Plant functional traits and functional diversity across four land-use systems in Sumatra (Indonesia)

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Funktionelle Pflanzenmerkmale und funktionell Diversität in vier Landnutzungssystemen in Sumatra (Indonesien)

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Summary

Land-use intensification modifies the composition of plant communities in an ecosystem which may also result in an alteration in plant functional traits and functional diversity of those plant communities. The alteration in plant functional traits distribution and plant functional diversity will hamper the ecosystem processes related to those traits, thus, impacting key ecosystem functions.

In this study, I investigated the difference in plant functional traits between four land-use systems in the lowland of central Sumatra (Indonesia): tropical rainforest, rubber agroforestry, rubber monoculture and oil palm monoculture. This study comprised plant traits measured on 1050 plant individuals belonging to 730 species of which 570 were tree species and 160 were understorey species. Anatomical and morphological plant traits were selected as they represent plant's capacity to capture resources.

Previous plot-based vegetation surveys and functional trait data collection from the study area provided data on plant species composition of each plot as well as their functional traits. I investigated the consequences of land-use change on functional traits of trees and understorey by using statistical tools such as the Shapiro-Wilk normality test, Kruskal-Wallis rank sum test, and *post hoc* Wilcoxon rank sum test. I also investigated the effect of land-use change on the functional diversity of trees and understorey in the study area. The relationship between functional and taxonomic diversity was derived by carrying out regression analysis after fitting a linear model on the scatterplots.

I found that rainforest had a higher range of plant functional traits compared to monocultures when analyzing the traits on the land-use basis. The difference in plant functional traits was significant between rainforest representing low-intensity land-use system and monocultures representing high-intensity land-use systems. Considering the abundance data together with functional trait data, the community-weighted means of the functional traits in each plot varied significantly between four land-use systems signifying the contribution of plant community as a functional group in ecosystem functioning.

Overall, the functional diversity indices varied significantly between the four land-use systems. Functional richness was strongly related to species richness. Functional richness was highest in forest and lowest in oil palm, reflecting a decline in species richness with increasing land-use intensity. Forest and jungle rubber differed significantly in species richness but not in functional richness indicating a high level of functional redundancy between these land-use systems. Thus, jungle rubber is the most important system for ecosystem services among the three agricultural systems.

The relationship between functional diversity and taxonomic diversity in my study shows that functional diversity of trees at first decreases slowly until ca. two thirds of species are lost. After this point, functional diversity declines sharply. Understorey functional diversity shows a similar pattern with a suddenly sharper decline after about half the taxonomic diversity is lost. This result indicates that we lose plant functional diversity when we lose plant species, but not necessarily at the same rate.

Zusammenfassung

Landnutzungsintensivierung verändert die Zusammensetzung von Pflanzengemeinschaften, was wiederum zu einer Verschiebung von funktionellen Merkmalen und funktioneller Diversität dieser Gemeinschaften führen kann. Die Veränderung der Verteilung funktioneller Mekrmale und der funktionellen Diversität kann Ökosystemprozesse, die mit diesen Merkmalen zusammenhängen, erschweren und so wichtige Ökosystemfunktionen beeinflussen.

In dieser Arbeit habe ich die Unterschiede funktioneller Pflanzenmerkmale zwischen vier Landnutzungssystemen im Tiefland von Zentralsumatra (Indonesien) untersucht: tropischer Regenwald, Kautschuk-Agroforestry, Kautschuk-Monokultur und Ölpalm-Monokultur. Die Arbeit umfasst Pflanzenmerkmale von 1050 Pflanzenindividuen von 730 Arten, aufgeteilt in 570 Baumarten und 160 Arten des Unterwuchses.

Daten zur Pflanzenartenzusammensetzung und dazugehörigen funktionellen Merkmalen wurden von bereits durchgeführten Plot-basierten Aufnahmen der Vegetation und funktioneller Eigenschaften bereitgestellt. Ich habe die Auswirkungen des Landnutzungswandels auf die funktionellen Merkmale von Bäumen und Unterwuchs mit Hilfe von statistischen Methoden wie dem Shapiro-Wilk-Normalitätstest, Kruskal-Wallis-Test und *post hoc* Wilcoxon-Rangsummentest untersucht. Zudem habe ich die Auswirkungen des Landnutzungswandels auf die funktionelle Diversität von Bäumen und Unterwuchs untersucht. Der Zusammenhang zwischen funktioneller und taxonomischer Diversität wurde anhand von Regressionsanalysen mit einem linearen Modell erörtert.

Basierend auf der Analyse funktioneller Merkmale nach Landnutzungsform zeigte Regenwald im Vergleich zu Monokulturen eine höhere Bandbreite funktioneller Merkmale. Die Merkmale zwischen dem extensiven Nutzungssystem Regenwald und den intensiven Monokulturen waren signifikant. Wenn Abundanzen der Arten zusammen mit den funktionellen Merkmalen berücksichtigt wurden (*community-weighted means* pro Plot), zeigten die funktionellen Merkmale signifikante Unterschiede zwischen alle vier Landnutzungstypen.

Insgesamt unterschieden sich auch die funktionellen Diversitätsindizes zwischen den vier Landnutzungsformen; dabei zeigte sich ein starker Zusammenhang zwischen *functional richness* und Artenreichtum. Die *functional richness* war am höchsten in Regenwald und am niedrigsten in Ölpalmplantagen, konsistent mit der Abnahme des Artenreichtums mit zunehmender Intensivierung. Regenwald und Kautschuk-Agroforestry unterschieden sich signifikant in ihrem Artenreichtum, nicht jedoch in der functional richness, was auf eine hohe funktionelle Redundanz der Pflanzengemeinschaften beider Systeme hindeutet. Demnach ist Kautschuk-Agroforestry unter den drei Agrarnutzungsformen die wichtigste für den Erhalt von Ökosystemdienstleistungen.

Der Zusammenhang zwischen funktioneller und taxonomischer Diversität in meiner Arbeit zeigt, dass die funktionelle Diversität der Bäume bei Abnahme der Artenvielfalt langsam zurückgeht, bis ca. zwei Drittel der Arten verloren wurden. Ab diesem Punkt nimmt die funktionelle Diversität rapide ab. Die funktionelle Diversität des Unterwuchses zeigt ein ähnliches Muster, nur dass bei ca. 50 % des Artenreichtums die funktionelle Diversität plötzlich stärker abnimmt. Diese Ergebnisse zeigen, dass bei einem Verlust der Artenvielfalt auch die funktionelle Diversität von Pflanzen abnimmt. Die Geschwindigkeit der Abnahme ist allerdings nicht gleich.

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1. Introduction

1.1 The EFForTS-project

This master's thesis was carried out under the interdisciplinary research project "Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems in Sumatra, Indonesia" (EFForTS). EFForTS focus on ecological and socioeconomic effects of rainforest transformation in four different land-use systems (Forest, jungle rubber agroforest, rubber plantation, oil palm plantation,) in Jambi Province, Indonesia (Drescher et al. 2016). EFForTS is based on three major lines of research (i) environmental processes, (ii) biota and ecosystem services, and (iii) human dimensions (Drescher et al. 2016).

1.2 Tropical rainforests of Sumatra

Tropical rainforests of Indonesia are among the most diverse ecosystems on the earth (Brooks et al. 2006, Koh et al. 2013) and home to a large number of endemic and rare species (Sodhi et al. 2010). Sumatra is the home for tropical lowland rainforest which is well known as biodiversity reservoir (Gibbs et al. 2010). The biodiversity in lowland rainforests of Sumatra is threatened because of the highest deforestation rates in Indonesian rainforest at present (Hansen et al. 2013, Margono et al. 2014). One of the main reasons behind the deforestation is the conversion of complex rainforests into monocultural plantations of oil palm, rubber and *Acacia* (Butchart et al. 2010). The main reason for this conversion is the higher income related to the intensification of agriculture (Rist et al. 2010, Clough et al. 2016). Biodiversity is reduced in the plantations (Clough et al. 2016, Rembold et al. 2017) because they exhibit a less complex structure like the lower canopy, uniform tree age, sparse undergrowth and less stable microclimate (Foster et al. 2011, Meijaard and Sheil 2013). The additional causes of biodiversity loss apart from the land-use transformation in Indonesian rainforest are hunting, fires and commercial logging (Edwards et al. 2014).

1.3 Deforestation, land-use change and its consequences on plant diversity in Sumatra

It has been shown by various studies that land-use change and land-use intensification results in the loss of plant diversity (Butchart et al. 2010, Rembold et al. 2017). At present these processes are occurring at a great scale in rainforests of Indonesia (Hansen et al. 2013, Rembold et al. 2017). Because these rainforests provide multiple livelihood options for people (Margono et al.

2014), deforestation and land-use change not only affects biodiversity but also people and the ecosystem as a whole (Díaz et al. 2006).

The change in land-use intensities has an significant impact on biodiversity and their ecosystem services (Rodríguez-Echeverry et al. 2018). These changes present an urgent need to understand the relationship between biodiversity and ecosystem services (Rodríguez-Echeverry et al. 2018). Especially, the effect of land-use change on plant diversity seems high, as plants are the fundamental components of ecosystems, which ensure the survival of animals and the well-functioning of ecosystem processes (Wallace 2007, Edwards et al. 2010, Foster et al. 2011, Böhnert et al. 2016). Thus, understanding the effects of conversion on plant diversity of Sumatra can give a better understanding of conversion effects on whole ecosystem of Sumatra.

1.4 Plant functional traits and functional diversity

The popularity of using plant functional traits to address the questions regarding plant functional diversity has been increasing recently (Baraloto et al. 2010). The hypothesis that the variation in the plant functional traits is responsible for ecosystem functioning has resulted in the use of functional traits to understand the concept of functional and ecological roles of plant communities in an ecosystem (Finegan et al. 2015).

The traits of species which describes them in terms of the contribution they make to the ecosystem are functional traits (Díaz and Cabido 2001). Anatomical and morphological traits of plants are related to the plant's capacity to utilize the resources (Flynn et al. 2009). Chlorophyll content in plant resembles the plant ability to take part in photosynthesis and influence growth (Zhang et al. 2016). Leaf thickness of plant reflects its capacity to invest in biomass productivity and its response to water deficits (Givnish 1987, Farquhar et al. 2002, Pauli et al. 2017). Specific leaf area is related to the concentration of leaf nutrients (Hoffmann et al. 2005). Wood density is identified as a vital functional trait in plants as it reflects carbon storage in plant's stem (Chave et al. 2009), plant's growth (Perez-Harguindeguy et al. 2016) and plant's strength against environmental forces like gravity and wind (Hacke et al. 2001). Denser wood is supposed to provide greater mechanical strength to plants (Pratt et al. 2007, Poorter 2008). There is an

inverse relation between wood density and leaf size (Wright et al. 2004) as smaller leaf demands smaller sap (Chave et al. 2009).

Plant communities have a significant impact on ecosystem functioning (Hooper et al. 2002, Garnier and Navas 2012). Researchers have given clear evidence of the importance of functional groups in a community for ecosystem functioning (Hooper et al. 2002). They present many different reasons behind the significant contribution on ecosystem functioning by these functional group of plant communities (Hooper et al. 2002, Garnier and Navas 2012). The functional characteristics of these functional groups are the components of functional diversity in a community (Garnier and Navas 2012). Furthermore, these components are what we describe as value and range of traits (Garnier and Navas 2012). The distribution of trait values in functional groups can indicate niche differentiation in species (Roscher et al. 2018). Thus, taking community trait data in consideration we can derive a more detail understanding of how this whole community contributes as one functional group for ecosystem functioning.

The land-use change and intensification not only results in the loss of species diversity, often called taxonomic diversity (TD) but also in a loss of functional diversity (FD). Functional diversity is defined as the measurement and range of functional traits of the community of species or organism which contributes to the well-functioning of the ecosystem (Tilman 2001).

The use of trait-based functional diversity indices like functional richness, functional evenness and functional divergence (Mason et al. 2005) helps to demonstrate the process through which biodiversity and ecosystem functioning are connected (Villéger et al. 2008). If species which are more functionally unique are added at larger proportions, they have significant contribution to the increase in functional diversity (Kuebbing et al. 2018). Thus, choosing functional richness, functional evenness, and functional divergence may not give a proper understanding effect of non-native species on functional diversity of the ecosystem (Kuebbing et al. 2018). In this circumstances, functional dispersion can indicate functional diversity because it allows predicting beforehand which non-native species will have a greater influence on functional diversity (Mumme et al. 2015) without being influenced by species richness (Laliberté and Legendre 2010).

Often taxonomic diversity is a base to add functional and phylogenetic diversity to an ecosystem but it is not alone sufficient to indicate the ecosystem functioning. In a diverse habitat, it is possible that losing some species will definitely cause the change in taxonomic diversity but not necessarily a change in functional diversity if the same traits are covered by other species in this system. This explains the functional redundancy within the plant community where there are taxonomically distinct plant species which have similar roles in ecosystem functioning (Stagnol et al. 2016). It might also be that extinction of a few species may not result in a vast difference in the taxonomic diversity but may have a very important and notable effect on functional diversity. To understand the relationship between functional diversity and taxonomic diversity there is a need for biodiversity assessment especially in regions that which have suffered a huge land-use change and biodiversity loss like Sumatra, Indonesia.

1.5 Research objectives

This master's thesis studies the difference in plant functional traits and functional diversity among four prominent land-use systems (LUS) in Sumatra, namely forest, jungle rubber agroforest, oil palm, and rubber monocultures. Furthermore, this study addresses the difference in community-weighted means (CWMs) of plant functional traits between four land-use systems in Sumatra. This study also compares different functional diversity indices across the four land-use systems in Sumatra and derives an understanding of the effects of land-use transformation on plant functional diversity. Furthermore, this study explores the relationship between functional diversity and taxonomic diversity.

1.6 Research hypothesis

Three hypotheses were addressed:

H1: Plant functional traits differ significantly between the four land-use systems.

H2: Community-weighted means (CWMs) of plant functional traits differ in the four land-use systems.

H3: Functional diversity indices of plants differ in the four land-use systems.

H4: Functional diversity is positively but may not be linearly related to taxonomic diversity

2. Methods

2.1 Study area

The study was carried out within the EFForTS project area (Drescher et al. 2016) in the Jambi province in Sumatra, Indonesia. Acrisols was found to be the main soil type in the study area (Allen et al. 2015). The lowland of Jambi has a tropical humid climate with two peak rainy seasons occurring around March and December and a notable dryer period occurring during July and August. The mean annual temperature is 26.7°C with relatively constant temperature throughout the year (Drescher et al. 2016).

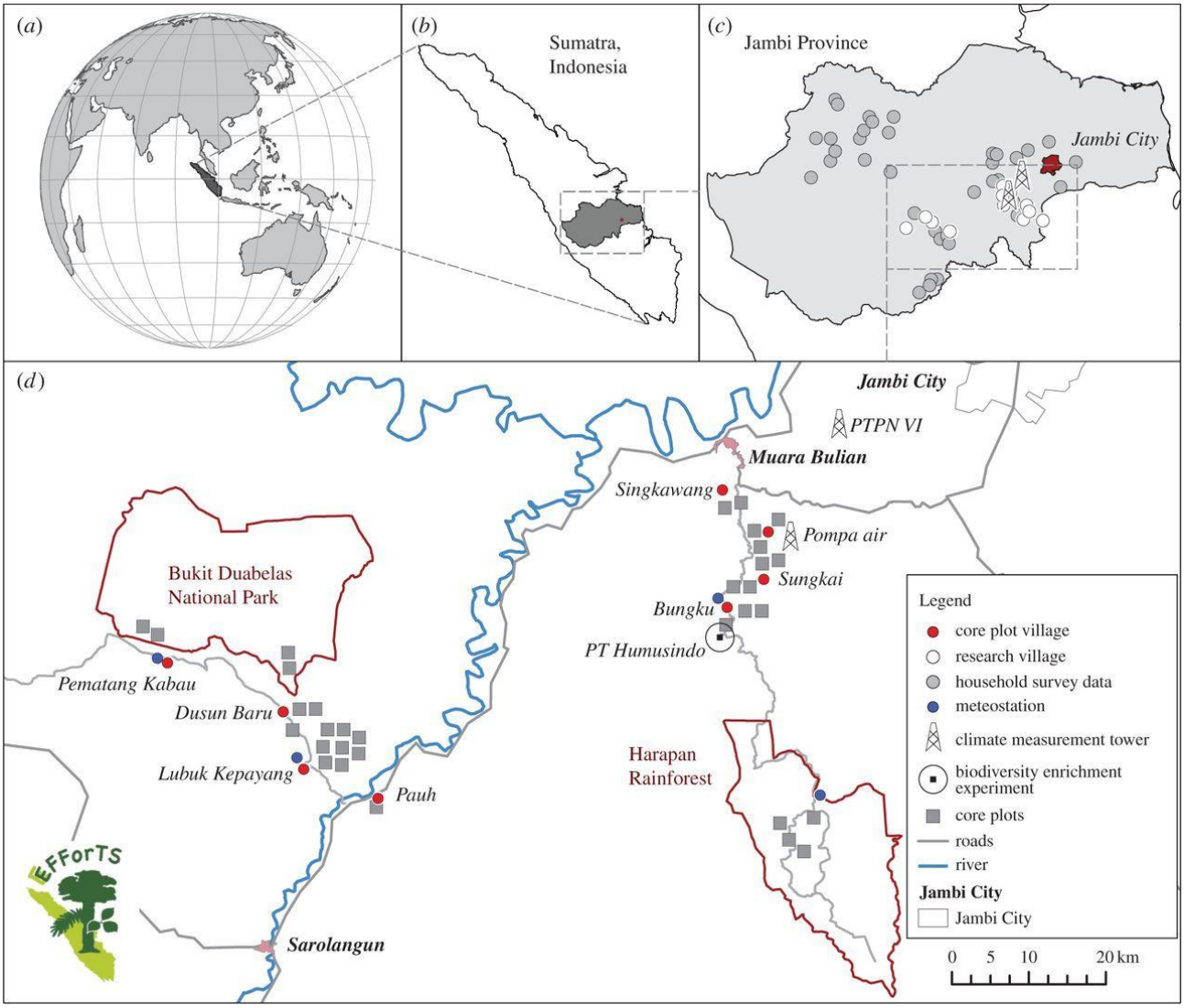

Figure 1: Location of EFForTS study areas in Sumatra in Jambi Province (a, b and c). The core plots are located in four different land-use systems in two landscapes: near to Bukit Duabelas National Park and Harapan Rainforest (d) (Rembold et al. 2017).

2.2 Plot design

A core plot design was used to collect ecological data (Drescher et al. 2016). Eight core plots measuring 50m x 50m in each of the four land-use systems was established in 2012, resulting in a total of 32 core plots in the overall project area (Drescher et al. 2016). Five nested sub-plots measuring 5m x 5m were established at a fixed position within each core plot (Drescher et al. 2016).

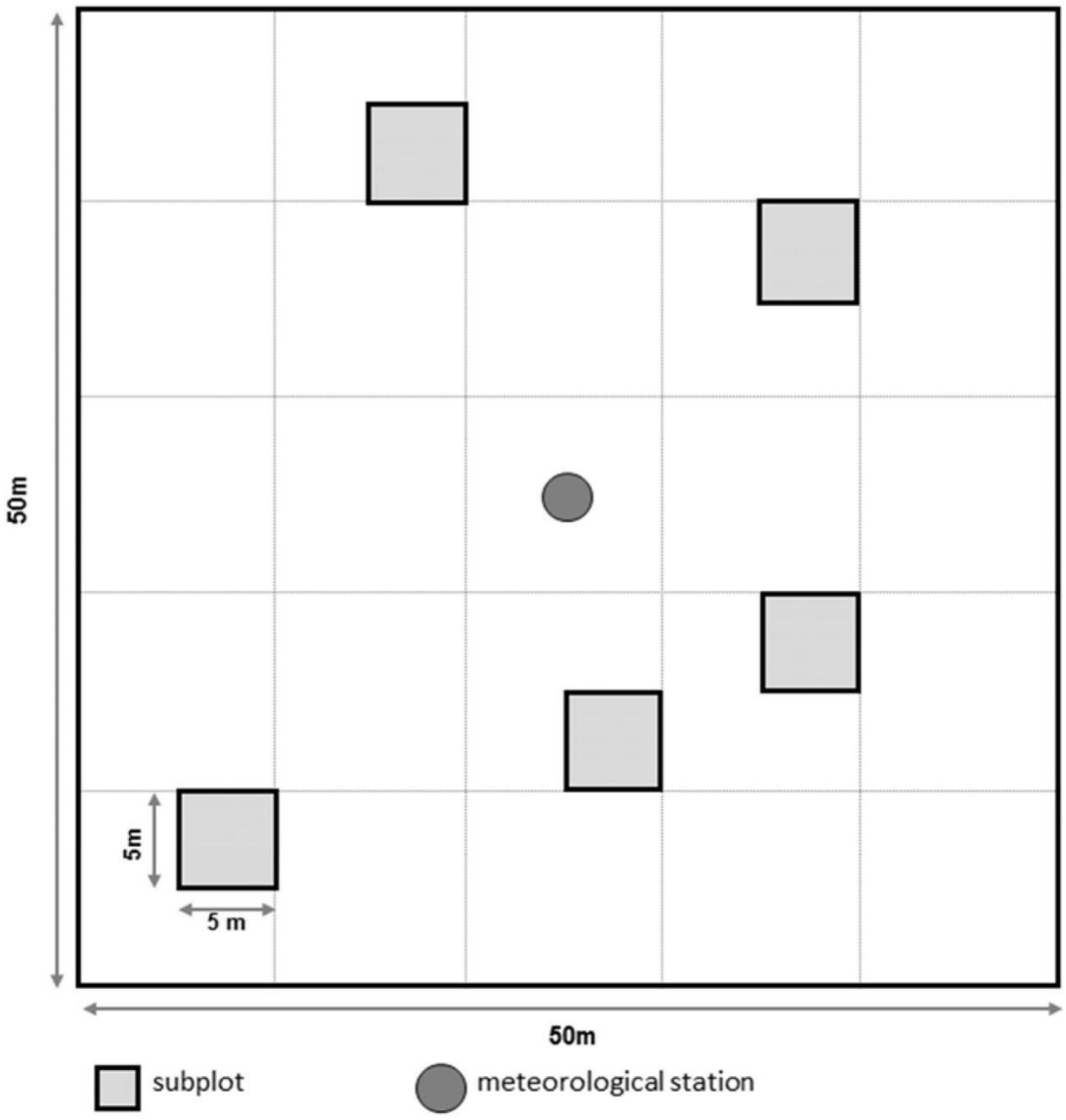

Figure 2: A core plot design of EFForTs project measuring 50m x 50m with 5 nested sub-plots measuring 5m x5m at fixed distance used for collecting ecological data (Drescher et al. 2016).

2.3 Land-use systems in the study area

2.3.1 Tropical rainforest

The lowland rainforest in our study area is a primary degraded lowland rainforest (Margono et al. 2014) which represents land-use with low intensity or minimum human disturbance (Schneider et al. 2015). This diverse rainforest is the main region which encountered huge forest loss in recent times (Margono et al. 2014). Our selected core plots in the forest had no direct indication of anthropogenic disturbance but the rainforests in our study area experienced selective logging and fragmentation in the past (Rembold et al. 2017).

2.3.2 Rubber agroforestry

Rubber (*Hevea brasiliensis)* was introduced in Sumatra by Dutch private estates in the 20th century which with time and demand turned into jungle rubber system (Penot 2004). Jungle rubber is defined as a "complex agroforestry system"(Gouyon et al. 1993). At present jungle rubber is a traditional agroforestry system in Sumatra, which consists of planting rubber trees into degraded lowland rainforest (Rembold et al. 2017). These systems are under extensive management (Schneider et al. 2015).

2.3.3 Rubber plantations

Rubber plantations are the monocultures of rubber trees (*Hevea brasiliensis)*. These are the high-intensity land-use system with a lot of human disturbance like the use of herbicides, fertilizers and liming (Kotowska et al. 2015, Schneider et al. 2015). There were rubber trees aged between a narrow range of 6-16 years in rubber plantations when the core plots were established in 2012 (Drescher et al. 2016).

2.3.4 Oil palm plantations

Oil palm plantations are the monocultures of oil palm trees *(Elaeis guineensis)*. They are also the high-intensity land-use systems like rubber plantation which encounters a lot of anthropogenic disturbances (Schneider et al. 2015) and even more fertilizers input in comparison to rubber plantation (Clough et al. 2016). There were oil palm trees aged between 8-15 years in rubber plantations when the plots were established in 2012 (Drescher et al. 2016).

2.4 Data collection

Functional traits were measured for 1136 individuals (570 individuals from tree species and 566 individuals from the understorey species) from 730 plant species in the study area. Among the 730 species, 570 species were trees and 160 species were the understorey. Tree sampling consisted 63% of species from forest plots, 35% of species from jungle rubber plots and 2% of species from plots in rubber plantation. Understorey sampling consisted 19% of species from forest plots 21% of species from jungle rubber plots 24% of species from plots in rubber plantation and 36% species from plots in oil palm plantation.

Eight anatomical and morphological tree traits were selected as they are tied to a species capacity to capture resources (Flynn et al. 2009), thus give a detailed understanding of how these species help in ecosystem functioning as a whole (Table 1). For some species, all the eight anatomical and morphological traits were not available because of many factors like wrong trait measurements, drying out of leaves when it was scanned, selection of dead/wrinkled leaves etc. These species were noted and were considered for recollection of traits for future analysis.

Table 1: List of our target plant functional traits with their ecological significance. Data from Perez-Harguindeguy et al. (2016), modified.

Functional Trait	Ecological significance	Measurement units
Chlorophyll content	Related to the photosynthetic ability	-
Leaf thickness	Linked to light regime / sun-imposed stress at high light regimes	mm
Wood density/ Stem specific density (SSD)	Related to the above ground storage of carbon, mechanical stability, defense against pathogens and predators and resistance against hydraulic failure	mg/mm^3
Specific leaf area (SLA)	Related to relative growth rate, leaf life span and functional strategies of plants in different environmental conditions	cm^2/g
Leaf area	Related to ecological strategy, water transport, photosynthetic rate, competitive and mechanical strength	cm^2
Leaf perimeter	Related to ecological strategy, competitive strength	mm
Leaf aspect ratio	Water and light availability and leaf functions	-
Leaf form coefficient	Resource allocation and plant fitness and adaptation	-

Here, a trait is defined as "a measurable aspect of an organism which impacts its interaction with the environment, its capacity to find and acquire resources, and which therefore affects the fitness of a species via its effects on growth, reproduction, and survival" (Flynn et al. 2009).

Previous species surveys and functional trait data collection from the study area in Sumatra provided data on tree and understorey species composition of each plot (Rembold et al. 2017).
I used these species survey data to extrapolate our functional trait data from few individuals to assign trait data to entire plots based on species distribution. Thus, it was possible to undergo plot based analysis with data from a few sampled individuals. Functional traits like leaf dry weight in the total sample, chlorophyll content, leaf thickness and wood density /stem specific density for one individual per species were available for analysis.

2.4.1 Collection of tree traits

Tree sampling was carried out in core plots. For obtaining leaf traits from trees, 10 fully expanded and healthy sun leaves from one mature tree per species were collected from 24 core plots in three land-use systems using a predefined protocol. Trees were identified as those plants with a diameter at breast height (dbh) ≥10cm measured at 1.30 m and for rubber trees measured at 1.70 m above the tapping zone (Rembold et al. 2017). Traits were not collected from oil palm (*Elaeis guineensis*) but were collected from rubber trees (*Hevea brasiliensis*). There were no trees other than oil palm tree *(Elaeis guineensis)* in oil palm plantation thus; tree traits were collected only from three land-use systems and 24 core plots.

Leaf thickness resembles a plant capacity to invest in biomass productivity and the plant response to water deficits (Pauli et al. 2017). Leaf thickness was measured for 10 leaves (from one tree per species) with the help of a caliper. One measurement was taken at the middle of each leaf avoiding the caliper to touch the primary and secondary venation.

A SPAD 502 Plus Chlorophyll Meter (Spectrum Technologie, Aurora, USA) was used to measure the chlorophyll content in the middle of each 10 leaves (from one tree per species) avoiding the primary and secondary venation. Chlorophyll content was not measured in direct sunlight as this would disturb the measurement.

For obtaining leaf traits from trees, the collected leaves were scanned. The scans were named with a unique identification number and stored in a systematic way. These leaf scans were processed in the computer software Winfolia 2016 as a part of this master's thesis to extract the measurement of functional leaf traits. The compound leaves were separated with specific letters and stored accordingly. The images were saved in an upright position as Winfolia gives correct measurements if the leaves are in an upright position. Images were edited in the computer software Irfanview, Microsoft paint and Winfolia for further accuracy in extracting trait measurements.

These 10 leaves which were used in extracting different trait measurements were kept in paper envelopes and stored in compartment drier for 72 hours at 70°C. They were weighted after 72 hours (in case that the leaves were not yet dried after 72 hours, they were dried for one more day) and the total weight measured for 10 leaves was noted. Wood density data was provided by subproject B04.

2.4.2 Collection of the understorey traits

Understorey sampling was carried out in subplots nested within the core plot. Traits were collected by B06 field team from the understorey plants in all the 32 core plots and four land-use systems in our study area. At the beginning of field sampling, the understorey traits were aimed to be collected for 10 most abundant species per plot (based on our vegetation survey 2013-2014). Unlike tree traits, the understorey traits were aimed to be collected for three individuals per species that means a maximum of 30 individuals per plot. Because many of the understorey species were among the most individual rich species in several plots, they were only collected in one plot. This led our dataset to have less than 10 species in most plots because they already occurred in other plots. Understorey trait sampling is yet not completed and currently, the available understorey traits were collected mainly from oil palm plantations and only a few understorey species from the forest were sampled for trait measurement.

For the understorey plants, it was difficult to find sun leaves as required for trees. Thus adult and healthy understorey plants were sampled. It was made sure that the stem of the plant we collect a

leaf from is suitable so that stem sample could be collected from the same individual for stem specific density.

The understorey trait sampling was carried out using the same methods as for tree traits. The only exception was that in trees branch samples were used for collecting wood-density data whereas in the understorey stem samples were used to collect data on stem-specific density. The remaining process with packing, scanning, drying, weighing, and storage is the same for collecting tree traits and understorey traits.

2.5 Data handling

Data cleaning was carried out using the free software for statistical and computing R version 3.4.4 (R Core Team 2018). The raw data from Winfolia was cleaned taking care of each trait measurement both in simple and compound leaves. The traits from all leaflets of compound leaves were aggregated to get measurements for a whole compound leaf. The traits measurements from many leaves of a single individual were further aggregated to make the cleaned data appear in form of an individual- trait matrix.

This matrix was further combined with other anatomical and morphological traits that were already collected by the B06 field team. This combined individual trait matrix was further aggregated in the form of land-use- trait matrix. It was very important to decide which of the traits to use for our analysis as Winfolia measured many traits from leaf scans. A simple way to decide this was to include all the functionally informative traits available (Petchey and Gaston 2006). Only functionally significant plant traits were taken for analysis discarding unnecessary measurements which were automated from Winfolia. The significant plant traits were our target traits which are listed below with their ecological significance. In absence of the target traits from our trait matrix, formulas were used to calculate it. Specific leaf area (SLA) was calculated as the ratio of leaf area and leaf dry weight (unit cm^2 g-1).

2.6 Statistical analysis

For statistical analysis, free software for statistical analysis and computing R version 3.4.4 (R Core Team 2018) was used. All the tests and analysis were performed for functional traits in

three categories: a) combining all the tree and understory functional traits together, b) only functional traits of trees and c) only functional traits from understory.

Shapiro-Wilk Normality Test was performed for each plant functional traits to find out whether the traits follow a normal distribution or not. The result from the normality test was used as a base to determine the further tests and analysis. For the non-normal distribution, Kruskal-Wallis rank sum test (Pohlert 2014) was carried out to check if there is a significant difference in plant traits between four land-use systems in the study area.

The results from the Kruskal-Wallis test showed if the traits vary significantly between land-use systems, but it did not give information about which particular pair of land-use systems varies in plant functional traits. Thus, the *post hoc* Wilcoxon rank sum test (Pohlert 2014) was performed as a follow-up test between functional traits from all pairs of land-use systems in the study area. The distribution of traits in four land-use systems was presented in Violin plots and the test results were presented in letters automated from function 'multcompletters' in R package 'multcompView'.

Community-weighted means (CWMs) of traits was calculated using the 'functcomp' function of FD from vegan package in R (Laliberté and Legendre 2010). For this abundance data of trees and understorey species per plot was used along with the functional trait data. Functional trait data was used as species by traits matrix and abundance data was used as a site by species matrix. The 'functcomp' function returned numerical values of all the traits in all the 32 plots. This plot-wise return value of all traits was tested for significance using the Kruskal-Wallis rank sum test and tested for significant difference between particular land-use systems using Wilcoxon rank sum test.

Principal component analysis was performed to find out the contribution of traits to the component. The principal component analysis for CWMs of traits was done using R package 'factoMineR'(Husson et al. 2018). Furthermore, the contribution of traits to the principal component (CWMs in our study) was calculated as percentage contribution of each trait in a total contribution of traits and presented as a bar graph and scree plot.

The Indices of functional diversity i.e. functional richness, functional evenness, functional dispersion, functional divergence, and Rao's quadratic entropy was calculated by using the dbFD function from FD package in R (Laliberté et al. 2014). The plot level measurement of these functional diversity indices was used to generate land-use level understanding of the change in functional diversity indices. Wilcoxon rank sum test was used to test the significant difference in these indices between four land-use systems. Species richness was compared with the functional diversity indices. These indices were plotted against the species richness data extracted from abundance table to know the effect on functional diversity with an increase or decrease in species richness. The relationship between functional diversity indices and taxonomic diversity were presented as a simple scatter plot along with the regression and coefficient results.

3. Results

3.1 Distribution of plant functional traits in the study area

All the target plant functional traits for combined dataset of tree and understorey showed a non-normal distribution with the p-value <0.05 resulted from Shapiro-Wilk normality test (Figure 3 and Annex 2). The wood density (stem specific density for the understorey) showed a bimodal distribution (Figure 3H) which means that the plants cluster in two groups when categorized by density: high wood density in trees and low stem density in the understorey. Furthermore, the stem densities in understorey cluster in a very narrow range in comparison to that of trees.

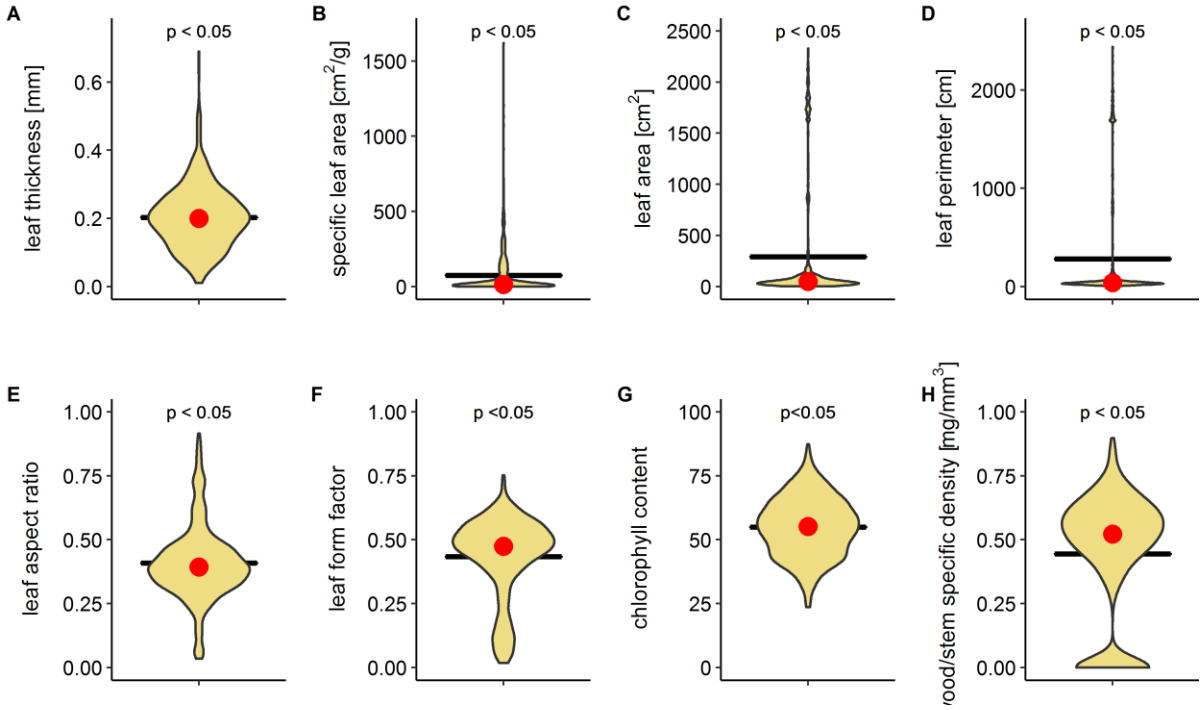

Figure 3: Shapiro-Wilk normality test shows a non-normal distribution of plant functional traits from the tree and understorey level combined (p-value<0.05, level of significance 0.05) in all the 32 core plots from four land-use systems in the study area. The distribution is presented in violin plots where the mean of plant functional traits are displayed as crossbar and median displayed as a red dot.

At tree level, all the functional traits showed a non-normal distribution with p-value<0.05 (Figure 4 and Annex 2) except chlorophyll content with p-value = 0.9434. At understorey level, all the functional traits showed a non-normal distribution with the p-value <0.05 (Figure 5 and Annex 2). Some traits like leaf area, leaf perimeter, and specific leaf area showed a bimodal distribution (Figure 5) in the understorey level denoting that most understorey plants species are from same families or same genera having similar stem density.

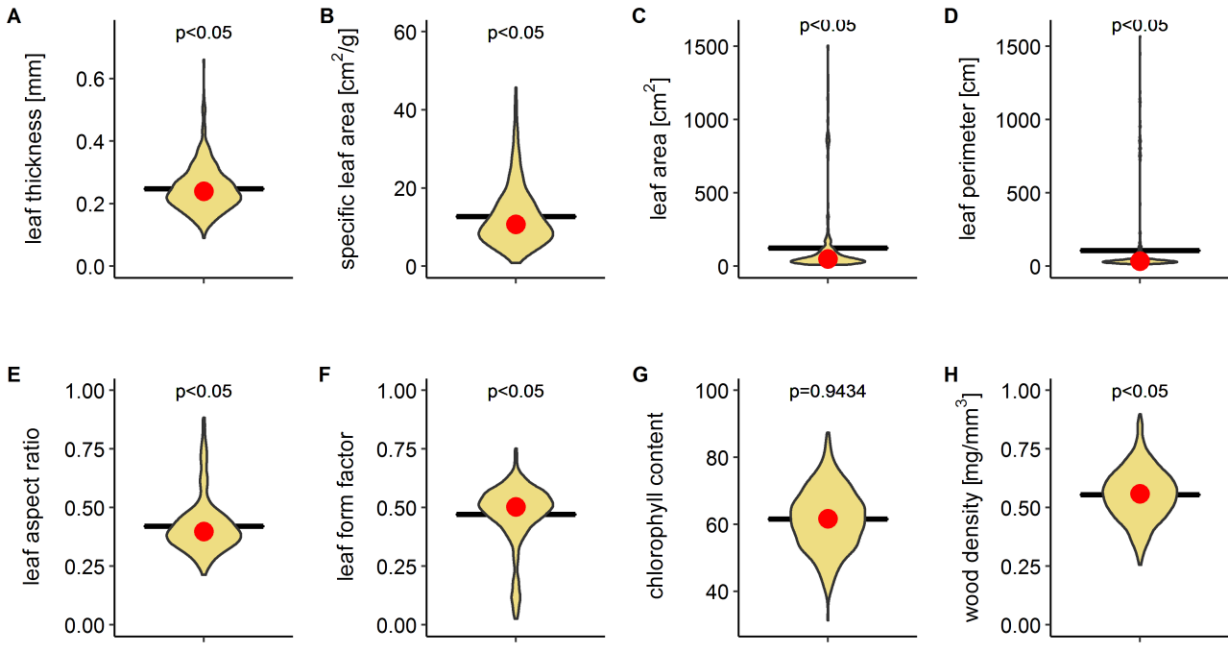

Figure 4: Shapiro-Wilk normality test shows a non-normal distribution of functional tree traits (p-value<0.05) with exception of chlorophyll content distributed normally (p-value=0.9434, level of significance=0.05) in 24 core plots from three land-use systems in the study area. The distributions are presented in violin plots where mean of functional tree traits are displayed as crossbar and median displayed as a red dot.

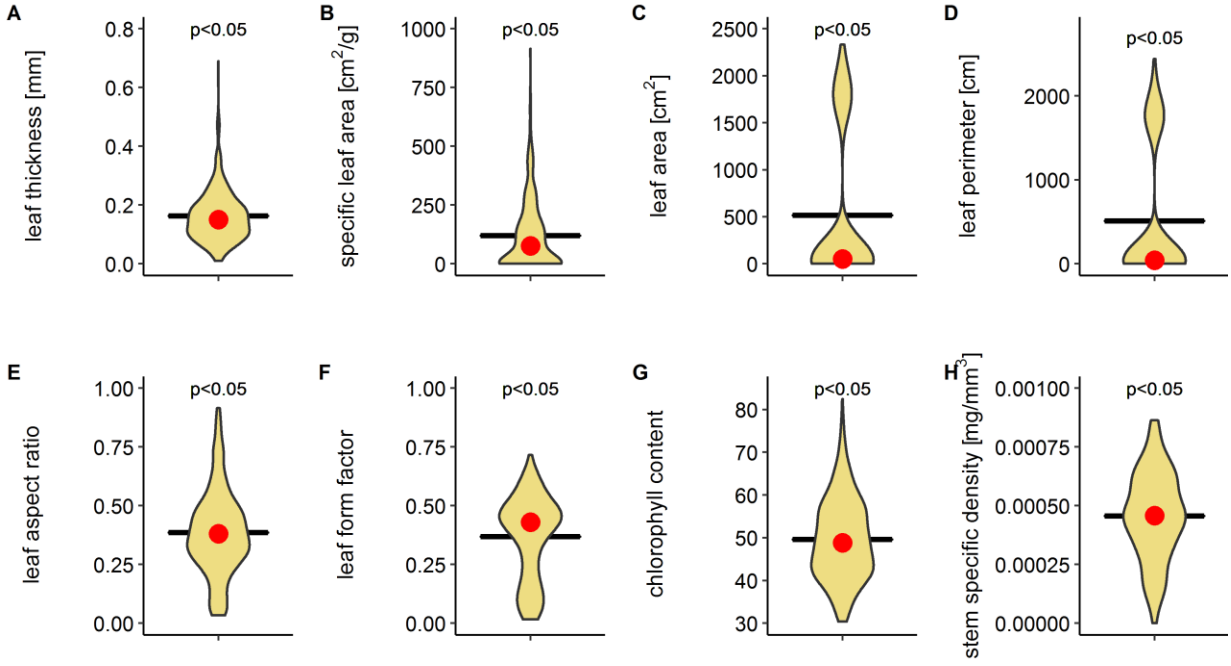

Figure 5: Shapiro-Wilk normality test shows a non-normal distribution of functional understorey traits (p-value < 0.05, level of significance = 0.05) in all the 32 core plots from four land-use systems in the study area. The distributions are presented in violin plots where the mean of functional understorey traits are displayed as crossbar and median displayed as a red dot.

3.2 Plant functional traits across four land-use systems

For the combined dataset of trees and understorey, traits varied significantly between the four land-use systems except for leaf aspect ratio (Figure 6, see Annex 3). Leaf thickness of plants varied significantly between all four land-use systems which indicates that the leaf thickness differs between the plants from high-intensity land-use and low-intensity land-use systems. Forest and rubber plantations had significantly higher specific leaf area than jungle rubber. There was no significant difference in forest and rubber in specific leaf area. This is because of the presence of the understorey with big compound leaves in our combined dataset. The value of chlorophyll content was high in forest and low in oil palm suggesting that the land-use has an effect on plants ability in producing green pigments. The wood density or stem specific density was high in plants from forest and low in oil palm. It also varied significantly between land-use systems except in forest and jungle rubber.

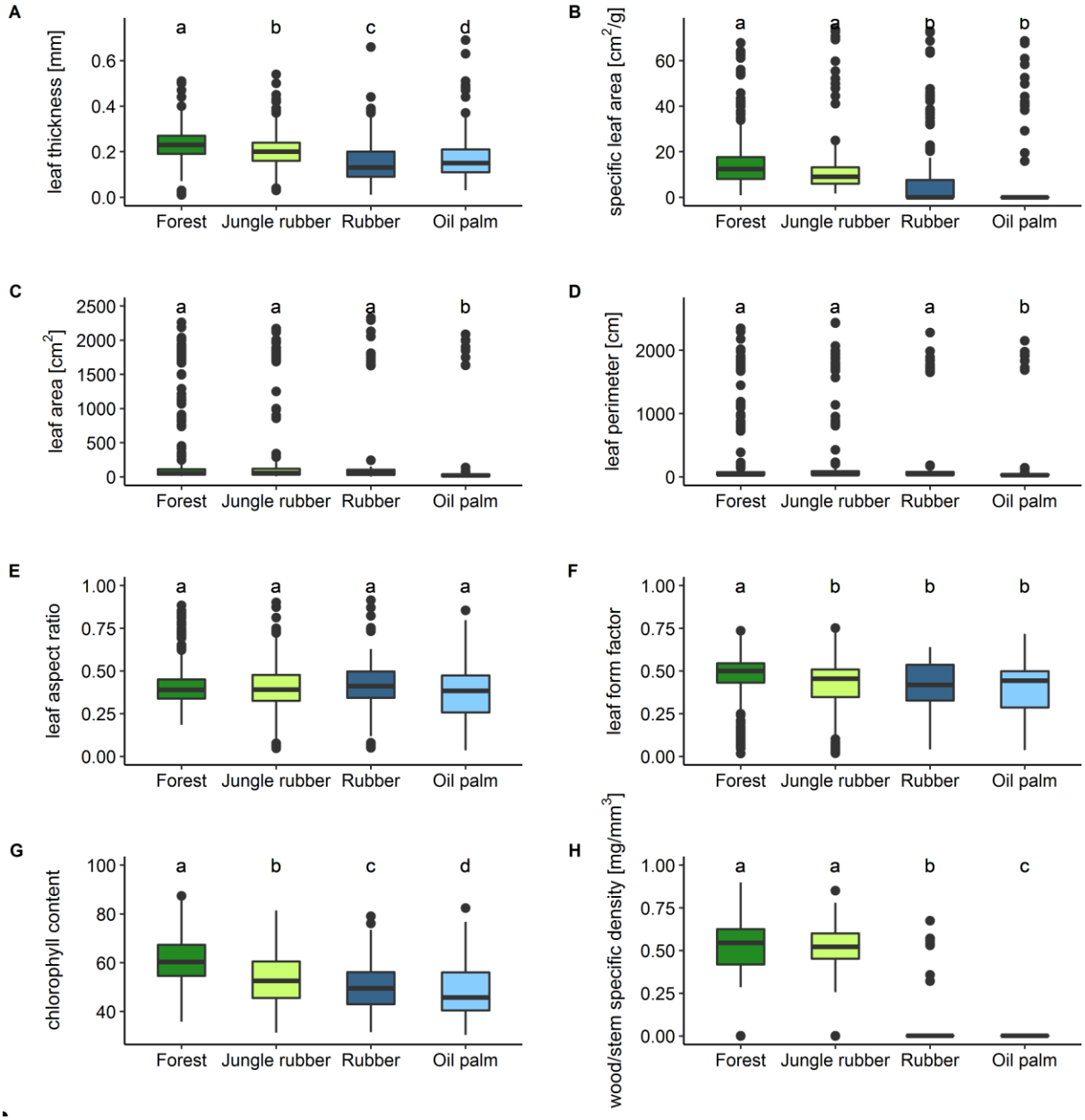

Figure 6: Kruskal-Wallis rank sum test applied on the combined tree and understorey traits showed that there is a significant difference in plant functional traits in 32 plots across four land-use systems ($p<0.05$, level of significance=0.05, see Annex 3) except for leaf aspect ratio ($p>0.05$). Furthermore, Wilcoxon rank sum test showed a significant difference in plant traits in particular land-use systems which are presented as letters at the top of box plots.

Analysis of functional tree traits showed that there is a significant difference in functional tree traits across different land-use systems ($p<0.05$, see Figure 7, Annex 3) except for leaf thickness and average leaf aspect ratio ($p>0.05$). Tree traits like chlorophyll content, wood density, leaf area, leaf perimeter, and leaf form factor were only significantly different between forest and

jungle rubber but not between other land-use systems. The analysis showed that the specific leaf area varied significantly between jungle rubber and the rest of the land-use systems.

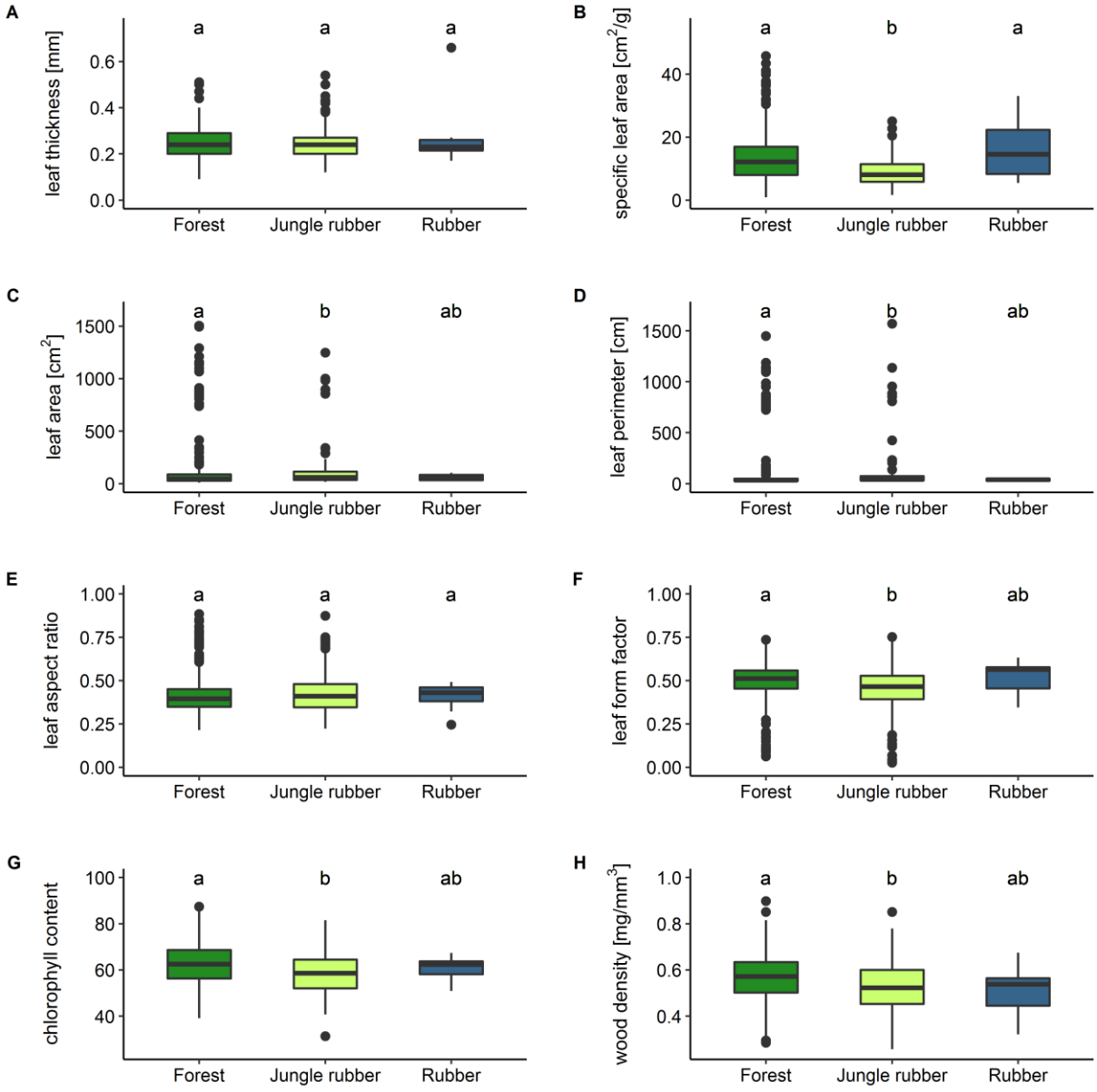

Figure 7: Kruskal-Wallis rank sum test applied on tree traits showed that there is a significant difference in functional tree traits in 24 plots across three land-use systems ($p<0.05$, level of significance=0.05, see Annex 3) except for leaf thickness and leaf aspect ratio ($p>0.05$, see Annex 3). Furthermore, Wilcoxon rank sum test showed a significant difference in tree traits in particular land-use systems which are presented as letters at the top of box plots.

All the target functional understorey traits showed a significant difference between different land-use systems ($p<0.05$, see Figure 8, Annex 3). The analysis revealed very different results

than in trees level. Chlorophyll content and wood density varied significantly between forest and the rest of the land-use systems. Leaf thickness varied significantly between forest, jungle rubber and rubber but did not show any significant difference between jungle rubber and oil palm. Specific leaf area varied significantly between monocultures and other two land-use systems.

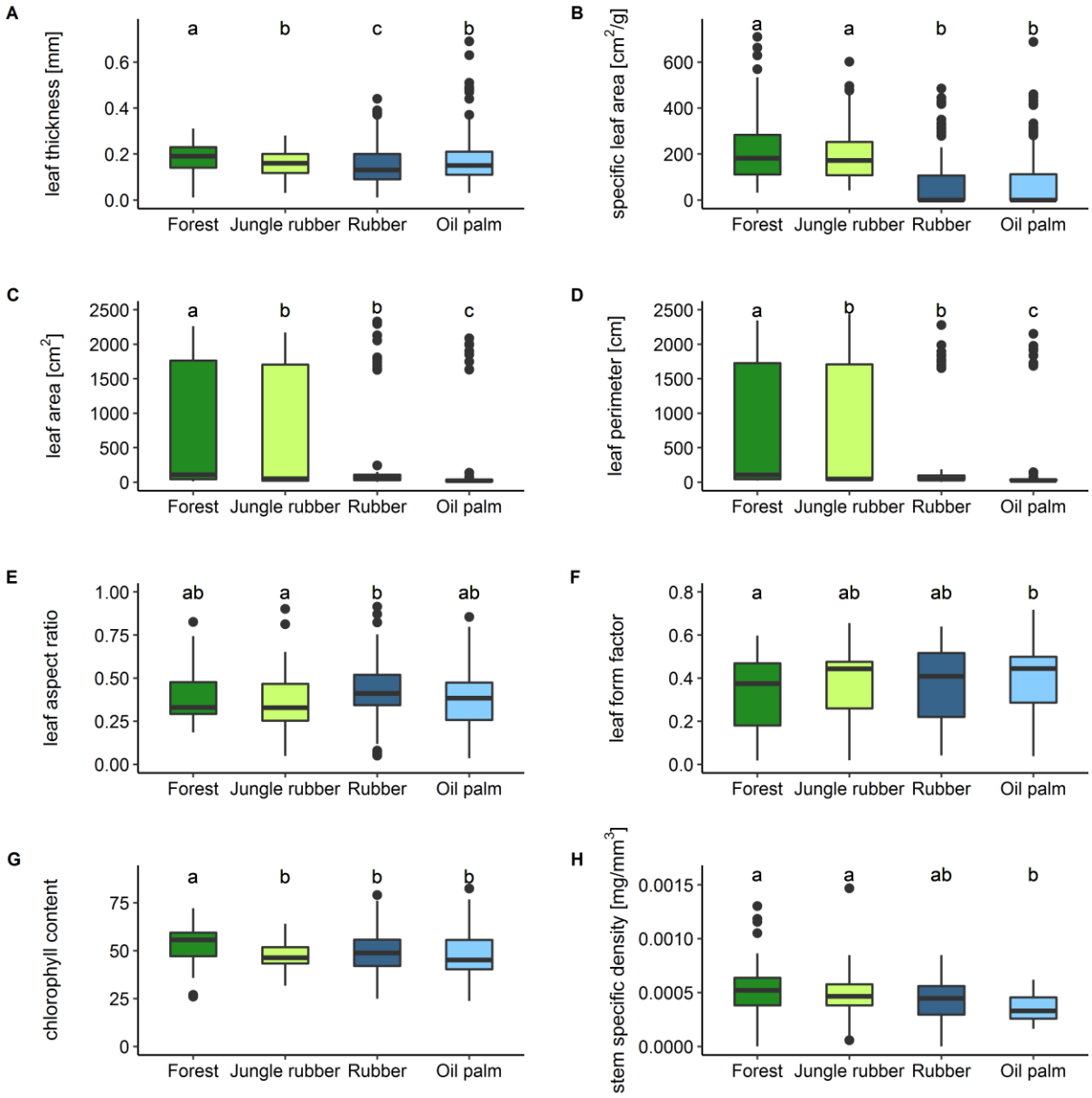

Figure 8: Kruskal-Wallis rank sum test applied on the understorey traits showed that there is a significant difference in functional understorey traits in 32 plots across four land-use systems ($p<0.05$, level of significance=0.05, see Annex 3). Furthermore, Wilcoxon rank sum test showed a significant difference in understorey traits in particular land-use systems which are presented as letters at the top of box plots.

3.3 Functional composition (community-weighted means) of plant traits across four land-use systems

When considering the data of species abundance per plot in four land-use systems, our results appeared very different in comparison to our results from analysis on the species level. When community-weighted means of functional tree traits were analyzed, Jungle rubber had the highest value for leaf thickness. Leaf thickness also differed significantly between forest and jungle rubber and jungle rubber and oil palm (Figure 9A).

The specific leaf area and wood density in trees were highest in forest and it varied significantly between forest and other three land-use systems. This indicates that land-use intensification in Sumatra has strong influence in the functional composition of specific leaf area and wood density in trees (Figure 9B and 9H).

The leaf area, leaf perimeter and leaf form factor showed no significant difference between the land-use systems (Figure 9C, 9D, 9F). The leaf aspect ratio varied significantly between forest and rubber and between jungle rubber and rubber (Figure 9E). The chlorophyll content in tree was high in forest followed by jungle rubber and it also varied significantly between forest and the two monocultures and between jungle rubber and two monocultures (Figure 9G). This shows the effect of land-use change on functional composition of green pigments present in tree leaves thus indicates the different capacity of functional groups to take part in photosynthesis across four land-use systems in Sumatra.

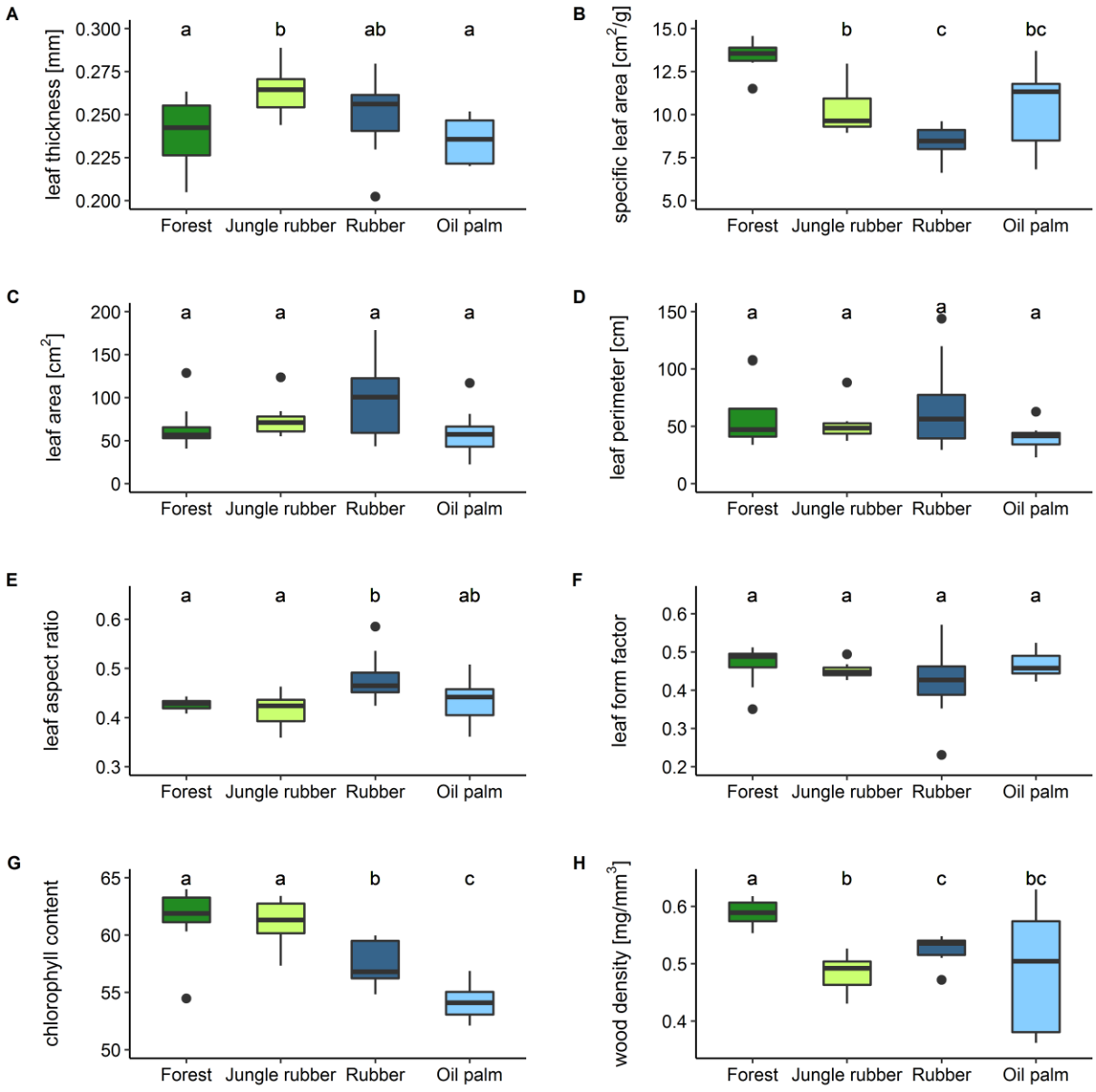

Figure 9: Community-weighted means of tree traits in four land-use systems based on abundance data with median displayed as crossbar in the box plot. Kruskal-Wallis rank sum test applied on community-weighted means of tree traits showed a significant difference in community-weighted means of all our target traits except for leaf area (C), leaf perimeter (D) and leaf form factor (F) in 32 plots across four land-use systems (see Annex 4). Furthermore, Wilcoxon rank sum test showed the difference in community-weighted means of tree traits in particular land-use systems which are presented as letters.

When functional compositions of understorey traits were analyzed, leaf thickness and specific leaf area did not vary significantly between the four land-use systems (Figure 10A and 10B). The leaf area and leaf perimeter showed a significant difference between forest and other three land-use systems (Figure10C and 10D). The leaf aspect ratio varied significantly between forest and

jungle rubber and forest and oil palm (Figure 10E). The chlorophyll content only varied significantly between jungle rubber and other three systems (Figure 10G). The stem specific density varied significantly between forest and jungle rubber and forest and oil palm (Figure 10H).

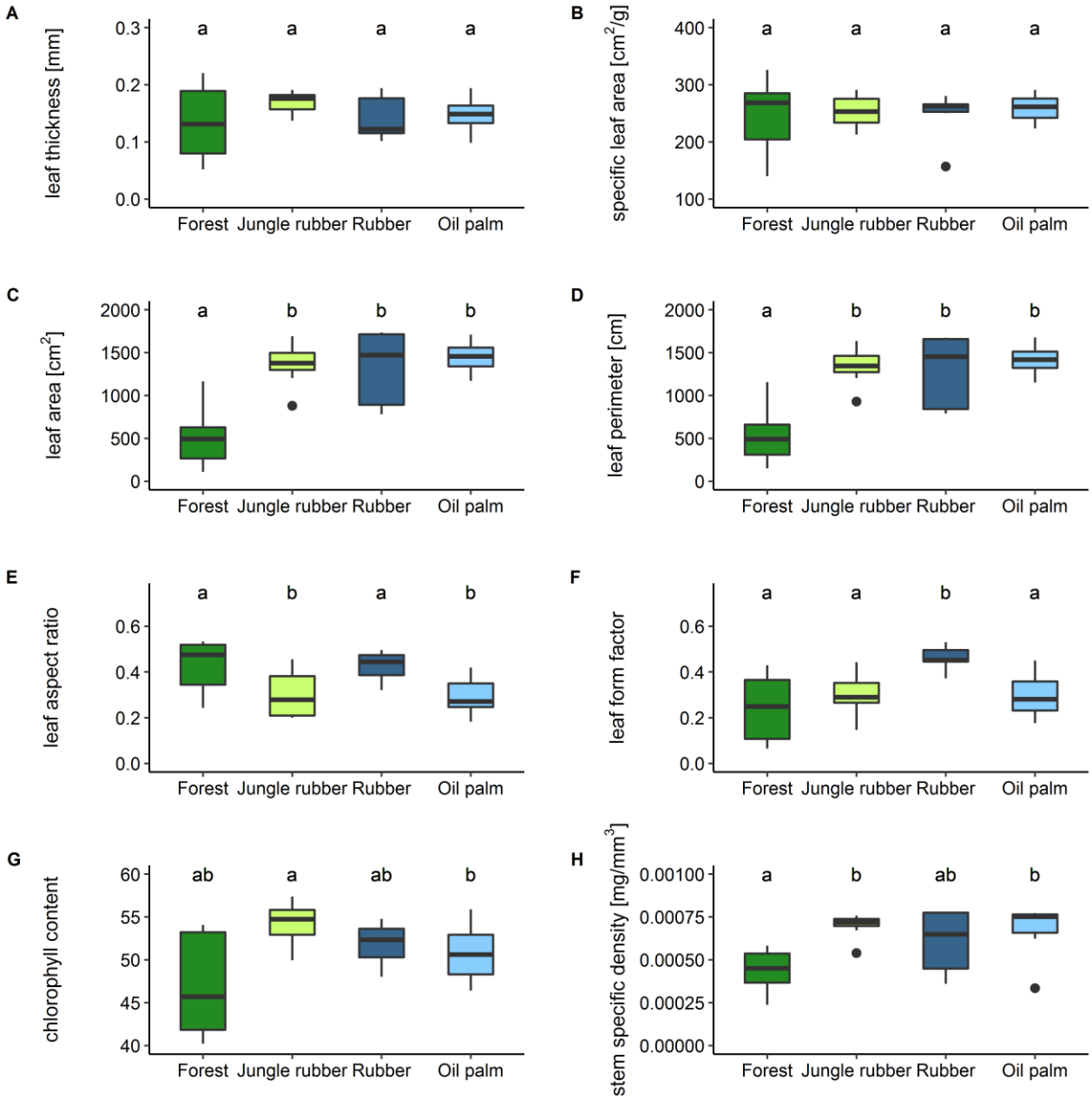

Figure 10: Community-weighted means of the understorey traits in four land-use systems based on abundance data with median displayed as crossbar in the box plot. Kruskal-Wallis rank sum test applied on community-weighted means of the understorey traits showed a significant difference in community-weighted means of all our target traits except for leaf thickness (A) and specific leaf area (B) in 32 plots across four land-use systems (see Annex 4). Furthermore, Wilcoxon rank sum test showed the difference in the understorey traits in particular land-use systems which are presented as letters.

3.4 The principal component analysis

The principal component analysis revealed different contributing variables to dimension 1 and dimension 2 of our principal component i.e community-weighted means of traits. Leaf area and leaf perimeter were significantly positively correlated for both tree and understorey. For, both tree traits and the understorey traits, we could see that the leaf traits were more important contributors than the wood trait (Figure 11).

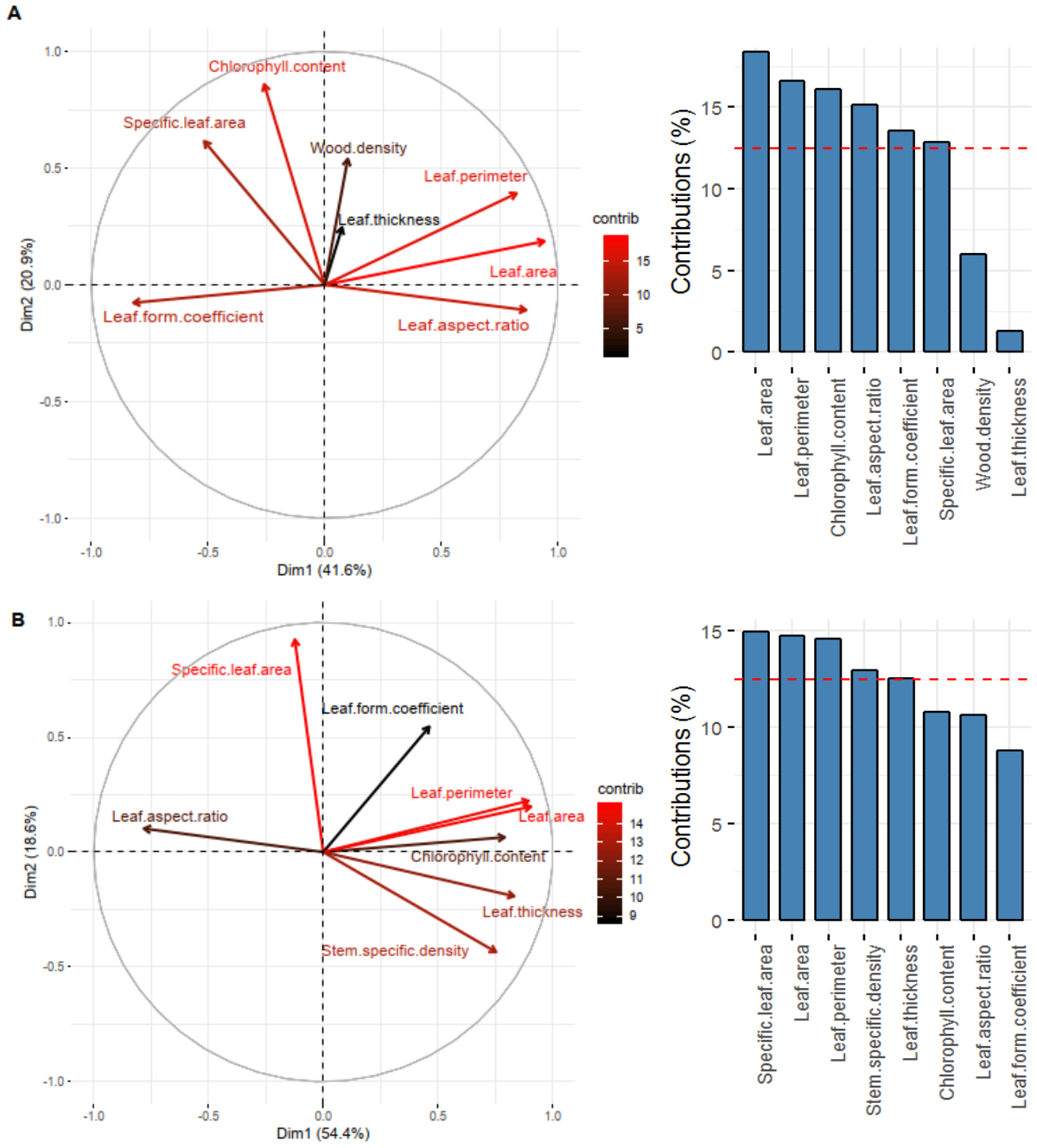

Figure 11: Principal component analysis of community-weighted means of tree traits (A) and understorey traits (B) with their contribution shown as a variance in color (high contribution= red, low contribution= black). The percentage of contribution of each trait in both Dimension 1 and Dimension 2 of principal component is presented as a bar graph with a red bar showing the expected contribution.

3.5 Comparison of functional diversity indices across four land-use systems

This research explored the change in four different functional diversity indices (functional richness, functional evenness, functional divergence, and functional dispersion) as well as Rao's quadratic entropy as the influence of land-use intensification.

Forest had significantly highest species richness and functional richness for trees followed by jungle rubber, rubber, and oil palm plantations. Forest varied significantly with jungle rubber in species richness but not in functional richness (Figure 12A and 12F). The functional evenness was highest in oil palm and lowest in jungle rubber. Jungle rubber and oil palm also differed significantly in functional evenness (Figure 12B). This shows that functional evenness has strong negative relationship with species richness and functional richness.

There was no significant difference in functional divergence for trees across different land-use systems showing that land-use intensification does not cause significant influence on functional divergence of trees (Figure 12C). Jungle rubber agroforestry had the highest value of functional dispersion and Rao's quadratic entropy and oil palm had the lowest. Tests revealed that functional dispersion was significantly different only between forest and oil palm whereas Rao's quadratic entropy was significantly different between forest and oil palm as well as jungle rubber and oil palm (Figure 12D and 12E).

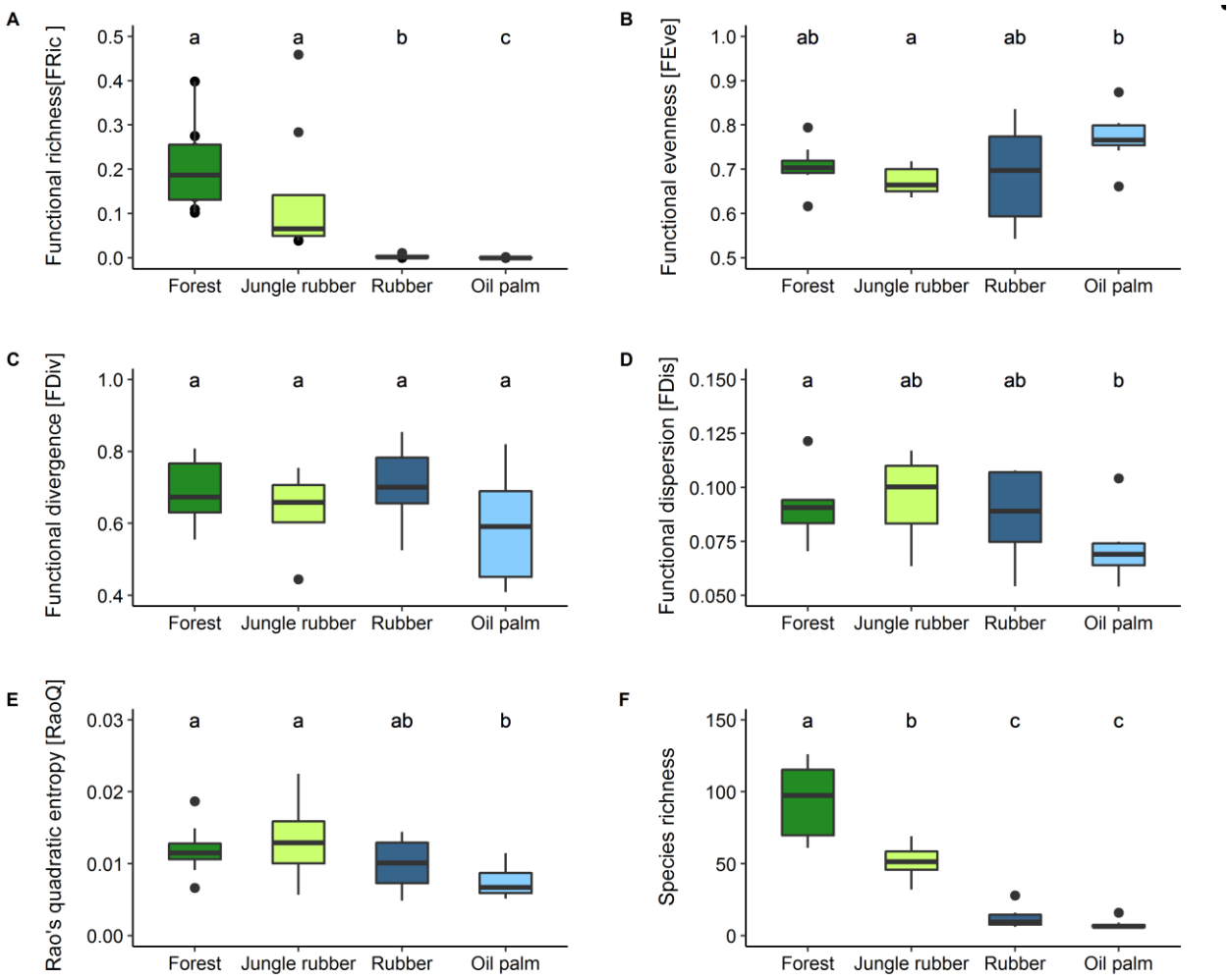

Figure 12: Functional diversity indices: functional richness (A), functional evenness (B), functional divergence (C), functional dispersion (D) and Rao's quadratic entropy (E) along with species richness(F) at tree level across four land-use systems in the study area. Kruskal-Wallis rank sum test applied on functional diversity indices and species richness showed that there is a significant difference in functional diversity indices across four land-use systems ($p<0.05$) except for functional divergence ($p=0.1833$). Furthermore, Wilcoxon rank sum test showed a significant difference in the functional diversity indices and species richness in particular land-use systems which are presented as letters at the top of box plots.

At the understorey level, in the current dataset that is mainly composed by oil plan understorey species, oil palm had the highest species richness and functional richness followed by jungle rubber, rubber, and forest (Figure 13A and 13F). This gives an extremely contrasting result as it has already been shown that our study area has the highest understorey species richness in forest and lowest in oil palm (Rembold et al. 2017). As mentioned in methods, this is because the understorey traits were collected so far mainly from oil palm plantations while the majority of the forest understorey species are currently missing. Our biased understorey dataset, having more

understorey traits collected from oil palm gives more functional richness in oil palm. In spite of this bias from our dataset, we can still see that functional richness is highly dependent to species richness.

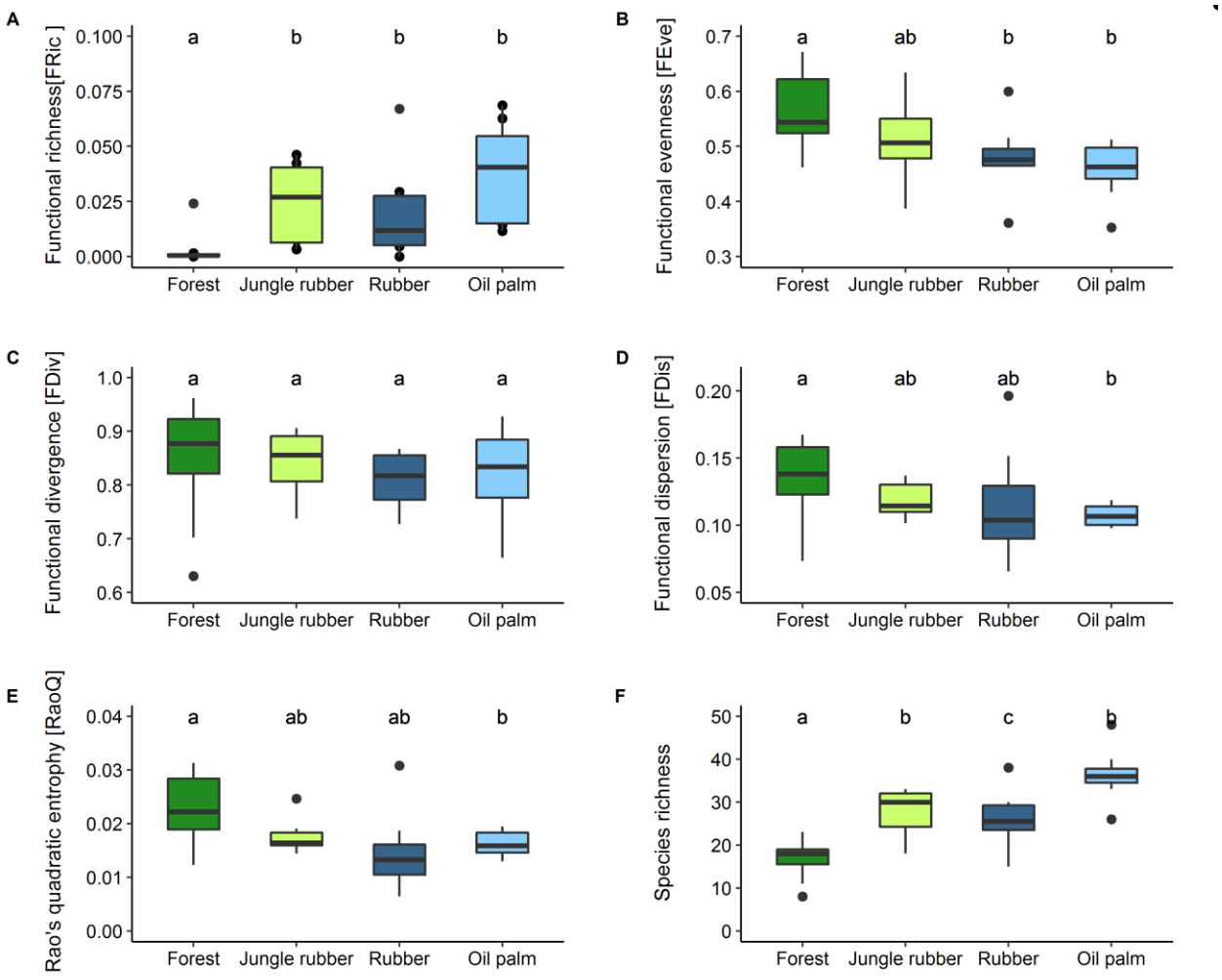

Figure 13: Functional diversity indices: functional richness (A), functional evenness (B), functional divergence (C), functional dispersion (D) and Rao's quadratic entropy (E) along with species richness(F) at the understorey level across four land-use systems in the study area. Kruskal-Wallis rank sum test applied on functional diversity indices and species richness showed a significant difference in functional diversity indices across four land-use systems ($p<0.05$) except for functional divergence ($p=0.1833$). Furthermore, Wilcoxon rank sum test showed a significant difference in functional diversity indices and species richness in particular land-use systems which are presented as letters at the top of box plots.

3.6 Relationship between taxonomic diversity and functional diversity indices

The relationship between functional diversity indices and taxonomic diversity was explored by plotting each functional diversity indices in all 32 core plots against taxonomic diversity in those

plots. Functional richness of trees increased with taxonomic diversity although non-linearly. Functional richness of trees maintained a low measurement close to zero when taxonomic diversity of trees in our plot was less than 30 (Figure 14A). When taxonomic tree diversity reached above fifty, functional richness of trees started to increase as well. When the taxonomic diversity of trees increases from 100 to 125 there is no prominent change in functional diversity.

Functional evenness of trees had the highest values when taxonomic diversity in of trees in our plot was less than 10 (Figure 14B) which shows evenness increases with a decrease in the number of species. This might be because decrease in number of species in the plot gives a less complex species composition in that plot. Functional divergence, functional dispersion, and Rao's quadratic entropy did not show any clear relation with taxonomic diversity in tree level analysis.

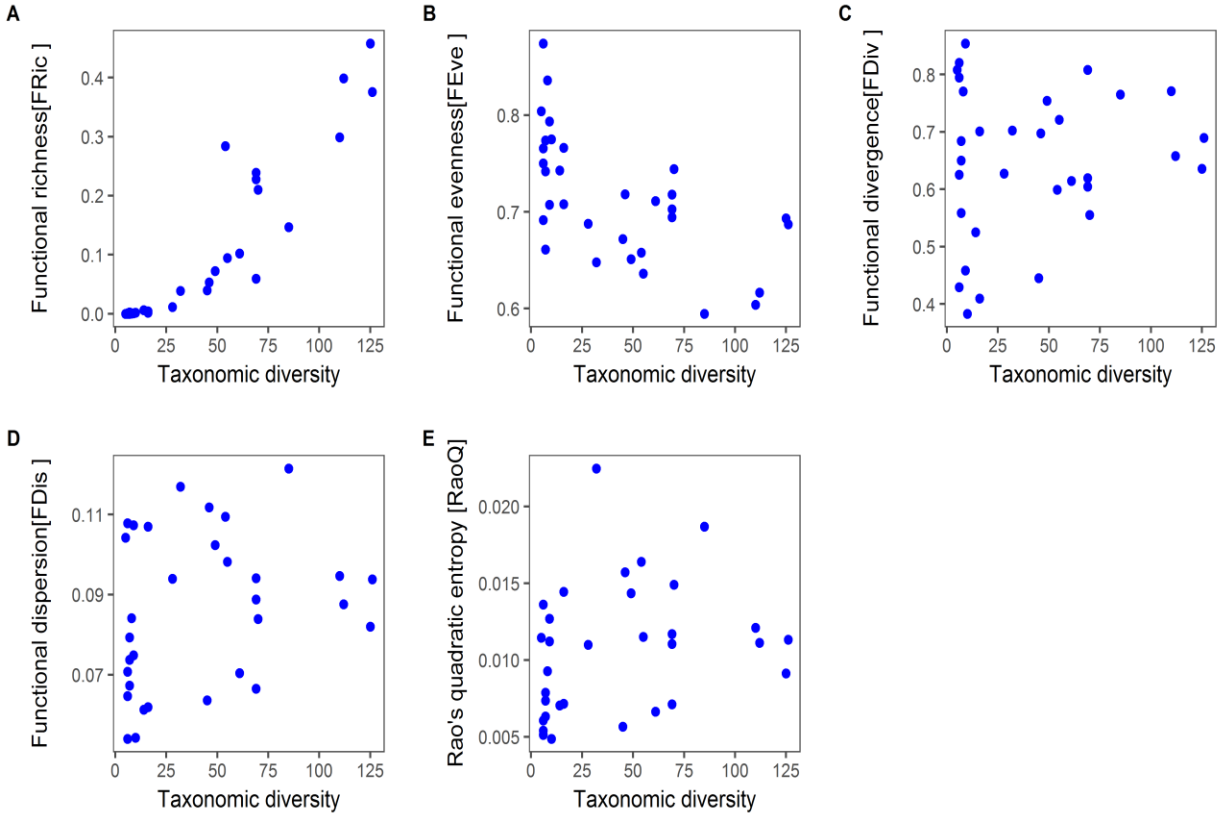

Figure 14: Relation between indices of functional diversity and taxonomic diversity at tree level where functional diversity indices i.e. functional richness (A), functional evenness (B), functional divergence (C), functional dispersion (D) and Rao's quadratic entropy (E) are presented in y-axis and taxonomic diversity is presented in x-axis.

Functional richness of understorey increased with an increase in taxonomic understorey diversity. Functional richness in understorey was highest when understorey taxonomic diversity was highest in our plots. Functional richness declines slowly until half of the understorey species is lost. Functional richness of understorey declines sharply after half of the understorey species is lost and maintains a low measurement close to zero (Figure 15A). Overall, this result shows that functional richness is strongly and non-linearly related to taxonomic diversity both for trees and understorey.

Functional evenness of understorey in our plots had the highest value when taxonomic diversity of understorey in our plot was less than 20 (Figure 15B) which shows evenness increases with a decrease in the number of species giving a less complex understorey species composition. Functional divergence, functional dispersion, and Rao's quadratic entropy did not show any clear relation with taxonomic diversity in understorey level analysis.

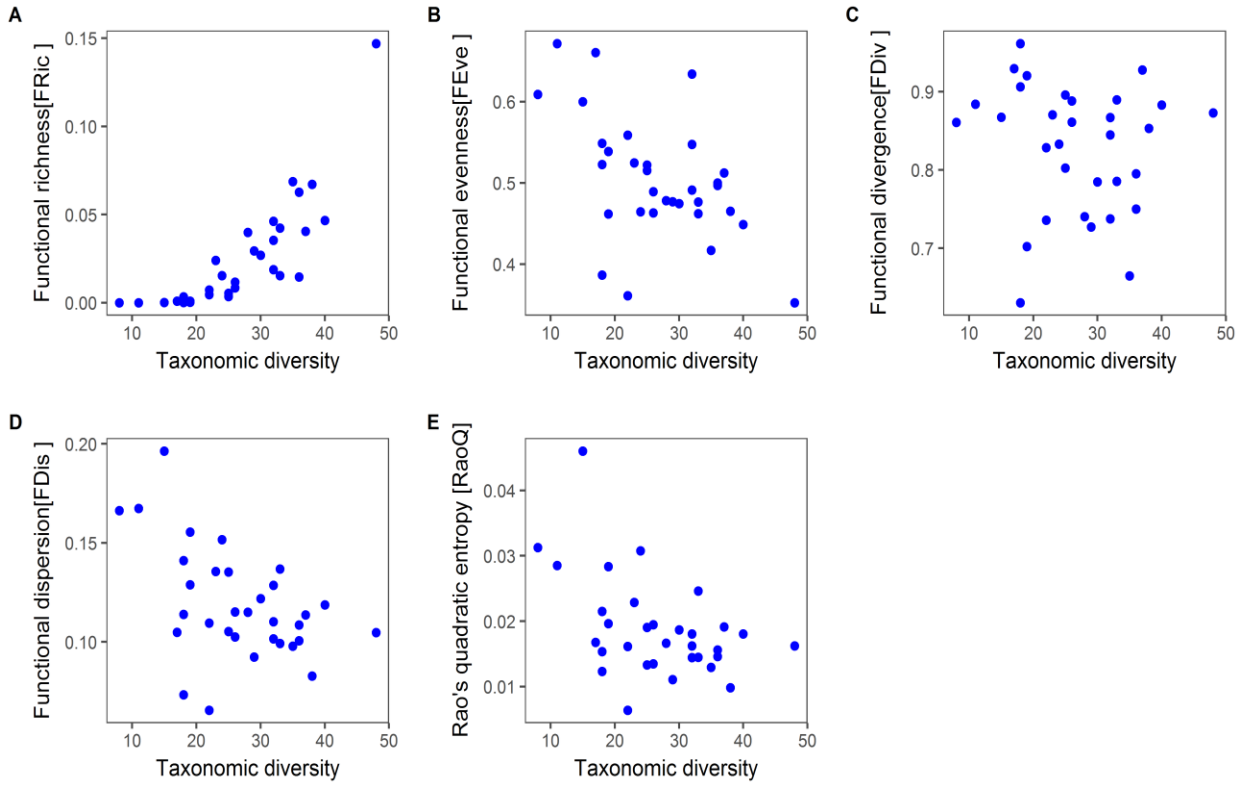

Figure 15: Relation between indices of functional diversity and taxonomic diversity at the understorey level where functional diversity indices i.e. functional richness (A), functional evenness (B), functional divergence (C), functional dispersion (D) and Rao's quadratic entropy (E) are presented in y-axis and taxonomic diversity is presented in x-axis.

When we carried out regression by fitting a linear model on the scatterplots, we observed that there is a relation between functional diversity (FD) and taxonomic diversity (TD). It was observed that functional diversity decreased with a decrease in taxonomic diversity (or increased with an increase in taxonomic diversity) in a non-linear way.

We observed that functional diversity of trees is not affected when the taxonomic diversity of trees in our plot is reduced from 125 to 100. This result conveys that losing few tree species may not necessarily cause a decline in functional diversity of Sumatra. This holds true if we lose few species, but their role in ecosystem functioning can be fulfilled by other remaining species. Functional tree diversity was observed to decline gradually with a decrease in taxonomic tree diversity. It was observed that there is a sharp decline in functional diversity if when we have less than 40 tree species in the plot. If there are less than 40 tree species in the plot the functional diversity value is very close to zero indicating a lot of loss in ecosystem functioning (Figure 16A).

It was observed that functional diversity of understorey declines sharply when the understorey species are reduced to half. When there are less than 50% of understorey species in the plots, the functional understorey diversity approaches very near to zero (Figure 16B).

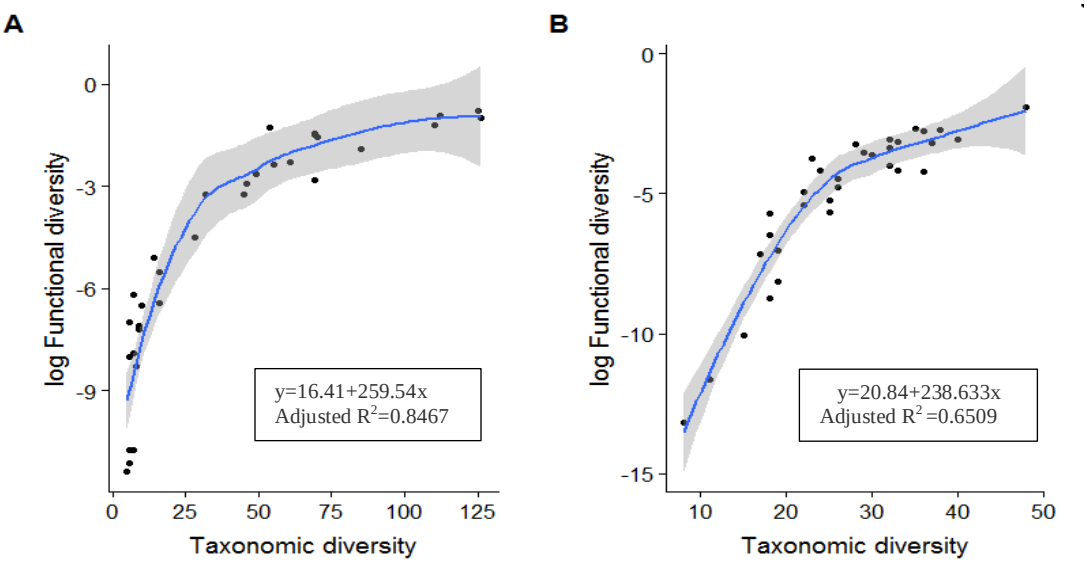

Figure 16: Relation between Functional tree diversity and tree taxonomic diversity (A), and the relation between functional understorey diversity and understorey taxonomic diversity (B) (where functional diversity is plotted in the y-axis and taxonomic diversity is plotted in x-axis) showing a non-linear relationship.

4. Discussion

The goal of this study was to examine the significant difference in plant functional traits and compare the functional diversity indices between four prominent land-use systems in the central lowland of Sumatra. I analyzed eight anatomical and morphological traits relating to leaf economics (Wright et al. 2004) and wood economics (Chave et al. 2009) from 730 plant species. Overall, all our functional traits deviated from a normal distribution except in the chlorophyll content in trees. Our observation on the distribution of plant traits aligns with the result by TRY- a global database of plant traits which revealed that there is a general tendency of higher trait variation when the trait dimensions increase (Kattge et al. 2011). We identified a significant difference in trait composition in plant species as the result of a change in land-use intensity. We also investigated the effect of land-use change on community-weighted means of traits and indices of functional diversity. Furthermore, we explored the relationship between taxonomic diversity (TD) and functional diversity (FD).

4.1 Plant functional traits across four land-use systems

The significant difference of leaf thickness between understorey plants from four land-use systems shows that the understorey plant community has different capacity to invest in biomass productivity in the four land-use systems. Additionally, it also reflects the different response of these plants to water deficits (Pauli et al. 2017). The understorey vegetation from oil palm plantation has the highest value for leaf thickness resembling the high capacity of oil palm plantation to invest in biomass productivity. No significant difference in leaf thickness of trees between four land-use systems resembles that the trees in all four land-use systems have a similar capacity to contribute in biomass production as well as they respond in a similar way towards water deficits.

Higher specific leaf area (SLA) in the forest means forest exhibits higher concentrations of leaf nutrients than other land-use systems (Hoffmann et al. 2005). The results from the Cerrado region in Brazil shows higher SLA in the forest than savanna with nutrient concentration strongly and positively correlating with SLA (Hoffmann et al. 2005). Thus, higher SLA in the forest among other land-use systems in our results mirrors the higher nutrient concentration in the forest in our study area. The main driver of deforestation at our study area is the conversion

of remaining forests into the intensively managed plantation of rubber and oil palm (Carlson et al. 2018). This presents a threat that the extensively managed monocultures tend to exhibit less SLA than that of forest and jungle rubber resulting in a decline in nutrient concentration. This decline in nutrient concentration results in a decrease of ecological functioning of that ecosystem.

The amount of incident light absorbed by leaves is highly dependent on its chlorophyll content (Lei et al. 1996). Chlorophyll content in plant resembles the plant's ability to take part in photosynthesis and influence growth (Zhang et al. 2016). The normal distribution of chlorophyll content seen in trees is because the chlorophyll content is measured as concentration per leaf area, and concentration-related traits tend to show less variation according to TRY- a global database of plant traits (Kattge et al. 2011). The lower concentration of chlorophyll in leaves indicates that the plants are under high stress because of which their proportion of light-absorbing pigments has changed resulting in an overall decrease in absorption with chlorophyll a and b (Zarco-Tejada et al. 2001). Forest had the highest measurement of chlorophyll content and monocultures had the lowest. This implies that the monoculture rubber and oil palm plantations in our study area puts a lot of stress to overall plant communities pressurizing them to only produce few green pigments. As green pigments are very important for the photosynthesis of plants (Ekici et al. 2007), lack of it causes negative effects on plant function. In return, the whole ecosystem functioning is affected.

Wood density reflects a plant's strength against environmental forces like gravity and wind (Hacke et al. 2001) and defense against predators and pathogens (Chave et al. 2009). Furthermore, it represents a trade-off between the construction capacity of plant species and their risk of mortality from biological, mechanical or hydraulic failure (Díaz et al. 2016). The smaller range of stem density in understorey compared to wood density in trees indicates that the most understorey plants are closely related species from the same family or same genera (Kusuma et al. 2018). It was observed in our study that the wood density in trees or stem specific density in the understorey decreased with increasing land-use intensity. Forest had the highest value of wood density in trees and stem specific density in the understorey reflecting forest is associated with stronger plants against detrimental conditions. The worldwide wood economic spectrum

says that the high wood density is related to slower growth and high survival of plants in diverse tropical forest (Chave et al. 2009). Highest wood density in trees from forest might be because our analyses mainly included herbaceous species from oil palm plantations and excluded the woody ones like oil palms.

Overall, the variation in our plant functional traits along land-use intensity coincides with many pieces of researches which show that resource availability causes plant functional trait to vary continuously (Lavorel 2013). This continuous variation in functional traits resembles a wide variation in the ecosystem functioning of plants thus, making functional traits strongly correlated with ecosystem services (Lavorel 2013, Ostertag et al. 2015).

4.2 Functional composition (community-weighted means) of plant traits across the four land-use systems

The CWMs of traits are expected to vary along the land-use intensity gradient as it comprises large differences in biotic and abiotic conditions between them (Schellenberger Costa et al. 2017). Thus, different land-use intensities showed significant effects on CWMs of most of our target traits. In particular, CWMs of plants traits in less intensive land-use systems like forest and jungle rubber differed significantly from CWMs of plant traits growing in monocultures with the exception of CWMs of leaf area, leaf perimeter and leaf form factor measured in trees. This result is very similar to that from Roscher et al. 2018 where CWMs of trait measurements from solitary plants differed significantly from CWMs of trait measurements on plants growing in monocultures or mixtures (Roscher et al. 2018). As a whole, the different value of community-weighted means of each functional trait mirrors that these functional communities of plants have a different resource use trade-offs (Reich 2014).

The Principal component analysis of community-weighted means of plant functional traits showed that leaf traits were among the top contributors to community-weighted means of traits for both dimensions of the principal component. However, this could only generalize the contribution of functional traits in the overall study area. Separate analyses of the contribution of each trait in each of four land-use systems could give us detailed understanding on how plant communities contribute to the ecosystem functioning in different land-use systems.

4.3 Functional diversity across four land-use systems

Communities which have a higher species richness have a higher chance to contain species having specific trait values (Wang and Yu 2018). This, in turn, will increase the trait difference between these species and other species in that community hence, increasing functional diversity (Wang and Yu 2018). This was confirmed by our tree data where the forest had the highest species richness and highest functional richness.

Functional richness followed the same reduction pattern like species richness giving the highest value in forest and lowest in oil palm. It indicates that conversion of natural forests into more intense systems will result in the loss of functional groups (Goswami et al. 2017) and eventually causing loss of functional diversity (Senior et al. 2013). Species richness is directly linked to ecosystem services (Hooper et al. 2002) and hence functional diversity (Swift et al. 2004). The low species richness and functional richness in oil palm plantations for tree data are in line with other researches where the ecosystem functioning of oil palm plantation was low in comparison to the forest (Dislich et al. 2017). This shows that the tree communities in oil palm plantation are not taking advantage of resources available to them (Mason et al. 2005) which will reduce the productive capacity in those plant communities (Petchey 2003). This means that the tree species in plantations will have a less buffering effect against the detrimental environmental conditions as they won't be efficiently utilizing the available resources (Tilman 1996).

For tree dataset, functional evenness was highest in oil palm and lowest in the forest. This can be because the intensive land-use practices result in less tree species diversity causing an increase in functional evenness. Functional evenness denotes the degree to which species is distributed in a niche space so that they can fully utilize the resources available in that niche (Mason et al. 2005). High functional evenness in plantations resembles that the resources available in the plantation are not fully utilized thus decreasing the invasion resistance of plantations (Mason et al. 2005). For understorey dataset, functional evenness was lowest in oil palm plantation because of the bias in our understorey sampling where a majority of the understorey was sampled from oil palm plantation.

Data on both trees and understorey shows no significant difference in functional divergence between four land-use systems. This means that there is no significant difference in resource use competition between four land-use systems (Mason et al. 2005). Functional dispersion and RaoQ's quadratic entropy was highest in jungle rubber and lowest in oil palm. Both of them showed a significant difference between forest and oil palm. Low-intensity land-use systems had lower functional dispersion in some studies (Luck et al. 2013). The higher functional dispersion in jungle rubber shows that they are subjected to more ecological filtering which will cause a more random community to assemble in this system (Mumme et al. 2015). Some studies found that functional dispersion is not affected by land-use intensity (Barragán et al. 2011, Audino et al. 2014) but our study showed a significant difference between high-intensity land-use like oil palm and low-intensity land-use like the forest.

The number of the understorey for which traits were available in our dataset was least in forest and highest in oil palm. This affected species richness and functional diversity indices in four land-use systems. Our analysis gave a biased result where oil palm had the highest species richness and functional richness followed by jungle rubber, rubber, and forest. This result is an extremely contrasting result in comparison to other researches in our study area where species richness was highest in the forest and lowest in oil palm (Rembold et al. 2017).. Additionally, phylogenetic diversity in understorey plant communities in our study area is high in the forest and low in the plantations (Kusuma et al. 2018).

In a diverse plant community like that of tropical rainforest, the understorey community represents a majority of the vascular plant species (Linares-Palomino et al. 2009). Thus, overall plant functional diversity in an area is also affected by the functional understorey diversity and the bias in our dataset avoided us from studying the actual variation in the understorey functional diversity between four land-use systems. In spite of this bias in our dataset, we can still see that functional richness is highly dependent to species richness as a species-rich land-use system had a high functional richness.

4.4 Relation between taxonomic diversity and functional diversity

Conservation of biodiversity has shifted its focus from only maintaining species richness to maintaining the resilience of the ecosystem (Chapman et al. 2017). This shift has resulted in adding phylogenetic diversity (PD) and functional diversity (FD) as two important matrices as an indicator of biodiversity (Chapman et al. 2017). In this study, we investigated the relationship between taxonomic diversity (TD) and functional diversity (FD) for trees and understorey vegetation.

Functional diversity in trees is not significantly affected when the taxonomic tree diversity is reduced from 125 to 100. This shows that losing upto one-fifth of tree species does not cause a decline in functional diversity of Sumatra. This holds true if we lose few species, but their role in ecosystem functioning can be fulfilled by other remaining species. This study shows that functional diversity falls sharply and is very close to zero when we lose two thirds of the tree species. Understorey functional diversity shows a similar pattern with a sudden sharper decline after about half of the understorey taxonomic diversity is lost. It can be perceived that at the point where functional diversity falls near to zero the ecosystem loses a lot of its function in spite of having a taxonomic diversity. This holds true if all the functionally redudant species disappear earlier in an ecosystem and only those species which have a very little role in the overall function of the ecosystem remain. Overall, our result indicates that we lose plant functional diversity when we lose plant species, but not necessarily at the same rate.

Land-use change and intensification cause loss of taxonomic diversity (Rembold et al. 2017) and hence reduces functional diversity (Hatfield et al. 2018). Forest had the highest taxonomic diversity and monocultures had the lowest in our study area (Rembold et al. 2017). Our results on the relation of taxonomic and functional diversity reflect that intensely managed land-use systems like monocultures of rubber and oil palm have the lowest functional diversity and hence the lowest contribution to ecosystem functioning of Sumatra. Functional diversity is very responsive to anthropogenic disturbances caused by habitat alteration and degradation (Colin et al. 2018). Continuing this intensification in future will harbor less or no species that has a contribution in ecosystem function thus leading the functional diversity of Sumatra to collapse.

5. Conclusions

The plant diversity in Sumatra possesses a wide range of functional traits. These functional traits vary significantly between the four prominent land-use systems which are under different land-use intensities. This study shows a significant difference in plant functional traits between rainforest, jungle rubber agroforest and monoculture plantations. Rainforest and jungle rubber having the greater range of functional traits reflect their greater variation in functional roles in the whole ecosystem of Sumatra. Whereas the low range of functional traits in monocultures reflects less variation in functional roles which makes them susceptible to losing ecological functions.

This study shows that adopting jungle rubber agroforestry results in a decrease in species richness but not in functional richness of the tropical ecosystem. Thus, rubber agroforestry system can serve as a viable option for protecting remaining functional diversity in Sumatra in comparison to monocultures. But, adopting rubber agroforestry means also losing species richness and change in species composition in comparison to the forest. Additionally, rubber agroforest will also increase the possibility of an increase in invasive species. Thus, forest cannot be replaced by any other system in terms of species richness, species composition and maintaining ecosystem functioning in Sumatra.

At the present situation, almost all the rainforest in Sumatra are already deforested and the remaining expansion of oil palm and rubber plantation targets the deforestation and conversion of jungle rubber agroforest system. This indicates that there is an urgent need of protecting the remaining lowland rainforest and stopping further land-use intensification and expansion of monocultures in jungle rubber agroforestry system.

As the understorey traits were mostly from the understorey in plantations and not from the forest, our study could not derive unbiased results on the functional understorey diversity between four land-use systems. Tree traits were collected from only one individual per species and one species was sampled only once in only one plot although it occurred in various plots. These two limitations of this study present space for future research on similar topics considering these limitations.

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7. Appendices

Annex 1

Table 1: Functional tree traits from 24 core plots from three land-use systems in the study area

Tree ID	land-use systems	species	chlorophyll content	leaf thickness (mm)	specific leaf area (cm^2/g)	leaf area (cm^2)	leaf perimeter (cm)	Leaf aspect ratio	leaf form coefficient
49	Forest	*Archidendron bubalinum*	49	0.17	12.864	53.183	52.056	0.793	0.274
9274	Forest	*Santiria apiculata*	46.17	0.24	12.581	166.207	133.015	0.778	0.119
256	Forest	*Xerospermum noronhianum*	57.06	0.16	7.604	130.051	97.405	0.723	0.175
379	Forest	*Saraca declinata*	74.44	0.18	7.573	167.289	97.142	0.883	0.249
9566	Forest	*Dialium polysepalum*	69	0.18	4.890	121.839	131.053	0.852	0.092
175	Forest	*Mischocarpus cf. sundaicus*	75.96	0.24	2.813	123.214	88.674	0.842	0.194
9536	Forest	*Nephelium cuspidatum*	59.14	0.29	8.229	123.284	121.705	0.812	0.106
9289	Forest	*Canarium ovatum*	44.52	0.23	10.196	136.637	129.785	0.810	0.106
121	Forest	*Santiria rubiginosa*	59.61	0.14	13.327	95.618	105.872	0.787	0.107
235	Forest	*Nephelium subfalcatum*	70.75	0.2	7.726	69.831	88.933	0.778	0.115
9525	Forest	*Dialium indum*	49.35	0.16	12.738	167.696	144.137	0.773	0.113
2830	Forest	*Santiria apiculata*	61.17	0.14	9.712	127.853	97.598	0.770	0.174
271	Forest	*Aglaia lawii*	72.84	0.17	10.508	199.653	153.601	0.749	0.124
345	Forest	*Lamiaceae sp. 01*	66.96	0.24	4.380	113.825	90.982	0.733	0.175
9555	Forest	*Callerya atropurpurea*	72.63	0.21	12.474	174.996	159.272	0.717	0.087
9300	Forest	*Dialium polycephalum*	51.75	0.15	7.265	128.455	116.533	0.711	0.125
230	Forest	*Palaquium obovatum*	43.26	0.18	10.038	119.324	158.074	0.707	0.066
2926	Forest	*Sindora leiocarpa*	46.6	0.13	12.250	12.912	14.755	0.697	0.735
3172	Forest	*Endospermum diadenum*	80.34	0.37	5.536	104.201	48.965	0.694	0.499
9062	Forest	*Koompassia malaccensis*	54.5	0.12	9.702	159.155	180.23	0.653	0.062
406	Forest	*Burseraceae sp. 27*	54.42	0.26	6.179	414.057	226.277	0.643	0.112
9831	Forest	*Sacrotheca diversifolia*	53.81	0.21	16.411	44.770	62.712	0.640	0.149
9230	Forest	*Macaranga bancana*	57.85	0.32	3.242	251.233	97.440	0.638	0.340
9330	Forest	*Sacrotheca diversifolia*	56.96	0.26	23.608	37.489	53.343	0.635	0.168
118	Forest	*Canarium caudatum*	45.13	0.21	10.686	93.215	139.865	0.622	0.062
9977	Forest	*Carallia brachiata*	75.51	0.34	7.191	14.634	16.483	0.611	0.671
391	Forest	*Timonius cf. esherianus*	55.01	0.24	16.673	139.540	49.511	0.610	0.709
287	Forest	*Pseudoclausena chrysogyne*	57.05	0.19	12.080	135.178	166.245	0.608	0.061
2986	Forest	*Prunus polystachya*	72.3	0.29	8.107	180.627	61.237	0.596	0.613
363	Forest	*Polyscias diversifolia*	67.06	0.2	10.969	245.587	224.094	0.591	0.063
343	Forest	*Tetrameles nudiflora*	40.82	0.29	7.648	89.266	55.163	0.577	0.383
9299	Forest	*Beilschmiedia madang*	66.86	0.23	19.154	55.433	33.097	0.562	0.626

2792	Forest	*Dillenia indica*	43.99	0.27	6.590	46.729	33.492	0.555	0.518
3009	Forest	*Carallia brachiata*	64.4	0.16	18.016	22.033	19.969	0.555	0.689
3232	Forest	*Dialium Indum*	68.2	0.25	30.485	18.749	20.077	0.549	0.589
9832	Forest	*Syzygium longifolium*	71.33	0.36	7.695	42.116	29.041	0.534	0.623
2934	Forest	*Mezzettia parviflora*	71.4	0.27	7.966	17.022	19.013	0.533	0.589
2835	Forest	*Madhuca sericea*	59.63	0.21	12.362	53.503	32.489	0.527	0.612
2878	Forest	*Sandoricum koetjape*	73.05	0.2	28.902	56.360	33.082	0.524	0.637
3044	Forest	*Dacryodes rugosa*	61.75	0.26	13.550	28.754	24.339	0.523	0.608
458	Forest	*Artocarpus hispidus*	60.26	0.32	12.764	297.413	75.663	0.522	0.640
321	Forest	*Terminalia bellirica*	67.15	0.23	5.235	56.848	36.130	0.521	0.531
9277	Forest	*Macaranga cf. sumatrana*	62.51	0.25	15.734	56.722	39.798	0.518	0.445
9134	Forest	*Carallia brachiata*	69.76	0.27	11.927	26.121	22.885	0.508	0.626
3660	Forest	*Litsea resinosa*	46.79	0.23	10.144	16.950	19.257	0.506	0.568
9835	Forest	*Carallia brachiata*	70.76	0.32	6.314	18.670	20.149	0.502	0.577
3721	Forest	*Calophyllum pulcherrimum*	60.7	0.2	18.632	17.943	18.954	0.500	0.615
9053	Forest	*Elaeocarpus petiolatus*	72.49	0.33	7.840	113.655	54.063	0.497	0.485
3635	Forest	*Hopea sangal*	56.06	0.29	14.259	18.323	20.064	0.492	0.565
9130	Forest	*Lithocarpus bancanus*	65.27	0.28	8.468	35.106	27.949	0.491	0.563
260	Forest	*Diospyros korthalsiana*	62.68	0.21	4.805	95.271	45.487	0.490	0.583
3066	Forest	*Shorea parvifolia*	60.1	0.32	10.241	58.231	36.035	0.490	0.558
2930	Forest	*Parinari sumatrana*	67.5	0.16	6.696	31.955	25.598	0.488	0.607
3101	Forest	*Lithocarpus blumeanus*	55.45	0.21	5.832	78.239	40.412	0.485	0.584
3043	Forest	*Shorea acuminata*	48.3	0.24	3.912	24.355	22.484	0.484	0.600
3031	Forest	*Alangium javanicum*	71.9	0.32	13.492	185.819	65.516	0.482	0.542
3637	Forest	*Terminalia Foetidissima*	70.12	0.22	10.735	32.054	26.623	0.481	0.563
360	Forest	*Prunus cf. arborea*	67.19	0.21	21.968	66.058	38.881	0.480	0.551
9207	Forest	*Lindera lucida*	70.49	0.34	6.529	29.809	25.759	0.480	0.564
3725	Forest	*Baccaurea pubera*	68.23	0.2	27.868	50.748	35.402	0.479	0.497
3700	Forest	*Syzygium cf. tetrapterum*	63.93	0.27	14.151	32.647	25.405	0.474	0.628
3228	Forest	*Castanopsis javanica*	53.36	0.29	8.102	42.356	28.722	0.473	0.637
3743	Forest	*Canarium megalanthum*	57.26	0.18	15.599	45.051	31.846	0.472	0.556
3752	Forest	*Triomma malaccensis*	57.4	0.23	9.251	22.470	21.884	0.471	0.588
2825	Forest	*Memecylon myrsinoides*	79.16	0.37	5.260	11.457	16.286	0.470	0.541
3198	Forest	*Santiria laevigata*	60.2	0.27	14.117	39.725	29.111	0.468	0.569
3614	Forest	*Parastemon urophyllus*	52.7	0.21	18.626	25.351	23.054	0.468	0.582
3745	Forest	*Nephelium cuspidatum*	59.6	0.19	13.490	51.773	31.399	0.464	0.655
9570	Forest	*Artocarpus dadah*	83.43	0.5	6.458	80.898	41.759	0.464	0.575
317	Forest	*Nauclea subdita*	57.52	0.27	8.348	13.298	17.359	0.464	0.550
3783	Forest	*Palaquium gutta*	65.8	0.39	12.976	17.856	19.849	0.463	0.558
2951	Forest	*Galearia maingayi*	76.9	0.26	24.447	32.563	27.790	0.462	0.517
3648	Forest	*Melanochyla beccariana*	56.42	0.47	12.096	67.063	38.083	0.460	0.577

283	Forest	*Litsea glutinosa*	53.71	0.25	4.911	165.724	59.621	0.459	0.556
9601	Forest	*Flacourtia rukam*	71.23	0.28	5.275	113.146	50.834	0.457	0.544
245	Forest	*Aporosa prainiana*	61.33	0.3	14.396	54.315	34.066	0.457	0.583
3230	Forest	*Syzygium cf. tetrapterum*	58.52	0.32	9.390	28.735	23.497	0.455	0.632
3669	Forest	*Xylopia malayana*	75.9	0.25	8.640	40.824	28.587	0.454	0.622
3184	Forest	*Syzygium lineatum*	54.91	0.26	7.497	13.636	18.496	0.454	0.497
2948	Forest	*Terminalia sp. 03*	63	0.24	16.431	102.297	50.421	0.452	0.475
9817	Forest	*Dialium sp. 01*	55.06	0.34	10.746	18.580	18.684	0.451	0.661
3051	Forest	*Syzygium palembanicum*	68.9	0.33	6.356	33.892	27.060	0.450	0.569
3627	Forest	*Ptychopyxis costata*	55.8	0.09	18.669	42.767	31.367	0.450	0.543
9196	Forest	*Acronychia pedunculata*	60.66	0.3	8.169	43.199	32.513	0.450	0.509
2988	Forest	*Pimelodendron amboinicum*	67.3	0.22	11.867	121.356	57.290	0.447	0.448
9575	Forest	*Shorea parvifolia*	51.09	0.22	16.864	37.033	28.814	0.446	0.548
9332	Forest	*Memecylon garcinioides*	76.82	0.23	10.453	13.275	17.777	0.446	0.527
3689	Forest	*Horsfieldia grandis*	64.9	0.44	24.823	124.416	50.493	0.444	0.570
3610	Forest	*Strombosia ceylanica*	62	0.15	23.668	27.360	25.158	0.443	0.534
9137	Forest	*Annonaceae sp. 122*	74.89	0.26	11.388	33.504	26.563	0.442	0.591
39	Forest	*Gironniera cf. nervosa*	59.83	0.3	13.216	38.274	27.942	0.441	0.610
2811	Forest	*Irvingia malayana*	43.59	0.19	12.075	70.741	39.077	0.441	0.577
9543	Forest	*Shorea leprosula*	51.06	0.21	5.969	19.944	22.494	0.441	0.506
9574	Forest	*Shorea leprosula*	57.38	0.19	12.345	35.121	28.580	0.441	0.532
3620	Forest	*Gironniera hirta*	71.3	0.26	12.673	66.145	37.689	0.440	0.578
9535	Forest	*Memecylon myrsinoides*	64.95	0.25	5.278	20.868	22.413	0.439	0.519
2957	Forest	*Dialium platysepalum*	70.79	0.21	15.565	39.235	29.147	0.438	0.568
9822	Forest	*Rhodamnia cinerea*	64.84	0.26	14.107	35.833	28.241	0.438	0.560
9613	Forest	*Syzygium longifolium*	65.59	0.26	16.824	38.326	30.533	0.437	0.506
355	Forest	*Diospyros sumatrana*	67.31	0.22	10.834	33.044	25.624	0.436	0.617
9256	Forest	*Memecylon paniculatum*	56.43	0.27	9.395	56.945	33.629	0.436	0.626
2807	Forest	*Syzygium paludosum*	50.7	0.2	24.298	33.264	28.074	0.436	0.530
3628	Forest	*Blumeodendron tokbrai*	73	0.33	7.634	101.186	49.954	0.434	0.500
361	Forest	*Alangium uniloculare*	64.15	0.21	36.354	92.872	44.701	0.434	0.565
3644	Forest	*Syzygium pseudoformosum*	55.41	0.27	24.545	31.049	25.184	0.433	0.614
9254	Forest	*Xylopia elliptica*	54.73	0.21	9.343	10.940	14.863	0.433	0.624
301	Forest	*Pentace triptera*	48.38	0.19	10.858	21.522	22.602	0.433	0.516
38	Forest	*Shorea singkawang*	57.68	0.18	5.920	72.092	39.123	0.432	0.587
9577	Forest	*Knema conferta*	61.06	0.16	13.935	112.872	49.603	0.431	0.570
3082	Forest	*Neoscortechinia kingii*	72.08	0.29	7.917	23.600	23.439	0.429	0.541
9612	Forest	*Xylopia malayana*	63.87	0.23	13.007	34.339	26.722	0.429	0.599
2762	Forest	*Ochanostachys amentacea*	78.23	0.18	34.340	38.907	30.458	0.429	0.525
9046	Forest	*Xanthophyllum sp. 01*	74.75	0.23	7.324	16.406	19.490	0.428	0.542
68	Forest	*Memecylon edule*	72.98	0.29	3.903	33.307	26.785	0.428	0.583

9172	Forest	*Tabernaemontana macrocarpa*	69.85	0.32	9.667	87.570	43.516	0.427	0.562
9551	Forest	*Shorea ovalis*	59.21	0.32	16.334	41.244	30.967	0.427	0.539
9192	Forest	*Palaquium rostrata*	73.02	0.25	3.902	17.772	20.787	0.426	0.514
9579	Forest	*Xanthophyllum korthalsianum*	59.24	0.16	12.209	18.276	20.119	0.426	0.564
34	Forest	*Baccaurea pyriformis*	72.06	0.32	6.459	36.237	32.086	0.425	0.438
3137	Forest	*Knema glaucescens*	52.49	0.21	8.174	129.526	53.550	0.424	0.563
9531	Forest	*Elaeocarpus cf. serratus*	58.22	0.22	16.662	56.401	36.559	0.423	0.522
9531	Forest	*Elaeocarpus cf. serratus*	69.1	0.17	21.243	56.401	36.559	0.423	0.522
91	Forest	*Palaquium hexandrum*	64.22	0.3	4.405	24.642	24.308	0.421	0.511
9179	Forest	*Xylopia ferruginea*	75.63	0.29	12.413	26.726	23.066	0.418	0.625
265	Forest	*Shorea bracteolata*	53.05	0.17	11.377	74.917	40.917	0.418	0.559
3074	Forest	*Xerospermum laevigatum*	65.2	0.21	11.847	22.864	22.440	0.416	0.564
3777	Forest	*Hopea beccariana*	42.7	0.18	7.605	14.313	18.423	0.416	0.518
3690	Forest	*Diospyros javanica*	62.1	0.26	27.662	80.046	41.497	0.415	0.562
9814	Forest	*Baccaurea javanica*	59.27	0.44	16.341	72.818	42.502	0.413	0.500
2872	Forest	*Alseodaphne bancana*	54.5	0.23	11.594	24.012	23.110	0.412	0.554
9078	Forest	*Tree 121*	55.36	0	7.257	50.356	33.372	0.412	0.566
2943	Forest	*Dehaasia incrassata*	62.3	0.17	31.521	36.186	30.314	0.410	0.488
9992	Forest	*Shorea parvifolia*	52.6	0.18	14.160	31.123	26.248	0.410	0.564
3192	Forest	*Hopea ferruginea*	39.05	0.16	24.140	9.728	15.124	0.410	0.532
3699	Forest	*Cratoxylum cochinchinense*	62.96	0.13	8.914	12.418	16.544	0.409	0.567
3705	Forest	*Timonius flavescens*	60.2	0.19	23.721	23.343	23.481	0.409	0.522
2967	Forest	*Diospyros sp. 01*	62.4	0.28	11.443	74.131	39.009	0.408	0.606
3746	Forest	*Shorea acuminata*	56.32	0.22	5.270	26.781	24.814	0.408	0.536
9075	Forest	*Terminalia foetidissima*	67.76	0.25	15.786	53.262	37.337	0.406	0.471
3195	Forest	*Syzygium splendens*	66.5	0.24	9.362	23.956	23.081	0.406	0.558
9132	Forest	*Tree 122*	64.97	0.23	4.077	71.425	39.188	0.406	0.577
3	Forest	*Gonystylus affinis*	63.81	0.33	25.906	51.398	32.347	0.406	0.596
174	Forest	*Syzygium sp. 08*	67.92	0.23	7.498	21.608	22.787	0.405	0.519
9064	Forest	*Knema latifolia*	58.68	0.23	13.557	106.051	48.009	0.404	0.550
440	Forest	*Lunasia amara*	54.17	0.24	30.335	183.544	64.629	0.402	0.543
3019	Forest	*Acronychia pedunculata*	52.7	0.35	17.065	97.250	51.324	0.401	0.462
105	Forest	*Bhesa paniculata*	83.08	0.23	14.716	52.370	37.010	0.401	0.477
9602	Forest	*Glochidion philippicum*	74.33	0.19	9.330	28.250	25.196	0.401	0.559
4965	Forest	*Euonymus sp. 02*	73.84	0	2.839	27.719	25.826	0.401	0.520
9133	Forest	*Syzygium sp. 38*	66.3	0.27	17.237	53.693	35.084	0.400	0.543
3162	Forest	*Gordonia oblongifolia*	67.52	0.3	7.934	26.024	24.479	0.400	0.545
9328	Forest	*Litsea oppositifolia*	60.19	0.32	15.382	31.332	26.125	0.400	0.573
9580	Forest	*Palaquium sumatranum*	70.17	0.23	5.985	36.877	29.772	0.399	0.519
2832	Forest	*Aporosa antennifera*	76.77	0.22	7.719	16.834	19.461	0.399	0.539
3744	Forest	*Gynotroches axillaris*	66.1	0.21	27.776	26.026	24.095	0.398	0.559

44	Forest	*Gironniera nervosa*	55.14	0.3	16.008	19.690	20.894	0.398	0.565
3612	Forest	*Cryptocarya densiflora*	52.7	0.16	5.958	108.397	52.697	0.398	0.479
3640	Forest	*Artocarpus Kemando*	50.03	0.22	19.013	28.995	25.026	0.398	0.580
9605	Forest	*Glochidion philippicum*	70.72	0.15	14.605	30.276	26.608	0.398	0.533
20	Forest	*Fagaceae sp. 01*	65.88	0.21	9.426	45.376	34.336	0.396	0.485
9041	Forest	*Lithocarpus bancanus*	56.56	0.24	9.977	50.581	34.300	0.396	0.516
365	Forest	*Gironniera cf. subaequalis*	67.68	0.27	7.378	76.067	42.429	0.395	0.525
3761	Forest	*Diospyros venosa*	60.06	0.19	8.988	16.870	19.365	0.395	0.563
10	Forest	*Lithocarpus sp. 01*	60.06	0.22	4.066	38.436	28.900	0.394	0.571
45	Forest	*Syzygium sp. 02*	67.69	0.31	12.750	50.580	34.782	0.393	0.515
9625	Forest	*Castanopsis cf. inermis*	57.25	0.14	20.298	65.807	39.552	0.392	0.517
3652	Forest	*Shorea bracteata*	58.78	0.17	27.740	46.382	32.899	0.392	0.531
3667	Forest	*Drepananthus ramuliflorus*	81.2	0.5	6.404	331.931	84.066	0.392	0.587
3691	Forest	*Santiria oblongifolia*	53.5	0.25	3.733	79.886	43.638	0.392	0.523
9273	Forest	*Shorea acuminata*	55.16	0.21	14.337	38.740	29.752	0.391	0.535
9557	Forest	*Baccaurea deflexa*	74.33	0.3	9.036	109.861	56.290	0.390	0.435
9191	Forest	*Alseodaphne marbunga*	77.96	0.33	9.643	47.954	34.889	0.390	0.492
2977	Forest	*Dyera costulata*	60.1	0.19	16.001	129.450	55.882	0.390	0.480
327	Forest	*Ficus globosa*	50.2	0.21	21.428	51.021	34.820	0.387	0.512
249	Forest	*Antidesma leucopodum*	52.57	0.19	11.101	38.486	29.308	0.387	0.558
2968	Forest	*Helicia excelsa*	68.4	0.19	37.111	21.153	22.142	0.386	0.527
2960	Forest	*Litsea lanceolata*	50.4	0.2	34.683	99.402	44.805	0.386	0.560
2796	Forest	*Phoebe grandis*	62.11	0.26	7.785	49.387	34.229	0.385	0.526
338	Forest	*Baccaurea parviflora*	72.06	0.25	5.809	44.814	35.271	0.385	0.452
3013	Forest	*Shorea Pauciflora*	60.4	0.21	15.420	33.708	29.468	0.384	0.481
3675	Forest	*Aglaia rubiginosa*	84.1	0.39	21.515	95.527	53.819	0.384	0.409
2899	Forest	*Sarcotheca diversifolia*	56.1	0.21	9.358	10.472	15.408	0.384	0.554
9294	Forest	*Syzygium polycephalum*	72.13	0.24	11.256	18.411	22.112	0.383	0.466
9272	Forest	*Syzygium polycephalum*	63.81	0	10.420	35.677	29.085	0.383	0.527
9830	Forest	*Tree 123*	70.39	0.3	10.126	16.647	20.988	0.382	0.469
3056	Forest	*Palaquium sumatranum*	58.2	0.26	20.739	36.563	30.446	0.382	0.486
2963	Forest	*Bhesa robusta*	79.7	0.22	9.483	31.009	28.778	0.382	0.465
3123	Forest	*Canarium pilosum*	61.77	0.2	9.532	28.310	25.639	0.382	0.541
3676	Forest	*Canarium album*	52.2	0.26	1.485	15.073	9.866	0.382	0.522
447	Forest	*Prainea limpato*	62.73	0.23	9.502	209.468	68.160	0.380	0.547
9562	Forest	*Pternandra azurea*	60.72	0.21	13.966	28.448	25.177	0.379	0.563
2995	Forest	*Chisocheton patens*	85.9	0.27	7.248	33.927	27.613	0.379	0.559
273	Forest	*Xylopia elliptica*	53.36	0.19	12.944	10.394	14.874	0.379	0.578
2860	Forest	*Trigoniastrum hypoleucum*	65.87	0.27	16.918	38.862	29.730	0.378	0.544
333	Forest	*Tabernaemontana macrocarpa*	64.86	0.26	5.946	173.150	65.171	0.378	0.513
380	Forest	*Drepananthus biovulatus*	73.69	0.24	12.776	54.985	36.948	0.377	0.500

123	Forest	*Gironniera nervosa*	53.87	0.24	9.093	43.812	32.269	0.377	0.525
9541	Forest	*Artocarpus nitidus*	72.54	0.29	10.917	44.030	32.280	0.377	0.527
9298	Forest	*Litsea castanea*	49.39	0.27	9.188	21.868	23.008	0.375	0.512
401	Forest	*Discospermum abnorme*	60.31	0.19	23.544	34.374	29.042	0.375	0.512
332	Forest	*Litsea aurea*	60.53	0.33	7.017	132.060	57.231	0.374	0.505
102	Forest	*Litsea robusta*	41	0.32	7.399	154.593	61.412	0.374	0.507
3685	Forest	*Castanopsis argentea*	54.8	0.22	9.432	55.290	35.669	0.374	0.532
9260	Forest	*Lauraceae sp. 46*	68.13	0.35	6.125	73.866	43.215	0.373	0.491
9125	Forest	*?*	51.35	0.2	20.078	59.611	35.944	0.373	0.575
7525	Forest	*Syzygium polyanthum*	60.54	0.17	6.649	19.748	22.528	0.372	0.489
316	Forest	*Croton cascarilloides*	58.95	0.22	19.844	53.022	39.022	0.370	0.425
9810	Forest	*Aporosa nervosa*	67.02	0.32	22.082	46.261	34.005	0.369	0.491
9278	Forest	*Macaranga cf. sumatrana*	64.19	0.21	14.494	16.494	23.267	0.369	0.378
145	Forest	*Barringtonia scortechinii*	51.79	0.22	19.777	33.106	29.321	0.368	0.471
3144	Forest	*Syzygium euneuron*	71.8	0.27	8.864	15.698	19.309	0.368	0.526
347	Forest	*Horsfieldia macrothyrsa*	71	0.33	12.517	114.551	51.733	0.367	0.525
427	Forest	*Atuna racemosa*	55.84	0.17	7.742	25.426	24.344	0.366	0.531
9067	Forest	*Bhesa paniculata*	71.01	0.27	11.351	98.319	51.727	0.365	0.455
9131	Forest	*cf. Endiandra sp. 08*	68.04	0.24	14.696	22.529	23.876	0.364	0.497
3737	Forest	*Mangifera caesia*	49.6	0.29	26.201	43.493	32.071	0.364	0.528
9984	Forest	*Discospermum abnorme*	65.35	0.23	16.407	52.156	35.327	0.364	0.515
9572	Forest	*Aporosa nervosa*	75.45	0.29	30.338	46.751	34.550	0.363	0.486
9526	Forest	*Lindera lucida*	58.84	0.24	8.514	69.129	44.108	0.362	0.443
2841	Forest	*Endiandra sp. 05*	62.76	0.24	8.788	19.896	22.415	0.362	0.496
3625	Forest	*Baccaurea mollis*	70.2	0.35	17.469	53.931	41.560	0.361	0.391
2846	Forest	*Rhodamnia cinerea*	58.66	0.27	9.772	16.691	20.201	0.361	0.512
9550	Forest	*Baccaurea mollis*	61.18	0.27	27.506	38.041	34.701	0.361	0.395
9833	Forest	*Knema latifolia*	64.7	0.21	16.116	100.013	48.907	0.360	0.516
3734	Forest	*Syzygium acuminatissimum*	64.7	0.24	14.309	35.500	29.371	0.360	0.501
61	Forest	*Scaphium linearicarpum*	65.1	0.32	3.439	203.581	70.060	0.360	0.499
3001	Forest	*Baccaurea polyneura*	64.9	0.28	8.023	60.169	40.214	0.359	0.453
445	Forest	*Hydnocarpus cf. wrayi*	58.38	0.23	12.449	92.477	46.259	0.359	0.541
3774	Forest	*Cryptocarya crassinervia*	56.5	0.36	9.180	41.302	31.113	0.359	0.528
2882	Forest	*Dillenia eximia*	53.6	0.27	7.215	45.684	37.865	0.358	0.399
3731	Forest	*Dacryodes costata*	76.06	0.14	23.044	30.971	31.074	0.358	0.405
3227	Forest	*Kokoona ochracea*	60.49	0.22	8.644	35.215	30.235	0.357	0.479
2772	Forest	*Pertusadina eurhyncha*	57.86	0.13	13.723	30.315	29.706	0.357	0.423
9269	Forest	*Macaranga cf. sumatrana*	62.05	0.18	9.876	35.048	34.634	0.355	0.373
3636	Forest	*Lophopetalum cf. javanum*	69.54	0.21	13.467	49.247	34.945	0.353	0.507
253	Forest	*Litsea machilifolia*	51.78	0.28	15.425	40.397	32.388	0.353	0.475
3062	Forest	*Chrysophyllum roxburghii*	46.7	0.11	15.875	19.050	21.418	0.352	0.517

9052	Forest	*Aporosa lucida*	65.38	0.3	17.206	53.148	36.742	0.352	0.486
2771	Forest	*Urophyllum sp. 07_1*	66.94	0.17	6.752	19.074	22.447	0.352	0.470
9534	Forest	*Terminalia cf. oblonga*	67.33	0.17	13.197	47.020	36.194	0.351	0.444
3653	Forest	*Horsfieldia glabra*	68.33	0.3	11.958	35.014	29.902	0.349	0.490
2822	Forest	*Elaeocarpus nitidus*	53.53	0.19	9.459	16.885	22.274	0.349	0.428
3666	Forest	*Barringtonia lanceolata*	87.4	0.28	20.219	28.913	27.968	0.348	0.454
9603	Forest	*Syzygium laxiflorum*	74.77	0.19	13.533	20.164	22.939	0.348	0.471
137	Forest	*Syzygium sp. 10*	73.14	0.25	8.528	23.076	24.717	0.347	0.469
9322	Forest	*Syzygium schottecinii*	71.83	0.26	19.416	54.482	35.928	0.347	0.529
9120	Forest	*Macaranga cf. sumatrana*	60.8	0.2	15.701	33.695	34.028	0.346	0.364
3073	Forest	*Syzygium cf. confertum*	58.4	0.28	9.324	21.679	23.602	0.345	0.488
3696	Forest	*Diospyros sp. 17*	53.89	0.12	2.000	8.733	15.271	0.344	0.466
2984	Forest	*Cryptocarya ferrea*	64.2	0.24	14.281	44.284	32.722	0.344	0.512
3147	Forest	*Knema cinerea*	58.5	0.13	17.664	63.075	38.909	0.344	0.513
2799	Forest	*Chionanthus montanus*	46.08	0.21	14.711	25.641	25.145	0.344	0.510
3071	Forest	*Santiria apiculata*	70.47	0.24	4.359	70.302	41.702	0.343	0.508
3650	Forest	*Aporosa frutescens*	65.77	0.2	30.157	17.340	20.454	0.343	0.503
60	Forest	*Alseodaphne sp. 01*	63.49	0.2	3.908	55.717	39.132	0.343	0.451
2788	Forest	*Shorea ovalis*	58.2	0.34	2.773	69.047	40.150	0.342	0.537
178	Forest	*Antidesma forbesii*	59.01	0.2	16.112	32.063	28.870	0.339	0.477
386	Forest	*Aporosa lunata*	62.89	0.31	6.982	74.039	42.697	0.339	0.503
2837	Forest	*Baccaurea javanica*	56.57	0.3	26.975	29.348	29.192	0.338	0.430
3668	Forest	*Durio excelsus*	58.9	0.21	31.995	35.802	29.539	0.336	0.512
3171	Forest	*Syzygium chloranthum*	60.09	0.17	18.416	67.950	41.153	0.336	0.502
9310	Forest	*Durio acutifolius*	59.06	0.23	29.236	60.373	38.676	0.336	0.506
3747	Forest	*Diospyros lanceifolia*	65.2	0.21	8.681	25.279	24.828	0.336	0.500
290	Forest	*Antidesma cf. velutinum*	62.98	0.14	39.872	33.652	28.843	0.333	0.503
402	Forest	*Nostolachma densiflora*	66.33	0.2	24.068	44.959	33.498	0.333	0.495
3201	Forest	*Mangifera foetida*	51.65	0.34	6.672	71.614	44.383	0.332	0.461
2815	Forest	*Polyalthia lateriflora*	67.98	0.19	14.513	63.709	39.493	0.332	0.512
3733	Forest	*Baccaurea reticulata*	62.6	0.27	3.781	60.813	44.221	0.332	0.390
3058	Forest	*Pometia pinnata*	54	0.15	10.864	38.968	31.114	0.331	0.502
2982	Forest	*Santiria tomentosa*	64.6	0.26	20.470	79.248	45.028	0.330	0.491
381	Forest	*Aporosa lucida*	67.08	0.21	11.589	30.734	28.582	0.329	0.469
9044	Forest	*Elaeocarpus cf. serratus*	65.31	0.21	19.702	43.128	35.959	0.329	0.407
3007	Forest	*Beilschmiedia madang*	48.3	0.18	12.511	41.274	32.355	0.328	0.486
2858	Forest	*Drypetes longifolia*	63.06	0.27	34.314	84.755	46.655	0.325	0.488
2809	Forest	*Antidesma cuspidatum*	68.34	0.22	14.091	33.213	30.072	0.325	0.454
408	Forest	*Dichapetalum timoriense*	45.08	0.15	37.757	31.376	29.427	0.324	0.455
2849	Forest	*Aporosa subcaudata*	56.22	0.27	10.320	30.391	28.115	0.324	0.481
3775	Forest	*Gironniera cf. subaequalis_1*	47.2	0.26	20.572	25.653	26.079	0.323	0.472

9263	Forest	*Syzygium sp. 39*	56.77	0.38	3.408	15.496	22.264	0.322	0.389
9988	Forest	*Aporosa nervosa*	68.62	0.36	7.961	28.326	27.889	0.320	0.454
340	Forest	*Saurauia cf. tristyla*	55.54	0.23	9.368	80.862	57.167	0.320	0.304
269	Forest	*Aporosa arborea*	70.8	0.23	7.752	87.273	51.427	0.320	0.424
50	Forest	*Baccaurea deflexa*	70.03	0.29	8.006	38.150	35.312	0.319	0.380
455	Forest	*Buchanania sessilifolia*	46.8	0.21	22.165	83.521	48.003	0.317	0.447
9235	Forest	*Aporosa nervosa*	75.04	0.4	17.526	31.302	29.919	0.314	0.433
3613	Forest	*Gymnacranthera bancana*	64.7	0.22	17.747	348.287	94.105	0.314	0.493
9968	Forest	*Polyalthia cf. lateriflora*	54.46	0.14	15.694	53.564	37.265	0.312	0.486
9237	Forest	*Knema latifolia*	66.73	0.33	9.119	86.856	47.911	0.312	0.474
3671	Forest	*Gymnacranthera farquhariana*	53.5	0.19	12.542	27.733	27.851	0.310	0.442
369	Forest	*Salicaceae sp. 06*	57.54	0.15	10.126	31.665	29.216	0.309	0.465
72	Forest	*Calophyllum sp. 01*	67.32	0.26	9.485	18.647	23.264	0.306	0.425
2959	Forest	*Madhuca penicillata*	60.9	0.27	7.552	61.637	43.178	0.306	0.416
9063	Forest	*Aporosa nervosa*	53.95	0.32	0.815	43.715	35.338	0.304	0.437
3168	Forest	*Maasia hypoleuca*	70.86	0.2	4.910	15.549	20.466	0.303	0.467
9524	Forest	*Aporosa subcaudata*	62.36	0.24	12.229	35.978	31.842	0.303	0.442
3046	Forest	*Pimelodendron amboinicum*	59.5	0.21	12.284	27.492	31.490	0.302	0.352
3617	Forest	*Pimelodendron griffithianum*	69.35	0.19	15.081	50.101	43.173	0.302	0.344
9189	Forest	*Xylopia ferruginea*	81.67	0.33	2.751	8.833	15.020	0.300	0.491
421	Forest	*Dichapetalum gelonioides*	49.53	0.17	16.104	29.375	29.480	0.300	0.421
9568	Forest	*Horsfieldia polyspherula*	71.28	0.22	11.064	50.640	37.487	0.300	0.449
2778	Forest	*Gymnacranthera forbesii*	78.45	0.17	NA	42.840	33.963	0.299	0.462
3024	Forest	*Aporosa sp.10*	56.6	0.23	14.593	33.600	30.925	0.296	0.441
3150	Forest	*Santiria griffithii*	65.5	0.22	15.827	23.646	25.595	0.296	0.454
9264	Forest	*Litsea sumatrana 2*	72.29	0.25	8.046	83.947	47.468	0.294	0.456
3231	Forest	*Mangifera torquenda*	61.54	0.27	4.581	41.295	36.147	0.293	0.403
138	Forest	*Myristica maxima*	67.87	0.38	4.994	181.756	75.492	0.290	0.402
3140	Forest	*Canarium littorale*	60.51	0.3	6.518	87.192	48.015	0.289	0.473
9066	Forest	*Cryptocarya ferrea*	64.56	0.19	6.873	88.438	48.891	0.286	0.464
284	Forest	*Litsea forstenii*	60.02	0.3	9.056	61.451	43.278	0.280	0.406
2993	Forest	*Aglaia malaccensis*	62.4	0.21	16.423	20.316	29.449	0.276	0.311
231	Forest	*Maasia glauca*	66.9	0.23	17.402	18.011	22.590	0.276	0.441
9049	Forest	*Litsea sumatrana 1*	76.45	0.21	16.969	63.836	42.112	0.268	0.447
2978	Forest	*Dacryodes laxa*	56.1	0.18	14.671	44.968	36.764	0.265	0.417
460	Forest	*Barringtonia macrostachya*	45.56	0.19	45.742	46.131	39.785	0.265	0.353
2994	Forest	*Bouea macrophylla*	52.9	0.19	16.524	23.712	28.260	0.264	0.374
3646	Forest	*Polyalthia glauca_1*	66.59	0.17	9.514	16.802	22.827	0.260	0.406
3072	Forest	*Myristica iners*	60.3	0.24	30.345	54.794	39.117	0.259	0.441
312	Forest	*Microcos florida*	63.01	0.23	8.285	56.473	42.144	0.255	0.396
3765	Forest	*Barringtonia pendula*	55.6	0.38	7.132	87.002	100.383	0.252	0.204

9978	Forest	*Horsfeldia eria*	66.34	0.27	7.802	22.065	27.150	0.247	0.374
9309	Forest	*Elaeocarpus salicifolius*	64.45	0.19	3.204	8.489	18.959	0.214	0.297
359	Forest	*Aporosa cf. falcifera*	61.96	0.17	17.322	32.339	32.876	0.213	0.373
3223	Forest	*Melicope glabra*	79.7	0.51	NA	NA	NA	NA	NA
9217	Forest	*Sterculia obovata*	54.72	0.5	17.336	1289.315	845.774	0.268	0.346
9976	Forest	*Mangifera foetida*	68.59	0.39	7.071	865.042	728.361	0.243	0.369
9815	Forest	*Gymnacranthera bancana*	85.08	0.37	5.396	1157.132	770.318	0.248	0.383
3085	Forest	*Prunus arborea var. Stipulacea*	73.1	0.37	NA	NA	NA	NA	NA
3217	Forest	*Luvunga sarmentosa*	68.4	0.37	NA	NA	NA	NA	NA
3089	Forest	*Dacryodes rostrata*	60	0.36	NA	NA	NA	NA	NA
9135	Forest	*Lauraceae sp. 45*	58.7	0.35	14.365	875.653	748.300	0.256	0.394
9205	Forest	*Jackiopsis ornata*	59.01	0.35	7.287	858.736	724.415	0.265	0.353
3206	Forest	*Xanthophyllum rufum*	65.6	0.35	NA	NA	NA	NA	NA
3216	Forest	*Aporosa nesvasa*	52	0.35	NA	NA	NA	NA	NA
9532	Forest	*Litsea robusta*	71.57	0.32	9.850	901.873	753.828	0.247	0.374
172	Forest	*Syzygium cf. borneense*	65.44	0.32	NA	NA	NA	NA	NA
3220	Forest	*Diospyros coriacea*	59.3	0.32	NA	NA	NA	NA	NA
3607	Forest	*Popowia tomentosa*	51.1	0.31	NA	NA	95.065	NA	NA
99	Forest	*Endiandra immersa*	60.69	0.3	NA	NA	NA	NA	NA
3225	Forest	*Drepananthus carinatus*	65.5	0.3	NA	NA	NA	NA	NA
9268	Forest	*Santiria laevigata*	45.48	0.29	9.560	1505.178	1142.539	0.345	0.504
9986	Forest	*Aglaia malaccensis*	72.28	0.29	15.678	1210.456	1121.454	NA	NA
9529	Forest	*Araliaceae sp. 05*	64.53	0.29	22.585	NA	NA	NA	NA
2779	Forest	*Baccaurea minor*	78.23	0.29	NA	NA	NA	NA	NA
3163	Forest	*Porterandia anisophylla*	64.5	0.29	NA	NA	NA	NA	NA
9184	Forest	*Macaranga conifera*	53.2	0.28	33.850	911.665	757.196	0.415	0.489
9124	Forest	*Scaphium affine*	53.37	0.28	24.345	886.593	756.237	NA	NA
3211	Forest	*Xanthophyllum stipitatum*	76	0.28	NA	NA	NA	NA	NA
3222	Forest	*Planchonella duclitan*	62.5	0.28	NA	NA	NA	NA	NA
296	Forest	*Aphanamixis polystachya*	71.6	0.27	11.502	1097.660	1093.450	NA	NA
3047	Forest	*Litsea firma*	52	0.27	NA	NA	NA	NA	NA
9538	Forest	*Canarium album*	53	0.27	NA	NA	NA	NA	NA
395	Forest	*Aglaia leucophylla*	74.66	0.26	22.918	NA	1448.704	NA	NA
387	Forest	*Chisocheton tomentosus*	70.31	0.26	41.125	1133.782	952.042	0.345	0.504
9812	Forest	*Triomma malaccensis*	59.26	0.26	15.486	885.923	875.497	0.269	0.612
2785	Forest	*Ixonanthes icosandra*	60.05	0.26	NA	NA	NA	NA	NA
9816	Forest	*Dacryodes rostrata*	68.17	0.25	15.108	853.447	787.994	0.415	0.489
354	Forest	*Chisocheton ceramicus*	77.78	0.25	22.403	NA	NA	NA	NA
9537	Forest	*Burseraceae sp. 93*	65.06	0.24	19.349	826.337	801.504	0.770	0.174
9540	Forest	*Nephelium laurinum*	74.36	0.24	43.417	738.193	774.533	0.345	0.504
2985	Forest	*Gymnacranthera farquhariana*	70	0.24	NA	NA	NA	NA	NA

7524	Forest	*Shorea sp. 09*	68.6	0.24	NA	NA	NA	NA	NA
9314	Forest	*Pternandra caerulescens*	57.99	0.24	NA	NA	NA	NA	NA
3207	Forest	*Aglaia cucullata*	77.1	0.23	27.395	808.134	852.726	NA	NA
9126	Forest	*Knema furfuracea*	59.14	0.23	12.561	883.297	743.742	NA	NA
247	Forest	*Artocarpus anisophyllus*	68.32	0.23	19.048	NA	NA	NA	NA
3088	Forest	*Antidesma coriaceum*	51.1	0.23	NA	NA	NA	NA	NA
9565	Forest	*Santiria laevigata*	60.6	0.22	21.469	NA	1117.863	NA	NA
3112	Forest	*Xanthophyllum eurhynchum*	66.3	0.22	NA	NA	NA	NA	NA
9552	Forest	*Aporosa lucida*	64.7	0.22	NA	NA	NA	NA	NA
3107	Forest	*Koompassia malaccensis*	52.5	0.21	NA	NA	NA	NA	NA
2952	Forest	*Artocarpus nitidus*	52.7	0.2	NA	NA	NA	NA	NA
9244	Forest	*Triomma malaccensis*	56.48	0.19	12.848	857.007	857.798	0.391	0.441
9162	Forest	*Nephelium uncinatum*	52.66	0.19	13.414	856.521	838.812	0.391	0.535
364	Forest	*Ailanthus integrifolia*	71.66	0.19	NA	NA	NA	NA	NA
3086	Forest	*Elaeocarpus mastersii*	47.4	0.19	NA	NA	NA	NA	NA
9604	Forest	*Burseraceae sp. 92*	72.19	0.18	33.934	834.511	824.172	0.221	0.345
3091	Forest	*Nephelium eriopetalum*	52.6	0.17	NA	NA	NA	NA	NA
9528	Forest	*Nephelium laurinum*	65.12	0.16	27.235	1067.330	986.512	NA	NA
9801	Forest	*Dacryodes laxa*	52.55	0.16	40.852	816.010	862.550	0.359	0.426
9559	Forest	*Santiria griffithii*	70.98	0.16	26.680	759.152	803.219	0.359	0.528
318	Forest	*Dracontomelon dao*	57.24	0.14	27.464	1494.039	1187.104	0.358	0.399
9223	Forest	*Nephelium uncinatum*	60.16	0.14	17.661	840.068	803.037	0.247	0.374
2489	Jungle rubber	*Archidendron fagifolium*	51.33	0.12	6.014	169.882	133.297	0.617	0.118
2406	Jungle rubber	*Nephelium mangayi*	58.41	0.3	7.719	65.829	48.751	0.865	0.355
3856	Jungle rubber	*Turpinia cf. brachypetala*	59.24	0.33	3.977	125.633	111.751	0.873	0.133
3866	Jungle rubber	*Macaranga hosei*	45.11	0.37	4.564	154.793	85.696	0.750	0.262
1456	Jungle rubber	*Vitex pinnata*	52.92	0.18	2.562	203.538	117.360	0.748	0.185
3508	Jungle rubber	*Nephelium mutabile*	64.02	0.23	3.847	202.786	133.081	0.746	0.157
2496	Jungle rubber	*Nephelium lappaceum*	64.1	0.2	5.464	116.891	74.661	0.732	0.256
3405	Jungle rubber	*Paranephelium cf. xestophyllum*	65.38	0.23	9.916	94.828	87.097	0.723	0.157
2354	Jungle rubber	*Vitex vestita*	42.01	0.25	9.988	119.649	108.534	0.705	0.127
1174	Jungle rubber	*Ganophyllum sp. 03*	60.65	0.25	3.962	183.129	138.452	0.689	0.128
3812	Jungle rubber	*Dysoxylum arborescens*	66.01	0.14	6.705	82.921	126.269	0.685	0.068
3314	Jungle rubber	*Hevea Brasiliensis*	64.43	0.14	5.140	123.701	91.561	0.669	0.185
3330	Jungle rubber	*Peltophorum pterocarpum*	68.4	0.21	5.944	338.849	425.326	0.666	0.025
3853	Jungle rubber	*Macaranga hypoleuca*	48.67	0.32	1.595	146.357	93.927	0.640	0.210
1470	Jungle rubber	*Alangium cf. kurzii*	41.15	0.25	7.830	185.378	66.304	0.622	0.527
2004	Jungle rubber	*Endiandra rubescens*	48.73	0.34	6.499	335.490	95.798	0.605	0.453
3315	Jungle rubber	*Glochidion superbum*	42.77	0.43	8.434	108.850	42.797	0.599	0.724
3578	Jungle rubber	*Glochidion superbum*	56.54	0.42	4.548	104.147	41.560	0.595	0.752
2457	Jungle rubber	*Parkia speciosa*	0	0.22	10.138	178.015	231.565	0.575	0.043

3327	Jungle rubber	*Macaranga bancana*	50.99	0.2	3.453	288.630	109.525	0.536	0.305
2176	Jungle rubber	*Garcinia griffithii*	54.09	0.39	6.487	212.735	72.373	0.512	0.516
2256	Jungle rubber	*Parkia speciosa*	0	0.22	15.249	89.463	204.723	0.496	0.028
3831	Jungle rubber	*Lindera lucida*	53.11	0.22	11.288	50.457	32.952	0.495	0.574
2397	Jungle rubber	*Baccaurea macrocarpa*	56.17	0.27	18.085	54.598	37.681	0.494	0.481
2318	Jungle rubber	*Pternandra caerulescens*	63.1	0.31	6.042	41.475	31.065	0.488	0.537
2023	Jungle rubber	*Styrax paralleloneuron*	51.95	0.17	13.753	56.001	34.863	0.488	0.571
2431	Jungle rubber	*Macaranga conifera*	58.12	0.18	12.975	33.125	34.028	0.486	0.363
2267	Jungle rubber	*Artocarpus rigidus*	66.91	0.45	2.567	70.240	49.109	0.481	0.473
2187	Jungle rubber	*Gironniera subaequalis*	58.77	0.24	16.720	54.322	32.909	0.480	0.614
3871	Jungle rubber	*Glochidion lutescens*	47.96	0.17	8.475	16.425	18.569	0.478	0.599
3406	Jungle rubber	*Cratoxylum formosum*	31.31	0.14	11.058	16.774	18.355	0.468	0.620
2484	Jungle rubber	*Artocarpus integer*	76.38	0.38	7.575	94.711	45.282	0.466	0.574
2396	Jungle rubber	*Alstonia cf. angustiloba*	61.77	0.43	9.185	21.724	22.151	0.466	0.562
3348	Jungle rubber	*Pternandra azurea*	54.92	0.18	5.077	26.025	22.788	0.465	0.629
3375	Jungle rubber	*Ficus variegata*	49.28	0.26	9.266	58.931	40.312	0.465	0.454
3810	Jungle rubber	*Croton argyratus*	55.84	0.19	10.799	17.268	20.772	0.463	0.495
2414	Jungle rubber	*Litsea elliptica*	63.07	0.22	8.171	33.590	27.993	0.458	0.534
3377	Jungle rubber	*Litsea monopetala*	57.36	0.18	6.833	47.191	32.661	0.458	0.546
1110	Jungle rubber	*Macaranga cf. conifera*	48.42	0.22	9.121	22.492	27.084	0.455	0.389
2323	Jungle rubber	*Artocarpus nitidus*	73.56	0.3	16.715	32.309	26.525	0.455	0.573
3571	Jungle rubber	*Kibatalia cf. maingayi*	69.86	0.26	5.982	30.799	25.564	0.452	0.588
3322	Jungle rubber	*Garcinia Sp. 07*	62.92	0.23	18.671	15.030	18.850	0.440	0.527
2043	Jungle rubber	*Castanopsis inermis*	59.42	0.17	4.346	63.912	37.620	0.440	0.559
3544	Jungle rubber	*Knema latifolia*	66.46	0.27	2.981	98.746	45.507	0.438	0.595
3395	Jungle rubber	*Syzygium Sp.23*	54.09	0.25	20.474	114.532	49.874	0.435	0.570
2497	Jungle rubber	*Elaeocarpus glaber*	71.25	0.24	6.082	70.263	43.558	0.434	0.463
3840	Jungle rubber	*Glochidion zeylanicum var. arborescens*	66.76	0.21	4.707	38.729	28.487	0.433	0.599
2252	Jungle rubber	*Scaphium affine*	50.1	0.24	7.358	116.542	57.517	0.427	0.440
1125	Jungle rubber	*Lagerstroemia cf. speciosa*	45.75	0.21	22.669	58.508	35.263	0.426	0.590
2191	Jungle rubber	*Litsea castanea*	40.66	0.23	17.020	46.941	31.856	0.425	0.574
1453	Jungle rubber	*Pellacalyx lobbii*	65.58	0.27	8.942	27.685	24.656	0.423	0.570
2333	Jungle rubber	*Sterculia rubiginosa*	52.78	0.26	11.740	73.312	39.991	0.417	0.562
2403	Jungle rubber	*Castanopsis schefferiana*	45.68	0.29	9.811	45.717	33.714	0.415	0.489
3340	Jungle rubber	*Styrax benzoin*	48.75	0.19	4.961	30.834	27.576	0.413	0.505
3545	Jungle rubber	*Tetractomia tetrandra*	57.85	0.27	11.527	20.299	21.843	0.409	0.528
2215	Jungle rubber	-	0	0	NA	40.309	31.507	0.406	0.509
3372	Jungle rubber	*Scolopia spinosa*	56.36	0.18	7.682	28.386	26.593	0.405	0.503
3297	Jungle rubber	*Symplocos fasciculata*	47.99	0.15	9.584	89.645	111.988	0.404	0.278
3862	Jungle rubber	*Baccaurea dulcis*	61.67	0.34	2.925	58.180	39.456	0.401	0.466

2068	Jungle rubber	*Heritiera sumatrana*	51.96	0.25	11.347	58.217	37.904	0.398	0.506
3329	Jungle rubber	*Cinnamomum porrectum*	53.14	0.24	7.146	22.094	25.034	0.394	0.443
3357	Jungle rubber	*Aporosa octandra*	53.43	0.21	10.394	34.852	28.206	0.392	0.547
3813	Jungle rubber	*Dipterocarpaceae sp. 15*	71.65	0.27	11.329	60.784	41.577	0.391	0.441
1083	Jungle rubber	*Garcinia sp. 06*	62.98	0.24	7.375	52.948	36.411	0.386	0.499
3518	Jungle rubber	*Planchonella maingayi*	70.83	0.22	4.849	66.764	42.717	0.381	0.444
3822	Jungle rubber	*Elaeocarpus stipularis*	47.43	0.2	6.962	31.822	28.816	0.380	0.461
3570	Jungle rubber	*Gluta wallichii*	64.32	0.2	3.032	76.290	43.105	0.380	0.508
2283	Jungle rubber	*Syzygium sp. 34*	65.33	0.25	4.695	15.000	20.376	0.380	0.453
3480	Jungle rubber	*Persea rimosa*	55.04	0.28	19.476	34.378	30.587	0.380	0.459
2259	Jungle rubber	*Artocarpus cf. kemando*	66.57	0.32	4.378	63.415	37.379	0.379	0.512
2049	Jungle rubber	*Ixonanthes petiolaris*	61.42	0.27	11.856	32.331	28.844	0.372	0.477
3573	Jungle rubber	*Elaeocarpus stipularis*	64.61	0.28	5.279	83.551	47.948	0.371	0.455
2282	Jungle rubber	*Timonius wallichianus*	51.3	0.15	18.576	34.830	30.683	0.366	0.462
3295	Jungle rubber	*Terminalia subspathulata*	61.49	0.24	7.622	47.883	37.763	0.364	0.419
3362	Jungle rubber	*Bridelia glauca*	41.67	0.19	7.637	60.631	37.260	0.360	0.545
3583	Jungle rubber	*Garcinia parvifolia*	68.38	0.26	5.359	16.711	22.098	0.359	0.426
3600	Jungle rubber	*Lauraceae sp. 07*	66.94	0.24	5.903	31.976	29.194	0.356	0.464
1450	Jungle rubber	*Balakata baccata*	53.46	0.2	18.300	39.015	34.949	0.353	0.397
3560	Jungle rubber	*Dillenia sp. 02*	48.6	0.27	10.729	233.494	79.289	0.352	0.466
2026	Jungle rubber	*Artocarpus elasticus*	65.82	0.2	8.575	82.135	43.910	0.348	0.508
2751	Jungle rubber	*Dillenia Excelsa*	53.16	0.2	12.031	132.960	60.472	0.346	0.446
2268	Jungle rubber	*Streblus elongatus*	70.24	0.22	6.580	55.508	36.512	0.345	0.504
3318	Jungle rubber	*Urophyllum trifurcum*	61.81	0.18	8.464	92.534	47.631	0.345	0.502
3363	Jungle rubber	*Adinandra Cf. Integerrima*	54.87	0.22	11.569	23.590	24.172	0.343	0.503
2269	Jungle rubber	*Acer laurinum*	64.48	0.15	12.501	27.727	29.470	0.342	0.395
1113	Jungle rubber	*Melanochyla caesia*	62.82	0.23	12.217	58.005	37.722	0.338	0.511
2448	Jungle rubber	*Aporosa benthamiana*	52.13	0.27	18.656	89.698	44.792	0.336	0.556
3300	Jungle rubber	*Syzygium Sp.22*	65.35	0.26	6.168	43.461	33.373	0.333	0.490
2138	Jungle rubber	*Pouteria Malaccensis*	74.29	0.29	4.675	44.778	36.536	0.332	0.419
2399	Jungle rubber	*Alstonia pneumatophora*	63.07	0.36	4.937	40.578	31.953	0.332	0.498
2172	Jungle rubber	*Campnosperma auriculatum*	52.23	0.2	10.317	160.863	69.512	0.330	0.415
2479	Jungle rubber	*Agrostistachys hookeri*	71.62	0.31	6.265	162.493	72.850	0.330	0.374
3857	Jungle rubber	*Heritiera sp. 03*	59.99	0.33	2.389	28.303	31.892	0.329	0.347
2018	Jungle rubber	*Mischocarpus sumatranus*	55.18	0.17	9.930	118.121	55.591	0.307	0.482
2294	Jungle rubber	*Antiaris toxicaria*	54.67	0.22	24.995	49.466	35.381	0.305	0.491
2046	Jungle rubber	*Macaranga cf. Sumatrana*	60.27	0.16	10.044	22.829	31.367	0.303	0.293
2136	Jungle rubber	*Alstonia angustifolia*	55.93	0.26	10.423	25.745	26.927	0.298	0.444
2037	Jungle rubber	*Cratoxylum sumatranum*	49.75	0.15	22.806	24.449	25.758	0.295	0.463
1073	Jungle rubber	*Adinandra cf. sarosanthera*	59.74	0.33	7.325	86.888	48.498	0.292	0.460
2067	Jungle rubber	*Alstonia scholaris*	66.83	0.26	7.884	61.404	42.423	0.285	0.427

2171	Jungle rubber	*Garcinia atroviridis*	61.38	0.54	7.615	94.074	82.087	0.277	0.211
2284	Jungle rubber	*Horsfieldia polyspherula*	74.5	0.39	5.355	44.159	36.406	0.273	0.403
3823	Jungle rubber	*Elaeocarpus sp. 13*	57.52	0.2	2.994	49.584	44.919	0.269	0.307
3394	Jungle rubber	*Mangifera laurina*	58.38	0.17	10.109	56.860	42.928	0.254	0.388
2342	Jungle rubber	*Horsfieldia pulcherrima*	81.43	0.37	6.330	170.221	72.885	0.243	0.401
2123	Jungle rubber	*Myristica maingayi*	65.99	0.22	12.330	52.973	40.719	0.241	0.395
2193	Jungle rubber	*Annonaceae Sp. 09*	51.61	0.24	13.764	60.627	46.701	0.221	0.345
2742	Jungle rubber	*Artocarpus dadah*	61.48	0.5	NA	NA	NA	NA	NA
3448	Jungle rubber	*Ormosia sumatrana*	63.19	0.37	6.141	NA	NA	NA	NA
3308	Jungle rubber	*Peronema canescens*	42.41	0.24	9.865	983.280	854.904	0.773	0.113
3486	Jungle rubber	*Callerya atropurpurea*	62.73	0.22	15.009	856.231	808.616	0.247	0.374
3581	Jungle rubber	*Parishia insignis*	47.07	0.21	19.186	999.387	954.781	NA	NA
3296	Jungle rubber	*Parkia timoriana*	0	0.2	17.008	1248.029	1568.282	0.221	0.345
2481	Jungle rubber	*Paropsia varecifomis*	62.35	0.18	10.220	897.418	884.286	NA	NA
6128	Rubber	*Neolamarckia cadamba*	62.35	0.21	7.052	102.967	47.468	0.491	0.565
6130	Rubber	*Neolamarckia cadamba*	63.73	0.23	8.738	77.929	41.409	0.469	0.562
6676	Rubber	*Aquilaria malaccensis*	62.48	0	22.855	22.009	20.816	0.458	0.632
6650	Rubber	*Syzygium samarangense*	50.81	0	32.988	102.485	48.336	0.453	0.580
6678	Rubber	*Aquilaria malaccensis*	55.54	0	11.757	20.809	21.219	0.407	0.576
6092	Rubber	*Morac Sp.8*	63.78	0.17	22.055	37.627	33.644	0.400	0.413
6625	Rubber	*Durio zibethinus*	67.27	0.27	17.269	37.732	31.299	0.321	0.469
6644	Rubber	*Mangifera laurina*	58.15	0.23	5.373	68.616	49.750	0.246	0.345
6110	Rubber	*Dillenia Sp.5*	58.28	0.66	NA	NA	NA	NA	NA

Table 2: Wood density data for trees received from Boe4 working group of EFForTS project

Species	wood density ($mg/mm^{3)}$	land-use systems
"no leaves"	0.600	Forest
Acronychia pedunculata	0.546	Forest
Adinandra dumosa	0.502	Forest
Agelaea macrophylla	0.571	Forest
Aglaia crassinervia	0.674	Forest
Aglaia leucophylla	0.546	Forest
Aglaia malaccensis	0.606	Forest
Aglaia odoratissima	0.467	Forest
Aglaia rubiginosa	0.571	Forest
Aglaia spectabilis	0.600	Forest
Ailanthus integrifolia	0.517	Forest
Alangium javanicum	0.600	Forest
Alangium uniloculare	0.571	Forest
Alseodaphne sp. 01	0.545	Forest
Alstonia scholaris	0.294	Forest
Anacardiaceae sp. 16	0.522	Forest
Anacardiaceae sp. 19	0.438	Forest
Anisoptera costata	0.545	Forest
Annonaceae sp. 76	0.522	Forest
Antidesma cf. velutinum	0.634	Forest
Antidesma coriaceum	0.688	Forest
Antidesma cuspidatum	0.634	Forest
Antidesma forbesii	0.674	Forest
Antidesma leucopodum	0.571	Forest
Antidesma sp. 21	0.674	Forest
Aphanamixis polystachya	0.467	Forest
Aporosa antennifera	0.634	Forest
Aporosa arborea	0.517	Forest
Aporosa benthamiana	0.524	Forest
Aporosa cf. falcifera	0.545	Forest
Aporosa frutescens	0.675	Forest
Aporosa lucida	0.613	Forest
Aporosa lunata	0.637	Forest
Aporosa nervosa	0.595	Forest
Aporosa prainiana	0.522	Forest
Aporosa sp. 06	0.596	Forest
Aporosa subcaudata	0.573	Forest
Archidendron bubalinum	0.541	Forest
Archidendron clypearia	0.402	Forest
Ardisia purpurea	0.522	Forest
Artocarpus anisophyllus	0.645	Forest
Artocarpus dadah	0.522	Forest
Artocarpus hispidus	0.502	Forest
Artocarpus integer	0.571	Forest
Artocarpus kemando	0.571	Forest
Artocarpus nitidus	0.558	Forest
Artocarpus rigidus	0.603	Forest
Atuna racemosa	0.579	Forest
Baccaurea cf. velutina	0.851	Forest
Baccaurea deflexa	0.674	Forest
Baccaurea dulcis	0.612	Forest
Baccaurea javanica	0.572	Forest
Baccaurea macrocarpa	0.545	Forest
Baccaurea minor	0.620	Forest
Baccaurea mollis	0.636	Forest
Baccaurea parviflora	0.502	Forest
Baccaurea polyneura	0.573	Forest
Baccaurea pubera	0.699	Forest
Baccaurea pyriformis	0.502	Forest
Baccaurea reticulata	0.600	Forest
Baccaurea sp. 25	0.647	Forest
Baccaurea sumatrana	0.600	Forest
Barringtonia lanceolata	0.612	Forest
Barringtonia macrostachya	0.571	Forest
Barringtonia pendula	0.600	Forest
Barringtonia scortechinii	0.606	Forest
Beilschmiedia madang	0.571	Forest
Bhesa paniculata	0.533	Forest
Bhesa robusta	0.571	Forest
Blumeodendron tokbrai	0.721	Forest
Bouea macrophylla	0.623	Forest
Buchanania sessilifolia	0.402	Forest
Burseraceae sp. 27	0.600	Forest
Burseraceae sp. 28	0.664	Forest
Burseraceae sp. 41	0.545	Forest
Burseraceae sp. 46	0.622	Forest
Burseraceae sp. 48	0.571	Forest
Burseraceae sp. 58	0.483	Forest
Burseraceae sp. 63	0.634	Forest
Burseraceae sp. 64	0.502	Forest
Burseraceae sp. 65	0.502	Forest
Burseraceae sp. 66	0.545	Forest
Callerya atropurpurea	0.603	Forest
Calophyllum pulcherrimum	0.607	Forest
Calophyllum soulattri	0.483	Forest

Calophyllum sp. 01	0.600	Forest
Calophyllum sp. 03	0.600	Forest
Calophylum	0.467	Forest
Canarium album	0.383	Forest
Canarium caudatum	0.603	Forest
Canarium littorale	0.545	Forest
Canarium megalanthum	0.596	Forest
Carallia brachiata	0.692	Forest
Castanopsis argentea	0.571	Forest
Castanopsis sp. 04	0.570	Forest
cf. Ardisia sp. 08	0.492	Forest
cf. Beilschmidea sp. 1_2	0.600	Forest
cf. Garderia sp. 01	0.851	Forest
cf. Porterandia anisophyllea seedling	0.634	Forest
Chionanthus curvicarpus	0.522	Forest
Chionanthus montanus	0.605	Forest
Chionanthus sp. 02	0.674	Forest
Chisocheton ceramicus	0.499	Forest
Chisocheton patens	0.597	Forest
Chisocheton tomentosus	0.631	Forest
Clonostylis forbesii	0.592	Forest
Cratoxylum cf. formosum	0.779	Forest
Cratoxylum cochinchinense	0.721	Forest
Cratoxylum formosum	0.779	Forest
Croton argenteus	0.678	Forest
Croton argyratus	0.548	Forest
Croton	0.571	Forest
cascarilloides		
Cryptocarya costata	0.502	Forest
Cryptocarya crassinervia	0.851	Forest
Cryptocarya densiflora	0.502	Forest
Cryptocarya ferrea	0.674	Forest
Dacryodes costata	0.690	Forest
Dacryodes laxa	0.649	Forest
Dacryodes rostrata	0.534	Forest
Dacryodes rugosa	0.657	Forest
Dialium indum	0.851	Forest
Dialium platysepalum	0.779	Forest
Dichapetalum gelonioides	0.634	Forest
Dichapetalum timoriense	0.634	Forest
Dillenia eximia	0.551	Forest
Diospyros cf. borneensis	0.721	Forest
Diospyros javanica	0.721	Forest
Diospyros korthalsiana	0.634	Forest
Diospyros lanceifolia	0.698	Forest
Diospyros sumatrana	0.600	Forest
Diospyrus sp. 01	0.634	Forest
Diospyrus sp. 13	0.727	Forest
Dipterocarpaceae sp. 15	0.571	Forest
Discospermum abnorme	0.680	Forest
Disoxylum densiflorum	0.578	Forest
Dracontomelon dao	0.524	Forest
Drepananthus biovulatus	0.383	Forest
Drepananthus carinatus	0.402	Forest
Drepananthus ramuliflorus	0.499	Forest
Drypetes longifolia	0.634	Forest
Durio oxleyanus	0.661	Forest
Dyera costulata	0.368	Forest
Elaeocarpus mastersii	0.571	Forest
Elaeocarpus nitidus	0.525	Forest
Endiandra cf. rubescens	0.600	Forest
Endiandra immersa	0.634	Forest
Endiandra sp. 05	0.330	Forest
Endospermum diadenum	0.420	Forest
Fagaceae sp. 01	0.545	Forest
Fagaceae sp. 03	0.545	Forest
Ficus globosa	0.440	Forest
Ficus variegata	0.363	Forest
Galearia cf. Maingayi	0.595	Forest
Garcinia parvifolia	0.571	Forest
Gironniera cf. nervosa	0.634	Forest
Gironniera cf. subaequalis	0.425	Forest
Gironniera hirta	0.423	Forest
Gironniera nervosa	0.476	Forest
Gonystylus affinis	0.502	Forest
Gonystylus maingayi	0.571	Forest
Gordonia oblongifolia	0.461	Forest
Gymnacranthera bancana	0.578	Forest
Gymnacranthera farquhariana	0.529	Forest
Gymnacranthera farquhariana var.	0.468	Forest

Eugeniifolia		
Gymnacranthera forbesii	0.522	Forest
Gynotroches axillaris	0.529	Forest
Hancea penangensis	0.545	Forest
Helicia excelsa	0.735	Forest
Helicia sp. 06	0.634	Forest
Hopea beccariana	0.581	Forest
Hopea ferruginea	0.552	Forest
Hopea sangal	0.373	Forest
Horsfieldia cf. Glabra	0.571	Forest
Horsfieldia cf. polyspherula	0.483	Forest
Horsfieldia glabra	0.509	Forest
Horsfieldia grandis	0.634	Forest
Horsfieldia macrothyrsa	0.452	Forest
Horsfieldia polyspherula	0.308	Forest
Horsfieldia pulcherrima	0.545	Forest
Hunteria zeylanica	0.674	Forest
Hydnocarpus cf. sumatrana	0.634	Forest
Hydnocarpus cf. wrayi	0.573	Forest
Hypericaceae sp. 01	0.698	Forest
Irvingia malayana	0.727	Forest
Ixonanthes petiolaris	0.571	Forest
Knema cinerea	0.571	Forest
Knema furfuracea	0.600	Forest
Knema latifolia	0.467	Forest
Koompassia malaccensis	0.775	Forest
Koompassia sp. 01	0.560	Forest
Lagerstroemia cf. speciosa	0.483	Forest
Lagerstroemia sp. 03	0.425	Forest
Lamiaceae sp. 01	0.467	Forest
Lauraceae sp. 04	0.517	Forest
Lauraceae sp. 15	0.674	Forest
Lauraceae sp. 32	0.522	Forest
Lauraceae sp. 40	0.600	Forest
Lithocarpus blumeanus	0.546	Forest
Lithocarpus sp. 01	0.485	Forest
Litsea aurea	0.392	Forest
Litsea cubeba	0.438	Forest
Litsea firma	0.446	Forest
Litsea forstenii	0.374	Forest
Litsea glutinosa	0.452	Forest
Litsea machilifolia	0.374	Forest
Litsea monopetala	0.475	Forest
Litsea resinosa	0.461	Forest
Litsea robusta	0.417	Forest
Litsea sp. 35	0.545	Forest
Lophopetalum cf. javanicum	0.721	Forest
Lophopetalum javanicum	0.764	Forest
Lunasia amara	0.502	Forest
Luvunga sarmentosa	0.545	Forest
Maasia glauca	0.650	Forest
Maasia sumatrana	0.571	Forest
Macaranga bancana	0.351	Forest
Macaranga cf. sumatrana	0.402	Forest
Macaranga gigantea	0.365	Forest
Macaranga hypoleuca	0.467	Forest
Macaranga sp. 07	0.324	Forest
Macaranga sp. 09	0.343	Forest
Madhuca penicillata	0.648	Forest
Madhuca sericea	0.502	Forest
Magnolia elegans	0.402	Forest
Malvaceae sp. 24	0.545	Forest
Malvaceae sp. 26	0.522	Forest
Malvaceae sp. 29	0.643	Forest
Mangifera caesia	0.679	Forest
Mangifera torquenda	0.562	Forest
Melanochyla caesia	0.571	Forest
Meliaceae sp. 12	0.522	Forest
Meliaceae sp. 46	0.330	Forest
Melicope glabra	0.486	Forest
Memecylon edule	0.600	Forest
Memecylon myrsinoides	0.721	Forest
Mesua sp. 01	0.634	Forest
Mezzettia parviflora	0.634	Forest
Microcos florida	0.443	Forest
Mischocarpus sundaicus (cf.)	0.634	Forest
Myristica iners	0.554	Forest
Myristica maxima	0.460	Forest
Myristicaceae sp. 27	0.483	Forest
Myristicaceae sp. 38	0.571	Forest
Myrtaceae sp. 67	0.571	Forest
Nauclea subdita	0.438	Forest
Neoscortechinia kingii	0.636	Forest
Nephelium cuspidatum	0.678	Forest
Nephelium cuspidatum var. eriopetalum	0.779	Forest
Nephelium subfalcatum	0.898	Forest
Nostolachma densiflora	0.522	Forest
Ochanostachys amentacea	0.662	Forest
Oncosperma	0.310	Forest

horridum		
Orania silvicola	0.310	Forest
Palaquium gutta	0.511	Forest
Palaquium hexandrum	0.517	Forest
Palaquium obovatum	0.476	Forest
Palaquium ridleyi	0.759	Forest
Palaquium sumatranum	0.434	Forest
Parashorea cf. lucida	0.674	Forest
Parastemon urophyllus	0.815	Forest
Parinari sumatrana	0.721	Forest
Parishia insignis	0.545	Forest
Parkia speciosa	0.538	Forest
Paropsia varecifomis	0.721	Forest
Payena acuminata	0.502	Forest
Payena leerii	0.674	Forest
Pellacalyx lobbii	0.518	Forest
Pertusadina eurhyncha	0.678	Forest
Petraeovitex sumatrana (cf.)	0.721	Forest
Phoebe grandis	0.597	Forest
Phyllanthaceae sp. 01	0.483	Forest
Pimelodendron griffithianum	0.530	Forest
Pimelodendron zoanthogyne	0.513	Forest
Planchonella duclitan	0.621	Forest
Polyalthia lateriflora	0.628	Forest
Polyalthia rumphii	0.600	Forest
Polyscias	0.586	Forest

diversifolia		
Pometia pinnata	0.576	Forest
Popowia tomentosa	0.571	Forest
Porterandia anisophylla	0.603	Forest
Pouteria malaccensis	0.456	Forest
Prunus cf. arborea	0.452	Forest
Prunus cf. grisea	0.440	Forest
Prunus polystachia	0.439	Forest
Prunus sp. 11	0.467	Forest
Prunus sp. 12	0.438	Forest
Pternandra caerulescens	0.535	Forest
Pterocymbium tubulatum	0.420	Forest
Ptychopyxis bacciformis	0.600	Forest
Ptychopyxis costata	0.634	Forest
Quercus lineata	0.674	Forest
Rhodamnia cinerea	0.717	Forest
Rinorea cf. sclerocarpa	0.358	Forest
Rubiaceae sp. 67	0.573	Forest
Sandoricum koetjape	0.506	Forest
Santiria apiculata	0.533	Forest
Santiria griffithii	0.626	Forest
Santiria laevigata	0.563	Forest
Santiria oblongifolia	0.568	Forest
Santiria rubiginosa	0.519	Forest
Santiria tomentosa	0.540	Forest
Sapindaceae sp. 25	0.721	Forest
Sapindaceae sp. 28	0.721	Forest
Saraca declinata	0.562	Forest
Sarcotheca diversifolia	0.597	Forest
Saurauia cf. tristyla	0.448	Forest
Scaphium affine	0.612	Forest

Shorea acuminata	0.429	Forest
Shorea bracteata	0.647	Forest
Shorea bracteolata	0.483	Forest
Shorea ovalis	0.432	Forest
Shorea parvifolia	0.393	Forest
Shorea pauciflora	0.431	Forest
Shorea singkawang	0.464	Forest
Sindora leiocarpa	0.586	Forest
Sterculia macrophylla	0.285	Forest
Sterculia megistophylla	0.600	Forest
Strombosia ceylanica	0.679	Forest
Styrax benzoin	0.498	Forest
Styrax paralleloneuron	0.545	Forest
Syzygium acuminatissimum	0.619	Forest
Syzygium cf. borneense	0.630	Forest
Syzygium cf. polycephylum	0.590	Forest
Syzygium cf. tetrapterum	0.683	Forest
Syzygium chloranthum	0.647	Forest
Syzygium euneuron	0.779	Forest
Syzygium glabratum	0.634	Forest
Syzygium palembanicum	0.522	Forest
Syzygium paludosum	0.522	Forest
Syzygium polyanthum	0.573	Forest
Syzygium pseudoformosum	0.634	Forest
Syzygium sp. 02	0.594	Forest
Syzygium sp. 03	0.668	Forest
Syzygium sp. 06	0.637	Forest

Syzygium sp. 07	0.721	Forest
Syzygium sp. 08	0.674	Forest
Syzygium sp. 09	0.674	Forest
Syzygium sp. 10	0.634	Forest
Syzygium splendens	0.714	Forest
Syzygium tetrapterum	0.634	Forest
Tabernaemontana macrocarpa	0.484	Forest
Terminalia bellirica	0.413	Forest
Terminalia foetidissima	0.571	Forest
Terminalia sp. 03	0.502	Forest
Tetrameles nudiflora	0.350	Forest
Timonius flavescens	0.721	Forest
Tree 104	0.634	Forest
Tree 111	0.634	Forest
Tree 85	0.571	Forest
Tree 87	0.483	Forest
Trigoniastrum hypoleucum	0.634	Forest
Trigonopleura malayana	0.483	Forest
Triomma malaccensis	0.671	Forest
Urophyllum trifurcum	0.452	Forest
Vitex quinata	0.467	Forest
Wrightia laevis	0.502	Forest
Xanthophyllum eurhynchum	0.700	Forest
Xanthophyllum rufum	0.682	Forest
Xanthophyllum stipitatum	0.721	Forest
Xerospermum laevigatum	0.618	Forest
Xerospermum noronhianum	0.710	Forest
Xylopia elliptica	0.661	Forest
Xylopia malayana	0.599	Forest
#N/A	0.512	Forest
Acer laurinum	0.571	Jungle rubber
Adinandra cf. integerrima	0.468	Jungle rubber
Adinandra cf. sarosanthera	0.545	Jungle rubber
Agrostistachys hookeri	0.351	Jungle rubber
Alangium cf. kurzii	0.425	Jungle rubber
Alstonia angustifolia	0.587	Jungle rubber
Alstonia cf. Angustiloba	0.360	Jungle rubber
Alstonia pneumatophora	0.256	Jungle rubber
Alstonia scholaris	0.343	Jungle rubber
Anacardiaceae sp. 02	0.545	Jungle rubber
Annonaceae sp. 09	0.571	Jungle rubber
Antidesma cuspidatum	0.467	Jungle rubber
Aporosa benthamiana	0.634	Jungle rubber
Aporosa octandra	0.674	Jungle rubber
Archidendron bubalinum	0.511	Jungle rubber
Archidendron clypearia	0.452	Jungle rubber
Archidendron fagifolium	0.408	Jungle rubber
Archidendron microcarpum	0.502	Jungle rubber
Arecaceae sp. 01	0.310	Jungle rubber
Artabotrys maingayi	0.600	Jungle rubber
Artocarpus anisophyllus	0.640	Jungle rubber
Artocarpus cf. kemando	0.477	Jungle rubber
Artocarpus dadah	0.569	Jungle rubber
Artocarpus elasticus	0.495	Jungle rubber
Artocarpus integer	0.506	Jungle rubber
Artocarpus kemando	0.502	Jungle rubber
Artocarpus nitidus	0.563	Jungle rubber
Artocarpus rigidus	0.582	Jungle rubber
Baccaurea dulcis	0.600	Jungle rubber
Baccaurea macrocarpa	0.497	Jungle rubber
Balakata baccata	0.388	Jungle rubber
Bhesa robusta	0.600	Jungle rubber
Bridelia glauca	0.461	Jungle rubber
Bridelia tomentosa	0.545	Jungle rubber
Burseraceae sp. 14	0.674	Jungle rubber
Callerya atropurpurea	0.634	Jungle rubber
Campnosperma auriculatum	0.353	Jungle rubber
Canarium littorale	0.498	Jungle

		rubber
Canarium pilosum	0.522	Jungle rubber
Carallia brachiata	0.600	Jungle rubber
Carallia sp. 03	0.545	Jungle rubber
Castanopsis inermis	0.469	Jungle rubber
Castanopsis schefferiana	0.634	Jungle rubber
cf. Annonaceae sp. 14	0.600	Jungle rubber
Champereia manillana	0.522	Jungle rubber
Cinnamomum porrectum	0.522	Jungle rubber
Clausena excavata	0.452	Jungle rubber
Cratoxylum sumatranum	0.662	Jungle rubber
Croton argyratus	0.581	Jungle rubber
Croton cascarilloides	0.425	Jungle rubber
Dacryodes rostrata	0.522	Jungle rubber
Dacryodes rugosa	0.502	Jungle rubber
Dehaasia incrassata	0.452	Jungle rubber
Dialium indum	0.779	Jungle rubber
Dialium platysepalum	0.699	Jungle rubber
Dillenia excelsa	0.571	Jungle rubber
Dillenia eximia	0.650	Jungle rubber
Dipterocarpaceae sp. 15	0.600	Jungle rubber
Drepananthus carinatus	0.376	Jungle rubber
Durio zibethinus	0.498	Jungle rubber
Dyera costulata	0.346	Jungle rubber
Dysoxylum arborescens	0.467	Jungle rubber
Elaeocarpus glaber	0.483	Jungle rubber
Elaeocarpus petiolatus	0.634	Jungle rubber
Elaeocarpus salicifolius	0.383	Jungle rubber
Elaeocarpus sp. 13	0.452	Jungle rubber
Elaeocarpus stipularis	0.507	Jungle rubber
Endiandra cf. rubescens	0.425	Jungle rubber
Endiandra vellutina	0.452	Jungle rubber
Endospermum diadenum	0.427	Jungle rubber
Fabaceae sp. 71	0.600	Jungle rubber
Ficus fulva	0.524	Jungle rubber
Ficus ribes	0.452	Jungle rubber
Ficus schwarzii	0.460	Jungle rubber
Ficus sp. 22	0.452	Jungle rubber
Ficus variegata	0.350	Jungle rubber
Garcinia atroviridis	0.851	Jungle
		rubber
Garcinia griffithii	0.634	Jungle rubber
Garcinia parvifolia	0.674	Jungle rubber
Garcinia sp. 06	0.634	Jungle rubber
Garcinia sp. 07	0.502	Jungle rubber
Gironniera cf. nervosa	0.392	Jungle rubber
Gironniera hirta	0.474	Jungle rubber
Gironniera nervosa	0.514	Jungle rubber
Gironniera subaequalis	0.483	Jungle rubber
Glochidion lutescens	0.545	Jungle rubber
Glochidion superbum	0.586	Jungle rubber
Glochidion zeylanicum var. arborescens	0.485	Jungle rubber
Gluta wallichii	0.483	Jungle rubber
Gymnacranthera bancana	0.571	Jungle rubber
Gymnacranthera forbesii	0.522	Jungle rubber
Gynotroches axillaris	0.547	Jungle rubber
Helicia excelsa	0.678	Jungle rubber
Heritiera sp. 03	0.522	Jungle rubber
Heritiera sumatrana	0.542	Jungle rubber
Hevea brasiliensis	0.529	Jungle

		rubber
Horsfieldia grandis	0.571	Jungle rubber
Horsfieldia polyspherula	0.571	Jungle rubber
Horsfieldia pulcherrima	0.452	Jungle rubber
Hypericaceae sp. 03	0.634	Jungle rubber
Ilex cymosa	0.522	Jungle rubber
Irvingia malayana	0.779	Jungle rubber
Ixonanthes petiolaris	0.554	Jungle rubber
Kibatalia cf. maingayi	0.522	Jungle rubber
Knema latifolia	0.634	Jungle rubber
Knema sp. 03	0.522	Jungle rubber
Koompassia malaccensis	0.727	Jungle rubber
Lagerstroemia cf. speciosa	0.600	Jungle rubber
Lauraceae sp. 07	0.634	Jungle rubber
Lindera cf. insignis	0.433	Jungle rubber
Lindera lucida	0.468	Jungle rubber
Litsea castanea	0.502	Jungle rubber
Litsea elliptica	0.413	Jungle rubber
Litsea firma	0.460	Jungle rubber
Litsea monopetala	0.483	Jungle rubber
Litsea robusta	0.438	Jungle rubber
Macaranga bancana	0.391	Jungle rubber
Macaranga cf. conifera	0.432	Jungle rubber
Macaranga cf. sumatrana	0.430	Jungle rubber
Macaranga conifera	0.374	Jungle rubber
Macaranga gigantea	0.358	Jungle rubber
Macaranga hosei	0.368	Jungle rubber
Macaranga hypoleuca	0.374	Jungle rubber
Macaranga sp. 07	0.405	Jungle rubber
Macaranga sp. 12	0.483	Jungle rubber
Magnifera sp. 03	0.532	Jungle rubber
Mangifera laurina	0.467	Jungle rubber
Melicope glabra	0.360	Jungle rubber
Mischocarpus sundaicus (cf.)	0.851	Jungle rubber
Moraceae sp. 08	0.851	Jungle rubber
Moraceae sp. 10	0.483	Jungle rubber
Myristica maingayi	0.571	Jungle rubber
Myrtaceae sp. 38	0.571	Jungle rubber
Neonauclea excelsa	0.438	Jungle rubber
Nephelium cuspidatum var. eriopetalum	0.571	Jungle rubber
Nephelium maingayi	0.721	Jungle rubber
Nephelium mutabile	0.700	Jungle rubber
Nephelium subfalcatum	0.851	Jungle rubber
Ochanostachys amentacea	0.634	Jungle rubber
Ormosia sumatrana	0.571	Jungle rubber
Palaquium gutta	0.551	Jungle rubber
Paranephelium xestophyllum (cf.)	0.676	Jungle rubber
Parkia speciosa	0.477	Jungle rubber
Parkia timoriana	0.482	Jungle rubber
Paropsia varecifomis	0.644	Jungle rubber
Pellacalyx lobbii	0.499	Jungle rubber
Peltophorum pterocarpum	0.559	Jungle rubber
Peronema canescens	0.610	Jungle rubber
Persea rimosa	0.545	Jungle rubber
Pertusadina eurhyncha	0.705	Jungle rubber
Planchonella cf. obovata	0.674	Jungle rubber
Planchonella maingayi	0.678	Jungle rubber
Pometia pinnata	0.571	Jungle rubber
Porterandia	0.572	Jungle

anisophylla		rubber
Pouteria malaccensis	0.664	Jungle rubber
Prunus polystachya	0.429	Jungle rubber
Pternandra azurea	0.522	Jungle rubber
Pternandra caerulescens	0.522	Jungle rubber
Pterocymbium tubulatum	0.285	Jungle rubber
Rhodamnia cinerea	0.402	Jungle rubber
Sandoricum koetjape	0.483	Jungle rubber
Santiria apiculata	0.634	Jungle rubber
Santiria griffithii	0.576	Jungle rubber
Santiria laevigata	0.425	Jungle rubber
Santiria oblongifolia	0.537	Jungle rubber
Santiria tomentosa	0.524	Jungle rubber
Sapindaceae sp. 19	0.721	Jungle rubber
Sapindaceae sp. 21	0.571	Jungle rubber
Saraca declinata	0.634	Jungle rubber
Saurauia cf. tristyla	0.446	Jungle rubber
Scaphium affine	0.512	Jungle

		rubber
Scolopia spinosa	0.721	Jungle rubber
Sloetia elongata	0.769	Jungle rubber
Sterculia megistophylla	0.436	Jungle rubber
Sterculia parvifolia	0.522	Jungle rubber
Sterculia rubiginosa	0.452	Jungle rubber
Styrax benzoin	0.452	Jungle rubber
Styrax paralleloneuron	0.452	Jungle rubber
Symplocos fasciculata	0.386	Jungle rubber
Syzygium acuminatissimum	0.634	Jungle rubber
Syzygium cf. acuminatisimum	0.600	Jungle rubber
Syzygium lineatum	0.600	Jungle rubber
Syzygium palembanicum	0.617	Jungle rubber
Syzygium sp. 22	0.615	Jungle rubber
Syzygium sp. 23	0.285	Jungle rubber
Tabernaemontana macrocarpa	0.452	Jungle rubber
Terminalia foetidissima	0.634	Jungle rubber
Terminalia	0.452	Jungle

subspathulata		rubber
Tetracera cf. scandens	0.779	Jungle rubber
Tetractomia tetrandra	0.527	Jungle rubber
Timonius flavescens	0.721	Jungle rubber
Timonius wallichianus	0.644	Jungle rubber
Trigoniastrum hypoleucum	0.698	Jungle rubber
Turpinia cf. brachypetala	0.499	Jungle rubber
Uncaria lanosa var. ferrea	0.600	Jungle rubber
Urophyllum trifurcum	0.490	Jungle rubber
Vitex pinnata	0.634	Jungle rubber
Vitex vestita	0.402	Jungle rubber
#N/A	0.480	Jungle rubber
Alstonia angustifolia	0.321	Rubber
Artocarpus heterophyllus	0.571	Rubber
Callicarpa pentandra	0.358	Rubber
Hevea brasiliensis	0.538	Rubber
Magnifera sp. 01	0.557	Rubber
Parkia speciosa	0.674	Rubber
#N/A	0.531	Rubber

Table 3: Functional understorey traits from 32 core plots from four land-use systems in the study area

Individual ID	land-use systems	species	chlorophyll content	leaf thickness (mm)	specific leaf area (cm^2/g)	stem specific density ($mg/mm^{3)}$	leaf area ($cm^{2)}$	leaf perimeter (cm)	leaf aspect ratio	leaf form cofficient
235	Forest	*Tectaria barberi*	46.7	0.18	126.850	NA	NA	2345.719	NA	NA
236	Forest	*Tectaria barberi*	43.68	0.19	188.935	NA	2261.720	2176.443	NA	NA
42	Forest	*Taenitis blechnoides*	58.44	0.22	98.364	NA	1902.053	2016.115	NA	NA
237	Forest	*Tectaria barberi*	41.04	0.2	444.274	NA	1836.594	1989.514	NA	NA
41	Forest	*Taenitis blechnoides*	40.18	0.28	158.242	NA	1887.301	1882.238	NA	NA
40	Forest	*Taenitis blechnoides*	47.7	0.29	201.967	NA	1845.019	1845.196	NA	NA
230	Forest	*Schismatoglottis calyptrata*	55.24	0.22	188.922	NA	2039.962	1838.455	NA	NA
229	Forest	*Schismatoglottis calyptrata*	52.42	0.2	301.318	NA	1989.789	1816.228	NA	NA
223	Forest	*Boesenbergia sp. 02*	44.04	0.23	442.041	NA	1886.935	1771.384	NA	NA
225	Forest	*Boesenbergia sp. 02*	43.74	0.23	232.836	NA	1822.971	1724.694	NA	NA
224	Forest	*Boesenbergia sp. 02*	42.8	0.23	512.460	NA	1801.506	1721.657	NA	NA
45	Forest	*Selaginella intermedia*	35.75	0.01	294.124	NA	19.412	74.938	0.551	0.047
231	Forest	*Schismatoglottis calyptrata*	53.6	0.18	206.045	NA	61.813	55.039	0.273	0.263
44	Forest	*Selaginella intermedia*	25.96	0.02	287.555	NA	13.967	48.645	0.579	0.078
43	Forest	*Selaginella intermedia*	26.36	0.01	423.858	NA	16.954	48.247	0.614	0.100
7	Forest	*Kunstleria ridleyi*	63.03	0.11	30.766	NA	107.108	96.940	0.715	0.141
46	Forest	*Rothmannia macrophylla*	71.85	0.24	266.925	0.001302	1762.260	1693.892	NA	NA
279	Forest	*Combretum nigrescens*	51.37	0.11	215.450	0.001183	22.838	22.951	0.356	0.533
278	Forest	*Combretum nigrescens*	56.04	0.15	150.197	0.001157	33.194	29.307	0.332	0.473
47	Forest	*Spatholobus ferrugineus*	39	0.14	56.024	0.001052	95.330	100.093	0.743	0.119
39	Forest	*Rothmannia macrophylla*	59.81	0.19	310.880	0.000863	1740.961	1693.331	NA	NA
37	Forest	*Koilodepas brevipes*	59.68	0.19	129.334	0.000849	51.087	36.697	0.423	0.484
28	Forest	*Roureopsis emarginata*	57.24	0.08	61.216	0.000807	65.030	226.331	0.471	0.017
23	Forest	*Willughbeia coriacea*	56.56	0.15	129.948	0.000779	51.719	41.222	0.242	0.382
34	Forest	*Croton argyratus*	59.33	0.21	270.694	0.000776	1779.553	1715.082	NA	NA
280	Forest	*Santiria tomentosa*	53.2	0.2	271.386	0.000739	1933.629	1846.286	NA	NA
49	Forest	*Strychnos ignatii*	62.74	0.09	166.430	0.000734	23.716	23.546	0.436	0.529
268	Forest	*Rinorea cf. sclerocarpa*	53.34	0.17	238.919	0.000734	24.848	26.393	0.294	0.442
2	Forest	*Tetracera scandens*	60.14	0.2	67.656	0.000715	88.972	45.414	0.398	0.525
270	Forest	*Rinorea cf. sclerocarpa*	56.07	0.18	101.890	0.000698	50.945	37.692	0.266	0.434
36	Forest	*Koilodepas brevipes*	54.41	0.17	115.852	0.000677	57.926	43.692	0.251	0.372
29	Forest	*Roureopsis emarginata*	54.95	0.03	85.784	0.000676	43.750	181.352	0.504	0.017
10	Forest	*Agelaea borneensis*	55.63	0.23	67.847	0.000659	102.762	73.245	0.732	0.241

19	Forest	*Ventilago malaccensis*	56.1	0.1	173.927	0.000655	30.959	28.474	0.311	0.473
27	Forest	*Roureopsis emarginata*	55.78	0.07	63.225	0.000655	66.387	218.599	0.572	0.018
18	Forest	*Ventilago malaccensis*	57.68	0.09	174.993	0.000649	42.873	32.396	0.337	0.512
14	Forest	*Agelaea macrophylla*	58.57	0.24	41.607	0.000638	107.175	102.633	0.643	0.126
50	Forest	*Strychnos ignatii*	72.06	0.1	149.266	0.000638	18.125	22.132	0.324	0.442
31	Forest	*Spatholobus ferrugineus*	26.97	0.17	209.963	0.000637	1883.511	1775.692	NA	NA
246	Forest	*Mallotus peltatus*	53.66	0.28	78.725	0.000637	454.929	388.631	NA	NA
17	Forest	*Ventilago malaccensis*	59.58	0.1	137.674	0.000635	39.788	32.399	0.308	0.473
16	Forest	*Agelaea macrophylla*	63.84	0.25	314.330	0.000634	1849.174	1811.398	NA	NA
30	Forest	*Spatholobus ferrugineus*	35.9	0.14	498.685	0.000617	1745.340	1727.496	NA	NA
22	Forest	*Willughbeia coriacea*	46.97	0.14	154.626	0.000613	39.687	40.820	0.185	0.295
283	Forest	*Alchornea tiliifolia*	48.18	0.23	532.801	0.000612	1752.425	1694.573	NA	NA
245	Forest	*Mallotus peltatus*	59.35	0.31	197.070	0.000612	1731.953	1684.566	NA	NA
35	Forest	*Koilodepas brevipes*	61.38	0.21	64.117	0.000608	72.363	46.004	0.276	0.425
51	Forest	*Santiria laevigata*	57.9	0.12	75.863	0.000599	2186.874	1980.055	NA	NA
48	Forest	*Strychnos ignatii*	65.15	0.09	171.977	0.00059	23.217	25.691	0.322	0.436
32	Forest	*Croton argyratus*	56.96	0.22	257.326	0.000585	1726.511	1687.286	NA	NA
4	Forest	*Aporosa subcaudata*	63.56	0.17	139.717	0.000579	32.414	29.710	0.303	0.457
244	Forest	*Mallotus peltatus*	57.55	0.27	42.132	0.000573	101.337	54.053	0.356	0.429
1	Forest	*Tetracera scandens*	56.06	0.22	54.730	0.000567	111.564	47.378	0.477	0.597
220	Forest	*Selaginella frondosa*	35.87	0.03	243.114	0.000561	19.449	59.556	0.475	0.081
5	Forest	*Aporosa subcaudata*	60.24	0.17	122.725	0.000537	35.415	31.426	0.297	0.441
269	Forest	*Rinorea cf. sclerocarpa*	57.38	0.18	207.619	0.00053	34.465	29.602	0.324	0.479
21	Forest	*Psychotria viridiflora*	57.27	0.19	486.270	0.000528	1856.906	1770.259	NA	NA
26	Forest	*Santiria laevigata*	60.24	0.1	53.717	0.00052	NA	2294.862	NA	NA
25	Forest	*Santiria laevigata*	61.6	0.11	112.577	0.0005	2033.401	1904.068	NA	NA
15	Forest	*Agelaea macrophylla*	63.24	0.24	40.183	0.0005	114.033	93.095	0.624	0.166
243	Forest	*Piper venosum*	47.8	0.17	241.825	0.00049	47.398	39.533	0.243	0.373
282	Forest	*Santiria tomentosa*	44.97	0.2	129.676	0.000485	1998.216	1891.258	NA	NA
20	Forest	*Psychotria viridiflora*	58.8	0.15	96.431	0.000476	72.217	45.448	0.286	0.437
9	Forest	*Agelaea borneensis*	57.76	0.23	40.714	0.000475	114.053	83.847	0.714	0.197
13	Forest	*Rothmannia macrophylla*	58.83	0.19	249.697	0.000474	1855.845	1735.643	NA	NA
38	Forest	*Psychotria viridiflora*	55.3	0.19	115.456	0.000466	99.449	54.769	0.299	0.416
24	Forest	*Willughbeia coriacea*	66.6	0.26	122.855	0.000459	40.016	31.365	0.377	0.514
241	Forest	*Piper venosum*	51.39	0.21	113.247	0.000457	104.453	54.771	0.290	0.435
33	Forest	*Croton argyratus*	53.55	0.21	80.970	0.000445	68.224	47.675	0.324	0.374
276	Forest	*Scindapsus hederaceus*	68.18	0.29	107.913	0.000437	37.230	42.218	0.216	0.247
285	Forest	*Alchornea tiliifolia*	47.22	0.21	408.809	0.000423	1763.690	1695.351	NA	NA

281	Forest	*Santiria tomentosa*	47.58	0.17	207.807	0.000421	2038.874	1894.199	NA	NA
12	Forest	*Kunstleria ridleyi*	42.49	0.13	315.777	0.00042	1835.813	1779.073	NA	NA
3	Forest	*Tetracera scandens*	51.42	0.2	80.237	0.000417	119.239	54.267	0.359	0.505
242	Forest	*Piper venosum*	50.98	0.18	245.519	0.000406	49.513	40.284	0.232	0.368
217	Forest	*Leptaspis urceolata*	55.54	0.12	569.345	0.000398	1683.235	1691.351	NA	NA
275	Forest	*Scindapsus hederaceus*	61.39	0.24	173.107	0.00039	19.907	28.305	0.263	0.309
6	Forest	*Aporosa subcaudata*	66.44	0.22	110.508	0.000386	38.402	31.869	0.328	0.476
274	Forest	*Scindapsus hederaceus*	68.42	0.26	147.300	0.000377	11.195	22.799	0.209	0.266
273	Forest	*Marantodes pumilum*	40.7	0.25	263.788	0.000359	1760.776	1709.172	NA	NA
272	Forest	*Marantodes pumilum*	42.74	0.24	344.418	0.000354	1721.044	1691.652	NA	NA
277	Forest	*Combretum nigrescens*	52.67	0.1	241.790	0.000348	22.003	23.346	0.324	0.495
271	Forest	*Marantodes pumilum*	41.66	0.25	390.302	0.000343	1727.660	1690.676	NA	NA
11	Forest	*Kunstleria ridleyi*	46.18	0.14	384.487	0.000336	1845.966	1801.917	NA	NA
222	Forest	*Selaginella frondosa*	42.77	0.03	237.811	0.00033	21.063	66.697	0.382	0.064
240	Forest	*Anadendrum microstachyum*	54.48	0.26	194.997	0.000319	60.774	60.684	0.215	0.209
284	Forest	*Alchornea tiliifolia*	44.4	0.2	483.743	0.000292	1738.301	1692.306	NA	NA
219	Forest	*Leptaspis urceolata*	47.27	0.28	710.070	0.000274	1678.946	1691.774	NA	NA
221	Forest	*Selaginella frondosa*	37.84	0.03	268.548	0.000228	58.006	127.617	0.826	0.050
233	Forest	*Anadendrum latifolium*	66.36	0.18	628.565	0.000194	1729.790	1699.542	NA	NA
8	Forest	*Agelaea borneensis*	56	0.17	94.932	0.000175	85.650	79.836	0.615	0.174
226	Forest	*Elettaria sp. 02*	58.74	0.18	408.266	0.000173	1757.552	1769.253	NA	NA
239	Forest	*Anadendrum microstachyum*	53.32	0.26	914.579	0.000136	1687.248	1673.068	NA	NA
227	Forest	*Elettaria sp. 02*	45.8	0.18	530.485	0.000125	1721.388	1749.765	NA	NA
228	Forest	*Elettaria sp. 02*	59.46	0.17	483.667	0.000122	1727.382	1756.066	NA	NA
234	Forest	*Anadendrum latifolium*	60.43	0.18	163.217	0.000114	47.877	42.921	0.328	0.306
238	Forest	*Anadendrum microstachyum*	57.85	0.25	662.517	9.74E-05	1690.086	1681.473	NA	NA
218	Forest	*Leptaspis urceolata*	50.68	0.24	154.429	7.75E-05	1666.926	1684.478	NA	NA
232	Forest	*Anadendrum latifolium*	65.98	0.2	62.621	1.59E-08	62.204	46.078	0.381	0.348
126	Jungle rubber	*Alocasia cf. wongii*	45.32	0.16	41.040	NA	2118.041	1936.166	NA	NA
125	Jungle rubber	*Alocasia cf. wongii*	50.88	0.06	164.241	NA	1978.499	1865.309	NA	NA
204	Jungle rubber	*Scaphochlamys sp. 01*	45.7	0.23	495.532	NA	1725.313	1735.839	NA	NA
167	Jungle rubber	*Globba leucantha*	42.25	0.09	1132.593	NA	1697.700	1722.842	NA	NA
166	Jungle rubber	*Globba leucantha*	44	0.08	1071.940	NA	1704.385	1713.153	NA	NA
168	Jungle rubber	*Globba leucantha*	41.37	0.09	1621.175	NA	1686.022	1697.002	NA	NA
203	Jungle rubber	*Scaphochlamys sp. 01*	53.74	0.19	44.452	NA	50.938	51.156	0.197	0.223
202	Jungle rubber	*Scaphochlamys sp. 01*	46.8	0.2	83.794	NA	42.212	50.161	0.159	0.213
123	Jungle rubber	*Ottochloa nodosa*	41.85	0.08	257.428	NA	11.263	35.099	0.098	0.115
121	Jungle rubber	*Ottochloa nodosa*	45.4	0.09	230.396	NA	7.200	30.050	0.077	0.102

122	Jungle rubber	*Ottochloa nodosa*	44.45	1.2	226.248	NA	7.353	27.362	0.125	0.120
68	Jungle rubber	*Globba pendula*	43.42	0.09	328.716	NA	9.314	21.166	0.234	0.258
69	Jungle rubber	*Globba pendula*	40.47	0.08	458.362	NA	6.548	17.542	0.232	0.267
67	Jungle rubber	*Globba pendula*	40.21	0.08	309.260	NA	4.252	13.983	0.258	0.275
74	Jungle rubber	*Nephrolepis biserrata*	48.34	0.17	52.098	NA	NA	NA	NA	NA
73	Jungle rubber	*Nephrolepis biserrata*	48.98	0.15	55.329	NA	NA	NA	NA	NA
75	Jungle rubber	*Nephrolepis biserrata*	48	0.16	47.873	NA	NA	NA	NA	NA
124	Jungle rubber	*Alocasia cf. wongii*	46.05	0.17	122.818	NA	NA	NA	NA	NA
210	Jungle rubber	*Fordia stipularis*	49.1	0.09	185.436	0.001467	2171.370	2069.496	NA	NA
53	Jungle rubber	*Phyllanthus oxyphyllus*	56.44	0.11	174.756	0.000845	12.058	17.189	0.318	0.485
81	Jungle rubber	*Alstonia angustifolia*	51.19	0.14	107.431	0.000831	85.676	54.169	0.242	0.368
78	Jungle rubber	*Streblus elongatus*	59.82	0.14	86.476	0.000827	94.361	48.263	0.329	0.501
164	Jungle rubber	*Spatholobus littoralis*	43.9	0.14	361.283	0.000738	1780.001	1745.153	NA	NA
77	Jungle rubber	*Streblus elongatus*	62.33	0.15	80.154	0.000733	103.387	52.298	0.307	0.467
79	Jungle rubber	*Alstonia angustifolia*	44.59	0.16	199.168	0.000717	68.286	52.623	0.232	0.310
187	Jungle rubber	*Phanera kockiana*	39.77	0.16	91.388	0.000702	46.608	35.758	0.514	0.450
171	Jungle rubber	*Selaginella plana*	31.94	0.03	416.522	0.00069	17.494	84.907	0.489	0.031
165	Jungle rubber	*Spatholobus littoralis*	43.35	0.13	455.303	0.000678	1734.812	1726.780	NA	NA
190	Jungle rubber	*Antidesma cuspidatum*	53.5	0.2	139.470	0.000677	59.693	40.941	0.362	0.446
56	Jungle rubber	*Spatholobus macropterus*	55.4	0.15	69.649	0.000676	83.249	77.733	0.901	0.167
54	Jungle rubber	*Phyllanthus oxyphyllus*	59.79	0.13	148.948	0.000652	17.543	19.048	0.410	0.604
119	Jungle rubber	*Clidemia hirta*	46.43	0.18	185.395	0.000636	41.482	32.151	0.464	0.499
110	Jungle rubber	*Tabernaemontana pauciflora*	49.01	0.11	264.069	0.000608	21.126	25.766	0.272	0.393
206	Jungle rubber	*Pternandra azurea*	63.93	0.19	136.072	0.000606	30.541	24.335	0.507	0.634
76	Jungle rubber	*Streblus elongatus*	60.23	0.15	90.960	0.000603	85.417	47.620	0.330	0.462
55	Jungle rubber	*Spatholobus macropterus*	53.72	0.15	59.712	0.000588	127.441	112.781	0.637	0.127
213	Jungle rubber	*Dicoelia sumatrana*	55.6	0.28	328.322	0.000578	1739.694	1690.458	NA	NA
163	Jungle rubber	*Spatholobus littoralis*	52.6	0.15	224.594	0.000574	1867.131	1777.727	NA	NA
189	Jungle rubber	*Phanera kockiana*	42.97	0.18	70.672	0.000572	48.807	36.564	0.534	0.440
57	Jungle rubber	*Spatholobus macropterus*	51.04	0.14	49.929	0.000562	99.263	94.413	0.812	0.137
80	Jungle rubber	*Alstonia angustifolia*	41.65	0.12	104.713	0.000555	54.429	44.231	0.252	0.353
188	Jungle rubber	*Phanera kockiana*	50.5	0.16	137.023	0.000541	73.444	47.968	0.511	0.409
184	Jungle rubber	*Garcinia parvifolia*	38.54	0.19	182.784	0.000534	20.655	23.934	0.304	0.445
186	Jungle rubber	*Garcinia parvifolia*	44.85	0.2	172.155	0.000533	16.010	20.403	0.342	0.476
64	Jungle rubber	*Byttneria curtisii*	51.31	0.2	187.576	0.000526	36.952	31.880	0.296	0.449
249	Jungle rubber	*Croton oblongus*	56.56	0.2	72.727	0.000523	50.327	39.389	0.364	0.409
173	Jungle rubber	*Breynia racemosa*	49.14	0.15	138.715	0.000507	7.768	12.218	0.483	0.653
211	Jungle rubber	*Dicoelia sumatrana*	54.3	0.24	160.364	0.000502	1771.330	1704.719	NA	NA

158	Jungle rubber	*Tetracera indica*	47.44	0.12	188.035	0.000496	23.128	25.394	0.325	0.448
191	Jungle rubber	*Antidesma cuspidatum*	44.66	0.15	139.639	0.000495	50.869	35.139	0.382	0.506
52	Jungle rubber	*Phyllanthus oxyphyllus*	44.62	0.13	141.977	0.000493	10.648	14.620	0.438	0.623
71	Jungle rubber	*Stenochlaena palustris*	40.24	0.21	77.699	0.000487	NA	NA	NA	NA
107	Jungle rubber	*Spatholobus gyrocarpus*	32.18	0.15	1203.958	0.00048	1818.058	1807.238	NA	NA
185	Jungle rubber	*Garcinia parvifolia*	35.74	0.19	178.417	0.000475	17.306	21.693	0.322	0.458
111	Jungle rubber	*Tabernaemontana pauciflora*	42.54	0.09	271.605	0.000468	16.568	19.692	0.393	0.517
66	Jungle rubber	*Byttneria curtisii*	46.27	0.17	190.094	0.000465	33.131	30.050	0.291	0.437
159	Jungle rubber	*Tetracera indica*	49.32	0.06	186.104	0.000464	18.610	24.200	0.298	0.398
114	Jungle rubber	*Clibadium surinamense*	45.34	0.17	296.245	0.000455	46.214	34.847	0.408	0.472
157	Jungle rubber	*Tetracera indica*	50.76	0.11	168.540	0.000455	19.382	23.119	0.328	0.455
109	Jungle rubber	*Tabernaemontana pauciflora*	52.57	0.13	256.023	0.00045	16.898	21.645	0.339	0.450
169	Jungle rubber	*Selaginella plana*	31.62	0.04	298.464	0.000448	29.846	150.646	0.652	0.018
195	Jungle rubber	*Gnetum cuspidatum*	41.15	0.26	69.239	0.000445	55.911	47.648	0.179	0.309
172	Jungle rubber	*Breynia racemosa*	57.04	0.17	124.727	0.000443	6.361	10.879	0.504	0.655
174	Jungle rubber	*Breynia racemosa*	55.98	0.17	120.566	0.000442	8.199	12.555	0.476	0.650
205	Jungle rubber	*Pternandra azurea*	52.46	0.18	149.313	0.000433	33.147	26.379	0.397	0.593
106	Jungle rubber	*Spatholobus gyrocarpus*	33.24	0.18	354.127	0.000428	1813.054	1753.700	NA	NA
194	Jungle rubber	*Gnetum cuspidatum*	44.74	0.23	143.539	0.000428	28.528	38.537	0.143	0.238
118	Jungle rubber	*Clidemia hirta*	44.4	0.16	239.532	0.000425	45.511	33.659	0.468	0.503
192	Jungle rubber	*Antidesma cuspidatum*	49.73	0.2	125.853	0.000424	59.510	40.137	0.325	0.460
212	Jungle rubber	*Dicoelia sumatrana*	51.86	0.24	337.694	0.000419	1709.261	1679.523	NA	NA
65	Jungle rubber	*Byttneria curtisii*	49.73	0.19	187.569	0.000407	34.325	30.797	0.304	0.448
247	Jungle rubber	*Croton oblongus*	49.99	0.2	82.249	0.000407	65.259	47.065	0.321	0.364
72	Jungle rubber	*Stenochlaena palustris*	43.68	0.18	83.151	0.000406	NA	2438.815	NA	NA
248	Jungle rubber	*Croton oblongus*	57.38	0.21	73.493	0.000381	58.353	42.564	0.329	0.400
193	Jungle rubber	*Gnetum cuspidatum*	46.28	0.23	130.867	0.000381	29.445	35.779	0.152	0.262
115	Jungle rubber	*Tabernaemontana macrocarpa*	53.06	0.19	476.844	0.000351	1850.404	1716.309	NA	NA
209	Jungle rubber	*Fordia stipularis*	43.4	0.1	282.317	0.000348	1993.041	1990.665	NA	NA
208	Jungle rubber	*Fordia stipularis*	42.48	0.1	252.872	0.000335	2007.598	1937.842	NA	NA
113	Jungle rubber	*Clibadium surinamense*	51.07	0.2	156.614	0.000322	46.458	35.793	0.383	0.459
108	Jungle rubber	*Spatholobus gyrocarpus*	34.84	0.14	376.997	0.000316	1854.570	1753.494	NA	NA
70	Jungle rubber	*Stenochlaena palustris*	41.72	0.2	109.850	0.000312	NA	2430.224	NA	NA
120	Jungle rubber	*Clidemia hirta*	42.02	0.2	205.380	0.000305	48.675	35.085	0.478	0.493
116	Jungle rubber	*Tabernaemontana macrocarpa*	48.52	0.17	478.939	0.000298	1850.193	1718.781	NA	NA
112	Jungle rubber	*Clibadium surinamense*	43.5	0.22	132.882	0.000295	59.461	39.680	0.430	0.466
170	Jungle rubber	*Selaginella plana*	33.02	0.03	601.640	0.000267	25.269	80.821	0.544	0.048

161	Jungle rubber	*Steinchisma laxum*	45.34	0.09	180.963	0.000222	7.962	34.787	0.061	0.081
250	Jungle rubber	*Amydrium medium*	42.48	0.21	234.914	0.000214	1888.038	1807.178	NA	NA
117	Jungle rubber	*Tabernaemontana macrocarpa*	54.57	0.2	324.027	0.000172	1834.046	1713.993	NA	NA
252	Jungle rubber	*Amydrium medium*	53.14	0.21	99.716	0.000138	2135.994	1982.130	NA	NA
207	Jungle rubber	*Pternandra azurea*	60.43	0.18	156.680	0.000136	45.241	29.711	0.490	0.641
251	Jungle rubber	*Amydrium medium*	44.14	0.23	225.928	0.000131	1961.391	1887.588	NA	NA
160	Jungle rubber	*Steinchisma laxum*	44.03	0.1	173.543	9.47E-05	10.123	45.617	0.047	0.061
162	Jungle rubber	*Steinchisma laxum*	51.2	0.04	225.557	5.62E-05	9.022	44.472	0.049	0.057
261	Oil palm	*Christella dentata*	29.04	0.14	308.626	NA	1848.091	2152.103	NA	NA
260	Oil palm	*Christella dentata*	31.84	0.12	688.522	NA	1748.950	1977.915	NA	NA
259	Oil palm	*Christella dentata*	25.44	0.11	135.659	NA	49.971	126.662	0.475	0.045
143	Oil palm	*Vittaria ensiformis*	56.26	0.37	44.236	NA	10.836	46.679	0.071	0.067
142	Oil palm	*Vittaria ensiformis*	57.01	0.32	112.104	NA	10.370	43.129	0.049	0.075
90	Oil palm	*Centotheca lappacea*	57.53	0.07	101.783	NA	17.578	38.810	0.137	0.151
88	Oil palm	*Centotheca lappacea*	56.39	0.09	107.304	NA	18.885	37.726	0.153	0.167
144	Oil palm	*Vittaria ensiformis*	54.75	0.36	58.348	NA	11.780	34.731	0.076	0.122
89	Oil palm	*Centotheca lappacea*	62.27	0.07	105.645	NA	15.361	33.537	0.187	0.178
146	Oil palm	*Cyrtococcum patens*	47.7	0.05	251.724	NA	5.754	22.611	0.125	0.150
145	Oil palm	*Cyrtococcum patens*	39.28	0.06	271.545	NA	5.884	21.871	0.136	0.153
147	Oil palm	*Cyrtococcum patens*	45.7	0.06	317.684	NA	6.354	21.539	0.216	0.169
215	Oil palm	*Legazpia polygonoides*	53.09	0.1	283.892	NA	2.555	7.445	0.854	0.582
214	Oil palm	*Legazpia polygonoides*	48.24	0.09	332.954	NA	2.081	6.818	0.797	0.560
139	Oil palm	*Spermacoce exilis*	37.88	0.07	NA	NA	1.838	6.226	0.433	0.599
216	Oil palm	*Legazpia polygonoides*	47.2	0.1	300.644	NA	1.503	6.106	0.611	0.508
141	Oil palm	*Spermacoce exilis*	37.77	0.05	NA	NA	NA	4.353	0.439	0.573
140	Oil palm	*Spermacoce exilis*	42.95	0.04	NA	NA	NA	3.833	0.405	0.577
T0280	Oil palm	*Poikilospermum suaveolens*	66.29	0.28	NA	NA	NA	NA	NA	NA
58	Oil palm	*Rolandra fruticosa*	64.22	0.16	144.527	0.000619	9.250	15.986	0.309	0.440
155	Oil palm	*Ruellia repens*	44.5	0.09	281.481	0.000615	6.193	15.689	0.243	0.316
201	Oil palm	*Lygodium circinatum*	38.49	0.17	42.012	0.00057	73.942	141.129	NA	0.049
59	Oil palm	*Rolandra fruticosa*	60.61	0.18	147.617	0.000536	17.419	20.641	0.384	0.503
60	Oil palm	*Rolandra fruticosa*	70.82	0.18	154.152	0.00048	9.557	16.308	0.323	0.450
63	Oil palm	*Melastoma malabathricum*	51.72	0.19	164.956	0.000459	14.021	18.575	0.350	0.505
62	Oil palm	*Melastoma malabathricum*	52.3	0.17	180.811	0.000455	24.229	25.880	0.302	0.449
61	Oil palm	*Melastoma malabathricum*	48.04	0.15	184.597	0.000426	20.860	24.729	0.280	0.422
156	Oil palm	*Ruellia repens*	31.16	0.1	417.326	0.000424	7.929	18.298	0.222	0.300
153	Oil palm	*Stachytarpheta indica*	42.44	0.11	310.143	0.000383	15.197	19.922	0.472	0.476
200	Oil palm	*Lygodium circinatum*	34.83	0.14	39.958	0.000359	49.851	124.818	NA	0.040

152	Oil palm	*Stachytarpheta indica*	41.56	0.11	291.705	0.000337	27.420	28.170	0.432	0.430
199	Oil palm	*Lygodium circinatum*	38.28	0.14	41.354	0.000322	62.859	143.371	NA	0.036
154	Oil palm	*Ruellia repens*	43.85	0.05	271.177	0.000318	4.881	14.965	0.182	0.271
151	Oil palm	*Stachytarpheta indica*	47.63	0.11	244.916	0.000317	23.228	23.822	NA	0.452
87	Oil palm	*Spermacoce laevis*	46.65	0.15	417.758	0.000277	18.103	21.872	0.444	0.483
86	Oil palm	*Spermacoce laevis*	41.75	0.15	412.764	0.000273	11.695	16.531	0.484	0.538
257	Oil palm	*Scleria sumatrensis*	75.42	0.11	NA	0.000267	1632.080	1691.747	NA	NA
258	Oil palm	*Scleria sumatrensis*	76.56	0.13	49.786	0.000229	10.977	44.653	0.061	0.071
84	Oil palm	*Ageratum conyzoides*	37.78	0.12	432.165	0.000215	22.329	28.486	0.444	0.349
256	Oil palm	*Scleria sumatrensis*	82.44	0.12	NA	0.000198	1634.447	1686.593	NA	NA
82	Oil palm	*Ageratum conyzoides*	40.67	1.31	333.089	0.000193	17.321	21.447	0.557	0.460
85	Oil palm	*Spermacoce laevis*	41.68	0.14	460.153	0.000177	13.805	17.758	0.492	0.548
83	Oil palm	*Ageratum conyzoides*	40.63	0.09	447.185	0.000162	9.503	15.599	0.476	0.467
T0277	Oil palm	*Leea indica*	57.68	0.24	38.222	NA	1992.724	1929.623	NA	NA
T0276	Oil palm	*Leea indica*	63.05	0.25	29.215	NA	2003.855	1909.802	NA	NA
T0278	Oil palm	*Leea indica*	52.38	0.26	52.570	NA	1901.720	1833.767	NA	NA
T0279	Oil palm	*Poikilospermum suaveolens*	67.63	0.28	44.227	NA	2087.493	1727.771	NA	NA
T0281	Oil palm	*Poikilospermum suaveolens*	53.99	0.27	19.464	NA	137.773	67.704	0.396	0.382
T0156	Oil palm	*Solanum jamaicense*	43.28	0.35	93.132	NA	71.994	42.750	0.499	0.490
T0182	Oil palm	*Rhynchospora corymbosa*	55.08	0.44	41.231	NA	8.823	40.950	0.034	0.081
T0157	Oil palm	*Solanum jamaicense*	41	0.35	153.888	NA	74.419	40.400	0.494	0.557
T0172	Oil palm	*Uncaria lanosa*	44.99	0.16	60.920	NA	74.077	38.637	0.463	0.621
T0170	Oil palm	*Uncaria lanosa*	37.69	0.18	67.567	NA	63.995	36.541	0.460	0.601
T0095	Oil palm	*Urena Lobata*	30.42	0.3	68.720	NA	43.825	36.055	0.723	0.430
T0171	Oil palm	*Uncaria lanosa*	40.15	0.2	93.880	NA	55.585	35.180	0.453	0.563
T0096	Oil palm	*Urena Lobata*	47.77	0.12	228.189	NA	35.280	35.070	0.727	0.331
T0097	Oil palm	*Urena Lobata*	34.82	0.29	117.156	NA	33.038	30.594	0.694	0.444
T0208	Oil palm	*Rhodamnia cinerea*	50.39	0.16	110.941	NA	34.709	29.728	0.351	0.493
T0184	Oil palm	*Rhynchospora corymbosa*	67.07	0.48	44.306	NA	6.546	29.529	0.045	0.101
T0127	Oil palm	*Allamanda cathartica*	70.23	0.35	106.818	NA	24.806	28.028	0.257	0.396
T0101	Oil palm	*Lantana camara*	36.68	0.17	198.470	NA	26.595	27.861	0.599	0.433
T0183	Oil palm	*Rhynchospora corymbosa*	66.27	0.47	15.900	NA	5.710	27.709	0.046	0.108
T0126	Oil palm	*Allamanda cathartica*	70.82	0.31	113.377	NA	25.056	27.529	0.269	0.409
T0102	Oil palm	*Lantana camara*	41.54	0.18	163.840	NA	27.198	27.306	0.639	0.456
T0207	Oil palm	*Rhodamnia cinerea*	49.77	0.17	112.508	NA	23.627	27.077	0.293	0.403
T0129	Oil palm	*Melastoma malabathricum*	57.13	0.25	115.836	NA	23.283	25.239	0.311	0.459
T0125	Oil palm	*Allamanda cathartica*	76.7	0.34	106.525	NA	19.601	24.969	0.256	0.394
T0179	Oil palm	*Tetracera indica*	40.47	0.11	191.880	NA	20.531	24.778	0.302	0.419

T0103	Oil palm	*Lantana camara*	34.75	0.21	152.252	NA	23.447	24.423	0.662	0.493
T0169	Oil palm	*Bridelia tomentosa*	44.49	0.09	287.274	NA	29.589	24.274	0.472	0.627
T0167	Oil palm	*Bridelia tomentosa*	43.54	0.11	106.162	NA	29.794	24.224	0.457	0.636
T0206	Oil palm	*Rhodamnia cinerea*	49.14	0.2	110.640	NA	23.677	23.588	0.409	0.530
T0168	Oil palm	*Bridelia tomentosa*	39.62	0.11	264.183	NA	28.268	22.083	0.596	0.716
T0181	Oil palm	*Tetracera indica*	44.14	0.12	186.761	NA	17.742	21.806	0.356	0.460
T0180	Oil palm	*Tetracera indica*	40.41	0.12	188.752	NA	15.855	21.595	0.323	0.430
T0130	Oil palm	*Melastoma malabathricum*	58.33	0.27	117.143	NA	17.923	21.380	0.325	0.487
T0128	Oil palm	*Melastoma malabathricum*	59.7	0.28	118.795	NA	16.631	21.241	0.298	0.461
T0189	Oil palm	*Sida rhombifolia*	57.7	0.09	149.856	NA	5.695	12.081	0.408	0.472
T0188	Oil palm	*Sida rhombifolia*	71.37	0.08	138.346	NA	5.257	12.063	0.386	0.455
T0190	Oil palm	*Sida rhombifolia*	71.33	0.07	137.578	NA	3.990	11.035	0.324	0.417
T0270	Oil palm	*Lycopodiella cernua*	40	0.15	NA	NA	NA	NA	NA	NA
T0271	Oil palm	*Lycopodiella cernua*	40	0.1	NA	NA	NA	NA	NA	NA
T0272	Oil palm	*Lycopodiella cernua*	40	0.11	NA	NA	NA	NA	NA	NA
T0217	Oil palm	*Mapania tenuiscapa*	67.15	0.1	NA	NA	NA	NA	NA	NA
T0104	Oil palm	*Rolandra fructicosa*	66.93	0.16	NA	NA	NA	NA	NA	NA
T0216	Oil palm	*Mapania tenuiscapa*	65.8	0.14	NA	NA	NA	NA	NA	NA
T0106	Oil palm	*Rolandra fructicosa*	65.2	0.16	NA	NA	NA	NA	NA	NA
T0105	Oil palm	*Rolandra fructicosa*	63.69	0.17	NA	NA	NA	NA	NA	NA
T0117	Oil palm	*Vittaria ensiformis*	63.09	0.69	NA	NA	NA	NA	NA	NA
T0215	Oil palm	*Mapania tenuiscapa*	62.76	0.17	NA	NA	NA	NA	NA	NA
T0149	Oil palm	*Cuphea carthagenensis*	62.21	0.07	NA	NA	NA	NA	NA	NA
T0221	Oil palm	*Diodella sarmentosa*	61.75	0.08	NA	NA	NA	NA	NA	NA
T0161	Oil palm	*Cyrtococcum oxyphyllum*	61.56	0.07	NA	NA	NA	NA	NA	NA
T0213	Oil palm	*Paspalum dilatatum*	59.13	0.11	NA	NA	NA	NA	NA	NA
T0195	Oil palm	*Rhynchospora colorata*	58.94	0.14	NA	NA	NA	NA	NA	NA
T0116	Oil palm	*Vittaria ensiformis*	58.5	0.47	NA	NA	NA	NA	NA	NA
T0118	Oil palm	*Vittaria ensiformis*	58.26	0.63	NA	NA	NA	NA	NA	NA
T0147	Oil palm	*Dianella ensifolia*	58.09	0.32	NA	NA	NA	NA	NA	NA
T0124	Oil palm	*Fabaceae sp.91*	57.9	0.06	NA	NA	NA	NA	NA	NA
T0110	Oil palm	*Davallia denticulata*	57	0.19	NA	NA	NA	NA	NA	NA
T0162	Oil palm	*Cyrtococcum oxyphyllum*	56.86	0.07	NA	NA	NA	NA	NA	NA
T0148	Oil palm	*Dianella ensifolia*	56.01	0.31	NA	NA	NA	NA	NA	NA
T0163	Oil palm	*Cyrtococcum oxyphyllum*	55.98	0.07	NA	NA	NA	NA	NA	NA
T0196	Oil palm	*Rhynchospora colorata*	55.98	0.12	NA	NA	NA	NA	NA	NA
T0150	Oil palm	*Cuphea carthagenensis*	55.12	0.14	NA	NA	NA	NA	NA	NA
T0159	Oil palm	*Cyrtococcum patens*	55.05	0.12	NA	NA	NA	NA	NA	NA

T0123	Oil palm	*Fabaceae sp.91*	54.89	0.1	NA	NA	NA	NA	NA	NA
T0139	Oil palm	*Scleria ciliaris*	54.12	0.16	NA	NA	NA	NA	NA	NA
T0134	Oil palm	*Stachytarpheta jamaicensis*	53.72	0.2	NA	NA	NA	NA	NA	NA
T0151	Oil palm	*Cuphea carthagenensis*	53.5	0.16	NA	NA	NA	NA	NA	NA
T0122	Oil palm	*Fabaceae sp.91*	53.25	0.1	NA	NA	NA	NA	NA	NA
T0158	Oil palm	*Cyrtococcum patens*	52.75	0.12	NA	NA	NA	NA	NA	NA
T0212	Oil palm	*Paspalum dilatatum*	52.4	0.09	NA	NA	NA	NA	NA	NA
T0094	Oil palm	*Lindsaea ensifolia*	52.3	0.16	NA	NA	NA	NA	NA	NA
T0187	Oil palm	*Pennisetum polystachion*	52.09	0.21	NA	NA	NA	NA	NA	NA
T0186	Oil palm	*Pennisetum polystachion*	51.8	0.23	NA	NA	NA	NA	NA	NA
T0214	Oil palm	*Paspalum dilatatum*	51.43	0.08	NA	NA	NA	NA	NA	NA
T0146	Oil palm	*Dianella ensifolia*	51.14	0.24	NA	NA	NA	NA	NA	NA
T0160	Oil palm	*Cyrtococcum patens*	51.1	0.09	NA	NA	NA	NA	NA	NA
T0089	Oil palm	*Nephrolepis biserrata*	50.56	0.27	NA	NA	NA	NA	NA	NA
T0194	Oil palm	*Rhynchospora colorata*	49.4	0.11	NA	NA	NA	NA	NA	NA
T0090	Oil palm	*Nephrolepis biserrata*	49.3	0.22	NA	NA	NA	NA	NA	NA
T0135	Oil palm	*Stachytarpheta jamaicensis*	48.83	0.22	NA	NA	NA	NA	NA	NA
T0185	Oil palm	*Pennisetum polystachion*	48.1	0.22	NA	NA	NA	NA	NA	NA
T0093	Oil palm	*Lindsaea ensifolia*	47.84	0.13	NA	NA	NA	NA	NA	NA
T0112	Oil palm	*Davallia denticulata*	47.75	0.18	NA	NA	NA	NA	NA	NA
T0142	Oil palm	*Polygala paniculata*	47.55	0.14	NA	NA	NA	NA	NA	NA
T0193	Oil palm	*Axonopus compressus*	46.98	0.03	NA	NA	NA	NA	NA	NA
T0092	Oil palm	*Lindsaea ensifolia*	46.48	0.11	NA	NA	NA	NA	NA	NA
T0136	Oil palm	*Stachytarpheta jamaicensis*	46.41	0.18	NA	NA	NA	NA	NA	NA
T0209	Oil palm	*Paspalum conjugatum*	45.84	0.14	NA	NA	NA	NA	NA	NA
T0205	Oil palm	*Vitex pinnata*	45.31	0.11	NA	NA	NA	NA	NA	NA
T0138	Oil palm	*Scleria ciliaris*	45.14	0.2	NA	NA	NA	NA	NA	NA
T0200	Oil palm	*Ludwigia octovalvis*	45.07	0.11	NA	NA	NA	NA	NA	NA
T0114	Oil palm	*Asplenium nidus*	44.66	0.49	NA	NA	NA	NA	NA	NA
T0197	Oil palm	*Andrographis paniculata*	44.42	0.15	NA	NA	NA	NA	NA	NA
T0204	Oil palm	*Vitex pinnata*	44.31	0.12	NA	NA	NA	NA	NA	NA
T0107	Oil palm	*Chromolaena Odorata*	43.49	0.16	NA	NA	NA	NA	NA	NA
T0202	Oil palm	*Ludwigia octovalvis*	43.4	0.13	NA	NA	NA	NA	NA	NA
T0220	Oil palm	*Synedrella nodiflora*	43.39	0.11	NA	NA	NA	NA	NA	NA
T0137	Oil palm	*Scleria ciliaris*	43.03	0.23	NA	NA	NA	NA	NA	NA
T0201	Oil palm	*Ludwigia octovalvis*	42.93	0.12	NA	NA	NA	NA	NA	NA
T0091	Oil palm	*Nephrolepis biserrata*	42.8	0.22	NA	NA	NA	NA	NA	NA
T0119	Oil palm	*Goniophlebium percussum*	42.53	0.21	NA	NA	NA	NA	NA	NA

T0141	Oil palm	*Polygala paniculata*	42.51	0.14	NA	NA	NA	NA	NA	NA
T0144	Oil palm	*Croton hirtus*	42.43	0.12	NA	NA	NA	NA	NA	NA
T0111	Oil palm	*Davallia denticulata*	42.25	0.16	NA	NA	NA	NA	NA	NA
T0165	Oil palm	*Cyrtococcum oxyphyllum*	42.21	0.06	NA	NA	NA	NA	NA	NA
T0143	Oil palm	*Croton hirtus*	42.19	0.11	NA	NA	NA	NA	NA	NA
T0108	Oil palm	*Chromolaena Odorata*	42.17	0.17	NA	NA	NA	NA	NA	NA
T0120	Oil palm	*Goniophlebium percussum*	42.13	0.19	NA	NA	NA	NA	NA	NA
T0121	Oil palm	*Goniophlebium percussum*	42.07	0.19	NA	NA	NA	NA	NA	NA
T0210	Oil palm	*Paspalum conjugatum*	41.93	0.14	NA	NA	NA	NA	NA	NA
T0100	Oil palm	*Passiflora foetida*	41.78	0.16	NA	NA	NA	NA	NA	NA
T0164	Oil palm	*Cyrtococcum oxyphyllum*	41.59	0.07	NA	NA	NA	NA	NA	NA
T0145	Oil palm	*Croton hirtus*	41.3	0.1	NA	NA	NA	NA	NA	NA
T0203	Oil palm	*Vitex pinnata*	41.08	0.11	NA	NA	NA	NA	NA	NA
T0153	Oil palm	*Mikania micrantha*	40.51	0.17	NA	NA	NA	NA	NA	NA
T0191	Oil palm	*Axonopus compressus*	40.5	0.04	NA	NA	NA	NA	NA	NA
T0198	Oil palm	*Andrographis paniculata*	40.48	0.15	NA	NA	NA	NA	NA	NA
T0132	Oil palm	*Sphagneticola trilobata*	40.36	0.29	NA	NA	NA	NA	NA	NA
T0113	Oil palm	*Asplenium nidus*	40.18	0.51	NA	NA	NA	NA	NA	NA
T0218	Oil palm	*Synedrella nodiflora*	39.27	0.12	NA	NA	NA	NA	NA	NA
T0219	Oil palm	*Synedrella nodiflora*	39.16	0.1	NA	NA	NA	NA	NA	NA
T0154	Oil palm	*Mikania micrantha*	39.03	0.2	NA	NA	NA	NA	NA	NA
T0166	Oil palm	*Cyrtococcum oxyphyllum*	38.89	0.05	NA	NA	NA	NA	NA	NA
T0131	Oil palm	*Sphagneticola trilobata*	38.2	0.25	NA	NA	NA	NA	NA	NA
T0275	Oil palm	*Asplenium glaucophyllum*	37.88	0.14	NA	NA	NA	NA	NA	NA
T0192	Oil palm	*Axonopus compressus*	37.68	0.03	NA	NA	NA	NA	NA	NA
T0140	Oil palm	*Polygala paniculata*	36.68	0.11	NA	NA	NA	NA	NA	NA
T0133	Oil palm	*Sphagneticola trilobata*	36.59	0.28	NA	NA	NA	NA	NA	NA
T0109	Oil palm	*Chromolaena Odorata*	36.25	0.17	NA	NA	NA	NA	NA	NA
T0099	Oil palm	*Passiflora foetida*	35.91	0.13	NA	NA	NA	NA	NA	NA
T0155	Oil palm	*Solanum jamaicense*	35.78	0.37	NA	NA	NA	NA	NA	NA
T0199	Oil palm	*Andrographis paniculata*	35.63	0.17	NA	NA	NA	NA	NA	NA
T0098	Oil palm	*Passiflora foetida*	35.28	0.15	NA	NA	NA	NA	NA	NA
T0176	Oil palm	*Lygodium circinatum*	35.15	0.21	NA	NA	NA	NA	NA	NA
T0211	Oil palm	*Paspalum conjugatum*	34.24	0.15	NA	NA	NA	NA	NA	NA
T0177	Oil palm	*Lygodium circinatum*	33.5	0.18	NA	NA	NA	NA	NA	NA
T0115	Oil palm	*Asplenium nidus*	32.76	0.47	NA	NA	NA	NA	NA	NA
T0273	Oil palm	*Asplenium glaucophyllum*	32.5	0.11	NA	NA	NA	NA	NA	NA
T0152	Oil palm	*Mikania micrantha*	31.28	0.21	NA	NA	NA	NA	NA	NA

T0178	Oil palm	*Lygodium circinatum*	30.9	0.16	NA	NA	NA	NA	NA	NA
T0274	Oil palm	*Asplenium glaucophyllum*	30.45	0.12	NA	NA	NA	NA	NA	NA
T0173	Oil palm	*Lygodium salicifolium*	26.99	0.12	NA	NA	NA	NA	NA	NA
T0174	Oil palm	*Lygodium salicifolium*	24.39	0.1	NA	NA	NA	NA	NA	NA
T0175	Oil palm	*Lygodium salicifolium*	23.6	0.22	NA	NA	NA	NA	NA	NA
105	Rubber	*Lindsaea ensifolia*	67.82	0.25	173.291	NA	2128.017	2279.972	NA	NA
104	Rubber	*Lindsaea ensifolia*	66.82	0.16	229.188	NA	1782.409	1986.427	NA	NA
182	Rubber	*Molineria latifolia*	56.84	0.2	204.695	NA	1809.490	1832.242	NA	NA
183	Rubber	*Molineria latifolia*	36.54	0.25	331.752	NA	1802.324	1771.896	NA	NA
181	Rubber	*Molineria latifolia*	48.18	0.16	423.849	NA	1736.898	1739.954	NA	NA
197	Rubber	*Paspalum dilatatum*	41.87	0.09	NA	NA	1640.439	1694.203	NA	NA
198	Rubber	*Paspalum dilatatum*	38.18	0.1	NA	NA	1642.784	1693.188	NA	NA
196	Rubber	*Paspalum dilatatum*	37.83	0.12	NA	NA	1639.865	1687.330	NA	NA
138	Rubber	*Axonopus compressus*	63.78	0.06	NA	NA	1631.042	1661.779	NA	NA
137	Rubber	*Axonopus compressus*	65.67	0.06	NA	NA	1626.476	1651.835	NA	NA
103	Rubber	*Lindsaea ensifolia*	61.8	0.17	20.298	NA	44.569	120.437	0.342	0.041
97	Rubber	*Paspalum conjugatum*	54.83	0.09	294.615	NA	17.256	54.015	0.051	0.074
99	Rubber	*Paspalum conjugatum*	46.28	0.07	295.085	NA	15.246	40.515	0.079	0.120
136	Rubber	*Axonopus compressus*	60.66	0.05	175.719	NA	9.665	37.465	0.060	0.092
98	Rubber	*Paspalum conjugatum*	44.88	0.08	350.158	NA	9.804	33.418	0.072	0.112
94	Rubber	*Lindernia diffusa*	41.68	0.1	332.974	NA	2.664	7.711	0.753	0.577
96	Rubber	*Lindernia diffusa*	45.15	0.14	281.037	NA	2.810	7.424	0.740	0.630
95	Rubber	*Lindernia diffusa*	42.77	0.13	309.835	NA	2.066	6.758	0.733	0.573
101	Rubber	*Phyllanthus urinaria*	40	0.01	NA	NA	NA	3.015	0.313	0.581
100	Rubber	*Phyllanthus urinaria*	40	0.01	NA	NA	NA	2.722	0.310	0.568
102	Rubber	*Phyllanthus urinaria*	40	0.01	NA	NA	NA	2.382	0.353	0.605
266	Rubber	*Blechnum orientale*	59.86	0.25	42.405	NA	NA	NA	NA	NA
265	Rubber	*Blechnum orientale*	52.68	0.33	47.669	NA	NA	NA	NA	NA
267	Rubber	*Blechnum orientale*	63.42	0.26	37.105	NA	NA	NA	NA	NA
130	Rubber	*Dicranopteris linearis*	29.6	0.09	138.526	0.000847	2329.372	NA	NA	NA
175	Rubber	*Syzygium palembanicum*	47.51	0.2	43.703	0.000719	40.107	32.633	0.422	0.489
132	Rubber	*Dicranopteris linearis*	36.59	0.13	83.428	0.00066	NA	NA	NA	NA
178	Rubber	*Cynanchum sp. 02*	50.71	0.29	82.088	0.000659	28.567	25.245	0.459	0.559
253	Rubber	*Diodella sarmentosa*	53.01	0.12	146.502	0.000645	2.784	9.781	0.247	0.354
131	Rubber	*Dicranopteris linearis*	31.9	0.1	115.352	0.000625	2295.125	NA	NA	NA
177	Rubber	*Syzygium palembanicum*	45.7	0.25	38.128	0.0006	39.730	34.914	0.255	0.401
148	Rubber	*Asystasia gangetica*	36.59	0.12	444.831	0.000522	23.131	26.891	0.400	0.406
255	Rubber	*Diodella sarmentosa*	56.09	0.12	178.985	0.000502	2.685	9.445	0.256	0.375

129	Rubber	*Mussaenda frondosa*	63.43	0.22	89.103	0.000494	61.681	38.839	0.410	0.484
127	Rubber	*Mussaenda frondosa*	72.31	0.27	68.721	0.000479	100.394	51.112	0.449	0.478
176	Rubber	*Syzygium palembanicum*	46.07	0.27	34.717	0.000452	39.577	31.912	0.296	0.485
254	Rubber	*Diodella sarmentosa*	52.63	0.14	165.917	0.000451	3.152	10.262	0.265	0.377
264	Rubber	*Cyrtococcum oxyphyllum*	55.14	0.09	278.491	0.000445	2.785	12.781	0.143	0.213
180	Rubber	*Cynanchum sp. 02*	55.84	0.3	148.342	0.000444	24.922	23.198	0.467	0.570
149	Rubber	*Asystasia gangetica*	35.98	0.14	427.599	0.000414	27.794	31.468	0.371	0.350
128	Rubber	*Mussaenda frondosa*	60.95	0.21	99.193	0.000389	57.307	39.293	0.404	0.459
150	Rubber	*Asystasia gangetica*	36.95	0.14	484.964	0.000354	26.673	28.694	0.416	0.409
91	Rubber	*Croton hirtus*	46.03	0.1	444.476	0.000336	16.446	23.027	0.542	0.390
179	Rubber	*Cynanchum sp. 02*	55.61	0.3	160.994	0.00033	26.363	24.945	0.415	0.522
92	Rubber	*Croton hirtus*	41.75	0.1	421.197	0.000262	19.375	25.373	0.559	0.385
263	Rubber	*Cyrtococcum oxyphyllum*	59.67	0.09	311.315	0.000237	4.358	17.417	0.117	0.181
135	Rubber	*Scleria ciliaris*	76.05	0.13	NA	0.000212	1631.274	1679.133	NA	NA
134	Rubber	*Scleria ciliaris*	61.67	0.12	NA	0.000184	1635.841	1685.173	NA	NA
262	Rubber	*Cyrtococcum oxyphyllum*	58	0.09	318.127	0.000173	4.454	17.569	0.131	0.184
133	Rubber	*Scleria ciliaris*	73.49	0.1	NA	0.000148	1630.258	1678.300	NA	NA
93	Rubber	*Croton hirtus*	50.92	0.03	314.753	2.82E-07	12.066	20.722	0.552	0.348
T0015	Rubber	*Millettia sericea*	50.54	0.14	107.579	NA	2125.759	1892.104	NA	NA
T0013	Rubber	*Millettia sericea*	47.65	0.16	144.610	NA	2054.907	1841.266	NA	NA
T0029	Rubber	*Phyllanthus oxyphyllus*	51.4	0.07	417.801	NA	1686.743	1749.060	NA	NA
T0016	Rubber	*Breynia racemosa*	51.07	0.2	85.843	NA	146.363	183.340	0.385	0.055
T0014	Rubber	*Millettia sericea*	50.28	0.16	31.881	NA	243.250	171.456	0.915	0.104
T0017	Rubber	*Breynia racemosa*	49.14	0.07	142.735	NA	72.742	122.956	0.498	0.062
T0028	Rubber	*Phyllanthus oxyphyllus*	49.74	0.07	76.890	NA	45.196	106.331	0.534	0.113
T0018	Rubber	*Breynia racemosa*	47.28	0.06	132.628	NA	52.197	105.968	0.585	0.063
T0025	Rubber	*Dalbergia rostrata*	48.18	0.14	36.186	NA	113.985	103.103	0.823	0.131
T0030	Rubber	*Phyllanthus oxyphyllus*	45.34	0.07	95.491	NA	41.039	79.084	0.413	0.088
T0026	Rubber	*Dalbergia rostrata*	50.83	0.14	44.764	NA	81.196	77.322	0.871	0.171
T0066	Rubber	*Mapania tenuiscapa*	65.9	0.2	17.294	NA	45.367	72.617	0.069	0.136
T0065	Rubber	*Mapania tenuiscapa*	70.88	0.19	21.808	NA	48.558	70.486	0.059	0.127
T0228	Rubber	*Homalium caryophyllaceum*	50.95	0.35	22.916	NA	60.646	64.692	0.347	0.198
T0059	Rubber	*Clerodendrum laevifolium*	56.45	0.17	98.005	NA	109.030	59.916	0.381	0.391
T0258	Rubber	*Mallotus macrostachyus*	59.8	0.38	4.321	NA	97.352	59.586	0.575	0.345
T0027	Rubber	*Dalbergia rostrata*	54.46	0.14	46.056	NA	63.850	57.306	0.733	0.237
T0260	Rubber	*Mallotus macrostachyus*	56.17	0.38	7.931	NA	105.644	57.292	0.627	0.408
T0259	Rubber	*Mallotus macrostachyus*	55.45	0.36	6.981	NA	87.127	54.855	0.528	0.377
T0060	Rubber	*Clerodendrum laevifolium*	56.03	0.21	142.840	NA	96.417	54.709	0.368	0.406

T0003	Rubber	*Clidemia hirta*	48.75	0.2	122.833	NA	105.095	54.460	0.479	0.442
T0058	Rubber	*Clerodendrum laevifolium*	46.52	0.18	72.373	NA	92.744	52.691	0.364	0.409
T0088	Rubber	*Neolamarckia cadamba*	65.99	0.29	3.444	NA	117.908	50.099	0.574	0.610
T0046	Rubber	*Dioscorea pyrifolia*	54.71	0.15	106.842	NA	93.009	50.055	0.484	0.454
T0230	Rubber	*Homalium caryophyllaceum*	54.11	0.27	38.661	NA	54.666	45.941	0.232	0.324
T0001	Rubber	*Clidemia hirta*	39.02	0.18	133.766	NA	73.303	43.175	0.507	0.491
T0055	Rubber	*Aporosa cf octandra*	52.06	0.11	72.918	NA	70.150	42.701	0.398	0.487
T0002	Rubber	*Clidemia hirta*	47.4	0.16	217.542	NA	68.961	42.675	0.468	0.475
T0229	Rubber	*Homalium caryophyllaceum*	54.76	0.33	42.297	NA	47.693	42.183	0.234	0.335
T0266	Rubber	*Commersonia bartramia*	39.03	0.2	7.647	NA	81.788	41.690	0.522	0.565
T0057	Rubber	*Aporosa cf octandra*	49.35	0.12	64.292	NA	69.458	41.249	0.388	0.497
T0077	Rubber	*Mussaenda frondosa*	45.94	0.23	63.333	NA	73.463	41.115	0.496	0.541
T0078	Rubber	*Mussaenda frondosa*	59.56	0.24	156.613	NA	59.826	39.202	0.442	0.485
T0047	Rubber	*Dioscorea pyrifolia*	52.75	0.13	188.882	NA	57.879	38.284	0.392	0.444
T0265	Rubber	*Commersonia bartramia*	37.12	0.21	20.289	NA	64.479	37.463	0.529	0.558
T0262	Rubber	*Trema orientalis*	37.5	0.37	21.039	NA	44.056	36.904	0.401	0.404
T0048	Rubber	*Dioscorea pyrifolia*	58.24	0.13	157.963	NA	48.549	36.157	0.393	0.463
T0056	Rubber	*Aporosa cf octandra*	52.19	0.09	78.918	NA	50.143	34.599	0.393	0.525
T0264	Rubber	*Commersonia bartramia*	45.39	0.2	22.325	NA	58.623	33.277	0.547	0.639
T0076	Rubber	*Mussaenda frondosa*	47.6	0.22	162.548	NA	45.839	32.636	0.454	0.536
T0232	Rubber	*Combretum sp. 04*	48.64	0.18	124.903	NA	44.965	32.003	0.447	0.556
T0231	Rubber	*Combretum sp. 03*	49.63	0.19	109.100	NA	42.331	31.418	0.414	0.536
T0261	Rubber	*Trema orientalis*	42.19	0.44	10.991	NA	36.984	31.317	0.441	0.470
T0233	Rubber	*Combretum sp. 05*	52.46	0.18	109.875	NA	37.357	29.549	0.404	0.536
T0263	Rubber	*Trema orientalis*	40.13	0.39	7.562	NA	22.278	25.534	0.367	0.423
T0269	Rubber	*Blechnum orientale*	79	0.14	NA	NA	NA	NA	NA	NA
T0064	Rubber	*Mapania tenuiscapa*	69.81	0.23	NA	NA	NA	NA	NA	NA
T0227	Rubber	*Cheilocostus speciosus*	66.68	0.24	NA	NA	NA	NA	NA	NA
T0007	Rubber	*Spermacoce latifolia*	64.08	0.06	NA	NA	NA	NA	NA	NA
T0008	Rubber	*Spermacoce latifolia*	63.48	0.05	NA	NA	NA	NA	NA	NA
T0054	Rubber	*Tacca bibracteata*	63.22	0.27	NA	NA	NA	NA	NA	NA
T0004	Rubber	*Helminthostachys zeylanica*	63	0.16	NA	NA	NA	NA	NA	NA
T0053	Rubber	*Tacca bibracteata*	61.23	0.26	NA	NA	NA	NA	NA	NA
T0023	Rubber	*Phyllanthus urinaria*	60.77	0.07	NA	NA	NA	NA	NA	NA
T0223	Rubber	*Diodella sarmentosa*	59.63	0.07	NA	NA	NA	NA	NA	NA
T0268	Rubber	*Blechnum orientale*	59.35	0.14	NA	NA	NA	NA	NA	NA
T0062	Rubber	*Scoparia dulcis*	59.27	0.11	NA	NA	NA	NA	NA	NA
T0225	Rubber	*Cheilocostus speciosus*	58.89	0.24	NA	NA	NA	NA	NA	NA

T0241	Rubber	*Spermacoce exilis*	57.59	0.07	NA	NA	NA	NA	NA	NA
T0222	Rubber	*Diodella sarmentosa*	57.56	0.06	NA	NA	NA	NA	NA	NA
T0242	Rubber	*Spermacoce exilis*	57.24	0.07	NA	NA	NA	NA	NA	NA
T0009	Rubber	*Spermacoce latifolia*	55.98	0.05	NA	NA	NA	NA	NA	NA
T0224	Rubber	*Ludwigia octovalvis*	55.91	0.06	NA	NA	NA	NA	NA	NA
T0042	Rubber	*Lindernia diffusa*	55.77	0.09	NA	NA	NA	NA	NA	NA
T0226	Rubber	*Cheilocostus speciosus*	55.06	0.26	NA	NA	NA	NA	NA	NA
T0061	Rubber	*Scoparia dulcis*	54.6	0.11	NA	NA	NA	NA	NA	NA
T0010	Rubber	*Asystasia Gangetica*	52.29	0.06	NA	NA	NA	NA	NA	NA
T0022	Rubber	*Phyllanthus urinaria*	51.89	0.07	NA	NA	NA	NA	NA	NA
T0240	Rubber	*Spermacoce exilis*	51.66	0.05	NA	NA	NA	NA	NA	NA
T0045	Rubber	*Centotheca lappacea*	50.83	0.07	NA	NA	NA	NA	NA	NA
T0052	Rubber	*Tacca bibracteata*	50.71	0.28	NA	NA	NA	NA	NA	NA
T0073	Rubber	*Centrosema pubescens*	50.68	0.15	NA	NA	NA	NA	NA	NA
T0086	Rubber	*Oxalis barrelieri*	50.5	0.1	NA	NA	NA	NA	NA	NA
T0033	Rubber	*Molineria latifolia*	49.95	0.19	NA	NA	NA	NA	NA	NA
T0050	Rubber	*Bauhinia semibifida*	49.86	0.15	NA	NA	NA	NA	NA	NA
T0246	Rubber	*Araceae sp.38*	49.8	0.24	NA	NA	NA	NA	NA	NA
T0044	Rubber	*Centotheca lappacea*	49.76	0.08	NA	NA	NA	NA	NA	NA
T0249	Rubber	*Euphorbiaceae sp.31*	49.65	0.07	NA	NA	NA	NA	NA	NA
T0084	Rubber	*Stachytarpheta indica*	49.53	0.14	NA	NA	NA	NA	NA	NA
T0041	Rubber	*Lindernia diffusa*	49.42	0.08	NA	NA	NA	NA	NA	NA
T0032	Rubber	*Molineria latifolia*	49.04	0.18	NA	NA	NA	NA	NA	NA
T0040	Rubber	*Lindernia diffusa*	49.01	0.07	NA	NA	NA	NA	NA	NA
T0247	Rubber	*Araceae sp.38*	49	0.24	NA	NA	NA	NA	NA	NA
T0248	Rubber	*Araceae sp.38*	48.58	0.23	NA	NA	NA	NA	NA	NA
T0251	Rubber	*Euphorbiaceae sp.31*	48.43	0.08	NA	NA	NA	NA	NA	NA
T0087	Rubber	*Oxalis barrelieri*	48.03	0.1	NA	NA	NA	NA	NA	NA
T0239	Rubber	*Cyanthillium cinereum*	47.55	0.14	NA	NA	NA	NA	NA	NA
T0250	Rubber	*Euphorbiaceae sp.31*	47.44	0.1	NA	NA	NA	NA	NA	NA
T0067	Rubber	*Hyptis Capitata*	47.24	0.19	NA	NA	NA	NA	NA	NA
T0075	Rubber	*Centrosema pubescens*	47.19	0.16	NA	NA	NA	NA	NA	NA
T0005	Rubber	*Helminthostachys zeylanica*	47	0.08	NA	NA	NA	NA	NA	NA
T0006	Rubber	*Helminthostachys zeylanica*	47	0.09	NA	NA	NA	NA	NA	NA
T0012	Rubber	*Asystasia Gangetica*	46.89	0.09	NA	NA	NA	NA	NA	NA
T0011	Rubber	*Asystasia Gangetica*	46.37	0.09	NA	NA	NA	NA	NA	NA
T0237	Rubber	*Cyanthillium cinereum*	45.99	0.18	NA	NA	NA	NA	NA	NA
T0267	Rubber	*Blechnum orientale*	45.7	0.1	NA	NA	NA	NA	NA	NA

T0043	Rubber	*Centotheca lappacea*	45.11	0.07	NA	NA	NA	NA	NA	NA
T0070	Rubber	*Clibadium Surinamense*	44.98	0.31	NA	NA	NA	NA	NA	NA
T0049	Rubber	*Bauhinia semibifida*	44.9	0.14	NA	NA	NA	NA	NA	NA
T0069	Rubber	*Hyptis Capitata*	44.86	0.16	NA	NA	NA	NA	NA	NA
T0068	Rubber	*Hyptis Capitata*	44.24	0.17	NA	NA	NA	NA	NA	NA
T0035	Rubber	*Stenochlaena palustris*	43.7	0.13	NA	NA	NA	NA	NA	NA
T0238	Rubber	*Cyanthillium cinereum*	43.68	0.19	NA	NA	NA	NA	NA	NA
T0082	Rubber	*Stachytarpheta indica*	43.31	0.12	NA	NA	NA	NA	NA	NA
T0071	Rubber	*Clibadium Surinamense*	43.16	0.33	NA	NA	NA	NA	NA	NA
T0083	Rubber	*Stachytarpheta indica*	43.07	0.12	NA	NA	NA	NA	NA	NA
T0074	Rubber	*Centrosema pubescens*	42.97	0.13	NA	NA	NA	NA	NA	NA
T0051	Rubber	*Bauhinia semibifida*	42.55	0.13	NA	NA	NA	NA	NA	NA
T0253	Rubber	*Amaranthac sp.02*	42.35	0.12	NA	NA	NA	NA	NA	NA
T0252	Rubber	*Amaranthac sp.02*	41.82	0.13	NA	NA	NA	NA	NA	NA
T0034	Rubber	*Stenochlaena palustris*	41.63	0.14	NA	NA	NA	NA	NA	NA
T0254	Rubber	*Amaranthac sp.02*	41.42	0.11	NA	NA	NA	NA	NA	NA
T0256	Rubber	*Flagellaria indica*	41.36	0.12	NA	NA	NA	NA	NA	NA
T0024	Rubber	*Phyllanthus urinaria*	41.07	0.07	NA	NA	NA	NA	NA	NA
T0085	Rubber	*Oxalis barrelieri*	40.92	0.08	NA	NA	NA	NA	NA	NA
T0243	Rubber	*Legazpia polygonoides*	40.9	0.06	NA	NA	NA	NA	NA	NA
T0244	Rubber	*Legazpia polygonoides*	40.83	0.06	NA	NA	NA	NA	NA	NA
T0036	Rubber	*Stenochlaena palustris*	40.46	0.11	NA	NA	NA	NA	NA	NA
T0255	Rubber	*Flagellaria indica*	40.42	0.11	NA	NA	NA	NA	NA	NA
T0072	Rubber	*Clibadium Surinamense*	39.74	0.31	NA	NA	NA	NA	NA	NA
T0081	Rubber	*Lindsaea nitida*	39.42	0.06	NA	NA	NA	NA	NA	NA
T0063	Rubber	*Scoparia dulcis*	39.4	0.13	NA	NA	NA	NA	NA	NA
T0020	Rubber	*Fern 38*	38.58	0.04	NA	NA	NA	NA	NA	NA
T0079	Rubber	*Lindsaea nitida*	37.68	0.07	NA	NA	NA	NA	NA	NA
T0080	Rubber	*Lindsaea nitida*	37.47	0.06	NA	NA	NA	NA	NA	NA
T0038	Rubber	*Ageratum conyzoides*	37.04	0.12	NA	NA	NA	NA	NA	NA
T0037	Rubber	*Ageratum conyzoides*	36.24	0.14	NA	NA	NA	NA	NA	NA
T0245	Rubber	*Legazpia polygonoides*	35.45	0.06	NA	NA	NA	NA	NA	NA
T0031	Rubber	*Molineria latifolia*	34.23	0.11	NA	NA	NA	NA	NA	NA
T0039	Rubber	*Ageratum conyzoides*	33.14	0.15	NA	NA	NA	NA	NA	NA
T0257	Rubber	*Flagellaria indica*	32.03	0.09	NA	NA	NA	NA	NA	NA
T0019	Rubber	*Fern 38*	31.98	0.06	NA	NA	NA	NA	NA	NA
T0021	Rubber	*Fern 38*	31.47	0.04	NA	NA	NA	NA	NA	NA
T0236	Rubber	*Lygodium microphyllum*	24.83	0.09	NA	NA	NA	NA	NA	NA

T0234	Rubber	*Lygodium microphyllum*	24.78	0.09	NA	NA	NA	NA	NA	NA
T0235	Rubber	*Lygodium microphyllum*	24.78	0.09	NA	NA	NA	NA	NA	NA

Annex 2

Table 1: Results from the Shapiro-Wilk Normality test for plant functional traits combined from the tree and the understorey at the level of significance 0.05

Traits	W=	p-value
Leaf thickness	0.86587	2.2E-16
Specific leaf area	0.56532	2.2E-16
Leaf Area	0.50582	2.2E-16
Leaf Perimeter	0.48801	2.2E-16
Leaf Aspect Ratio	0.94592	3.65E-15
Leaf Form Coefficient	0.88178	2.2E-16
Chlorophyll content	0.99677	0.02764
Wood/Stem specific density	0.83035	2.2E-16

Table 2: Results from the Shapiro-Wilk normality test for functional tree traits at the level of significance 0.05

Traits	W=	p-value
Leaf thickness	0.93329	4.07E-14
Specific leaf area	0.89374	2.2E-16
Leaf Area	0.4481	2.2E-16
Leaf Perimeter	0.38483	2.2E-16
Leaf Aspect Ratio	0.87501	2.2E-16
Leaf Form Coefficient	0.85184	2.2E-16
Chlorophyll content	0.99846	0.9434
Wood density	0.99477	0.04924

Table 3: Results from the Shapiro-Wilk normality test for functional understorey traits at the level of significance 0.05

Traits	W=	p-value
Leaf thickness	0.73568	2.2E-16
Specific leaf area	0.71844	2.2E-16
Leaf Area	0.61489	2.2E-16
Leaf Perimeter	0.61173	2.2E-16
Leaf Aspect Ratio	0.97741	NA416
Leaf Form Coefficient	0.92493	3.28E-10
Chlorophyll content	0.99437	0.0349
Stem specific density	0.95527	4E-06

Annex 3

Table 1: Results from the Kruskal-Wallis test for plant functional traits from the tree and the understorey across four land-use systems at the level of significance 0.05

Traits	p-value
Leaf thickness	2.2E-16
Specific leaf area	2.13E-14
Leaf Area	8.44E-11
Leaf Perimeter	4.15E-07
Leaf Aspect Ratio	0.2304
Leaf Form Coefficient	2.1E-06
Chlorophyll content	2.2E-16
Wood/Stem specific density	2.2E-16

Table 2: Results from the the Kruskal-Wallis test for functional tree traits across four land-use systems at the level of significance 0.05

Traits	p-value
Leaf thickness	0.9963
Specific leaf area	4.59E-08
Leaf Area	0.02186
Leaf Perimeter	0.008715
Leaf Aspect Ratio	0.4194
Leaf Form Coefficient	0.001275
Chlorophyll content	0.9963
Wood density	0.33514

Table 3: Results from the Kruskal-Wallis test for functional understorey traits across four land-use systems at the level of significance 0.05

Traits	p-value
Leaf thickness	0.1144
Specific leaf area	2.2E-16
Leaf Area	1.53E-12
Leaf Perimeter	2.59E-13
Leaf Aspect Ratio	0.1005
Leaf Form Coefficient	0.1586
Chlorophyll content	1.52E-06
Stem specific density	0.004619

Annex 4

Table 1: Community-weighted means of functional tree traits across four land-use systems

Plot ID	Land-use Systems	Leaf thickness	Specific leaf area	Leaf Area	Leaf Perimeter	Leaf Aspect Ratio	Leaf Form Coefficient	Chlorophyll content	Wood density
BF1	Forest	0.227822	11.50063	128.6881	107.9997	0.431186	0.40717	62.09969	0.558343
BF2	Forest	0.221558	14.56753	83.91031	107.1824	0.421732	0.509919	63.99065	0.605556
BF3	Forest	0.26039	13.54817	49.04906	36.79002	0.410413	0.490653	63.87094	0.59114
BF4	Forest	0.204882	13.70146	58.27182	50.45547	0.425192	0.350815	54.48318	0.609899
HF1	Forest	0.246242	17.30664	55.36763	43.76359	0.407837	0.486243	63.0594	0.617485
HF2	Forest	0.263283	14.06939	40.63772	33.85008	0.435299	0.511657	61.37594	0.552874
HF3	Forest	0.253452	13.23546	59.32188	42.46956	0.442734	0.49009	61.6689	0.579432
HF4	Forest	0.238453	13.00816	54.18449	51.32433	0.432739	0.47727	60.31226	0.586869
BJ3	Jungle rubber	0.288738	9.301563	69.10172	45.92048	0.462518	0.426562	60.94481	0.468556
BJ4	Jungle rubber	0.250849	9.271559	123.5505	88.09857	0.450961	0.442396	60.22656	0.521379
BJ5	Jungle rubber	0.262696	10.91231	55.82479	44.90907	0.399112	0.445736	62.97858	0.498091
BJ6	Jungle rubber	0.255396	9.673377	72.77847	52.04085	0.431078	0.431587	57.31709	0.493404
HJ1	Jungle rubber	0.266319	8.92723	84.32996	54.32013	0.424861	0.448883	59.91599	0.526413
HJ2	Jungle rubber	0.273951	11.00704	76.08682	50.98873	0.422398	0.456121	63.40994	0.491201
HJ3	Jungle rubber	0.243814	9.580071	62.30655	40.06687	0.359059	0.46803	61.66624	0.447331
HJ4	Jungle rubber	0.269401	12.95732	54.80991	37.23003	0.372995	0.494013	62.66211	0.430171
BO2	Oil palm	0.22	11.5084	22.06396	22.78419	0.385013	0.524	52.53125	0.57075
BO3	Oil palm	0.220294	12.58537	55.99983	42.35969	0.440909	0.453651	53.58824	0.479696
BO4	Oil palm	0.245333	7.613143	81.03529	43.61932	0.461807	0.486618	54.78867	0.629571
BO5	Oil palm	0.234082	13.69291	42.3298	32.70916	0.411165	0.50192	56.85755	0.529063
HO1	Oil palm	0.25172	8.777766	61.4456	41.04099	0.456262	0.461682	49.62677	0.378877
HO2	Oil palm	0.250385	11.16451	58.56636	46.25391	0.442919	0.437711	54.10423	0.361722
HO3	Oil palm	0.221818	6.813875	116.805	62.6442	0.507562	0.42204	52.09318	0.583348
HO4	Oil palm	0.237333	11.51512	42.99653	34.54875	0.360791	0.445789	55.306	0.381233
BR1	Rubber	0.279474	8.067393	111.8685	56.43607	0.462096	0.400658	59.39568	0.517101
BR2	Rubber	0.2296	8.170829	104.1159	63.37616	0.535205	0.3517	55.9788	0.539945
BR3	Rubber	0.26	8.982088	45.36203	35.12924	0.433932	0.49142	59.96	0.542097
BR4	Rubber	0.202273	6.604654	43.11325	29.36419	0.457328	0.571299	54.82284	0.538476
HR1	Rubber	0.253784	7.809605	96.74739	56.3884	0.467272	0.452633	49.75288	0.472069
HR2	Rubber	0.244057	8.767138	154.0631	119.7056	0.476469	0.408155	56.79811	0.532484
HR3	Rubber	0.265667	9.472388	178.3625	143.9575	0.58524	0.230738	56.48529	0.547613
HR4	Rubber	0.258348	9.606869	63.7225	40.97214	0.423649	0.446194	59.58371	0.509925

Table 2: Community-weighted means of functional understorey traits across different land-use systems

Plot ID	Land-use Systems	Leaf thickness	Specific leaf area	Leaf Area	Leaf Perimeter	Leaf Aspect Ratio	Leaf Form Coefficient	Chlorophyll content	Stem specific density
BF1	Forest	0.086711	309.1743	505.0852	544.393	0.769029	0.067604	42.53813	0.000286
BF2	Forest	0.058937	276.9441	162.3481	221.0637	0.779372	0.06494	40.19252	0.000237
BF3	Forest	0.195	274.5239	993.0893	1004.729	0.3146	0.428725	53.15679	0.000394
BF4	Forest	0.220137	325.9721	1162.639	1154.767	0.242676	0.301904	60.49123	0.0004
HF1	Forest	0.187245	154.4102	497.346	490.5787	0.434925	0.415778	54.06536	0.000499
HF2	Forest	0.164041	139.9391	489.7076	491.2199	0.51473	0.347767	53.25459	0.000537
HF3	Forest	0.098585	220.8873	301.6137	338.7246	0.52023	0.196119	45.70229	0.000536
HF4	Forest	0.051782	262.5416	108.1187	149.1927	0.532339	0.120281	41.13656	0.000582
BJ3	Jungle rubber	0.136965	255.3694	880.5577	929.152	0.199503	0.241529	49.94282	0.000539
BJ4	Jungle rubber	0.173305	284.6012	1369.648	1352.954	0.455412	0.145226	52.80843	0.000671
BJ5	Jungle rubber	0.159726	212.5448	1328.473	1296.198	0.380555	0.272917	57.36098	0.000705
BJ6	Jungle rubber	0.178222	290.7973	1628.209	1604.218	0.262259	0.349384	55.56366	0.000757
HJ1	Jungle rubber	0.190892	272.2981	1690.35	1635.008	0.386681	0.441884	52.96267	0.000714
HJ2	Jungle rubber	0.181606	250.3814	1452.386	1414.19	0.202672	0.274545	56.20205	0.000741
HJ3	Jungle rubber	0.182688	231.295	1381.75	1335.858	0.211897	0.303422	55.69188	0.000737
HJ4	Jungle rubber	0.148929	234.788	1201.972	1200.991	0.294304	0.361605	53.93077	0.000724
BO2	Oil palm	0.168759	278.6194	1708.507	1675.423	0.239534	0.247631	55.86824	0.000757
BO3	Oil palm	0.098328	692.165	1276.772	1325.731	0.337196	0.334125	48.37077	0.000334
BO4	Oil palm	0.193907	235.9557	1648.037	1617.319	0.266896	0.249961	53.66335	0.000762
BO5	Oil palm	0.133463	248.3282	1416.271	1368.171	0.182273	0.181811	46.40076	0.000771
HO1	Oil palm	0.161975	261.5582	1529.371	1474.655	0.27561	0.311038	52.65992	0.000747
HO2	Oil palm	0.153801	223.2629	1493.517	1465.306	0.248931	0.175239	51.71932	0.000773
HO3	Oil palm	0.131292	290.7016	1359.632	1310.374	0.418526	0.449862	49.51921	0.00067
HO4	Oil palm	0.143231	273.1032	1169.486	1148.575	0.389197	0.430257	48.09604	0.000623
BR1	Rubber	0.190694	263.9964	1717.222	1654.293	0.40386	0.504679	53.35848	0.000774
BR2	Rubber	0.101148	671.8874	1423.092	1447.019	0.44891	0.529577	50.00846	0.000386
BR3	Rubber	0.116198	524.2831	781.8780	789.0226	0.476495	0.451825	54.75934	0.000359
BR4	Rubber	0.12349	280.2732	893.4803	842.4423	0.495726	0.492753	53.21634	0.00047
HR1	Rubber	0.113551	266.2717	1515.435	1460.646	0.440283	0.445573	51.43935	0.000732
HR2	Rubber	0.171472	261.2144	1732.928	1673.941	0.473255	0.452412	54.39918	0.000775
HR3	Rubber	0.121453	156.8365	880.8243	842.2605	0.331629	0.371566	48.00281	0.000568
HR4	Rubber	0.193754	249.8442	1713.474	1664.889	0.320398	0.442487	50.37092	0.000777

Annex 5

Table 1: Results from the Kruskal-Wallis significance test for community-weighted means of functional tree traits across four land-use systems at the level of significance 0.05.

Traits	p-value
Leaf thickness	0.01624
Specific leaf area	0.0003666
Leaf Area	0.1883
Leaf Perimeter	0.306
Leaf Aspect Ratio	0.02496
Leaf Form Coefficient	0.4224
Chlorophyll content	0.0001567
Wood density	0.001679

Table 2: Results from the Kruskal-Wallis significance test for community-weighted means of functional understorey traits across four land-use systems at the level of significance 0.05.

Traits	p-value
Leaf thickness	0.4994
Specific leaf area	0.8061
Leaf Area	0.001893
Leaf Perimeter	0.002104
Leaf Aspect Ratio	0.005007
Leaf Form Coefficient	0.001388
Chlorophyll content	0.1437
Stem specific density	0.01673

Annex 6

Table 1: Indices of functional tree diversity in 32 core plots across four land-use systems

Plot ID	Land-use systems	Number of tree species richness	Functional richness	Functional evenness	Functional divergence	Functional dispersion	Rao's quadratic entropy
BF1	Forest	85	0.21006	0.594594	0.765153	0.121492	0.018681
BF2	Forest	70	0.1466692	0.74415	0.554916	0.083887	0.014901
BF3	Forest	61	0.101889	0.711157	0.614237	0.070385	0.006633
BF4	Forest	69	0.22765	0.702803	0.807876	0.094067	0.011698
HF1	Forest	110	0.298598	0.603986	0.770894	0.094653	0.012092
HF2	Forest	125	0.375512	0.69341	0.635785	0.08197	0.009129
HF3	Forest	126	0.45790	0.686991	0.689167	0.093776	0.011322
HF4	Forest	112	0.39844	0.616526	0.657688	0.087571	0.011118
BJ3	Jungle rubber	46	0.052913	0.718049	0.697248	0.111788	0.015707
BJ4	Jungle rubber	54	0.283767	0.657933	0.599182	0.109441	0.016399
BJ5	Jungle rubber	69	0.059156	0.717824	0.6195	0.088774	0.011042
BJ6	Jungle rubber	49	0.072508	0.651022	0.754304	0.102377	0.014343
HJ1	Jungle rubber	32	0.038849	0.647739	0.702065	0.11696	0.02247
HJ2	Jungle rubber	55	0.094569	0.636035	0.72082	0.098196	0.011506
HJ3	Jungle rubber	45	0.039655	0.671822	0.444992	0.063575	0.00565
HJ4	Jungle rubber	69	0.059156	0.69432	0.604301	0.066533	0.007113
BO2	Oil palm	6	1.44E-05	0.87429	0.624983	0.064635	0.00512
BO3	Oil palm	7	2.17E-05	0.66109	0.558293	0.067304	0.006317
BO4	Oil palm	6	2.13E-05	0.765801	0.820323	0.070729	0.006058
BO5	Oil palm	9	0.000733	0.793575	0.458264	0.074817	0.011218
HO1	Oil palm	6	0.000336	0.291466	0.429162	0.054009	0.005399
HO2	Oil palm	7	0.000364	0.742039	0.649767	0.073748	0.007875
HO3	Oil palm	5	1.14E-05	0.804108	0.808026	0.104236	0.011454
HO4	Oil palm	16	0.00161	0.766313	0.409209	0.061924	0.007156
BR1	Rubber	7	0.002094	0.773947	0.684168	0.079317	0.007346
BR2	Rubber	9	0.000815	0.707446	0.854024	0.1073	0.012678
BR3	Rubber	8	0.000246	0.835956	0.770381	0.084122	0.009278
BR4	Rubber	10	0.001506	0.77494	0.382958	0.05427	0.004871
HR1	Rubber	14	0.006029	0.542754	0.525126	0.061262	0.007042
HR2	Rubber	16	0.004077	0.608078	0.700876	0.106983	0.014431
HR3	Rubber	6	0.000914	0.550203	0.79471	0.107846	0.013608
HR4	Rubber	28	0.011136	0.687591	0.627172	0.093975	0.010982

Table 2: Indices of functional understorey diversity in 32 core plots across four land-use systems

Plot ID	Land-use systems	Nymber of understorey species	Functional richness	Functional evenness	Functional divergence	Functional dispersion	Rao's quadratic entropy
BF1	Forest	23	0.024042	0.524565	0.870455	0.135585	0.022874
BF2	Forest	18	0.000163	0.522655	0.961412	0.073355	0.012327
BF3	Forest	11	8.92E-06	0.671614	0.883809	0.167399	0.028508
BF4	Forest	8	1.89E-06	0.608784	0.860627	0.166237	0.031273
HF1	Forest	19	0.00089	0.538879	0.702301	0.128816	0.019629
HF2	Forest	18	0.001536	0.548758	0.630506	0.141008	0.021488
HF3	Forest	19	0.00029	0.461966	0.920218	0.155471	0.028338
HF4	Forest	17	0.000791	0.660473	0.929251	0.104895	0.016776
BJ3	Jungle rubber	32	0.018664	0.633929	0.86687	0.128553	0.01804
BJ4	Jungle rubber	33	0.042367	0.476689	0.889467	0.13685	0.024624
BJ5	Jungle rubber	18	0.003301	0.386668	0.906101	0.11393	0.015347
BJ6	Jungle rubber	32	0.046225	0.491236	0.737513	0.101495	0.014437
HJ1	Jungle rubber	32	0.035329	0.547509	0.844647	0.110155	0.01621
HJ2	Jungle rubber	22	0.007224	0.558806	0.82858	0.109482	0.016138
HJ3	Jungle rubber	28	0.039807	0.478281	0.74033	0.115003	0.016642
HJ4	Jungle rubber	25	0.003462	0.522076	0.895761	0.13534	0.019048
BO2	Oil palm	36	0.062679	0.497019	0.750052	0.100576	0.014605
BO3	Oil palm	35	0.068664	0.41686	0.664527	0.097896	0.012956
BO4	Oil palm	37	0.040503	0.512285	0.927621	0.113601	0.019131
BO5	Oil palm	36	0.014517	0.500007	0.795042	0.108602	0.015583
HO 1	Oil palm	48	0.146979	0.35262	0.872888	0.104662	0.016205
HO 2	Oil palm	26	0.011571	0.462994	0.888044	0.115173	0.019445
HO 3	Oil palm	33	0.015407	0.462106	0.785306	0.099222	0.014481
HO 4	Oil palm	40	0.046659	0.448942	0.882723	0.118712	0.018037
BR1	Rubber	26	0.008334	0.489117	0.860902	0.102506	0.013476
BR2	Rubber	24	0.015371	0.464429	0.832774	0.151644	0.030785
BR3	Rubber	15	4.26E-05	0.600006	0.867212	0.196396	0.046033
BR4	Rubber	30	0.026928	0.474593	0.784637	0.121877	0.018679
HR1	Rubber	38	0.067074	0.465062	0.853203	0.082787	0.009833
HR2	Rubber	29	0.029381	0.476821	0.727167	0.092327	0.011068
HR3	Rubber	22	0.004557	0.361225	0.73591	0.065536	0.006395
HR4	Rubber	25	0.005368	0.51525	0.802266	0.105286	0.013303

Annex 7

Table 1: Results from the Kruskal-Wallis significance test for Indices of functional tree diversity across different land-use systems at the level of significance of 0.05.

Indices of functional diversity	p-value
Functional richness	0.00001016
Functional evenness	0.2492
Functional divergence	0.09124
Functional dispersion	0.306
Rao's Quadratic entropy	0.06078

Table 2: Results from the Kruskal-Wallis significance test for Indices of functional understorey diversity across different land-use systems at the significance level of 0.05.

Indices of functional diversity	p-value
Functional richness	0.001955
Functional evenness	0.01505
Functional divergence	0.4371
Functional dispersion	0.125
Rao's Quadratic entropy	0.1258

8. Statement of declaration

I hereby declare that this thesis entitled **"Plant functional trait and functional diversity across four land-use systems in Sumatra (Indonesia)"** has been completed as the result of my own work and investigations, except where otherwise stated. This work has not been submitted before to any other University for any kind of degree.

Biplabi Bhattarai

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Date: 22 January, 2019