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Forest diversity and aboveground carbon linkage between the national park and community managed tropical forests of Nepal

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The relationship of forest diversity and aboveground carbon has been poorly explored in tropical forests under different management regimes. An assessment of the linkage between forest diversity and carbon has become important, particularly to devise effective approaches to forest management and policy formulation. To assess the relation between forest diversity and carbon stock, we correlated the structural attributes (i.e., DBH, height, wood density, and stem density), diversity attributes (i.e., species richness, Shannon Weiner index and Shannon equitability index) and aboveground carbon of tree species ≥ 5cm in DBH from Bardia National Park and adjoining Buffer zone Community Forest. Our results showed that most structural attributes are correlated to aboveground carbon in both forest types. While the diversity attributes (i.e., species richness and Shannon index) and stem density had no relation with aboveground carbon in both forests. Similarly, species evenness had a significant inverse relation with aboveground carbon in both forests. The correlation of DBH and height was stronger with aboveground carbon in community managed forest while the same was moderate in national park. In addition, the carbon stock was found slightly higher in the community managed forest than in national park. This indicates that forest structural diversity enhances the aboveground carbon in tropical forests, and community managed forest promotes the growth of vegetation similar to natural forest. These results provide a better insight into forest management and its effects on forest diversity and aboveground carbon.

Keywords: Carbon stock, forest biodiversity, forest management, Nepal

Tropical forests, an important natural sink of organic carbon, are the most complex and species rich ecosystem in the world (Schemske & Mittelbach, 2017). In addition to providing many provisioning ecosystem services to human society (Millennium Ecosystem Assessment, 2005), tropical forests have one of the fastest carbon sequestration rates per unit land area (Harris et al., 2021) and, thus play a fundamental role in the mitigation of climate change by sequestering 30% of fossil fuel carbon dioxide emissions (Pan et al., 2011). A better understanding of distribution patterns and variability of carbons stocks is necessary for understanding how carbon stock changes over time (Houghton, 2005) and for increasing the carbon stock of forest ecosystems (Zhao & Zhou, 2006). Different studies have demonstrated that abiotic and biotic variables influence the carbon stock of the forest ecosystem (Dayamba et al., 2016; Poorter et al., 2015; Vayreda et al., 2012; Xu et al., 2015; Zhao & Zhou, 2006).

Forest diversity is one of the determinants of carbon stock patterns in forest ecosystems (Arasa-Gisbert et al., 2018; Day et al., 2014). Both the magnitude (Hector et al., 1999; Reich et al., 2001) and variability (Bai et al., 2004) of

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terrestrial biomass are influenced by the diversity and relative abundance of species. The study on the relationships between forest biodiversity and carbon stock among different types of forest ecosystems has increased over the years not only to maintain ecosystem functioning and protect biodiversity, but also to mitigate climate change effects (Bosworth et al., 2008; Con et al., 2013; Lei et al., 2009; Liang et al., 2007).

Although many studies have showed a positive relation between forest biodiversity and aboveground carbon stock (Ali & Yan, 2017; Dimobe et al., 2019; Ercanli, 2018; Liu et al., 2018; Thom & Keeton, 2019; Zhang et al., 2017), there has also been a negative association between forest diversity and aboveground carbon stock (Aryal et al., 2018; Suo et al., 2008; Szwagrzyk & Gazda, 2007; Zhang et al., 2011). Despite it, some studies have shown no relation between forest diversity and aboveground carbon stocks (Vilà et al., 2003).

This conflicting report on the linkage between carbon stocks and diversity from different parts of the world reassures about the complexity of the ecosystem structure and function (Wang et al., 2011). More research on the evidence of the relationship between carbon and diversity at different geography, forest quality, spatial scales, and on a range of taxa is necessary to ascertain the biodiversity and carbon storage relation (Day et al., 2014; Luintel et al., 2018). Though studies on relationship between biodiversity and carbon stocks in forest ecosystems are increasing, limited study was found on relation of forest diversity and aboveground carbon stock on different forest management, especially in the tropical forest of Nepal. Therefore, our research intends to assess the relationship between forest diversity and carbon stock of tropical forests that have the same history, topography and rainfall pattern but are under different management regimes in Nepal. The comparative study on the forests with different management regimes will answer the following research questions: 1) Does the forest management regime affect species diversity and aboveground carbon? 2) Does forest management regime influence the relation between species diversity and aboveground carbon? The findings of the study are expected to contribute to the maintenance of species diversity and forest carbon.

Materials and methods

Study area

The study was conducted in the south-western part of Nepal, located in Bardia district, which represents a tropical and subtropical ecosystem. The area falls within latitude 28°36` - 28° 50` N and longitude 81° 30`- 81° 45` E (Figure 1). The climate of the study area is that of a typical subtropical monsoonal with three distinct seasons, i.e. monsoon season (July-October), cold dry season (November-February) and hot dry season (March-June). The average temperature is 39.8^0 maximum and 9.6^0 minimum and annual rainfall is 1118 mm (DDC Bardiya, 2013). The forest ecosystem is dominated by *Shorea robusta* and *Terminalia tomentosa*. Bardia National Park (national park hereafter), the largest undisturbed forest area, is managed by government, was declared a national park in 1988. The park consists of tropical and subtropical ecosystem ranging from early successional floodplain grassland to mature climax Sal Forest. Buffer zone Community Forests (community managed forest hereafter), located adjoining to the national park, are managed by community and handed over to community in 2003 for conservation of forest and utilization of forest products in a sustainable way. Before declaration of buffer zone, this forest was degraded due to human interventions, overharvesting and uncontrolled grazing (Ranabhat et al., 2016), resulting in loss of regeneration. With the active participation

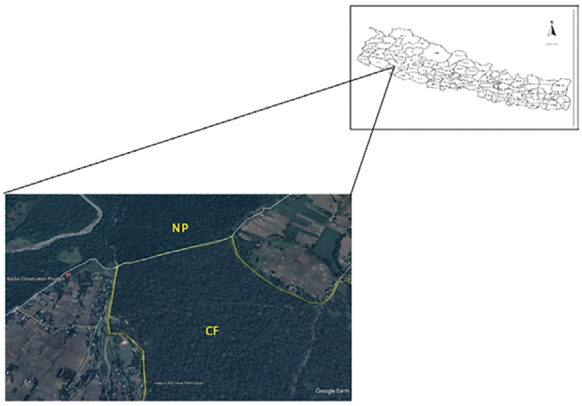

Figure 1: Study area (Source: Google, 2023)

of local communities, buffer zone forest was conserved and managed to bring noticeable improvement in forest condition. Buffer zone community forest user groups carry out different management activities, such as singling, thinning, cleaning, weeding, control fire etc. as per the operational plan.

Data collection:

Three transect lines were laid out parallel at 200m apart from each in the national park and community managed forest separately. Sample points were laid out 100m inside the boundary line in both forests to reduce boundary edge effects. Altogether 30 and 26 sample points were laid out systematically inside national park and community managed forest respectively at 150 m interval within respective transects. A circular concentric plot was laid out at each sample point. A concentric plot with radius of 12.62m, 5.64m, and 2.82m was established to measure the diameter at breast height of woody perennials of ≥ 30 cm (large trees), 10-29.9 cm (medium trees) and ≥5-9.9cm (small trees) respectively. Besides, the height of all trees was recorded in the sample plots.

Data analysis:

Quantification of forest diversity

For forest diversity we used two attributes: structural attributes and diversity attributes. Forest structural attributes were described based on basal area, density (no. of stems), wood density, height and DBH distribution. Basal area per plot of all stem ≥ 5cm was calculated using equation (1). Similarly, density of trees in a plot was calculated and converted to per hectare (ha) applying different expansion factors resulting from the respective size of the nested plots.We also counted all trees and recorded the names of all the tree species ≥ 5cm in DBH within the plot for species identification.

$$BA = \pi/4 * DBH\text{^}2 \qquad (1)$$

Diversity attributes were calculated by

i) species richness (S), which reflects the number of tree species present,

ii) ii) Shannon Wiener Diversity index (H) (Shannon index hereafter), which reflects to species richness and abundance of tree species,

$$H' = -\sum_{i=}^{S} p_i \ \ln p_i \qquad (2)$$

Where p_i is the stem proportion of species $i^{th.}$

iii) iii) Shannon evenness (J) index (evenness hereafter), which reflects the evenness of tree species.

$$J = \frac{H\prime}{\ln S} \qquad (3)$$

Estimation of biomass and aboveground carbon stock

The allometric equation (Ketterings et al., 2001) is commonly used for the estimation of forest biomass which later on used for the estimation of carbon stock in the forest (Basuki et al., 2009) using conversion factors (i.e. 47% of AGB) (IPCC, 2006). Therefore, allometric equation developed for moist tropical forest (Chave et al., 2005) was used for estimation AGTB as the study sites are located in the moist climatic zone. We used available air-dry density of wood for specificspecies available in Sharma and Pukkala (1990).

$$AGTB = 0.0509 * (\rho * \mathrm{DBH}^2 * \mathrm{h}) \qquad (4)$$

Where, TAGB=Total Aboveground Biomass (kg)
DBH= Diameter at breast height (cm)
h= total height of the tree (m)
ρ=wood density (gm cm^{-3})

Statistical analysis

For comparing different variables between two forest management regimes, we used t-test using *t.test* function if the data was normally distributed otherwise Mann-Whitney U test using *wilcox.test* function under R-package "stats". The Shapiro-Wilk goodness-of-fit test was utilized to confirm the normality of all variables using *shapiro.test* function under R-package "stats"(R Core Team, 2020). The relationships of aboveground carbon with species richness, species diversity and structural diversity were examined with Pearson correlation analysis using *"cor.test"* function under R-package "stats". Furthermore, species diversity was assessed using Shannon function under R-package "vegan" (Oksanen et al., 2019).

Results

Forest diversity

A total of 279 and 170 trees and shrubs were recorded in national park and community managed forest respectively. The number of species with DBH≥ 5 cm was found 19 species in national park and 14 species in community managed forest. The number of species per plot ranged from 2 to 7 in national park while ranged from 1 to 7 in community managed forest. The mean DBH was found larger in community managed forest while mean height was found higher in national park. Similarly, basal area was higher in national park compared to community managed forest (Table 1). There were more trees and shrubs per unit area in community managed forest (866.92±176.82 stem ha-1) than in national park (614.66±118.31 stem ha-1). The stem density was dominated by medium trees in national park while community managed forest was dominated by small trees (Figure 1). Shannon index was higher in community managed forest (Table 1). Species richness and evenness varied significantly ($p<0.05$) between the two forest types, while mean DBH, mean height, tree density and Shannon index were not significantly different.

Table1: Descriptive statistics of the forest diversity in two forest types. The values of diameter at breast height, tree height, basal area, density and aboveground biomass represent means and standard errors of the means, while species richness, Shannon index, and evenness represent the, total count of species, Shannon diversity index, and Shannon equitability index

Forest type	National Park	Community managed forest
No of sample plots	30	26
No. of trees	279	170
Mean dbh(cm)	36.6±3.85	39.36±5.45
Mean ht (m)	19.47±1.71	17.66±2.23
Basal area (m2 ha-1)	32.32± 2.37	28.82±2.46
Density (no. of stems ha-1)	614.66±118.31	866.92±164.61
Species richness	19*	14*
Shannon index	1.77	1.89
Evenness	0.60*	0.71*
AGB (Mg ha-1)	410.88±37.46	415.84±51.03
Carbon stock (Mg ha-1)	192.16±17.54	195±23.98

* shows significance level p< 0.05

Aboveground biomass and carbon stocks

This study showed that aboveground biomass is slightly higher in community managed forest than in national park. Carbon stock in community managed forest was 195±23.98 Mg ha^{-1} while in national park it was found 193±17.60 Mg ha^{-1}. However, there was no significant difference in carbon stock between the forest types. The maximum carbon was stored in large trees i.e. 97% in community managed forest and 89% in national park. With the increase in diameter, the amount of carbon stock has increased in both forests. While the density of trees has decreased with diameter classes in community managed forest. Though the density of medium trees was high, but the amount of carbon was found high in large trees in national park as well (Figure 2).

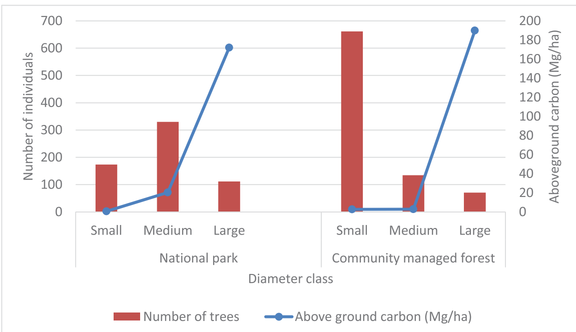

Figure 2: Distribution of aboveground carbon relative to the number of trees for different diameter classes. Small, medium and large diameter classes represent trees and shrubs with diameter at breast height of <10, 10-30 and ≥ 30 cm

In terms of relative abundance, *Shorea robusta* is the most abundant species (more than 40%) in both forests, contributing the highest (more than 70%) of the aboveground carbon stock (Table 2). After *Shorea robusta*, other species such as *Buchanania latifolia* (≈ 15%), *Terminalia tomentosa* (≈13%), *Lagerstroemia parviflora* (≈4%), *Schleicheraoleosa* (≈3%) were the most abundant species recorded in national park while the higher carbon stocks were found in *Terminalia tomentosa* (≈18%), *Adina cordifolia* (≈2%), *Buchanania latifolia* (≈ 1%) and *Schlericheraoleosa* (≈1%). In community managed forest, the other most abundant species were *Mallotusphilippinesis* (≈25%), *Terminalia tomentosa* (10%), *Eugenia jambolana* (≈8%), and *Cleistocalyxoperculatus* (≈4%) while *Terminalia tomentosa* (≈18%), *Adina cordifolia* (≈2%), *Eugenia jambolana* (≈2%), *Schlericheraoleosa* (≈2%) stored more percentage of carbon (Table 2).

Table 2: Relative abundance and contribution of the ten most dominant tree species (DBH≥ 5 cm) to aboveground carbon stocks between the two forest regimes

Forest Types	Species	Relative Abundance (%)	AGC contribution (%)
National Park	*S. robusta*	49.46	73.67
	B.latifolia	15.77	1.37
	T. tomentosa	12.90	18.53
	L.parviflora	3.58	0.29
	S.oleosa	2.86	1.08
	M.philippinensis	1.79	0.31
	A. cordifolia	1.43	2.38
	Mitragynaparviflora	0.71	0.81
	Anogeissuslatifolia	0.71	0.71
	E.jambolana	0.71	0.30
Community forest	*S. robusta*	36.47	72.60
	M. philippinensis	24.70	0.68
	T. tomentosa	10.00	19.24
	E. jambolana	7.64	1.66
	Berry **	4.11	0.01
	C.operculata	3.52	1.60
	S. oleosa	2.35	0.80
	L.parviflora	2.35	0.05
	A. cordifolia	1.17	3.26
	Cassia fistula	0.58	0.04

** local name

Note: All the tree species shown in Annex-1

Table 3: Correlations (r-values) between aboveground carbon and structural and diversity attributes in the national park and community managed forest

Attributes		National Park	Community Managed Forest
Structural	DBH	0.30*	0.54*
	Height	0.49*	0.57*
	Wood density	0.53*	0.55*
	Basal area	0.94*	0.89*
	Density	0.09	-0.13
Diversity	Shannon index	-0.15	-0.07
	Richness	0.16	0.05
	Evenness	-0.57*	-0.47*

*Shows significance level p<0.05

3.3 Relation between forest diversity and carbon stocks.

This study found that basal area was very strongly correlated with aboveground carbon in both forests (Table 3). While DBH and height were moderately correlated to aboveground carbon in national park, but had a strong relation to aboveground carbon in community managed forest. Similarly, wood density had a strong relation with aboveground carbon in both forests. However, species richness and diversity had no significant relation with aboveground carbon in both forests. On the contrary, species evenness had a significant negative relation with aboveground carbon in both forests.

Discussion

The aboveground carbon stock recorded in *Shorea robusta* forest was found higher than the other *Shorea robusta* forest of Terai region of Nepal. Other studies conducted in *Shorea robusta* forest reported 129.53-162.98 Mg ha^{-1} (Bhatta et al., 2021), 74.64±16.34 -163.12±20.23 t ha(Joshi et al., 2020) 1 and 160.4 Mg ha^{-1}(Regmi et al., 2021) in Nepal and 72.32 -143.36 t ha− 1(Raj & Jhariya, 2021)in India. However, it is markedly less than the subtropical *Shorea robust* forest of India (e.g., 274.15 Mg ha^{-1}) (Joshi et al., 2021). This might be due to the use of different biometric equations or the presence of trees with larger sized trees that contribute to higher biomass in the study site (Joshi et al., 2020). Also change in landforms, soil types, quality and prevailing weather conditions in study sites also varied the tree biomass and carbon storage (Raj & Jhariya, 2021) . However, the aboveground carbon stock found in this study falls within the carbon stock value range of tropical forest (5.75-238.63 t ha-1) (Pragasan, 2022).

Major contributor to aboveground carbon is *Shorea robusta* in the study site. Luintel et al (2018) also found that *Shorea robusta* contributed more than 70% of the carbon in the lower elevations (<1000m). Similar to trends in most forests, this study revealed the dominance of small trees in both forests, but higher contribution of large trees to aboveground carbon. The higher contribution of large-size trees to aboveground carbon despite of their low density has been reported in various vegetation types (Bastin et al., 2015; Dimobe et al., 2019; Lutz et al., 2018; Mcnicol et al., 2017; Slik et al., 2013). Due to greater height and heavier crowns which enable the large trees to occupy growing space not reachable to small trees and various light niches within the canopy, the large size trees have higher proportion of aboveground carbon (Mensah et al., 2020).

The comparison between national park and community managed forest showed that Shannon index and species evenness were higher in the community managed forest (Table 1). While species richness was found higher in natural forest. A forest with a small number of species can still have a high Shannon index if the species are evenly distributed. There was significant difference in the species richness in community managed forest to national park, this might be due to heavy human disturbance in community managed forest before the declaration of buffer zone area (Ranabhat et al., 2016).,

This study reveals that there is a significant positive relation of aboveground carbon with forest structure attributes, except for stem density (Table 3) in both forest types. The study result supports the finding of Rana et al (2017) that size and average carbon stock of particular trees is important than the number of trees. Murphy et al (2013) also reported no relation between carbon and stem density. This might be due to the presence of higher number of small and medium sized trees, the relation between aboveground carbon and stem density is weak. Wang et al (2011)also reported higher presence of small trees resulted less carbon in the forests. Positive relation between structural attributes and aboveground carbon was reported in subtropical forest (Ali et al., 2016), boreal forest (Zhang & Chen, 2015) and temperate forest (Dănescu et al., 2016).

Similar aboveground carbon in community managed forest and national park, and strong relation of DBH and height with aboveground carbon in community managed forest compared to national park supports the finding that managed forest enhances the growth of plants by providing better site, space, and nutrients for plants (Lung & Espira, 2015; Taylor et al., 2008). Implementation of appropriate management practicescould increase the potential of degraded forest to store carbon as in a natural forest.

Furthermore, the aboveground carbon has no significant relation with Shannon diversity index and species richness in both forests (Table 3).Negative or no relation between forest diversity and aboveground carbon was reported by other studies in various forest types (Asase et al., 2012; Pragasan, 2016; Rana et al., 2017; Urbano & Keeton, 2017). Different factors such as selective logging (Widenfalk and Weslien, 2009), abundance of lower carbon stocks species (Baral et al., 2009) influence the distribution of biodiversity and carbon in a forest. However, some studies found higher forest diversity increases carbon stock of a forest (Day et al., 2014; Dimobe et al., 2019; Pragasan, 2022).

We found a significant negative effect of evenness on carbon stock in both forests. Previous studies have demonstrated negative relation (Shirima et al., 2015; Sonkoly et al., 2019), or no relationship (Luintel et al., 2018) between species evenness and biomass /carbon. Under uniform environmental conditions, a community may be most productive when it is dominated by a highly productive species, instead of biomass being distributed evenly among all species (Hillebrand et al., 2008; Chalcraft et al., 2010). This refers that higher evenness means low aboveground carbon. However, some studies have also demonstrated the positive effect of evenness on carbon stocks (Schmitz et al., 2013).

The dominance of *Shorea robusta* and large sized trees in the contribution of aboveground carbon stock is likely to result in no relationship of Shannon index and species richness to aboveground carbon. Luintel et al (2018) also reported that presence of high carbon in a few species; reduce the influence of species richness to aboveground carbon. Besides, the historical forest disturbance is also likely to have a significant impact on forest carbon and forest diversity (Day et al., 2014), and the community managed forest have been under severe disturbance before handing over to communities. Furthermore, van der Sande et al (2017) has specified that the biodiversity, and carbon stock is strongly linked in mature forests and across larger spatial scales while weakly linked in disturbed forests and at local scales. Sullivan et al (2017) also indicated that diversity-carbon relation is scale dependent.

The study did not analyze below ground and soil organic carbon that might have provided additional insights into forest diversity and carbon relations under different management regimes. Further study is recommended at different scales by including different biotic and abiotic factors to understand the complex relationship between forest diversity and carbon.

Conclusion

This study aimed to assess the forest diversity and aboveground carbon relationship in the tropical forest of Nepal under different management regimes. It reveals that aboveground carbon increases with dbh, height, basal area, and wood density but it does not change with species richness, Shannon index and stem density. However, species evenness supports to decrease aboveground carbon, which attribute to the dominance of productive species in the study site. Effective conservation and management of degraded forest improves diversity and forest carbon similar to natural forest. Therefore, community managed forest with forest management interventions are successful approach for maintaining ecosystem diversity and productivity.

Author Contribution Statement

Sunita Ranabhat: Conception and design, Data collection, analysis, manuscript writing. Rajesh Malla: Conception and design, manuscript, result interpretation, manuscript revision,

Data availability

The data used in this study are accessible upon request to the corresponding author.

Conflict of Interest

The authors declare no conflict of interest.

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Annex 1: List of species found in the national park and community forest

Category	Family	Species	Local name	National Park	Community Forest
Trees and Poles	Anacardiaceae	*Buchanania latifolia*	Piyari	√	-
	Anacardiaceae	*Semecarpus anacardium*	Bhalayo	√	-
	Combretaceae	*Anogeissus latifolia*	Banjhi	√	-
	Combretaceae	*Terminalia alata*	Asna	√	√
	Dilleniaceae	*Dillenia pentagyna*	Tantari	√	-
	Dipterocarpaceae	*Shorea robusta*	Sal	√	√
	Ebenaceae	*Diospyros malabarica*	Tendu	√	-
	Euphorbiaceae	*Mallotus philippensis*	Sindhure	√	√
	Fabaceae	*Cassia fistula*	Raj Brikchhya	√	√
	Fabaceae	*Desmodium oojeinense*	Sadan	√	-
	Lythraceae	*Lagerstroemia parviflora*	Botdhainro	√	√
	Myrtaceae	*Cleistocalyx operculatus*	Kyamuna	√	√
	Myrtaceae	*Eugenia jambolana*	Jamun	√	√
	Myrsinaceae	*Myrsine semiserrata*	Kali kath	√	√
	Rhamnaceae	*Ziziphus sps*	Bayer	-	√
	Rubiaceae	*Mitragyna parviflora*	Phaldu	√	-
	Rubiaceae	*Adina cordifolia*	Haldu	√	√
	Sapindaceae	*Schleichera oleosa*	Kusum	√	√
	Sapotaceae	*Madhuca latifolia*	Lati Mauwa	√	-
Saplings	Anacardiaceae	*Buchanania latifolia*	Piyari	√	-
	Cordiaceae	*Ehretia laevis Roxb.*	Pan, Datrung	√	-
	Dipterocarpaceae	*Shorea robusta*	Sal	√	√
	Ebenaceae	*Diospyros malabarica*	*Tendu*	√	√
	Euphorbiaceae	*Mallotus philippinensis*	Sindhure	√	√
	Fabaceae	*Cassia fistula*	Raj Brikchhya	-	√
	Fabaceae	*Dalbergia sissoo*	Sisau	-	√
	Lythraceae	*Lagerstroemia parviflora*	Botdhainro	√	-
	Malvaceae	*Kydia calycina*	*Bori*	-	√
	Myrsinaceae	*Myrsine semiserrata*	Kali kath	√	√
	Myrtaceae	*Cleistocalyx operculatus*	Kyamuna	√	√
	Myrtaceae	*Eugenia jambolana*	*Jamun*	√	√
	Phyllanthaceae	*Bischofia javanica*	Kainjal	-	√
	Phyllanthaceae	*Bridelia retusa*	Gayo	-	√
	Rhamnaceae	*Zyziphus sps*	Bayer	-	√
	Rubiaceae	*Adina cordifolia*	Haldu	-	√
	Sapotaceae	*Madhuca latifolia*	Lati Mauwa	√	-
			Berry	-	√

Category	**Family**	**Species**	**Local name**	**National Park**	**Community Forest**
Seedlings	Anacardiaceae	*Buchanania latifolia*	Piyari	√	-
	Combretaceae	*Terminalia alata*	Asna	√	√
	Dipterocarpaceae	*Shorea robusta*	Sal	√	√
	Ebenaceae	*Diospyros malabarica*	Tendu	√	
	Euphorbiaceae	*Mallotus philippinensis*	Sindhure	√	√
	Fabaceae	*Cassia fistula*	Raj Brikchhya	-	√
	Fabaceae	*Dalbergia sissoo*	*Sisau*	-	√
	Lecythidaceae	*Careya arborea*	Khmubi	√	-
	Moraceae	*Ficus racemosa*	Gular	-	√
	Myrsinaceae	*Myrsine semiserrata*	Kali kath	√	√
	Myrtaceae	*Cleistocalyx operculatus*	Kyamuna	√	√
	Myrtaceae	*Eugenia jambolana*	Jamun	√	√
	Myrtaceae	*Psidium guajava*	Belauti, Amba	-	√
	Phyllanthaceae	*Bridelia retusa*	Gayo	-	√
	Rubiaceae	*Adina cordifolia*	*Haldu*	-	√
	Rubiaceae	*Mitragyna parvifolia*	Phaldu	-	√
	Sapindaceae	*Schleichera oleosa*	Kusum	√	√
	Sapotaceae	*Madhuca latifolia*	Lati Mauwa	√	-
	Not identified	Not identified	Patai	-	√