Assessment of Tree Species Diversity, Yield and Benefits of Small Scale Private Natural Forests to Owners in Ondo State, Nigeria

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Adekunle, V. A. J. and Alli, A. L. (2020): Assessment of Tree Species Diversity, Yield and Benefits of Small Scale Private Natural Forests to Owners in Ondo State, Nigeria. Nigerian Journal of Forestry 50 (1):1-8

Abstract

This paper examined the present status of small-scale natural forests in terms of tree species diversity, abundance, and yields in Ondo State, Nigeria. The contributions of the forests to owners' livelihood and the various forms of restrictions were highlighted. Data on tree species diversity and growth variables were collected from five plots (25 x 25m) randomly located in six different locations across the State. Information on benefits and restrictions were obtained from key informants, officials of Forestry Department, literatures, annual reports and files. A total of 344 stems/ha of 29 families and 99 species, (Shannon Index = 4.10, Evenness = 0.90) were encountered. The most abundant species and family were *Celtis zenkeri* and Sterculiaceae respectively. The forests were in form of woodlots, relics of natural forests, cocoa agroforest and highly economic tree species purposefully retained on farmlands. The dbh varied between 16.58 and 41.60cm, height between 15.99 and 18.40m, basal area between 12.13 and 48.05cm^2/ha and volume between 117.47 and 307.73m^3/ha. About 45% of the trees were merchantable. The social, economic and ecological benefits of these forests to owners and the various personal and institutional restrictions, in order of importance, were enumerated. It was suggested therefore that the effective use of forest extension agents could remove some of the restrictions and promote small-scale forest management in Nigeria.

Key Words: Species diversity, farmland, diameter at breast height, tree volume Diversity indices

Introduction

Indigenous and Community Conserved Areas (ICCAs) are natural sites, resources and species' habitats conserved in a voluntary and self-directed way through community values, practices, rules and institutions. Examples of ICCAs include indigenous bio-cultural heritage territories, indigenous protected areas, cultural land- and seascapes, sacred sites and species, migration routes of mobile indigenous peoples, sustainable resource reserves (Corrigan and Granziera, 2010). In Nigeria, about 200 hectares of the forest are being destroyed annually through many human activities that include accelerated urbanization, conversion of forest reserves to farmlands and housing estates. Forests are essential parts of rural livelihood. Income from private small-scale forests is able to boost rural economy. In the developing counties, an estimated 80% of the population depends on the forest resources for their daily survival. The timber products from these forests are very valuable for construction purposes and furniture works while the non-timber forest products (NTFPs) are harvested for primary health care delivery and food. For these reasons, communities dwelling in or near forests have in the past ensured that the rich and diverse forest areas are preserved and protected for the continuous production of these goods and services (Tiwari et al., 2010). Their proximity and total dependence on forest resources has enabled them to be willing to conserve the resources and use them judiciously. Therefore, rural farmers had always and deliberately retained trees on their farmland, planted trees in woodlots, left behind some relics of forest and protect trees that were planted. These old practices are some of the modern day agroforestry systems.

This study therefore examined the diversity and abundance of tree species in these small-scale forest types. The forests were quantified in terms of volume and basal area. The benefits of the forests to the owners and the constraints to sustainable forest management were also examined. This was done through field inventory of small scale forests and administration of well structured questionnaire to the forest owners in Ondo State, Nigeria.

Methodology

The study area: The present study was carried out in Ondo State, Nigeria. The State was created on 3rd February 1976 as one of the 36 States of Nigeria and it is located in

southwest Nigeria. It is an agrarian state with 18 Local Government Areas. Six different locations were randomly selected across the state and forests were selected in each location for data collection. The locations were selected to ensure the coverage of the entire State.

Method of Data Collection

Field inventory exercise: Systematic line transect was adopted for plot location in each of the sites. Four plots of 25 x 25m were located in each of the selected forests. In each field plot, all living trees with dbh >10 cm were recorded by species and assigned to families, the dbh, diameters at the base, middle and top and their total height were also measured. Community diversity indices were calculated from a mathematical formula that takes into account both species richness and relative abundance of each species in the community. The equation for the Shannon-Weaver diversity index used is: $H' = -\sum_{i=1}^{s} p_i Lnp_i$ and the Evenness (E) index is $E = \frac{H'}{LnS}$

H' is the Shannon diversity index, P_i is the relative density and Ln is natural logarithm and S is the total number of species in the community (Magurran, 2004; Lu et al. 2010)

Basal Area Calculation: The basal area of all trees in the sample plots was calculated using the formula:

$$BA = \frac{\pi D^2}{4}$$

Where BA = Basal area (m^2), D = Diameter at breast height (cm) and π = Pie (3.142).

Volume Calculation*:* The volume of each tree was calculated using the Newton's formula of Husch *et al* (2003): V = (h/6) (A_b + 4 A_m + A_t). where: V = Tree volume (in m^3), A_b, A_m and A_t = tree cross-sectional area at the base, middle and top of merchantable height, respectively (in m2) and h = total height (in meters).

All variables and calculation were extrapolated to the values on per hectare basis by multiplying sample plot values with the number of 25 x 25 plots in one hectare (16).

Socio-economic data: Data on the socioeconomic characteristics of the small-scale natural forest owners in the study area were obtained with the use of a well-structured questionnaire**.** A total numbers of 117 questionnaires were administered to the farmers in the six randomly selected locations. The questionnaire was designed to obtain information on respondents' background, land holding, benefits of trees to owners and the restrictions to plantation establishment and sustainable forest management. Additional information was obtained from forestry staff, office records, files and reports. These set of data were analyzed with descriptive statistics and one-way analysis of variance.

Results

Table 1 reveals the results of tree species diversity and abundance for the selected small-scale natural forests by private owners in Ondo state, Nigeria. The table also shows the summary of tree growth variables of these forests. The total number of stems encountered per hectare was 344, belonging to 52species and distributed among 26 families. The most abundant species is *Celtis zenkeri* in the family of Ulmaceae (18 stems/ha), this is followed by *Albizia zygia* and *Pycnanthus angolensis* with 14 stems per hectare each. Sterculiaceae family has the highest number of species (6 species) while Moraceae family has 3 species (table 2).

As shown in table 3, the Shannon Weiner and Evenness indices were very high (4.10 and 0.91 respectively). For the tree growth variables, a mean dbh and height of 38.47cm and 17.11m respectively were obtained. The mean basal area and volume per hectare were 32.18m^2 and 245.79m^3 respectively. High proportion of the trees encountered was of merchantable size (45%).

Table 1: Tree species diversity and abundance per hectare in the small scale natural forest in the study areas

S/N	Species	Families	N/ha
1	*Afzelia africana*	Caesalpiniodeae	32
2	*Albizia lebbeck*	Mimosoideae	8
3	*Albizia zygia*	Mimosoideae	80
4	*Alstonia boonei*	Apocynaceae	28
5	*Amphimas pterocarpoides*	Caesalpiniodeae	4
6	*Aningeria robusta*	Sapotaceae	4
7	*Antiaris africana*	Moraceae	24
8	*Brachystegia nigerica*	Caesalpiniodeae	24
9	*Canarium schweinfurthii*	Burseraceae	8
10	*Carapa procera*	Caesalpiniodeae	8
11	*Ceiba pentandra*	Bombacaceae	40
12	*Celtis zenkeri*	Ulmaceae	148
13	*Chrysophylum albidum*	Sapotaceae	28
14	*Cleistopholis patens*	Annonaceae	8
15	*Cola millenii*	Sterculiaceae	20
16	*Cordia millenii*	Boraginaceae	12
17	*Dacryodes edulis*	Burseraceae	4
18	*Danielia ogea*	Caesalpiniodeae	4
19	*Diospyros barteri*	Ebeneceae	24
20	*Distemonanthus benthamianus*	Caesalpiniodeae	16
21	*Dracenea mannia*	Agavaceae	8
22	*Drypetes paxii*	Euphorbiaceae	100
23	*Entandrophragma angolense*	Meliaceae	4
24	*Ficus exaspirata*	Moraceae	20
25	*Ficus mucuso*	Moraceae	32
26	*Funtumia elastica*	Apocynaceae	84
27	*Guarea cedrata*	Meliaceae	8
28	*Hannoa klaineana*	Simaroubaceae	44
29	*Hevea bracilensis*	Apocynaceae	24
30	*Holoptelia grandis*	Ulmaceae	8
31	*Irvingia gabonensis*	Irvingiaceae	12
32	*Khaya senegalensis*	Meliaceae	4
33	*Lannea egrigia*	Irvingiaceae	8
34	*Lecaniodiscus cupanioides*	Sapindaceae	56
35	*Lophira alata*	Ochinaceae	4
36	*Mansonia altisima*	Sterculiaceae	8
37	*Milicia excelsa*	Moraceae	40
38	*Mussanga cecropioides*	Aquifoliaceae	72
39	*Nauclea diderrichii*	Rubiaceae	12
40	*Nesogordonia papaverifera*	Sterculiaceae	12
41	*Newbouldia laevis*	Bignonaceae	8
42	*Piptadeniastrum africanum*	Mimosoideae	4
43	*Pterocarpus osun*	Papilionioideae	108
44	*Pterygota macrocarpa*	Sterculiaceae	108
45	*Pycnanthus angolensis*	Inyristicaceae	48
46	*Rauvolfia vomitoria*	Apocynaceae	8
47	*Ricinodendron heudelotii*	Euphorbiaceae	172
48	*Sterculia rhinopetala*	Sterculiaceae	68
49	*Terminalia superba*	Combretaceae	4
50	*Trema orientalis*	Ulmaceae	12
51	*Triplochyton scleroxylon*	Sterculiaceae	4
52	*Xanthoxylum zanthoxyloides*	Rutaceae	16
	Total	28	1,644

Table 2: Family distribution of species encountered in the small scale natural forest in the study area

S/N	Families	No of Spp
1	Agavaceae	1
2	Annonaceae	1
3	Apocynaceae	4
4	Aquifoliaceae	1
5	Bignonaceae	1
6	Bombacaceae	1
7	Boraginaceae	1
8	Burseraceae	2
9	Caesalpiniodeae	6
10	Combretaceae	1
11	Ebeneceae	1
12	Euphorbiaceae	2
13	Inyristicaceae	1
14	Irvingiaceae	2
15	Meliaceae	3
16	Mimosoideae	3
17	Moraceae	4
18	Ochinaceae	1
19	Papilionioideae	1
20	Rubiaceae	1
21	Rutaceae	1
22	Sapindaceae	1
23	Sapotaceae	2
24	Simaroubaceae	1
25	Sterculiaceae	6
26	Ulmaceae	3
Total	27	52

Table 3: Biodiversity indices and tree growth variables of small-scale private forests in Ondo State, Nigeria

s/n	Biodiversity indices		Tree growth variable	
	Indices	**Values**	**Variables**	**Values**
1	No of stems per ha	344	Mean DBH	38.47
2	No of species	99	Mean Height (m)	17.11
3	No of families	29	Mean Basal Area/ha (m^2)	32.18
4	Shannon Weiner Index (H')	4.10	Mean Volume/ha (m^3)	245.79
5	Evenness (E)	0.90	% merchantable	45

Table 4 revealed the socio-economic characteristics, sources of land for farming and forestry activities and the land holding capacity of the forest owners. The results show that all the respondents were males, married, mature adults and breadwinners. None of them was below the age of 30 years. The majority of the respondents (30%) were in the age group of 41- 50 years while the least proportion has their ages to be above 60 years (18%). A very high proportion of the respondents (67%) were without formal education, while 15% had primary education, only 8 and 1% had secondary and tertiary education respectively. Generally, the majority of the respondents have large family size. Sixty-six percent had a family size of between 8- 11 persons. This was followed by those with a family size of 4-7persons. Their primary occupation was farming (87%) and the main source of land for farm and forest works was family land obtained through inheritance. However, 20% claimed to purchase land while 15% rented the land for farming and tree planting. In addition, most of them were of small land holding as about 89% had a land holding that ranged between 1 and 4 hectares while very few (11%) had a land size that is more than 4ha. All the respondents have trees that scattered on their farm lands and relics of forest. However, about 10% claimed to have wood lots and abandoned farmlands left to fallow. The average size of this type of forest was about 0.8ha.

Table 4: Demographic characteristics of small scale forest owners in Ondo State, Nigeria

Variables	% of respondents	Statistic results	Variables	% of respondents	Statistic results
Age (Yrs)			**Primary Occupation**		
<30	0	F-calculated = 22.85, df = 4, P<0.05 (significant)	Farming	83	F-calculated = 112.34, df = 3, (P < 0.05)
31-40	24		Civil Service	12	
41-50	30		Trading	2	
51-60	29		Artisans	3	
>60 above	18				
Level of Education			**Farm sizes with small- scale forests**		
*1	67	F-calculated = 103.01, df = 3, P<0.05	< 1	16	F – calculated = 17.84, df = 3 (P < 0.05)
2	15		1 – 2	54	
3	8		3 – 4	35	
4	1		> 4	11	
Household size			**Sources of farm/forest Land**		
1-3	12	F-calculated = 45.06, df = 3, P<0.05	Family Land	65	F – calculated = 56.12, df = 3
4-7	32		Purchase	20	
8-11	66		Rented	12	
> 11	21		Gift	3	

1- No formal Education, 2- Primary education, 3- Secondary Education & 4 – Tertiary education

The reasons for deliberately retaining some specific tree species on farm lands, planting of trees among crops and taking care of those planted varied, and the benefits of the tree species to owners were presented in table 5. The majority of them reported that these actions were taken for economic reasons (66%). Trees were retained and cared for

so that they could be felled and sold as timber to meet some family emergency needs. This was followed by those who retained or planted trees among young crops to serve as shade and protection for crops like cocoa and coffee. Also, trees on farm lands are indicator of wealth for forest owners in the study area as reported by 25% of the respondents. Other benefits reported by the respondents include soil fertility enrichment, control of erosion, provision of non timber forest products (fruits, soap condiments, ethno-medicinal, etc) and fire wood.

Table 5: Benefits from small-scale natural forests to owners in Ondo State Nigeria

S/N	Benefits	% of respondents*
1	Income generation	66%
2	Shade for young crops	42%
3	Soil fertility enhancement and erosion control	35%
4	Indicator of wealth	28%
5	Provision of fuel wood and poles	25%
6	Others- supply of NTFP (fruits, leafy vegetables, medicinal plants etc)	33%

addition is not equal to 100 because the respondents indicated more than a benefit

There are some limitations and constrains to tree planting and small-scale forest management by rural communities in the study area. These constraints, as indicated by the respondents (table 6), include land tenure system, scarcity of planting materials, lack of technical-know-how, the usual long gestation period for tree species and institutional and government policies.

The results of the one-way analysis of variance show significant differences ($p<0.05$) in all the socio-economic characteristics of the respondents.

Table 6: Restrictions to small scale forest ownership in Ondo State, Nigeria

S/N	Restriction	% of respondents*
1	Scarcity of land for tree planting	69
2	Illiteracy and ignorance	24
3	Long gestation period of tree species	35
4	Institutional and government policies	26
5	Lack of planting materials, technical-know-how	20
6	Cost of plantation establishment	35

addition is not equal to 100 because the respondents indicated more than a restriction

Many plant species were reported by the respondents to have the potential of healing several diseases and solving many health problems. The list of the most popular plant species for ethno-medicinal uses, part of plant involved, mode of use and the various ailments they cure is presented in table 7. More than 30 species were reported to be of ethno-medicinal values to the respondents. Mode of use includes concoction, decoction, soaking in alcohol or water for some days and chewing of the stems. It was very common to combine and boil different plant species in order to obtain the desired healing effect.

Table 7: Some selected important tree species in small scale forests for health care delivery system

Species	Family Name	Local Name	Medicinal Value	Part Use	Mode Of Use
Albizia coriaria	Leguminosae: mimosoidae	Ayinre	Dysentery	Bark, leaves, root, flower	Decoction
Alstonia boonei	Apocynaceae	awun	Gonorrhea, mouth wash, yellow fever, dye and breast development	Root, bark, leave	Decoction
Bosqueia angolensis	Moraceae	Iputu	Cough	Bark	concoction
Brachystegia eurycoma	Leguminosea:caeslpinioidae	Akolodu	Fever	Leaves	Concoction
Bridelia spp	Euphorbiaceae	Ako-araasa	Cough	Bark, leaves, root, flower	Concoction
Chrysophyllum albidum	Sapotaceae	Agbalumo	Food/oil	Seed and leaves	cooked
Cola gigantia	Sterculiaceae	Ogugu	Thrush, toothache, caries, demulcent	*Bark, twig*	concoction
Cola milenii	Sterculiaceae	Obi-edun	Medicine and food	*Seed and leaves*	concoction
Cola hispida	Sterculiaceae	Atewo-edun	Medicine and food	*Seed and leaves*	
Diospyros monbuttensis	Ebenaceae	Eegun-ekun	Carving and walking stick	stem	
Diospyros spp	Ebenaceae	Osu	Carving	stem	
Discoglypremia caloneura	Euphorbiaceae	Sokunsowo	Fever	Leaves and latex	Boil in water and drink
Fagara spp	Rutaceae	Ata	Fever and pile	Bark	cooked
Ficus capensis	Moraceae	Opoto	Insomnia	Bark	cooked
Ficus Exasperata	Moraceae	Erepin	Insomnia	Bark	Cooked
Ficus mucuso	Moraceae	obobo	Insomnia	Bark f stem	cooked
Funtumia elastica	Apocynaceae	Ire	Chronic pile	Bark	concoction
Gloriosa superba	Liliaccac	Aje	skin diseases, labour pain, abortion, general debility	seed, tuber	cooked
Khaya grandifoliola	Meliaceae	Oganwo	Malaria, anemia	Stem, root, bark	cooked
Lannea acida	Anaeardiaceae	Eekan-aja	Pain	leaves	Boil leaves and drink
Lovoa trichiliodes	Meliaceae	Sida	pain	leaves	boiling
Monondora myristica	Annonaceae	Abo-lakoshe	Pile	Seed	concoction
Myrianthus arboreus	Moraceae	Obi sere	Dysentery	Bark	concoction
Oricia suaveolens	Simaroubaceae	odofin igbo	Headache and cold	leaves	Boiling in water
Pterocarpus erinaceus	Leguminosea: papilionoides	Osun dudu	Fruit/ medicinal	fruits	lick

Discussion

The roles of small-scale forests to rural livelihood cannot be dispensed with. Rural communities are aware of these numerous roles. So, they are determined to protect the forest, use it judiciously, deliberately retain trees on farmland, plant important species and take care of those planted. Small-scale forests are therefore very common in rural communities of Ondo State, Nigeria. These forests are inform of cocoa agroforest, deliberate retention of trees on farm land during land preparation for arable or permanent crop cultivation, abandoned farm land (fallow system), relics of forest especially around the streams, rivers and rocky areas during land clearing, family wood lot and tree species for boundary demarcation and fencing. Oke and Odebiyi (2007) reported on the deliberate retention of tree species on farm by rural farmers to serve as shade to young cocoa seedlings, referred to as cocoa agroforest.

The results of this work showed that these forests were of indigenous hardwood tree species of very economic and social importance to the owners. They were made up of species that are durable, highly sought by loggers and have high prize in timber markets. Tree species in this category include *Melicia excels, Khaya spp, Afzelia Africana, Terminalia superb, Sterculia rhinopetala, Celtis zenkeri and Annogacius leucarpus*. As a result, they are sources of emergency income to the owners to meet contingencies such as funeral ceremonies, payment of children school fees and construction purposes. These forests are very rich in tree species diversity. The diversity, abundance, mean dbh, height, basal area/ha and volume/ha of these forests compared favourably with what was obtained by Adekunle *et al* (2010) in a government managed forest reserves of Ondo state, Nigeria and also by Lu *et al* (2010) in a tropical forest ecosystem of Xishuangbanna, southwest China.

The species that were retained or planted by the forest owners depended on the types of resources and benefits to be derived from them by the owners. Species in the Legumeniosoide family has the ability to improve soil fertility while species like *Ficus mucoso, Pycnanthus angolensis* and *Alstonia booneii* were retained for their medicinal values. The medicinal values of tree species, the ailments they cure and mode of use have been reported by Jimoh (2009). To the rural people, the use of herbs to cure various ailments has stood the test of time. It is affordable and readily available in areas where government health facilities are grossly inadequate. In addition, some species like *Irvingia spp, Chrysophyllum albidum, Vitex doniana and Vitellaria paradoxa* were retained to provide edible fruits and soup condiments. Bello *et al* (2008) reported on the nutritional and mineral contents of some indigenous fruit species in this ecological zone. Most of the rural people cannot afford the cost of animal protein. These fruits could supplement their food quality which is mainly of carbohydrate. This can go a long way to reduce malnutrition and other nutrient deficient diseases like kwashiorkor and marasmus in children.

Small-scale forests, in form of trees retained on farmlands, woodlots, relics of forest left after land clearing and secondary forests, could reduce soil erosion and leaching, create micro-climate, sequestrate carbon and help to reduce global warming, prevent biodiversity loss and reduced emission through forest degradation and deforestation (REED) due to anthropogenic activities. Forest degradation practices include unsustainable commercial logging and over-harvesting of fuelwood (Essama-Nssah and Gockowski 2000), and degradation is commonly a driver of deforestation as reported by DeFries et al. (2007) and Angelsen (2008). Also, trees are used as stakes for yam, handles for farm implements, poles, and as house construction materials. Leaves of some tree species are used as mulch materials, animal folders, wrapping and preservation. Leaves of *Mitragyna cylindrical* and *Tomatococcus danieli* are valuable for wrapping and preservation in the study area.

Despite the numerous benefits to forest owners, there are restrictions and limitations to forest creation and tree planting by rural communities in Nigeria. The most important one is the scarcity of land due to tenurial system. Rural farmers in the study area, and generally in developing countries are of fixed small land holding (less than 2ha) as reported by Adekunle (2009). Their lands are barely enough for growing food crops to feed their large families, sharing it between arable cropping and tree planting becomes difficult. Only those with family lands, obtained through inheritance, and those that purchase lands could plant trees but those that rented lands are not allowed to plant permanent crops. Compensations are paid by the lessees to landlords in form of cash, share of crops or both. Ignorance, due to their level of education is another limitation to forest management. Most of the respondents believed that the trees are gift of nature and so could be harvested and used indiscriminately. Such people are not always willing to plant trees.

The usual long gestation period of tree species was also seen as hindrance to plantation development. The growth rate of indigenous trees is usually very slow, so most of the farmers are not willing to wait for this long period. The institutional restriction is the government policy

that made it mandatory for tree owners to obtain permit and pay all necessary fees before they can fell their trees (Adekunle and Olagoke, 2010). In Nigeria, the control of the government over the free areas (trees outside forest reserves) is limited to the issuance of permit after the payment of all levies unlike in the reserves where allocation of logs to loggers is fully controlled by the government. There is the scarcity of planting materials, lack of the necessary expertise for those willing to plant and the cost of plantation establishment is very prohibitive. In Nigeria, only the government and very few rich individuals could embark on afforestation projects. None of the respondent has ever enjoyed the services of forest extension agents. There are no forest extension agents that could sensitise the communities on tree planting and provide some informal training in Nigeria. Extension services have the potential to remove some of these limitations and educate the masses on the sustainable use of forest resources.

Conclusion and Recommendation

This study examined the potentials of small-scale natural forest to owners in Ondo State, Nigeria. Rural communities realised the importance of trees and are therefore involved in their conservation. Tree were retained or planted on farmlands by rural farmers for various reasons. The choice of species planted or retained were according to the benefits intended from the tree species. The various restrictions and limitations were set backs to private forestry in the study areas. It is recommended that there should be forest extension service and in formal education to reduce the effect of these restrictions.

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