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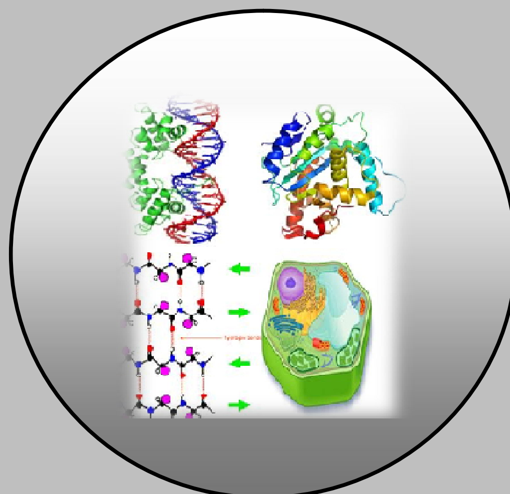

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RESEARCH PAPER

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The Changing Structural Face of Little-Ose Forest Reserve South-West Nigeria

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ABSTRACT

Plant species diversity, abundance and composition were investigated under relatively undisturbed natural forest, plantation forest and agricultural land that were developed from Little-Ose forest reserve with view a to determine the impact of changes in land use on indigenous plant species. Five land use types namely: relatively undisturbed natural forest serving as a control, logged-over natural forest, Gmelina arborea plantation, Tectona grandis plantation and abandoned agricultural land were assessed. Four sample plots of 50 m X 50 m were laid out in each of the land use. The results reveal that there were 321 different indigenous plant species (ranged between 99 to 30 per land use type) belonging to 66 families in the study area. Indigenous plant species were significantly low in Tectona grandis plantation compared to other land use types examined. The Shannon-Weiner diversity index showed that relatively undisturbed natural forest was richer (4.26) than other land use types (3.17-3.87). Comparatively, higher tree species was recorded in Logged-over natural forest, with 42.9 % of overall tree species recorded during the study. Higher diversity of herbs and grasses were encountered in Tectona grandis plantation and agricultural land compared to other land use types. About 60.78 % of the diversity of climbers was recorded in the relatively undisturbed natural forest, while zero was recorded in Tectona grandis plantation. The presence of rare native tree species such as; Afzelia africana, Mansonia altisima and Lophira alata in Gmelina arborea plantation revealed that plantation of Gmelina could provide a favourable habitat for indigenous tree species if the method of land preparation were not destructive. Our results showed that planted forest especially of Tectona grandis and abandoned agricultural land could decrease significantly the diversity and composition of native species. Considering the importance of diversity in ecosystem stability, its therefore imperative to conserve indigenous plant species in planted forests to prevent ecosystem imbalance.

Keywords: Forest reserve, Plantation, Natural forest, Species diversity, Land use

INTRODUCTION

Rate of forest conversion are extremely high in most tropical regions and these changes are known to have important impacts on biotas and ecosystems (William, 2004). There has been considerable research interest in the management of Nigerian forest reserves on the distribution and abundance of indigenous biodiversity in relation to farming activities, logging methods and thinning practices within the reserves (Adeofun and Akinsanmi (1997), Phillips *et al.,* 2003; Ojo, 2004; Ogunleye *et al.,* 2004, Adekunle (2006). What is clear from most of these studies is that forest conversion and indiscriminate tree harvesting represents a major disturbance to the forest and results in the loss of a substantial number of indigenous species (Phillips *et al.,* 2003; Ojo, 2004; Ogunleye *et al.,* 2004, Adekunle 2006). Forest reserves were created to protect representative sample of natural ecosystems for preservation of biodiversity and ecological process, for scientific study, environmental monitoring, and education and for the maintenance of genetic resources in a dynamic and evolutionary state (Isichei, 1995). These form a cornerstone for preserving biodiversity in an increasingly degraded environment like ours. In Nigeria, substantial parts of most of the Forest Reserves in South western Nigeria (such as, Omo, Oluwa, and Olokemeji*)* have been converted for the establishment of monoculture plantations of *Gmelina arborea, Tectona grandis* and *Pinus carribea*, while encroachment by landless farmers for both plantation and arable agricultural activities has further impoverished many (Ola-Adams, 1996, Ogunleye *et al.,* 2004). Many of the reasons for this development have been the search for both increased and more reliable wood and pulp production to satisfy local demand. But, the influences and impacts of different exotic tree species used in plantation establishment on regeneration of indigenous species are still largely unknown. The replacement of native forests by exotic tree plantations can cause important changes in diversity and community composition at local and regional scales (Brockerhoff *et al*., 2001) with tendency of affecting the ecosystem processes. Human activities are changing the planet, inducing high rates of extinction and a worldwide depletion of biological diversity at genetic, species, and ecosystem level (Chemini and Rizzoli, 2003). Forest plantations, especially exotic single-species plantations, are thought to offer a less favourable habitat than natural forests (Hunter 1999, Hartley 2002) and have a reputation for being “biological deserts” (Allen *et al*., 1995, Dyck 1997). However, objectively evaluating the value of plantations for conservation purposes is not trivial (Brockerhoff *et al*., 2008) and thus requires the comprehensive assessment of different exotic tree species and land use pattern on regeneration and conservation of indigenous plant species. There is no enough quantitative information on the ability of plantation forests in conservation of indigenous species, since survival of larger number of indigenous species depend considerable on method adopted in land clearing prior establishment, method of tree harvesting, proximity of the plantation to adjacent forest of indigenous plant, presence of scattered native species within the plantation and silvicultural activities employ during nurturing of the plantation.

It is our aim therefore to supply information on quantitative floristic composition revealing the status of indigenous plant species abundance, diversity and similarity of the different land use types developed from Little-ose forest reserves so as to provide impetus in describing the impact of changing land use on the forest biodiversity in the study area.

MATERIAL AND METHODS

Description of the study area

Little-Ose forest reserve is in Emure Local Government Area of Ekiti State in Southwest Nigeria. The area lies approximately between Latitudes 07° 33' and 07° 35' N of the Equator and Longitudes 05° 33' and 05° 34' E of the Greenwich Meridian. The average elevation is 330 m above sea level. Little-Ose forest reserve covers an area of 26.62 km^2 and located within the lowland rainforest zone. The climate is humid Sub-tropical (Thornthwaite, 1948) with seasonal variation in rainfall, temperature and humidity. The raining season last from March to November with break in August when rain is relatively low while the dry season last from November to March. The temperature falls within a uniformly high mean monthly temperature of about 25^0C and an annual rainfall of about 1400 mm (Adeniyi, 1993). The geological description of the area by Dessauvagie (1975) and Ola-Adams and Hall (1987) shows that the area is gently undulating plain with underlying rock which is gneiss and crystalline is found in the basement complex of continuous weathering. The forest was constituted between 1924 and 1925 with gazette number No. 8 Vol. 2 of 5-3-153 part B.61.Order No.53. The part of the reserve with plantation was established through Taungya farming between 1986-1990. It had a sizeable number of economic tree species such as *Milicia excels, Khaya grandifolia and Sterculia species* which made it attractive to timber contractors. Apart from logging, agricultural activities within the reserve are commonly practised which is the main cause of forest depletion.

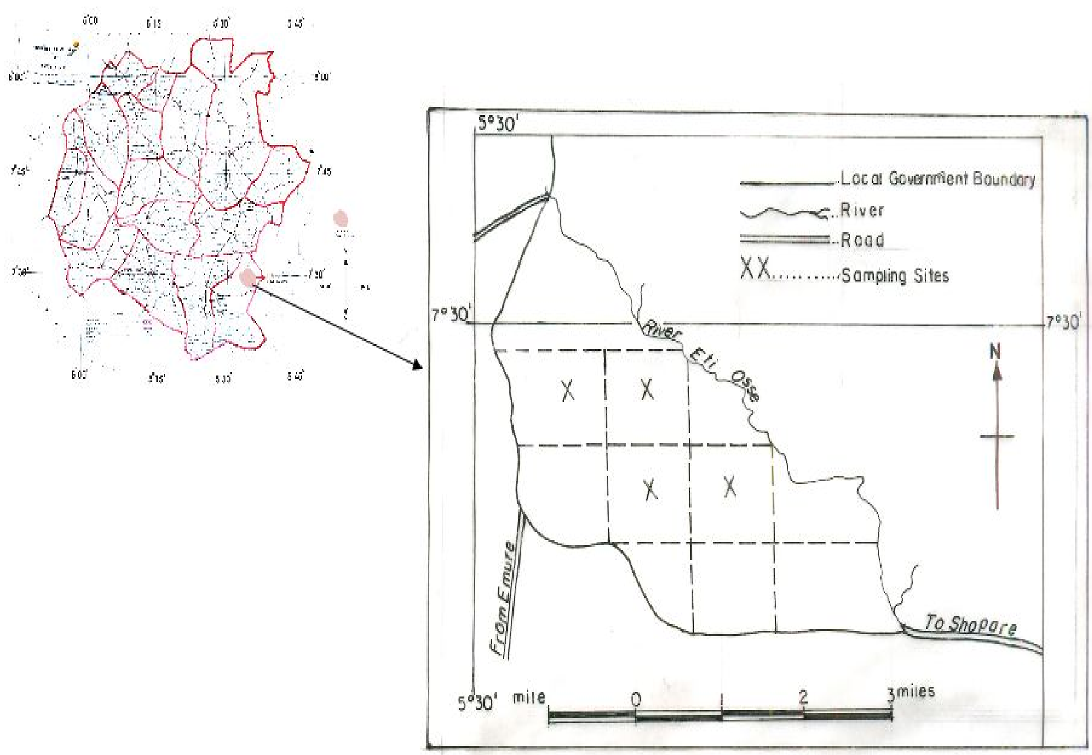

Figure 1. Map of Ekiti State, Nigeria, showing the location of Little-Ose Forest Reserve (inset).

Survey method

Systematic line transect was employed in the laying of the plots in each of the five land use types used for the study : relatively undisturbed natural forest serving as a control, logged-over natural forest, *Gmelina arborea* plantation, *Tectona grandis* plantation, and Agricultural land.. Two transects of 1000 m in length with a distance of at least 500 m between them was used in each of the study sites. Sampling plot of 50 m X 50 m in size was laid in alternate along each transect at 500 m interval and thus summing up to two sample plots per 1000 m transect and a total of four sample plots per land use type. The plant species were identified as far as possible on the site and those of unknown identity were collected as parts and pressed for later identification at the Department of Botany Herbarium, Obafemi Awolowo University, Ile-Ife. Each plant was classified into tree, shrub and climber while their families were also identified.

Plant Species Diversity Indices

The following biodiversity indices were used to obtain:

I. Species relative density (RD) number of individual per hectare was obtained using the formula according to Oduwaiye *et al*, (2003):

$$RD = \left[\frac{n_i}{N}\right] \times 100 \text{...(1)}$$

Where RD = relative density, n_i = number of individuals of species i and N = total number of individuals in the entire population.

II. Species diversity is the number of different species in a particular area. This was obtained using a mathematical formula that takes into account the species richness and abundance of each species in the ecological community. The equation for the Shannon-Wiener diversity index given by Price (1997) that was used is:

$$H^1 = -\sum_{i=1}^{S} p_i Lnp_i \text{...(2)}$$

H^1 is the Shannon diversity index, S is the total number of species in the community, p_i is the proportion of a species to the total number of plants in the community and Ln is the natural logarithm.

III. Species evenness (E) measures the distribution of the number of individual in each species. It was determined using Shannon's equitability (E_H) as stated by Kent and Coker (1992):

$$E = \frac{H^1}{Ln(S)} \text{...(3)}$$

S is the total number of species in each community.

IV. Sorensen's species similarity index SI of Nath *et al,* (2005) will be used to compare diversity across the study sites (shared species).

$$S.I = \frac{K}{K + a + b + c + d + e} \times 100 \text{..(4)}$$

Where, K is the number of plant species common all the land use type A, B,C,D, E, while, a, b, c, d and e are number of species peculiar to sites A, B, C, D and E respectively.

RESULTS

Based on the five land use types investigated (Table I), a comparison of the flora characteristics of the studied area showed that, total of 1,942 individual plants from 66 botanic families, 321 species of plants were encountered in the present study area. The predominant plant families were Apocynaceae, Euphorbiacea, Moraceae, Asteraceae, Rubiaceae, Poaceae, and Sterculiaceae. The species diversity index and evenness reduces from (4.26) and (0.69) for relatively undisturbed natural forest to (3.87) and (0.65) for logged-over forest.

Table 1. A Comparison of Plant Parameters at Little-Ose Forest Reserve.

Plant Species Variables	Relatively undistubed natural forest	Logged-over forest	*Gmelima arborea* plantation	*Tectona grandis* plantation	Agricultural land
Total number of individual/Abundance	474	558	312	202	396
Number of family	40	33	31	18	34
Number of species	99	72	52	30	60
Shannon-Weiner index	4.26	3.87	3.58	3.17	3.84
Evenness	0.69	0.647	0.623	0.597	0.642
Most Abundant Species	*Chromolena odorata, Rauvolfia vomitoria, Bridelia micrantha, Pterygota macrocarpa*	*Holarrhena floribunda, Chromolena odorata, Rauvolfia vomitoria, Bridelia micrantha*	*Chromolena odorata, Holarrhena floribunda, Cola gigantea, Mansonia altisima, Funtumia elastic*	*Chromolena odorata, Andropogon spp, Rauvolfia vomitoria*	*Chromolena odorata, Manihot ultissima, Zea mays*
Most abundant Family	Apocynaceae, Euphorbiaceae, Moraceae	Apocynaceae, Euphorbiaceae, Rubiaceae Moraceae Asteraceae	Apocynaceae, Euphorbiaceae, Poaceae, Sterculiaceae	Asteraceae, Poaceae, Apocynaceae, Moraceae	Asteracea, Euphorbiaceae, Poaceae
Habit description	Climber=62 Herb=14 Shrub=129 Tree=271	Climber=20 Herb=21 Shrub=91 Tree=426	Climber=16 Herb=22 Shrub=106 Tree=168	Climber=0 Herb=39 Shrub=53 Tree=86 Grass=24	Climber=4 Herb=124 Shrub=192 Tree=41 Grass=35

The reduction in species diversity index and evenness is significant low in *Gmelina arborea, Tectona grandis* plantation and agricultural land when compared with relatively undisturbed natural forest. Tree species composition accounted for over 60 % of all plant species in the study area. There were 271, 426, 168, 86, and 41 tree enumerated in relatively undisturbed natural forest, logge-over natural forest, *Gmelina arborea* plantation, *Tectona grandis* plantation and Agricultural land respectively. A total of 571 shrub stands were encountered during the study. It was comparatively higher in Agricultural land with 192 ha^{-1}, followed by relatively undisturbed natural forest, *Gmelina arborea* plantation and logged-over natural forest with 129 ha^{-1}, 106 ha^{-1} and 91 ha^{-1} respectively. The least number of shrubs were recorded in the *Tectona grandis* plantation with 53 shrub stands. A total of 220 herb stands were encountered, out of which 124 ha^{-1} were recorded in the Agricultural land to be the land use type with the highest number of shrubs. *Tectona grandis* plantation, *Gmelina arborea* plantation, logged-over natural forest and relatively undisturbed natural forest have 39 ha^{-1}, 22 ha^{-1}, 21 ha^{-1} and 14 ha^{-1} respectively in that order. Relatively undisturbed natural forest had 62 ha^{-1} numbers of climbers out of 102 encountered during the study in all the land use types investigated, this accounted for the highest number of climber stands in the study area. Logged-over natural forest, *Gmelina* and Agricultural land had 20 ha^{-1}, 16 ha^{-1} and 20 ha^{-1} of climbers respectively, while climber was not recorded in the *Tectona grandis* plantation. The abundance of grasses in Agricultural land and *Tectona grandis* plantation were 35 ha^{-1} and 24 ha^{-1} respectively. *Andrpogon gayanus, panicum laxum* and *panicum repens* were the most encountered grass stands in the study area. Absence of grasses was recorded in relatively undisturbed natural forest, logged-over natural forest, and *Gmelina arborea* plantation respectively.

DISCUSSION

Floristic Composition

Terrestrial biodiversity is closely linked to forest ecosystem but several forest species are threatened because of anthropogenic activities, including forest conversion, which has greatly altered forest structure, abundance of species and reducing species diversity. This transformation is dynamic and mechanism driven by poor intensification of agriculture, which has impoverished the secondary forest and degraded lands. A comparison of the flora characteristic of the study area revealed that, shrubs and herbaceous species had preponderance over tree species in plantation forestry and agricultural land. This is in consonance with Neeraj *et al.,* (2001) that Opening of canopy during forest disturbances provides greater opportunity for the recruitment of shrubs and herbs. Climbers are to a large extent dependent on trees for their support, the result showed that there are more climbers in relatively undisturbed natural forest compared to other land use types. Climber was not recorded in *Tectona grandis* plantation. Without adult trees, large clmbers are unlikely to occur, because they are less flourish in the forest with large gaps. This study take into consideration the species diversity and observed a significant reduction in the species diversity index of other land use types compared to relatively undisturbed natural forest during the investigation. This is an indication that land use changes had led to loss of some native species, especially highly south after economic wood in this reserve.

Table 2. Sorensen's species similarity in the different Land use types.

Perculiar to Teak plantation	Perculiar to Agricultural land	Perculiar to relatively undisturbed	Perculiar to logged-over	Perculiar to Gmelina plantation	Species Common to All
Spondias mombin	*Abutilon mauritianum*	*Achormanes difformis*	*Albizia ferruginea*	*Afzelia africana*	*Chromoleanaodorata*
Acanthus spp	*Adenia cissampeloides*	*Anacardium occidentalis*	*Aluphyllus Africana*	*Elaeis guineensis*	
Acroceras zizanioides	*Besmidia laurac*	*Cleistopholis patens*	*Bahumia plistigma*	*Cola gigantea*	
Amaranthus spinsus	*Calotropis procera*	*Culcasia spp*	*Boerhavia diffusa*	*Ficus exasperata*	
Bidens pilosa	*Cola acuminate*	*Holoptelia grandis*	*Bridelia cordifolia*	*Myrianthus arboreous*	
Brachiaria deflexa	*Cola hispida*	*Mangnifera indica*	*Combretum zenkeri*		
Combretum hispidum	*Culcasia spp*	*Milicia exelsa*	*Desmodium scorpiurus*		
Conyza sumatrensis	*Cuviera acutiflora*	*Monodora tenuifolia*	*Etanda gigers*		
Cyperus haspan	*Dichaptalum barteri*	*Smilax kraussiana*	*Hewitta sublobata*		
Diodia sarmentosa	*Diospyros mobuthensis*	*Treculia tragacantha*	*Hypoestes forskalei*		
Eragrostis tenella	*Diospyros spp*	*Zanthoxylum zanthoxyloides*	*Ipomoea triloba*		
Euphorbia hirta	*Hippocratea spp*		*Lophira alata*		
Heliotropium ovalifolium	*Keetia venosum*		*Mansonia altisima*		
Heterotis rotundifolia	*leptodemis micrantha*		*Merremia aegyptia*		
Indigofera hirsute	*Manniophyton fulvum*		*Olax subcopiodea*		
Ipomoea aquatic	*Manothus sobulathus*		*Smilax anceps*		
Ipomoea asarifolia	*Memocylon blakeioides*		*Trema orientalis*		
Kyllinga bulbosa	*Microdemis puberula*		*Triumfetta cordifolia*		
Ludwigia abyssinica	*Napolleona imperialis*				
Mariscus longibracteatus	*Octolobus spp*				
Mimosa pudica	*Pauridiantha hirtelia*				
Musa spp	*Piper guinensis*				
Newboldia laevis	*Rinorea weilwitschi*				
Parkia clapertoniana	*Rothmannia white*				
Paspalum conjugatum	*Rythigysia spp*				
Pennisetum pedicellatum	*Secamone afzeli*				
Plastostoma africanum	*Smilax kraussiana*				
Reissantia indica	*Sphenocentrum jollyanum*				
Sclerocarpus africanum	*Tremia ivorensis*				
Senna hirsute	*Tricalysia macrophylla*				
Sida acuta	*Trichilia heudelotii*				
Solanum torvum	*Trichilia prieureana*				
Solenostemon monostachyus	*Vitellaria paradoxa*				
Spigelia anthelmia	*Vitex paradosa*				
Synedrella nodiflora					
Tithonia diversifolia					
Vernonia amydalina					
Zea mays					

Hunter (1999) and Hartley (2002) reported that forest plantations, especially exotic single-species plantations, are thought to offer a less favourable habitat for indigenous species than natural forests. This could be the case in this forest reserve where we have fewer adult and wildlings of indigenous economic species in plantations and agricultural land. This revealed that the ecosystem studied had been adversely affected and disturbed by the growing human population engaging in farming activities within the reserve. As a result some species were endangered while several others are missing from the ecosystem.

Family Composition

The predominant plant families in the study area were Apocynaceae, Euphorbiaceae, Moraceae, Rubiaceae, Poaceae and Asteraceae. The families Apocynaceae, Moraceae and Euphorbiaceae were reported by Ihenyen *et al.* (2010) in Ehor forest reserve in Edo State to be among the dominant families in that forest reserve. This also agrees with Omorogbe, (2004) who also found Euphorbiaceae, Moraceae, Rubiaceae, and Apocynaceae to be among the dominant families in Sakpoba forest reserve. It conforms to the position of Adekunle (2006) that Moraceae and Euphorbiaceae were among the species that dominated Omo, Shasha and Ala forest reserve respectively all in the south western Nigeria. Apocynaceae, Euphorbiaceae and Moracea had the widest most predominant stands in all the land use types investigated. Asteracea and Poaceae were both among the most abundant families in other land use types except relatively undisturbed natural.

Tree Species Diversity

Tree species composition accounted for over 60 % of all plant species in the study area. There were 271, 426, 168, 86, and 41 tree species enumerated in relatively undisturbed natural forest, logge-over natural forest, *Gmelina arborea* plantation, *Tectona grandis* plantation and agricultural land respectively. This revealed to a large extent that total plant diversity depend on tree diversity. The heaviest lost of tree species was on the agricultural land. The number of tree encountered still falls within the range of tree species count per hectare of 20 to 223 as specified for tropical forests (Whitemore, 1984), with the exception of higher number of trees recorded in the logged-over natural forest. *Rauvolfia vomitoria,* and *Pterygota macrocarpa* were the most abundant tree species in the relatively undisturbed natural forest, while the logged-over forest have these three species and *Holarrhena floribunda* among the most abundant tree species. The kinds of tree species observed mostly in this area are lesser sought after species, this indicates that the area has been previously logged, during which valuable economic trees have been exploited. *Gmelina arborea* plantation has *Cola gigantea, Mansonia altisima,* and *Funtumia elastica* as the most abundant indigenous tree species. The presence of *Mansonia altisima, lophira alata*, and *Afzelia africana* in *Gmelina arborea* plantation revealed that these sought after endangered species have the potential of co-habiting *Gmelina arborea*. Apart from *Rauvolfia vomitoria* which was relatively present, most other tree species found in other land use were absent in the *Tectona grandis* plantation. This is in agreement with Myers, (1996) that the capacity of the *Tectona grandis* plantation to provide co-benefit by supporting other plants will be much less than that of the rain forest.

This could be explained on the allelopatic influence of *Tectona grandis* on other tree species whose evolutionary history is seldom connected (Jose, 2003). Tree species were least recorded in the agricultural land. Ogunleye *et al.*(2004) also reported low diversity of tree species in agricultural land in Olokemeji forest reserve, resulted from the extensive and intensive farming activities as most species in the zones had been cut down during farm clearing.

Sorensen's Similarity Index between Paired Land Use

The Sorensen's species similarity values indicated that there was high variability in the species composition among the land uses types investigated in the study area. The lower the similarity index values the higher the heterogeneity between the paired land use types. The demonstration of low value of similarity gives the impetus that land use changes could adversely affect plant species composition. This agrees with the findings of Ogunleye *et al.* (2004) in Olokemeji forest reserve who recorded low similarity values between the different land use types investigated. Turner *et al.* (1995) have reported that variability increased as the ratio of the disturbance interval to the recovery interval decreased. The continuous extractions of wood from this forest coupled with the unsustainable agricultural practices also contribute to the low similarity index values recorded in the study area.

CONCLUSION

From the preceding analyses, the development of plantations and agricultural land from Little-Ose forest reserve has not only transformed the physical landscape but also impacted negatively on the biological community of tree plants in both *Tectona grandis* plantation and agricultural land. Conversely, *Gmelina arborea* plantation provide habitat for a number of indigenous species and as such can contribute to their conservation. The effect of this growing land use change in *Tectona grandis* and agricultural land in the study area on native biodiversity is threatening, because it reduce significantly the abundance of native of indigenous plants, including rare and economic tree species. These findings can help guide afforestation and food security programs in the tropics, including those aimed at increasing terrestrial carbon sequestration. There is no enough quantitative information on the ability of plantation forests in conservation of indigenous species, since survival of larger number of indigenous species depend considerable on method adopted in land clearing prior establishment, method of harvesting, proximity of the plantation to adjacent forest of indigenous plant, presence of scattered native species within the plantation and silvicultural activities employed during nurturing of the plantation. This is clearly a key research need for the better understanding and management of our forests resources.

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