.356	0.922	0.47592	0.54782

Likelihood Ratio Test = 58.9096
McFadden R-Square = 29.2%
Number of Observation = 160
Mean Willingness to Pay = ₦84.67/ Household/ Month
Dependent Variable is the yes/no responses to the offered bid amounts.
*** Significant at 1%, **Significant at 5%, * Significant at 10%
Source: Computed from Field Survey Data, 2013.

DISCUSSION

The likelihood ratio of the logit model being 58.91 shows that all slope coefficients were significantly different from zero. In other words, the explanatory variables were collectively significant in explaining the WTP. The total WTP for the ecosystem services of ₦ 3,811,308,285.60/year for the whole study area is enormous. It represents the monetary value required as ecosystem services payment for the people in the study area to sustain the benefits derivable from AF driven green growth practice. The log of the offered bid having a negative and significant effect on the likelihood of the bid acceptance for environmental benefits of AF agrees with economic theory, as the higher the price of the environmental commodity, the lesser will be the demand. Increase in the household size reducing the likelihood in the WTP for AF benefits could be attributed to the fact that as the household size increases, increased proportion of income will be given to other welfare considerations of the households, thereby affecting downwards the likelihood in their WTP for these environmental benefits. Income of respondents having a positive and significant effect on the likelihood of the bid acceptance for environmental benefits of AF implies that increased income will shift the demand for the benefits of AF more to the right.

The contact with extension personnel positively influenced the likelihood in the WTP for the ecosystem benefits of AF shows that communication in knowledge about sequestering carbon and harvesting other benefits of AF services went a long way in improving attitude of respondents in paying for ecosystem services in the study area. This could have enlightened them on the major role AF driven green growth plays in global carbon cycle that was brought into the arena of international climate change policy in 1997 with the negotiation and signing of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (Murray 2000). The cost sharing dummy being positive and significant indicated support of the respondents for the international community's participation in cost sharing in the efforts to build up AF systems to offer ecosystem beneficial functions. This was highly emphasized by the respondents' seventy % consensus as the burden to be carried by the international community.

CONCLUSION

AF system through the cultivation of annual agricultural crops along with forest tree species has the capacity of fostering economic growth and development while ensuring that a green economy that ensures environmentally sound and sustainable development is achieved. The practice has resulted in the increases of productivity and farm yields that have served to reduce poverty. In this direction, the scarcity of hard evidence in recent past that has hindered the progress of AF based green growth practices and their acceptability by farmers and policy makers is being eroded. That the respondents in the study area were willing to pay as much as ₦3,811,308,285.60/year to sustain the AF practice and derive the ecosystem benefits indicate a new era of environmental consciousness and the deep understanding of the need to maintain ecological sustainability in the study area. This is keying in to the assertion of the United Nations General Assembly and several UN agencies during the recent global financial crisis that the crisis represented an opportunity to promote green economy initiatives that included AF driven green growth as part of the stimulus packages to be put in place to support the recovery.

Further findings show there is the need to share the cost burden of ensuring the environmental benefits of AF with the international community to ensure a green economy. The sampled respondents reached a consensus of 70 % cost burden for the international community to ensure AF aided projects of afforestation and reforestation that drive green growth for ecosystem benefits are ensured in the study area. This emphasizes the need for global cooperation and understanding in solving the issue of attaining environmentally sound and sustainable development. Efforts should also be made to raise the national minimum wage and general income levels as income had the likelihood of positively affecting the WTP for AF ecosystem benefits. It is only by so doing that investment in conservation and ecosystem payment services can be encouraged and sustained. The Bali protocol has spelt out what is mandatory in terms of carbon emission the developed countries must be burdened with while that of the developing countries is voluntary. This paper has shown this arrangement needs to be sustained for such environmental benefits of remaining ecosystems in the developing economies to be kept for global environmental stability. Positive environmental attitudes can be encouraged through proper environmental education and awareness. In such a way, ecosystem benefits of AF as a driver of green growth can be sustained in the study area.

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