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FLORISTIC COMPOSITION AND SOIL CHARACTERISTICS OF PLANTATION FOREST IN NORTHWEST SAMAR STATE UNIVERSITY, SAN JORGE CAMPUS

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Abstract

The study was conducted to assess the floristic composition and the soil characteristics in a plantation forest of NwSSU San Jorge Campus. Descriptive statistics was utilized to treat the data collected for vegetation and soil characteristics. Pearson's correlation was utilized to test the interrelationship between the soil and vegetation in the study area. Results showed that the floristic composition in the study site has starting to resemble that of the secondary forest. Floristic diversity is also comparable to the diversity of secondary forest. Diversity and evenness distribution though cannot be associated with the physiographic locations as the results have shown more diverse vegetation in a potentially erodible soil of the mid-slope than that of the upper and lower slope. Life forms in the plantation forests are mostly trees and shrubs. Soil physical properties indicated that the surface layers of the profiles contain considerable amount of humic materials which had caused the darker hues of the soil. Soil pH is considered to be in the tolerable range for crop production. Basically, the soil in the plantation forest is sandy clay loam. Organic matter is high in the lower slope than in the upper and mid-slope which was attributed to the continuous deposition and accumulation of organic materials. Nitrogen availability is relatively considered low to moderate for plant growth across all the physiographic locations. Phosphorus (P) on the other hand was found to be the limiting nutrient in the site, wherein the amount present is considered below the required amount for crop production. Upper and lower slope had higher potassium (K) content than the mid-slope. Results of the correlation analysis showed that there is high correlation between the soil organic matter and tree size. This indicates that the higher soil organic matter the bigger is the tree size.

***Keywords**: Floristic composition, soil characteristics, plantation*

INTRODUCTION

Forest plantations are forests established by planting or/and seeding in the process of afforestation or reforestation. The decline in the Philippine forest cover led to the establishment of forest plantations by private individuals, community groups, public and private entities to meet the increasing demand of the growing population for food and other forest-based products.

Establishment of forest plantations is usually carried out using single species planted at uniform distance, or a mix of 2-3 species depending on the purpose of establishment. Those plantations established for commercial or production purposes utilized single species of crop that developed into monoculture. On the other hand, plantations established for biodiversity conservation utilized mix species. Monoculture plantations had been the subject of criticism by environmentalists as it does not support biodiversity conservation since most of exotic species are invasive. However, for mixed species plantations, the chance of it developing later on into a secondary forest is possible according to the recent study conducted by Otuoma, Ouma, Okeyo and Anyango (2014). This means that forest plantations, if left undisturbed will later on develop into secondary forest.

Studying floristic composition in such land-use will give one insight as to the future management regime like enrichment planting and species monitoring. Furthermore, the results on the floristic composition will serve as baseline information that will further support the claim that plantation forest will later on undergo ecological succession since species composition in every ecological succession stage varies. This means that early succession forest has different species composition compared to the late succession forest. The change in species composition of the plantation is also determined by the characteristic of the plant substrate or the edaphic factor. To some extent, it also affects the growth and survival of planted tree species.

The forest plantation in NwSSU San Jorge, Samar was established in 1989, while some of its parcels were planted in 2010. Considering that it is a plantation, only few floral species can be found in the area which is not sufficient to provide a comprehensive data on the overall floristic composition of the plantation. Furthermore, other factors affecting the growth and distribution of plant species were also not considered. The findings should provide insights as to the appropriate species suited for the different slope category and for a specific soil characteristic.

Hence, the study in general was conducted to assess the floristic composition and soil characteristics of forest plantation in NwSSU, San Jorge Campus and specifically aimed to a.) assess the floristic composition and distribution in the three different physiograhic categories; b.) determine the biodiversity index and stocking volume per physiographic category; c.) describe the soil characteristics in the three physiographic categories; and describe the relationship between vegetation and soil characteristics.

MATERIALS AND METHODS

The Study Site

The study was conducted in Northwest Samar State University, San Jorge Campus, San Jorge, Samar from August 2016 to June 2017. Site is located 11°58’51” N and 124°49’26” E. Its climate type is Type II which is characterized by having no distinct wet and dry season. Rainy periods are occasionally observed from the month of October to January with maximum rainfall on the month of December.

Vegetation Sampling

A 10% sampling intensity was employed. Three 20 m x 20 m plots were purposively established in each of the slope category for tree measurements. For the whole study site, a total of 9 major plots were established, covering a total area of 3,600 sq. m. Purposive sampling was utilized to capture and record most of the floral species found in a specific slope category. For shrubs and other understorey species, two 2 m x 2 m sub-plots were laid out within the major plots. For ground vegetation collection, two 1 m x1 m subplots were nested within each of the major plots.

Soil Sampling

Soil samples were collected from the surface soils at a depth 0 – 20 cm across different physiographic positions. All soil samples were placed in properly labelled plastic bags, air-dried, pulverized using a wooden mallet, and sieved using a 2-mm wire mesh to get the fine earth for the determination of most soils physical and chemical properties. Prior to chemical analysis, soil physical properties such as soil color, soil texture, soil structure and other physical distinguishing features were characterized. In terms of chemical properties, enough soil samples were grounded and allowed to pass through a 0.425 mm wire mesh. Thereafter, soil samples were brought to Philrootcrops, Central Analytical Services Laboratory (CAS-L), VSU, Visca, Baybay City, Leyte for pH,OM, Nitrogen, Phosphorus and Potassium analysis.

Data Collection

All tree species within the 20 m x 20 m plot were identified and recorded according to its common name, scientific name and family names. Diameter-at-breast height (DBH) was measured using a diameter tape while tree height was measured using calibrated poles and clinometer. All shrubs within the 2 m x 2 m sub-plots were counted and recorded according to its family name, common name and scientific name. For ground vegetation, all species (including wildlings and grasses) within the 1 m x 1 m sub-plot were identified, counted and recorded in terms of its common name, scientific name and family name.

Floristic Composition and Distribution

In terms of the floristic composition, data were treated using descriptive analysis. All species encountered per vegetative stratum within every physiographic category were listed according to their family names, scientific names and common names. Frequency count was tallied for species in the understorey and ground layer. Floristic species encountered were also categorized according to their habit, whether it was a tree, a shrub or a grass. The uniformity of distribution was determined using the evenness diversity index with the following formula;

Evenness Index = H/Log S where: H = Shannon Weiner diversity index
S = Total number of species

Diversity Index and Volume

Diversity index per physiographic category was computed using the Shannon-Weiner Diversity index with the following formula;

$$H = \sum_{i=1} - (P_i * \ln P_i)$$

where:

H = the Shannon diversity index
P_i = fraction of the entire population made up of species i
S = numbers of species encountered
$\sum$ = sum from species 1 to species S

The volume of trees encountered was computed using the International Log Rule for volume computation, as follow;

$$V = 0.7854\mathrm{d}^2\mathrm{L}$$

Where : V = volume
d = diameter
L = length or merchantable height

Soil Analysis

All processed soil samples were subjected to the following chemical analysis: Soil pH was potentiometrically determined at 1:2.5 soil water ratio (ISRIC, 1995). Total nitrogen was quantified by micro-kjeldahl method (Bremner and Mulvaney, 1982) and organic matter using the Walkley-Black method as described by Nelson and Sommers (1982). The available phosphorus was extracted using the Bray-2 method (ISRIC, 1995) and absorbance was read using spectrophotometer (Spectronic 20D). Exchangeable K was quantified using the atomic absorption spectrophotometer (Varian Spectra 220 FS).

Soil-Vegetation Relationship

The relationship between soil and vegetation was analyzed using Pearson's correlation analysis.

RESULTS AND DISCUSSION

Floristic Composition and Distribution

A total of 45 floral species in 30 families and 41 genera were encountered in the plantation forest of NwSSU-San Jorge Campus. Of the 45 species, 13 of which were trees or that species occupying the upper storey, 31 species were encountered in the shrub layer and 24 species on the ground layer. The sum total of the species for the 3 vegetative layers may exceed the total species count for the whole plantation as some of the species appears in the 3 layers especially the tree species. It was observed that most tree species appear in the upper storey as tree, on the shrub layer as sapling and on the ground layer as wildling. Of the recorded species, only those appearing in the upper storey layer were planted. Those occurring on the shrub layer and ground layer were naturally growing. This observation justifies the claims of related studies that plantations if left undisturbed, will later on undergo ecological succession and will develop into secondary forest.

Table 1 presents the floristic composition of the plantation forest in NwSSU San Jorge Campus. Of the 30 families recorded, Moraceae is the most represented family which has a total of 5 species. These 5 species occurred mostly in the shrub layer though at maturity their habit is basically tree. It is also worth noting the high frequency of pioneer species mostly belonging to Moraceae family. Fabaceae has ranked 2nd in terms of species representation per family.

A total of 4 species were recorded for the said family. Out of these species, only one species (*Pterocarpus indicus*) is considered as tree. The other 3 species are classified as broadleaf weeds. Families Mimosaceae, Graminae and Verbenaceae were each represented by 3 species, while Guttiferae and Rubiaceae were each represented by 2 species. Other families were each represented by single species.

Floristic composition in the plantation forests were classified into 4 categories. These were trees, shrubs, grasses and/or weeds and ferns. Figure 2 shows the frequency and percentage of the various life forms in the plantation. Trees account for 33% of the total composition which is similar to shrubs that also accounts for 33%. Weeds and grasses account for 24% of the total floristic composition while fern and other habit account for 8% and 2% of the total species, respectively.

In terms of floristic distribution, it was given that some tree species like *Gmelina arborea* and *Sweitenia macrophylla* were found in the 3 physiographic categories since the site on study was plantation forest (Table 1). There were some species though that were naturally growing and were also observed to be common in the 3 physiographic locations. These species include *Fagraea racemosa*, *Cratoxylum formusom*, *Mussaenda philippinensis* and *Leucosyke capitellata.* The occurrence of weeds and/or grasses was observed to be common in the lower slope. The computed evenness index (Table 1) of distribution however revealed that mid-slope had more uniform distribution of species followed by the lower slope and the upper slope.

Table 1. Species composition and distribution of plantation forest in NwSSU-San Jorge, Campus

Family Name	**Scientific Name**	**Common Name**	**Habit**	**Physiographic Position**		
				US	MS	LS
Annonaceae	*Anaxagorea luzonensis*	bagang-aso	Shrub			x
Araliaceae	*Polyscias nodosa*	malapapaya	Tree/Shrub			x
Asteraceae	*Wedelia biflora*	beach sunflower	Weed	x	x	
	Chromolaena odorata	hagonoi	Weed	x	x	x
Blechnaceae	*Stenochalena palustris*	hagnaya	Fern		x	
Burseraceae	*Canarium ovatum*	pili	Tree		x	x
Casuarinaceae	*Casuarina nodiflora*	agoho	Tree		x	
Compositae	*Elephantopus tometosus*	malatabako	Weed	x	x	x
Convulvulaceae	*Ipomea qunquefolia*	morning glory	Weed	x		
Cyperacea	*Scleria scrobiculata*	sarat/daat	Weed	x	x	x
Dennstaedtiaceae	*Pteridium aquilinum*	bracken fern	Fern	x	x	x
Dryoteridaceae	*Nephrolepis hirsutula*	scaly swordfern	Fern	x	x	x
Ebenaceae	*Diospyros philippinensis*	kamagong	Shrub		x	
Fabaceae	*Pterocarpus indicus*	narra	Tree			x
	Alysicarpus vaginalis	alyce clover	Weed			x
	Arachis pintoi	mani-mani	Weed			x
	Calopogonium mucunoides	calopogonium	Weed		x	
Graminae	*Axonopus compressus*	carabao grass	Weed/grass			x
	Saccharum spontaneum	talahib	Grass	x		x
	Imperata cylindrica	cogon	Grass	x	x	x

Guttiferae	*Cratoxylum formosum*	paguringon	Tree/Shrub	x	x	x
	Syzygium cumini	duhat	Tree	x		
Loganiaceae	*Fagraea racemosa*	balat buaia	Shrub	x	x	x
Marantaceae	*Donax cannaeformis*	bamban	Weed			x
Melastomaceae	*Melastoma affine*	malatungao	Shrub	x	x	
Meliaceae	*Sweitenia macrophylla*	mahogany	Tree	x	x	x
Mimosaceae	*Samanea saman*	rain tree	Tree			x
	Mimosa pudica	makahiya	Weed	x		
	Leucaena leucocephala	ipil-ipil	Shrub	x	x	
Moraceae	*Ficus ulmifolia*	is-is	Shrub			x
	Ficus nota	tibig	Shrub/tree	x	x	x
	Ficus pseudopalma	niog-niogan	Shrub	x		
	Ficus septica	hauili	Shrub/tree	x		x
	Fiicus minahassae	hagimit	Shrub			x
Myrtaceae	*Psidium guajava*	guava	Shrub		x	x
Piperaceae	*Pippera aduncum*	spike pepper	Shrub	x	x	
Rubiaceae	*Neonauclea formicaria*	hambabalud	Shrub	x		x
	Mussaenda philippinensis	kahoi dalaga	Shrub	x	x	x
Selaginellaceae	*Selaginella cupressina*	sellaginella	Weed	x		x
Tiliaceae	*Colona serratifolia*	anilau	Tree	x		x
Urticaceae	*Leucosyke capitellata*	alagasi	Tree	x	x	x
Verbenaceae	*Duranta erecta*	duranta	Shrub			x
	Gmelina arborea	yemane	Tree	x	x	x
	Lantana camara	coronitas	Weed	x		
Zingeberaceae	*Alpina elegans*	tagbak	Other habit			x

Results in figure 1 shows the frequency and percentage of the various life forms in the plantation. Trees account for 33% of the total composition which is similar to shrubs that also accounts for 33%. Weeds and grasses account for 24% of the total floristic composition while fern and other habit account for 8% and 2% of the total species, respectively.

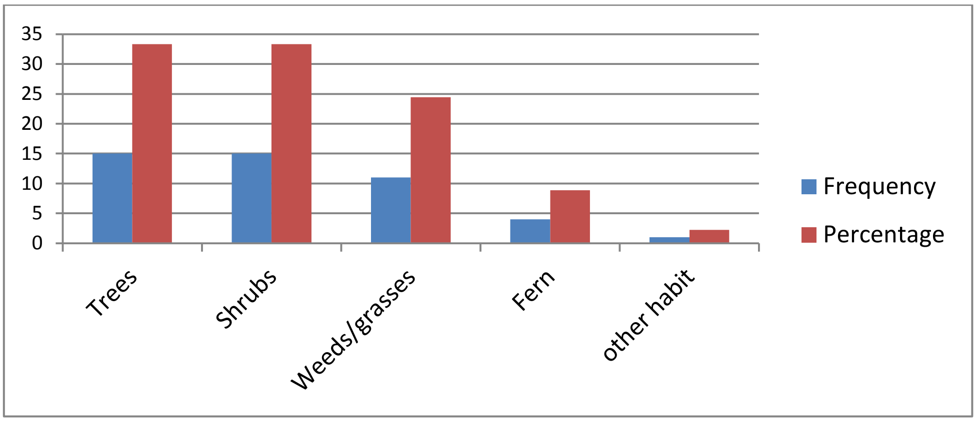

Figure 1. Floristic composition of various life forms in plantation forest of NwSSU, San Jorge Campus

Diversity and Stocking Volume

Results showed that floral diversity was highest in the mid-slope. This was followed by the lower slope and the upper slope (Table 2). The number of species per physiographic category was 32, 20 and 29 for lower slope, mid-slope and upper slope, respectively. The computed value however did not necessarily indicate that the mid-slope has the highest number of species but rather has the most number of individuals per species.

The stocking volume however showed that lower slope has the greatest stocking volume which was followed by the mid-slope and the upper slope had recorded the least volume. The pattern was clearly visible even during the data collection as species growing in the lower slope were observed to be taller and bigger than those found in the mid-slope and upper slope. Furthermore, a huge difference exists in the mean diameter measurements of the species found in the 3 physiographic categories. These results clearly indicate that relief and topography has effect on the growth rate of species planted in a specific area.

Soil Physical Properties

Results showed that the soils in the forest plantation have remarkable closeness in terms of matrix color which ranges from brown (10YR 5/3) to dark brown (10YR 4/3) across different physiographic positions (Table 3). The soil's color expresses its darkness of color due mainly to accumulation and/or decomposition of organic material in the soil surface. Similarly, their study stated that high percentage of organic matter in the surface soil promotes darker color and better aggregation (Genxu et al., 2004). Moreover, all soils in the three physiographic positions were characterized to have a silty clay texture. This agree to the findings of Deekor et al. (2012) that the increase in silt content in the secondary forest is attributed to the dense cover which helps to suppress soil erosion.

In addition, results revealed that soils are found to have a weak fine to medium sub angular blocky structure due to humus accumulation and aggregate stability; showed high degree of friability, contains considerable amount of roots and evidence of mottles (Table 3).

Table 2. Summary characteristics of plantation forest in NwSSU-San Jorge Campus

Characteristic	Upper Slope	Mid-Slope	Lower Slope
Shannon-Weiner Diversity Index (H')	2.04	2.32	2.17
Evenness Index	1.39	1.78	
Mean height (m)	6.43	7.88	9.09
Mean diameter (m)	0.1	0.13	0.2
Mean volume (cu.m)	0.128	0.212	0.567

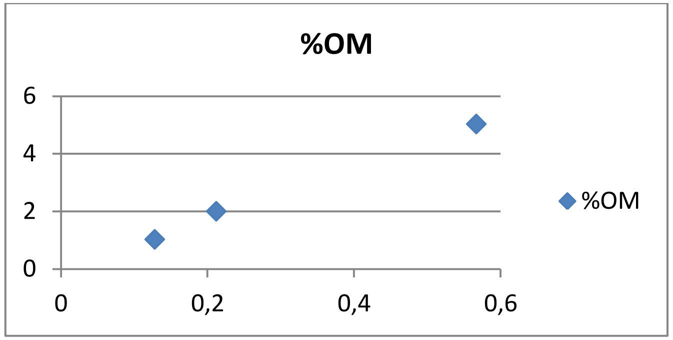

Figure 2. Soil OM and tree volume relationship in the plantation forest of NwSSU, San Jorge Campus

Table 3. Physical and Chemical characteristics of the soils in the plantation forest in San Jorge, Campus

Physiographic Position	Depth (cm)	Color (Munsell color- Moist)	Consistence Moist	Consistence Wet	Structure	Texture	Roots	Mottles	pH (H_2O)	OM (%)	N (%)	P (mg/kg)	K (mg/kg)
Upper Slope	0-20	10YR 4/3 (Dark brown)	friable	Sticky and plastic	Weak fine sub angular blocky	Silty clay	Common medium	few	5.28	2.96	0.17	2.24	407.50
Middle slope	0-20	10YR 5/3 (Brown)	friable	Sticky and slightly plastic	Weak fine sub angular blocky	Silty clay	Common coarse	Very few	5.65	2.11	0.18	2.23	190.00
Lower slope	0-20	10YR 4/3 (Dark brown)	Very friable	Sticky and slightly plastic	Weak medium sub angular blocky	Silty clay	Common medium	none	5.25	2.42	0.24	1.83	256.88

Soil Chemical characteristics

Table 3 showed that the soils of the plantation forest ranges from strongly acidic to slightly acidic with a pH range of 5.25 to 5.65. The pH value obtained agrees with the findings of Agbede (2008) that the pH of the forest soils in Nigeria falls with the range 4.5 to 7.5. It is also supported by the study of Yimer et al. (2007) that high pH values were observed in crop land than forest land. The acidity of the soils can be due to the higher amount of decomposed organic matter from leaf litter and other organic materials which produces organic and inorganic acids thereby lowering the pH (Tesema, 2008).

The soils were also characterized to have considerable adequate amount of organic matter which ranges from 2.11 to 2.96 %. Likewise, the content of Organic matter is high in the secondary forest soils which are attributable to the increase in plant density and cover which provides large amount of biomass decomposes to form nutrients in soil (Deekor et al., 2012). On the other hand, the soils in the plantation forest contain relatively low to moderate total nitrogen amount (0.17 – 0.24% range) which indicates the effect of N losses through leaching and nutrient uptake and the availability of phosphorus (1.83 to 2.24 mg kg^{-1}) was notably below the suitable amounts of 8–15 mg kg^{-1}(Landon 1991), suggesting that P is the limiting nutrient in the plantation forest. The low P availability in the soil can be explained by the low P content of the parent material, by the alkaline or acidic chemical condition of the soils to the reaction of P with non-crystalline Al and Fe oxides, resulting in the formation of insoluble metal-P compounds (Shoji et al., 1993) and is released during weathering and either retained in soils or lost through leaching and erosion (Yang et al., 2010).

As can be seen in also table, the amount of the exchangeable K is relatively higher in all soils which ranges from 190 to 407.50 mg kg^{-1}. In terms of nutrient availability, the higher values can be attributed to the contribution of the parent material particularly feldspar which are important sources of these nutrient elements. Those found in the upper and lower physiographic positions generally have higher amounts of the exchangeable K. Moreover, this is also attributed to the clay rich nature of the soils in the plantation forest, higher surface area or negative charges were available for cation exchange reaction. The finer texture of the soil the higher the negative charges, the higher the amount of exchangeable nutrients readily available for plant utilization.

Soil-Vegetation Relationship

The soil- vegetation analysis was analyzed using the Pearson's correlation. Considering the edaphic factors that contribute largely to the growth of trees in secondary forests and plantations, only two soil variables were tested against a vegetation variable. These variables were the depth of solum and the % organic matter in soil tested against the mean volume per physiographic location. It must be understood that tree height and diameter were already considered in the test since volume is a function of both variables and is also an indicator of tree growth. Results showed that solum higher volume is correlated with lower solum, with $r= -0.39$.

This result was due to the fact that the solum in the upper slope is higher than the one in the lower slope which is inversely related to the stocking volume. The negative correlation between the 2 variables mentioned was due to the fact that the upper slope values indicate inverse relationship. However, if the values for the 2 variables in the mid-slope and lower slope will be considered, a positive relationship can be generated. In addition, the consistency of the surface soil in profile 1 is friable but the subsurface was observed to be firm.

In contrast to the consistency of the profiles of the other 2 physiographic positions which were observed to be friable from the subsurface to subsurface layers. This has implication to the degree by which roots can be able to penetrate into the subsurface. In terms of volume and organic matter, greater volume is strongly correlated with higher organic matter content, with $r=0.99$ (Figure 7). Since the relationship between organic matter and nitrogen content is direct, it goes to show that the relationship of volume and nitrogen content is also direct. That is, growth rate of trees is largely affected by the presence of organic matter in the soil. This result is in consonance with the results of the study conducted by Eni, et.al (2012) in their study concerning the soil-vegetation interrelationships in secondary forests of Nigeria.

Soil pH on the other hand has no significant influence on the growth rate of the trees in the plantation since the pH values for the 3 physiographic locations did not greatly vary.

CONCLUSION

Based on the results, species composition in the plantation forest is comparable to that of the secondary forest considering the number of species present and the biodiversity index. As with any plantation forests, trees and shrub were dominant among the plant habits. Species distribution cannot be seen as a function of the slope since mid-slope has exhibited more even distribution of species than the other slope categories. Stocking volume is highest in the lower slope which is directly related to presence of high organic matter in the soil which is attributed to deposition of leached minerals from higher slopes.

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