How to define and recognize a rubber agroforest?

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Introduction

Biodiversity-rich rubber agroforest (RAF) contains a large share of the original forest plant and animal species of lowland Sumatra. It may be feasible to get market recognition for the forest-like production conditions, initially targeting 'niche markets'. Any form of certification, however, requires an operational definition of species-rich rubber agroforest. In fact there is a continuum of management intensities and species richness. Our goal is to define quantitative criteria that are:
- easy to understand
- easy to measure
- reliable
- clearly distinguishing 'jungle rubber' from 'rubber monoculture' (or intensively managed rubber agroforest with only little biodiversity values left).

Candidate criteria

This review suggests the following candidate criteria which provide threshold indicators for when RAF species and floristic structural complexity reasonably approaches natural forest. The data suggesting these indicators is shown below. We review the available data for forest (incl. not currently tapped RAF), currently tapped RAF and intensive rubber systems/monoculture (RM).
1. Number of tree species more than 10 cm dbh (diameter at breast height or 1.3 m above ground) in an 8 m circle around a random starting point
2. Relative rubber basal area, measured as a percentage of the total sum of diameter^2 of all trees in a sample area
3. Number of large trees (more than 40 cm dbh)
4. Number of seedling (shrubs, woody plants less than 2 m height) and sapling (woody species with dbh less than 10 cm and height more than 2 m) species in a defined sample area.

Data sets

A number of datasets of rubber agroforests have been collected in Jambi (Sumatra, Indonesia) that can be used to explore thresholds:
- ASB2 surveys lead by Dr. Suryo Hardiwinoto (Gadjah Mada University, Yogyakarta) in Rantau Pandan, Muara Kuamang, Sepunggur, Muara Buat and Pintas Tuo 1998 – 16 transects (87 plots),
- Recent surveys for the Belowground Biodiversity project in Rantau Pandan, Muara Kuamang and Kuamang Kuning (Bungo district, Jambi); Total area of forest, RAF and RM surveyed were 0.32 ha, 0.32 and 0.20 ha, respectively. Other data (incl. PhD Thesis Saida Rasnovi) did not use full characterization of the tree flora.

1. Number of tree species in a circle of 8 m radius

For the forest plots the lowest value found was 5, while the highest value for the 'rubber monoculture' was nearly 3. We this propose to take a threshold of 4 trees per plot. Nearly 20% of the 'rubber agroforest' plots did not make the mark on this criterion.
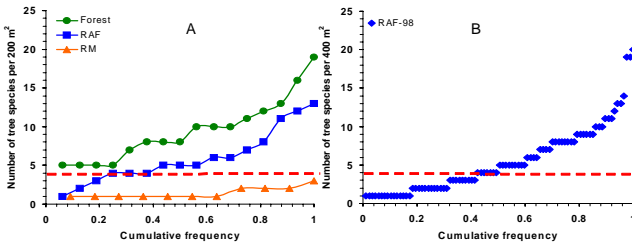

Fig. 1 (A) Number of tree species at forest, rubber agroforest (RAF) and intensively managed rubber plots ('rubber monoculture' or RM) in Bungo district, Jambi; (B) Number of tree species at rubber agroforest in the wider plots

2. Relative basal area of rubber

The lowest relative basal area of rubber in the RM plots was about 75% of total BA. We propose a threshold of 2/3 or 67% for RAF. (Fig. 2)
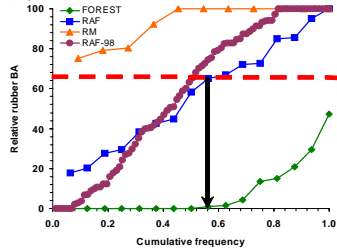

Fig. 2. Relative basal area of rubber trees in the forest, RAF and RM plot in Bungo district.

3. Combination of rubber basal area and tree diversity

The tree diversity (number of tree species) is most easily measured. In most cases, this measurement would be sufficient as an indicator.
- **RAF** define if most of the plots that meet the relative rubber basal area criterion of less than 2/3 also meet the criterion of > 4 trees in an 8-m circle or > 6 trees in 400m^2.
- **Species-rich RAF** define if most of the plots that meet the relative rubber basal area criterion of less than 1/3 also meet the criterion of > 8 trees in an 8-m circle or > 12 trees in 400m^2.
Relative rubber basal area would need to be measured only in borderline diversity cases. For 'borderline cases' it will be useful to measure the relative rubber basal area – in other cases that is not needed.
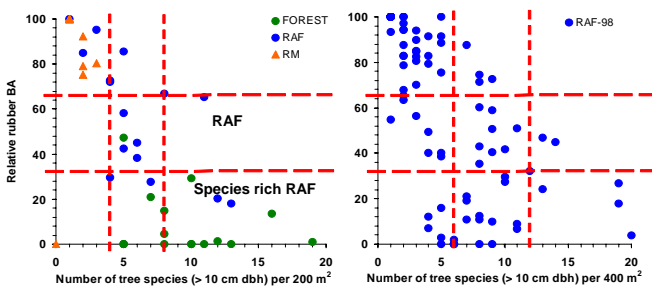

Fig. 3. Number of tree species versus relative BA rubber in the forest, RAF and RM plot

4. Number of tree bigger than 40 cm dbh (Tree Density)

Old rubber agroforest includes large trees, that may have been left when the land was initially cleared for rubber planting, or that have grown since that time. Biodiversity in birds, mammals, insects and epiphytes is disproportionately associated with large trees. The lowest number of trees >40 cm dbh encountered at RAF in Muara Kuamang (MK) was 6 stems per ha (1 stem/plot of 20 * 100 m or circle of 25 m radius), while we found 25 stem per ha (4 stem/plot of 20 * 100 m or circle of 25 m radius) in Rantau Pandan (RP).
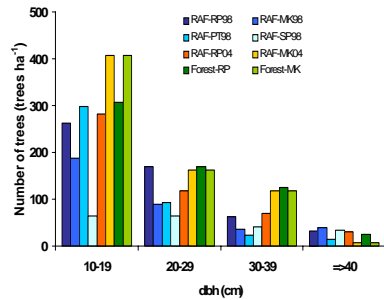
As threshold we this propose 1 tree > 40 cm dbh per circular plot of 25 m radius (or 20*100 m transect), as RAF is most similar to forest for this size tree.

Fig. 4. Distribution of trees in the forest and RAF of Rantau Pandan (RP) and Muara Kuamang (MK) in current condition (2004) and RAF of RP, MK, Pintas Tuo (PT) and Sepunggur (SP) in ASB2 data (1998)

5. Number of Seedlings and Saplings

Presence of seedlings and saplings in an ecosystem imply its regeneration. Diversity of seedling and sapling in RM was lower than in forest and RAF, but plot-to-plot variability was high. Seedlings are still abundant in rubber monocultures as well, so a seedling criterion will not help to differentiate management intensity. Therefore, in some cases seedling diversity could be as nearly as high in rubber monocultures as RAF. However, at the sapling stage forest and RAF show higher diversity. Sapling diversity is important because is indicates that the system allows survival of tree diversity. High tree diversity is important to faunal biodiversity because it produces structural canopy diversity providing many different niches.
Proposed threshold: at least 4 species of sapling (> 2 m high, < 10 cm dbh) in the circle of 8 m radius.

Table 1. Number of species, individual plants and families of seedling and sapling strata present at forest, RAF and RM

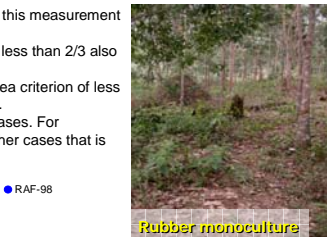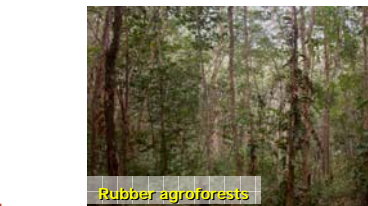| Strata	Forest	RAF	RAF-'98	RM
Seedlings:				
Number of species	15.4 ± 5.2	15.4 ± 5.2	4.23±2.5	7.2 ± 3.4
Number of individual plant	45.6 ± 5.3	47.8 ± 5.4	15.27±15.2	9.7 ± 29.0
Number of plant families	54	47		43
Saplings:				
Number of species	10.9 ± 5.3	10.4 ± 5.8	5.01±3.83	1.8 ± 1.7
Number of individual plant	17.7 ± 9.9	18 ± 12.9	8.70±6.48	4.2 ± 8.9
Number of plant families	50	42		8

Fig. 5. The proposed indicator at plot level are proxies for landscape level targets of a tree diversity of at least 70% of forest
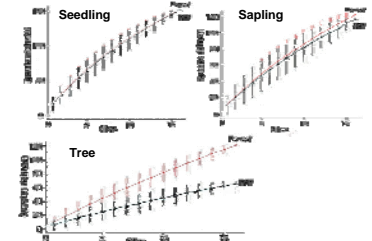
Suggested operational criteria for RAF and species-rich RAF

- **RAF**
  Trees of the present
    < 2/3 relative BA of rubber
  and > 4 tree species/200m^2
  Trees of the past
  and 1 tree > 40cm dbh/2000m^2
  Trees of the future
  and > 4 samplings species/200m^2

- **Species-rich RAF**
  Trees of the present
    < 1/3 relative BA of rubber
  and/or > 8 tree species
  Trees of the past and future as above

Next steps

- Discuss the proposed criteria in the villages that are interested to certify their old rubber agroforests. Test whether or not farmers can make reliable assessments on the basis of these (or modified) criteria.
- Explore other data sets to get further empirical basis for the criteria as 'proxies' for (agro)biodiversity.
- Discuss the draft criteria with certifying agencies to ascertain acceptability.

Forest

Rubber agroforests

Rubber monoculture