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Natural Regeneration of Indigenous Tree Species in a Mixed Stand of Exotic Tree Species at a Reclaimed Mine Site in Ghana

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ABSTRACT

The study was conducted to identify naturally regenerated indigenous tree species and their relative distributions and family diversities at Noble Gold Bibiani Limited. The total stand area of 10 hectares was demarcated and divided into four blocks of 2.50 hectares each. Fifty circular sample plots with radius of 12.6m with an estimated area of 500m^2 were laid in each block. Simple Random sampling was used to select five sub-plots. It was realized that natural regeneration of 25 indigenous tree species belonging to 16 tree families were identified under the stand. *Trichilia monadelpha* was the dominant tree species representing 24.9%. The least dominant tree species each representing 0.4% included *Terminalia ivorensis*, *Pterygota macrocarpa* and *Mansonia altissima*. The calculated Diversity Index of the native tree species was 2.44 by using Shannon Wiener Index formula, indicating a high species diversity of indigenous trees on the reclaimed site. The pre-felling inspection report of the area in year, 2000 collected from Forest Services Division, Bibiani confirmed that the identified 25 tree species and 16 families existed in the site before the mining operation began. However, three tree families that previously existed in the site were absent and these included *Guttiferae*, *Euphorbiaceae* and *Rubiaceae*.

Keywords: Natural regeneration, Indigenous tree species, exotic tree species, reclaimed site.

INTRODUCTION

Artificial forest regeneration is perhaps the only alternative in restoring forest landscapes especially on degraded soils. Low soil fertility, soil compaction after decommissioning of mining, and invasion by grasses and other aggressive vegetation can be serious obstacles to natural forest regeneration. There is a need for tree species that can grow in its natural environment to yield useful products as well as environmental benefits (Mongtagnini, 2006).

According to Mongtagnini, (2006), during forest landscape restoration, native or indigenous tree species is more preferable to exotic species because the major goal of vegetation restoration is to return a habitat to a more desirable condition involving a particular species composition, community structure, and/or a set of ecosystem functions that existed before disturbance. The preferred choice for vegetation restoration is the natural regeneration of indigenous species. Planting would only be a secondary option, to be used in cases where natural regeneration cannot proceed due to the obstacles such as poor soil conditions, long distances to seed sources, isolation, and invasion by aggressive grasses and herbs (Noss, 1990).

Considering the relevance of both indigenous and exotic species in mine site reclamation, it is important to know their ecological characteristics. These characteristics include growth rates and light requirements among others to enhance species selection for reclamation activities. Although the idea of using indigenous species in vegetation of abandoned mine site is now widely accepted, mostly exotic tree species are used. The fast growth rate and the ability of exotic tree species to reach their reproduction stage as early as possible, there is likelihood of massive seed production which has the ability to regenerate naturally and colonize the entire stand. There is however, the need to investigate into the natural regeneration of indigenous tree species, because they comparatively perform better than exotic species on their native lands. This study therefore identified naturally regenerated

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indigenous tree species under the stand and also determined the relative distribution of the naturally regenerated indigenous tree species under the stand.

MATERIALS & METHODS

Study Area

The study was carried out in the Central Waste Dump 'A' plantation stand at Noble Gold Bibiani Limited. The stand was established with both exotic and indigenous species and has a total stand area of ten hectares. The plantation site is located 1.0 km North-West of Bibiani. The average annual rainfall is between 1500mm and 1800mm. The average temperature is between 25˚C and relative Humidity is between 65% and 80%. The mixed stand of the Exotic tree species is made up of *Gmelina arborea, Cassia siamea, Azadirachta indica, Leucaena leucocephala, Cedrella odorata, Catalpa speciosa and Eucalyptus spp.* The most dominate species is *Leucaena leucocephala*

EXPERIMENTAL PROCEDURES

The total stand area of 10 ha was demarcated and divided into four (4) blocks. Each block has an area of 2.50 ha. Fifty (50) circular sample plots (sub plots) with radius of 12.6m with an estimated area of 500m^2 were laid in each block. Circular plots were used because of its unique nature unlike that of rectangular shapes.

Under the circular plots, the same radius is used for all the selected areas but different dimensions could be used to represent the same area. Simple Random sampling was used to select five (5) sub-plots from each block for data collection. A total of 20 out of 200 sub-plots were selected for the study. Geographical Positioning System (GPS) was used to take the coordinates of the center of each sub-plot. The sampling Intensity was 10%.

All Exotic tree species within each sample plot were identified and enumerated to indicate their dominance in the various sub-plots and its effect on natural regeneration. All the naturally regenerated indigenous tree species of all sizes in each sample plot were identified and enumerated.

The Shannon Wiener index was used for computing the species diversity because it combines two quantifiable measures that is, the species richness and species equitability

DATA ANALYSIS

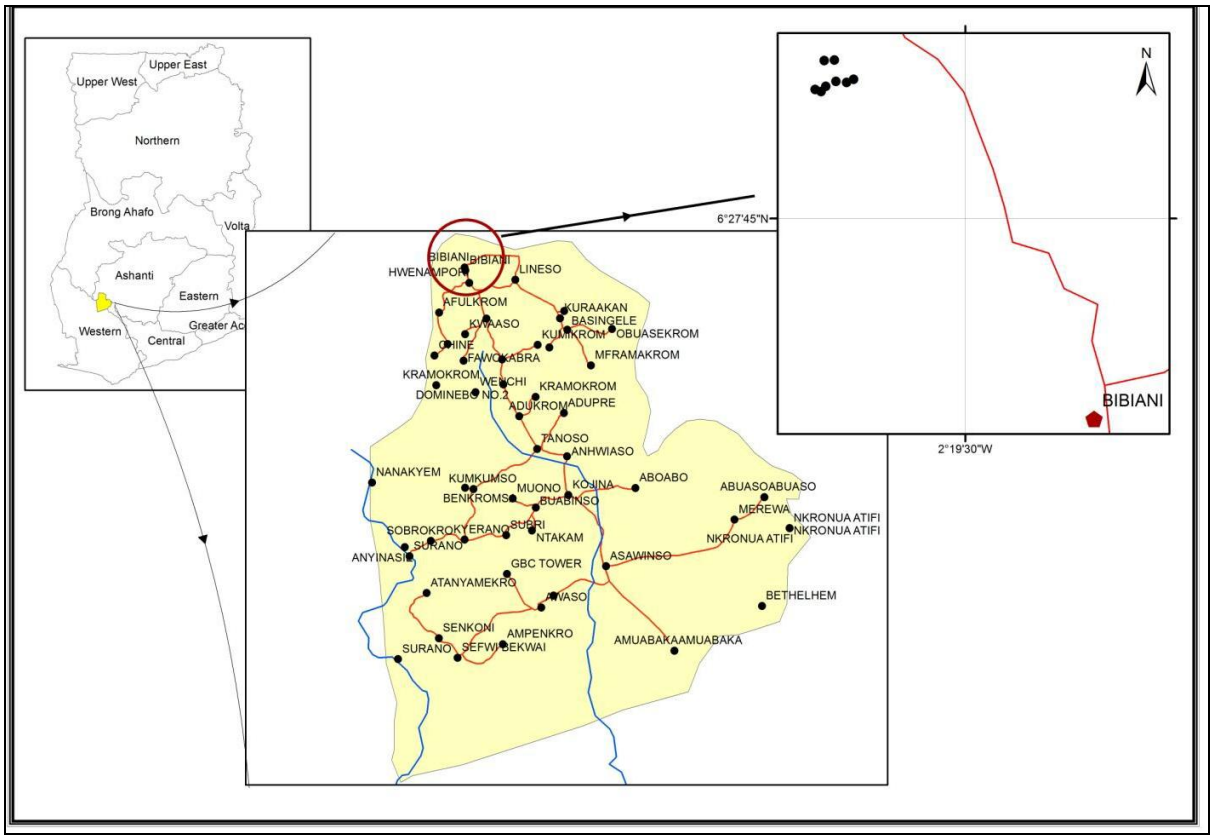

Plate1. *A map showing the Central Waste Dump 'A' plantation stand at Noble Gold Bibiani Limited.*

The data on naturally regenerated indigenous tree species were presented in tables and graphs. The frequencies of the various species were computed and presented in graphs.

Species diversity and richness were computed using Shannon-Wiener diversity index (HI),

HI = -∑ p iInp i,

Where pi = ni/ N

ni is the number of individual tree species identified.

N is the sum total of all the individual tree species identified.

RESULTS

Naturally Regenerated Indigenous Tree Species

A total of 25 indigenous tree species were enumerated (identified) within the four blocks containing sampling plots. The most dominant tree species identified was *Trichilia monadelpha (Tanuro) representing 24.9%. The least dominant tree species identified were Terminalia ivorensis, Glyphaea brevis, Morus mesogygia, Spathodea campanulata, Pterygo macrocarpa, Mansonia altissima, Pynanthus angolensis, Triplochitin scleroxylon* each with a percentage of 0.4%.

Table1. *Naturally regenerated indigenous tree species identified at the study area.*

Local Name	Scientific Name	Spp Abbrev.	Frequency	Percentage
Tanduro	*Trichilia monadelpha*	Trm	59	24.9
Edinam	*Entandrophragma angolense*	Ea	2	0.8
Onyina	*Ceiba pentandra*	Cp	39	16.5
Esa	*Celtis mildbraedii*	Cem	35	14.8
Nyamedua	*Astonia boonei*	Abo	16	6.7
Funtum	*Funtumia elastica*	Fue	3	1.2
Kakapenpen	*Rauvolfia vomiteria*	Rau	3	1.2
Ofram	*Terminalia superb*	Ts	15	6.3
Emire	*Terminalia ivorensis*	Ti	1	0.4
Awudifokete	*Veronia conferta*	Ver	13	5.5
Akyee	*Blighia sapida*	Bls	11	4.6
Watapuo	*Cola gigantia*	Cog	9	3.8
Wawa	*Triplochitin scleroxylon*	Tri	1	0.4
Wonton	*Morus mesogygia*	Mor	1	0.4
Oprono	*Mansonia altissima*	Man	1	0.4
Koto	*Pterygota macrocarpa*	Ptm	1	0.4
Kyenkyen	*Antiaris toxicaria*	Ant	7	3
Nyankyerene	*Ficus exasperata*	Fie	2	0.8
Hotrohotro/Fotie	*Hannea klaineana*	Han	5	2.1
Dwene	*Baphia nitida*	Bap	4	1.7
Okoro	*Albizia zygia*	Abz	4	1.7
Asafena	*Pouteria altissima*	Pou	2	0.8
Otie	*Pycthanthus angolensis*	Pyc	1	0.4
Foto	*Glyphae abrevis*	Gly	1	0.4
Akokonisuo	*Spathodea campanulata*	Spa	1	0.4
TOTAL			**237**	**100**

Relative Distribution of the Families of the Indigenous Tree species

A total of 25 indigenous tree species were identified within the four blocks containing sampling plots. This total number of trees is distributed in sixteen tree families. The various tree species identified were categorized into their respective families. The *malvaceae* family recorded the highest percentage of 20% of the category while *sapindaceae, sapotaceae, ulmaceae, tiliaceae, bignoniaceae, apocynaceae, leguminosae, bombacaceae, mysristicaeae* and *simaroubaceae* each recorded 4%.

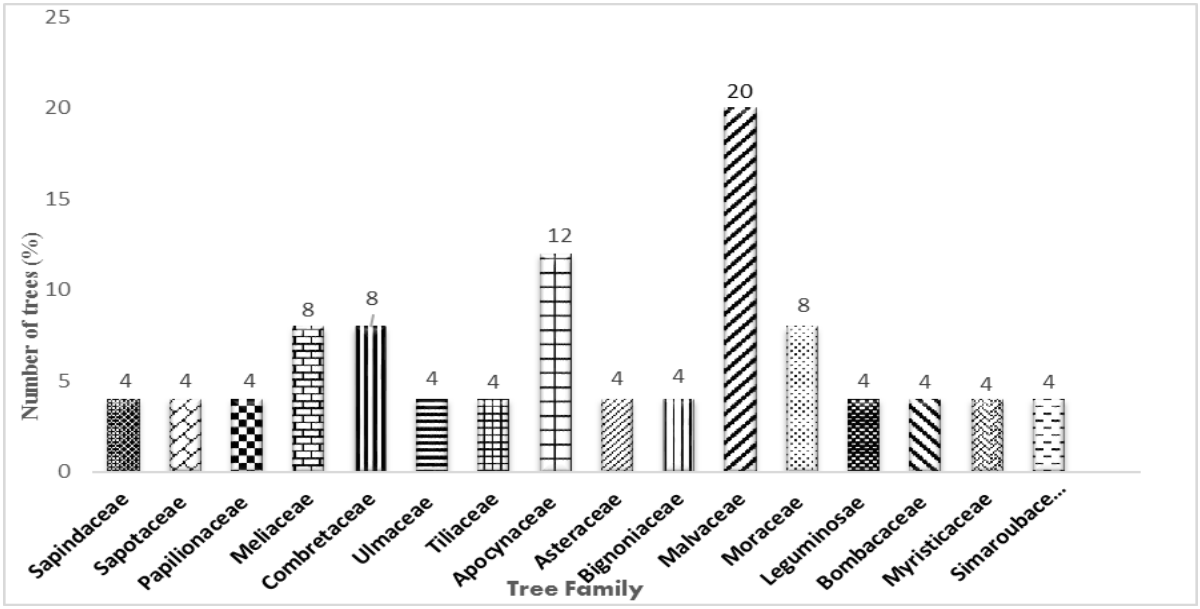

Figure1. *Relative Distribution of Tree Families*

Table2. *Comparison of referenced ecosystem and reclaimed ecosystem*

Family	Tree Species	Ref. Site	Reclaimed Site
Meliaceae	*Trichilia monadelpha*	Present	Present
	Entandrophragma angolense	Present	Present
Bombaceae	*Ceiba pentandra*	Present	Present
Ulmaceae	*Celtis mildbraedii*	Present	Present
Apocynaceae	*Astonia boonei*	Present	Present
	Funtumia elastica	Present	Present
	Rauvolfia vomiteria	Present	Present
Combretaceae	*Terminalia superb*	Present	Present
	Terminalia ivorensis	Present	Present
Asteraceae	*Veronia conferta*	Present	Present
Sapindaceae	*Blighia sapida*	Present	Present
Malvaceae	*Cola gigantia*	Present	Present
	Triplochitin scleroxylon	Present	Present
	Morus mesogygia	Present	Present
	Mansonia altissima	Present	Present
	Pterygota macrocarpa	Present	Present
Moraceae	*Antiaris toxicaria*	Present	Present
	Ficus exasperata	Present	Present
Simaroubaceae	*Hannea klaineana*	Present	Present
Papilionaceae	*Baphia nitida*	Present	Present
Leguminosae	*Albizia zygia*	Present	Present
Sapotaceae	*Pouteria altissima*	Present	Present
Myristicaceae	*Pycnanthus angolensis*	Present	Present
Tiliaceae	*Glyphaea brevis*	Present	Present
Bignoniaceae	*Spathodea campanulata*	Present	Present
Euphorbiaceae	*Ricinodendron heudelotii*	Present	**Absent**
	Macaranga bateri	Present	**Absent**
Guttiferae	*Garcinia kola*	Present	**Absent**
Rubiaceae	*Nauclea diderrichii*	Present	**Absent**

DISCUSSION

The greater abundance of *Trichilia monadelpha* species on the site can be attributed to the fact that its seeds are dispersed by birds which feed on the seeds and are transported from far distances to the site. This is also observed by Krystyna *et al.*, (2000), who reported that deposition of seeds will not necessarily decline with increasing distance from the seed source of trees but may peck at particular locations where birds nest or perch. It could also be possible that some of the indigenous tree species had regenerated from the seed bank of the soil that was used to refill the site. Kimmins, (1987)

indicated that the seed droppings vary as a function of distance from wind-dispersed seeds and any other factor that influences seed dispersal and the seeds dropping contributes to the seed bank; the population of living but un-germinated seeds contained in the soil.

Other species which have relatively high percentage of natural regeneration under the stand include *Ceiba pentandra, Terminalia superba, and Celtis mildbraedii*. The seeds of these tree species are dispersed by wind and since their locations are very close to the plantation stand, they serve as seed source to promote natural regeneration. Krystyna *et al*., (2000) had observed that in restoring degraded landscapes, two aspects of seed dispersal will contribute to future plant community patterns. The first aspect is the removal and deposition of seeds from the plants that were introduced and second is the transport of seeds onto the sites from surrounding vegetation.

The natural regeneration of tree species like *Triplochitin scleroxylon, Entandrophragma angolense, Terminalia ivorensis and Mansonia altissima* were not encouraging under the stand. This could be attributed to the fact that *Triplochiton scleroxylon* does not fruit annually and the fruiting cannot be predetermined. Other tree species namely *Entandrophragma angolense, Terminalia ivorensis,* and *Mansonia altissima* had been over exploited in the adjacent ecosystem and no single tree of the species was located very close to the site to serve as seed tree. This is in accordance with Gordon and Cushman, (1996) who mentioned that repeated clearing depletes soil seed stocks and decreases the species diversity of the stand.

The natural regeneration of indigenous tree species in the plantation was less diverse than in the reference ecosystem. The study revealed that some indigenous tree species found regenerating in the plantation had representation in the reference ecosystem. However the families of *Guttiferae, Euphorbiaceae* and *Rubiaceae w*hich were previously present in the reference ecosystem were absent in the reclaimed mine site. The absence of these families in the site may be due to the destruction of the parent trees through farming activities. Gordon and Cushman, (1996) reported that repeated clearing depletes soil seed stock and decreases the species diversity of the stand.

The value of Shannon Wiener diversity index is between the range of 1.5 and 3.5 and value obtained in this study was 2.44 and this value indicates that indigenous tree species diversity is high on the reclaimed site Diversity indices provide more information about community composition than simply species richness (that is, the number of species present); they also take the relative abundance of different species into account (that is, species evenness). Diversity indices provide important information about reality and commonness of species in a community and it is the most important aspect of plant distribution. Malvaceae family which contains most of the important economic tree species was the highest in terms of diversity as indicated in figure 1. The family comprises Scarlet star species which are threatened due to over-exploitation (Abu and Hawthorne, 1995). It is therefore anticipated that when full restoration process is achieved, a lot of economic species will be present. The high diversity of the Malvaceae family shows that the reclaimed site would be rich with species of high economic index. Chadzon, (2008) had reported that in restoration ecology, introduction of exotic species leads to restoration of productivity but not the biological diversity. Consequently, to achieve restoration ecology, reintroduction of species existing in the pre-disturbed area should be encouraged. The species diversity and richness obtained from this study can be enhanced by direct reintroduction of species that existed in the pre-disturbed land.

CONCLUSION

The study revealed that 25 indigenous tree species were identified within the four blocks containing sampling plots. This total number of trees is distributed in sixteen tree families. The *Malvaceae* family had the highest species distribution and this indicates high economic index when full restoration is achieved. The least family distribution included *Sapindaceae, Sapotaceae, Papilionaceae, Asteraceae, Tiliaceae, Ulmaceae* and *Myristicaceae.* High species diversity was recorded 2.44 using Shannon-Wiener Diversity Index and this indicates that regeneration of indigenous species on the reclaimed site is fairly high. The findings of the study also revealed that the growth of *Leucaena leucocephala* tree species did not enhance natural regeneration of indigenous tree species under the stand. It is therefore recommended that regular thinning should be carried out in the areas where exotic tree species are dominating especially *Leucaena leucocephala* to enhance natural regeneration of indigenous species.

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