



“In the first years of ICRAF’s work in Indonesia, the Alternatives to Slash and Burn (ASB) research (Phase I&II) identified rubber agroforests as a *win-win* for profitability and environmental services, compared to food crop systems. Is woody plant regeneration really comparable to natural forests?”

## RATIONALE

- **Biodiversity loss is at alarming rate**
- **Deforestation**  
(case for Indonesia, the rate is about 2 million ha per year (FWI/GFW,2002))
- **Traditional rubber agroforest has long been recognized as a reservoir area for many wild species**
- **Most floristic survey base on a limited number of unit sampling in a unique site**

## OBJECTIVES

- **TO INVESTIGATE RAF POTENTIAL AT THE LANDSCAPE LEVEL AS A REFUGE AREA FOR FOREST WOODY SPECIES**
- **TO EXAMINE FACTORS AFFECT ON FLORISTIC DIVERSITY**


**RUBBER AGROFOREST**

“The background for my PhD research is that biodiversity loss in Indonesia is alarming, both by loss of overall habitat (‘deforestation’) and by loss of quality of remaining forests. Rubber agroforests have become a major reservoir for the original diversity of lowland forests. However, data refer only to ‘plot level’ analysis

“The objective of my research therefore is to assess the potential of rubber agroforests as refuge for regeneration of forest woody species, looking at both plot and landscape scale diversity. The data set was collected to characterize RAF richness as well as differences with natural forest.”

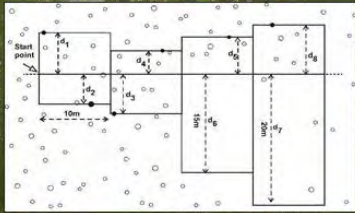
## SITE LOCATION

Plot Location	Total Plot RAF	Total Plot Forest
Muara Kuamang, Pelepat	16	
Pulau Batu, Jujuhan	2	
Rantaupandan, Rantaupandan	42	20
Sepungur, Muara Bungo	3	1
Rambah, Tanah Tumbuh	8	3
Semambu, Sumay	6	6
Pasir Mayang, Tebo Ulu		1
<b>Total</b>	<b>77</b>	<b>31</b>




## FLORISTIC SURVEY

### VARIABLE-AREA TRANSECT METHOD



**Remarks:**  
 $d_1, d_2, d_i$  : Distance of further tree of five closer trees to transect line  
 TL : Transect long (60 m)  
 i, ii, iii : Cell number (12)

### TRANSECT METHOD WITH CIRCULAR ELEMENTARY SUBPLOT



**Remarks:**  
 $d$  : subplot diameter (6 m)  
 TL : transect long (60 m)  
 1,2,3 : number of subplot

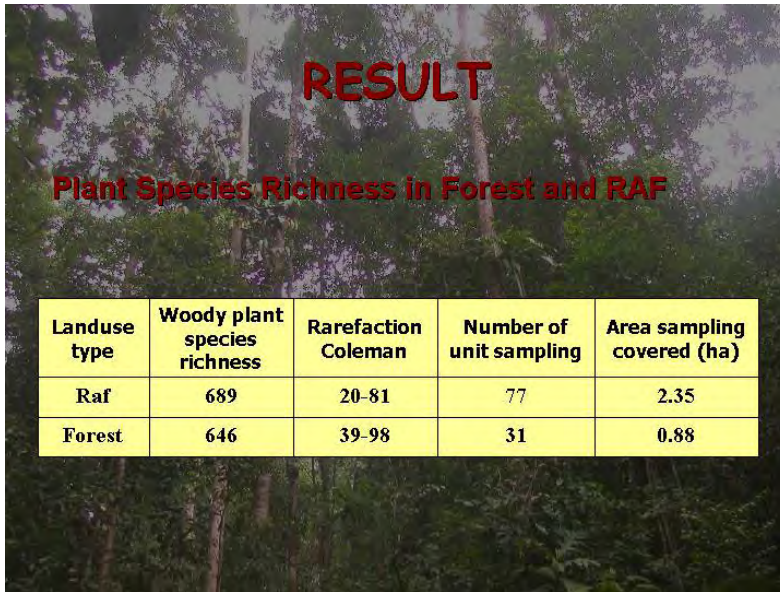
## OTHER DATA

- CANOPY STRUCTURE
- SOIL CHARACTERISTICS
- AGE OF 'KEBUN'
- PREVIOUS VEGETATION OF 'KEBUN'
- MANAGEMENT OF 'KEBUN'
- DISPERSAL MODES

“Research focussed on Muara Bungo district in Jambi (Sumatra). It involved rubber agroforest (RAF) and forest plots of multiple locations – all together 108 plots were characterized. However, natural forest not available for comparison at all locations.”

“The floristic survey used the variable-area method developed by Douglas Sheill (CIFOR), and included all saplings of woody plants, with a minimum height of 1 m and a maximum stem diameter of 3 cm.”

“Further data included the canopy structure, soil characteristics, age of the rubber agroforest and its history (derived from forest or from earlier agriculturally used land), current tapping and management regime. A database of dispersal modes of trees was based on fruit characteristics.



### Plant Species Richness in Forest and RAF

Landuse type	Woody plant species richness	Rarefaction Coleman	Number of unit sampling	Area sampling covered (ha)
Raf	689	20-81	77	2.35
Forest	646	39-98	31	0.88

“Analysis of the data set has not yet been completed, so the following results are indicative only. The total number of woody plant species found in the rubber agroforests matches that of forest, but the total sampled area is larger. The confidence intervals of ‘rarefaction’ results (corrected for sample size) overlapt.”

### 10 families which has higher species number in forest and RAF

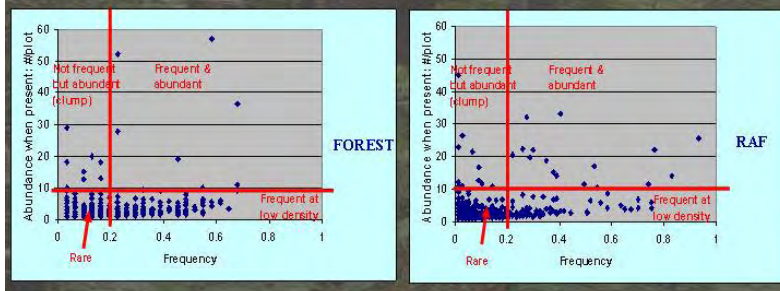
FOREST		RAF	
Family	Most abund. species	Family	Most abund. species
Euphorb. (72)	- <i>Agrostistachys</i> sp1	Euphorb. (90)	- <i>Hevea brasiliensis</i>
Lauraceae (44)	- <i>Actinodaphne procera</i>	Rubiace. (53)	- <i>Psychotria vindiflora</i>
Myrtac. (39)	- <i>Syzygium attenuata</i>	Lauraceae (48)	- <i>Litsea firma</i>
Rubiaceae (39)	- <i>Urophyllum ferrugineum</i>	Myrtac. (41)	- <i>Syzygium polyanthum</i>
Meliaceae (32)	- <i>Aglaia lawii</i>	Meliaceae (34)	- <i>Lansium domesticum</i>
Annonac. (31)	- <i>Popowia</i> sp1	Annonac. (31)	- <i>Goniothalamus macrophyllum</i>
Clusiace. (28)	- <i>Calophyllum of pulcherrimum</i>	Moraceae (28)	- <i>Ficus vrieseana</i>
Fabaceae (26)	- <i>Fordia nivea</i>	Fabaceae (27)	- <i>Fordia nivea</i>
Diptero (24)	- <i>Hopæa nigra</i>	Sapindac. (25)	- <i>Nephelium lappaceum</i>
Myrtisticac. (21)	- <i>Knema cinerea</i>	Clusiace. (20)	- <i>Garcinia parvifolia</i>

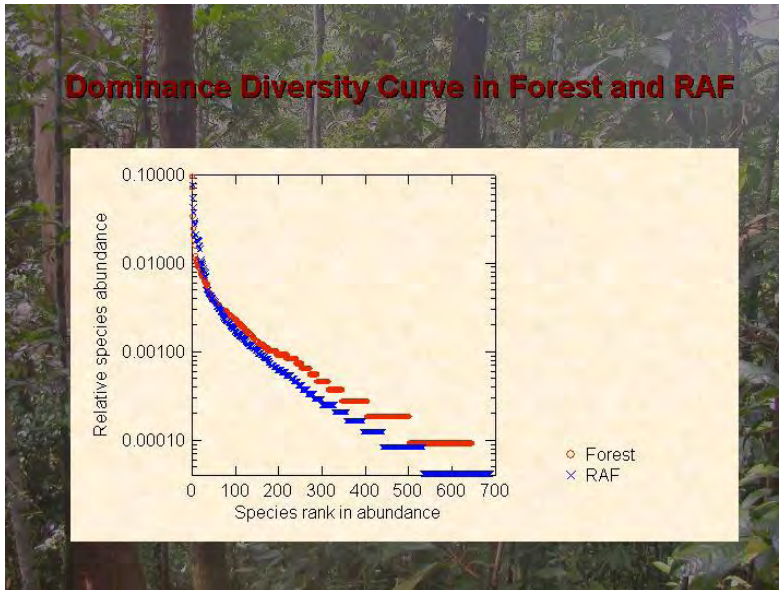
“Except for rubber, the ‘invasive exotic’ *Hevea brasiliensis*, all woody plants belong to the indigenous flora. There is little difference in the lists of the 10 most common plant families, but only 1 species occurred in the top 10 of both habitats.”

### Species Frequency and Abundance in Forest and RAF

	FOREST	RAF
Frequent and abundant	1.08%	1.60%
Not frequent but abundant	1.55%	2.32%
Frequent but not abundant	20.28%	11.47%
Rare	77.09%	84.61%
<b>Total species</b>	<b>689</b>	<b>646</b>

“Further analysis aimed at comparing frequency of occurrence (at plot level) and the abundance of the trees once they are present in a plot. 77 and 85% of the tree species is ‘rare and scarce’ for forest and RAF, respectively; only 20 and 11%, respectively, is ‘frequent and abundant’. No major difference, thus.”





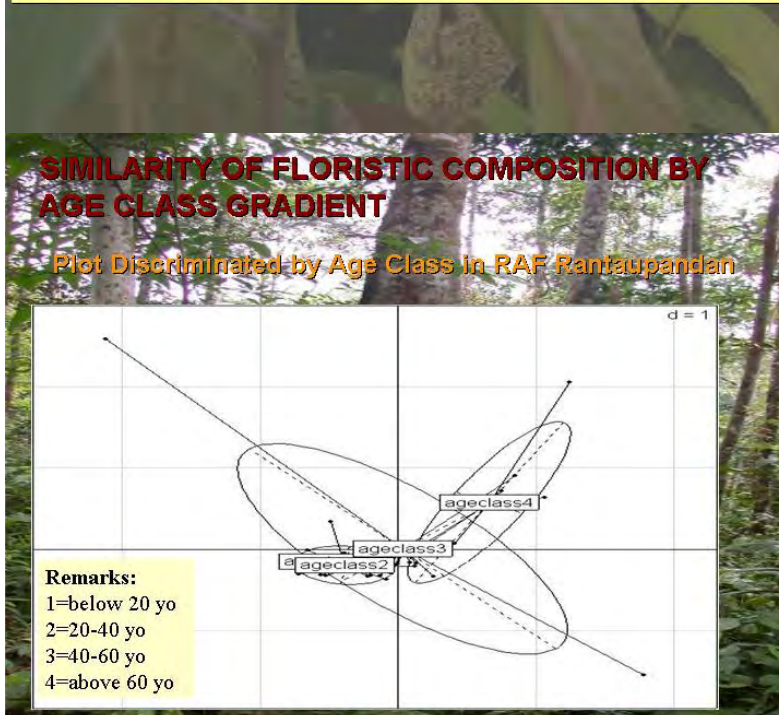
“A comparison of ‘Hubble-graphs’ for both systems reveals that the rubber agroforest is only slightly below the natural forest in its diversity profile; there is no indication at all of the ‘truncation’ that is typical of ‘habitat islands’. Both habitats have access to the full regional species pool.”

### Dispersal Modes

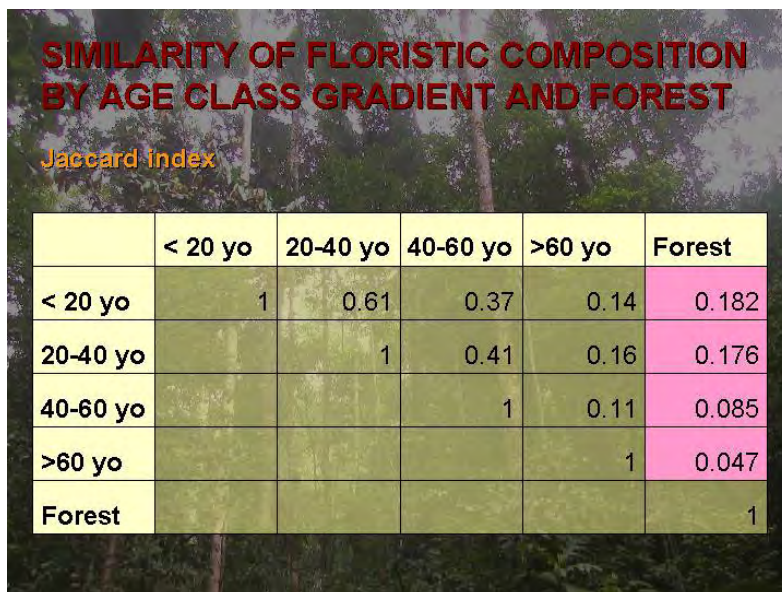
Fraction of species per dispersal modes in forest and RAF

	Num.	Anemochory distant	Zoochory distant	Zoochory short	Autochory local	NA
Species in RAF ONLY	284	0.0634	0.7113	0.0352	0.0458	0.1444
Shared Species	405	0.0543	0.7309	0.0419	0.0765	0.0963
Species in Forest ONLY	241	0.0498	0.6432	0.0415	0.1494	0.1162
<b>Total</b>	<b>930</b>					

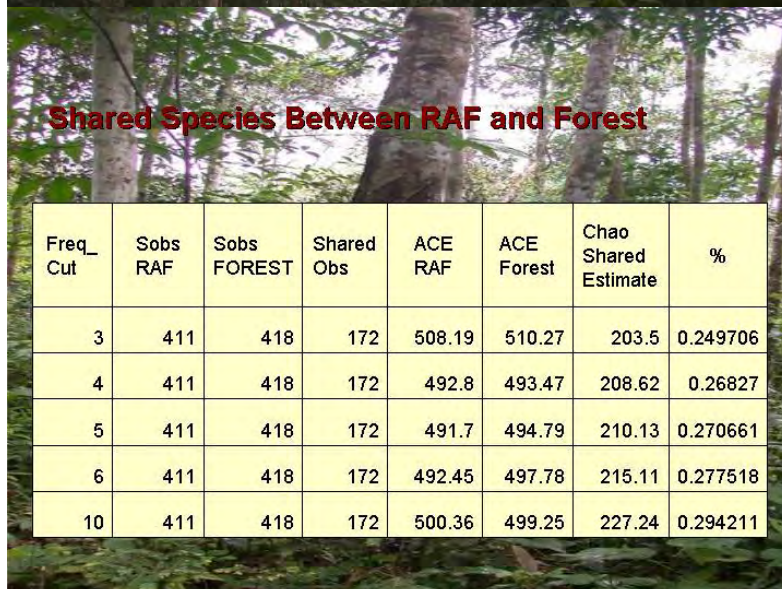
“Some difference in dispersal mode of the tree species was found: as expected the RAF has more wind-dispersed, small-seeded (early succession stages) trees and less large-seeded non-dispersed (‘autochory’) trees (typical of late succession)”



“Analysis of the floristic composition of the plots suggested that the rubber agroforests above 60 years of age are different from the others, with the 40-60 year old plots showing the largest between-plot differences.”



“Contrary to expectations, the floristic similarity with forests decreased with age of the rubber agroforests, rather than increasing. A possible explanation is that the younger plots were closer to remaining natural forests than the older ones and thus received more influx of forest tree seeds.”



“Using yet another way of analyzing the data set, the total species richness of RAF and forests appears to be remarkably similar, but the overlap between the two habitats is in fact small. Further analysis of landscape context and history is under way.”



“We tentatively conclude that rubber agroforests and natural forests have approximately similar levels of diversity of regenerating saplings, but that their species composition differs. Landscape context is probably important. A mosaic of RAF and forests will maximize landscape scale tree diversity.”