

Reclamation of *Imperata* Grassland using Agroforestry

Kurniatun Hairiah, Meine van Noordwijk and Pratiknyo Purnomosidhi



ICRAF's "**Slide Series**" are a visual support to the lecture notes and come with a 2-3 page narrative. The full resolution digital version is available on CD-ROM. Comments and suggestions are invited and can be addressed to the editors, Kurniatun Hairiah and Bruno Verbist or to the author(s) themselves. These slide series are periodically reviewed and updated to reflect advances in agroforestry research and development. They are made available to ICRAF trainees, collaborators, lecturers,

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These slide series are mainly developed in support of the training-of-trainers course on '*Agroforestry for improved land use and livelihood systems in Southeast Asia*', which was held in Chiang Mai from 8-20 March 1999, and its follow-up activities, both sponsored by the Netherlands' Government through DSO. However the materials are also meant to respond to the need for teaching materials formulated by universities and technical colleges in the region.

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Introduction

The spread of *Imperata* is often linked to a loss of soil fertility, leading to reduced crop vigour. The *Imperata* grass, which competes more effectively at lower fertility levels, gradually occupies an increasingly large area. This is particularly true after forest or long fallow (bush) clearance. Maintaining adequate soil nutrient status is thus one of the keys for stabilising crop productivity and preventing *Imperata* encroachment.

How to use this slide series?

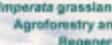
This slide series was originally produced as a visual support to a lecture on the Reclamation of *Imperata* grasslands using agroforestry in the context of ICRAF's training-of-trainers course 'Agroforestry for improved land use and livelihood systems in S.E. Asia'. However the materials are also meant to respond to the need for teaching materials formulated by universities and technical colleges.

The series is accompanied by a narrative, giving some examples and highlighting some of the important aspects related to the topic. For more information we refer to the lecture note itself and the literature listed at the end.

Whereas this series can adequately illustrate a general introductory presentation on Reclamation of *Imperata* grasslands using agroforestry, one should realise that it represents but a relatively small selection of available slides. As such, it will be much more relevant to revise and adapt it, or develop a new one, to reflect another regional or more location specific context. The present series can thus serve as an example to further develop other series. It is left to the imagination of the individual lecturer or trainer to take up this challenge.

List of slides and photographers

N°	Title	Photographer
1	An Imperata grassland	K. Hairiah © ICRAF
2	Various aspects of the Imperata issue	M. van Noordwijk © ICRAF
3	Sketch: Land use transformations from forest	M. van Noordwijk © ICRAF
4	Imperata grassland	K. Hairiah © ICRAF
5	Converting Imperata grassland to agricultural land	K. Hairiah © ICRAF
6	Sugar cane plantation	K. Hairiah © ICRAF
7	Imperata as weed	K. Hairiah © ICRAF
8	Rhizomes of Imperata	Anonymous
9	Soil fertility degradation	K. Hairiah © ICRAF
10	Carrying firewood	K. Hairiah © ICRAF
11	Imperata as fire climax vegetation	M. van Noordwijk © ICRAF
12	Risk of fire damage	M. van Noordwijk © ICRAF
13	Other fire climax species	M. van Noordwijk © ICRAF
14	Imperata as grazing land	M. van Noordwijk © ICRAF
15	Use as thatch	K. Hairiah © ICRAF
16	Use as thatch	M. Cairns © ICRAF
17	Imperata as soil cover	K. Hairiah © ICRAF
18	Possible rehabilitation	M. van Noordwijk © ICRAF
19	Conditions for rehabilitation	
20	Manual clearing of Imperata	K. Hairiah © ICRAF
21	Use of natural shade to control erosion	K. Hairiah © ICRAF
22	Graph: farmer clearing practices	
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24	Shading field experiment	M. van Noordwijk © ICRAF
25	Survey on light intensity reduction	M. van Noordwijk © ICRAF
26	Shading field experiment using nets	K. Hairiah © ICRAF
27	Graph: effect of shading	
28	Graph: effect of shading	
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30	Graph: effect of shading	
31	Conclusions	
32	On-farm survey	(picture left) K. Hairiah © ICRAF (picture right) J. Roshetko © ICRAF
33	On the right track?	K. Hairiah © ICRAF



Imperata grassland rehabilitation using Agroforestry and Assisted Natural Regeneration (ANR)

Kurniawan Rudianto and Meline van Noordwijk

The imperative issue has many aspects.

There are many possible solutions.

Opportunity for digitalization

Challenges:

- Digitalization is a complex task
- Digitalization is a long-term process
- Digitalization is a cross-functional task
- Digitalization is a cross-departmental task
- Digitalization is a cross-industry task
- Digitalization is a cross-border task
- Digitalization is a cross-cultural task

Solutions:

- Digitalization is a key to success
- Digitalization is a competitive advantage
- Digitalization is a source of innovation
- Digitalization is a driver of growth
- Digitalization is a catalyst for change
- Digitalization is a tool for collaboration
- Digitalization is a platform for transformation

The diagram shows a landscape restoration process over time, indicated by a timeline from 1 to 9. The landscape features a forest margin, a grassy area, and a river. The process involves human migration, fire, and land use changes.

- Human migration:** Indicated by arrows showing movement from the forest margin towards the river.
- Fire:** Indicated by a lightning bolt symbol, showing the fire front moving across the landscape.
- Land Use Changes:**
 - Forest margin:** Represented by a green tree icon.
 - Shrubs follow mouse-jay degradation:** Represented by a green shrub icon.
 - Grassland fire climax:** Represented by a green grass icon.
 - Grassland rehabilitation via agroforestry:** Represented by a green tree icon.

The timeline shows the progression of these changes, with the forest margin and shrubs appearing first, followed by grassland, and finally the grassland rehabilitation via agroforestry.

A landscape image showing a green field with a blue arrow pointing to a small tree labeled "Rubber". An inset image shows a close-up of a rubber tree. Text at the top asks "A golf course?" and text at the bottom asks "or a rice field?"

3



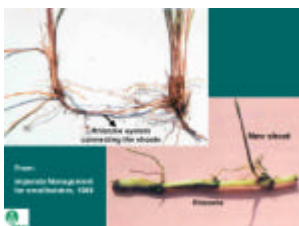
- 5open the grassland (open land in the middle) for a food crop based system.



- 6 Under a high input plantation system like sugarcane, usually the land is free of *Imperata*. Normally the sugarcane is planted on flat lands or on the (moderate) slopes, while the valley bottoms are covered by *riverine* or *gallery forest*. The white 'plumes' of this 'overripe' sugarcane almost look like flowering *Imperata*.



- 7 Plantation crops such as rubber or oil palm are particularly susceptible to *Imperata* at the early stages of development because they do not develop a dense enough canopy to adequately shade the weed. *Imperata* is not only an effective competitor for water and nutrients, due to its extensive and often shallow root systems, but it also has allelopathic effects on other plants.



- 8 *Imperata cylindrica* is a perennial rhizomatous grass. Its propagates sexually by seed and vegetatively by the extensive rhizome system. The underground rhizomes, which proliferate in the soil, give rise to shoots with intervals of 25 to 50 cm. Rhizomes fragmented by cultivation can also produce new shoots and rhizomes very rapidly. A 15-cm rhizome fragment can produce more than 350 shoots in six weeks. The rhizome is sometimes used to make herbal tea.



- 9 The spreading of *Imperata* is often linked to a loss of soil fertility, leading to reduced crop vigour and more chances for the grass, which competes for light more effectively at lower soil fertility levels. Therefore, maintaining adequate soil nutrient status is one of the keys for stabilising crop productivity and preventing *Imperata* encroachment.

Farmers experience in N. Lampung shows that continuous cropping of cassava (usually 3-5 years after forest or bush conversions) leads to unfertile soil, which is described in Bahasa Indonesia as “***tanah kurus***” or “***tanah panas***” (“***thin soil***” or “***hot soil***”). Farmers also describe “white soil” as unfertile, as you can see in this slide.



- 10 For many rural families firewood is still the basic energy supplier. Large areas of sheet *Imperata* prevent the growth of trees. This lady now has to walk miles in order to find firewood! Notice the reddish brown colour of the *Imperata* in this slide due to drought and also because it covered by dust!!!



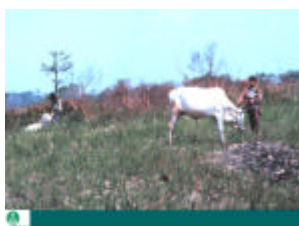
- 11 Most fires are set by people, either as a tool to clear land or as a weapon in attempt to settle land (tenure) conflicts. So, during dry seasons *Imperata* grassland is often a 'hot spot' of fire hazards! *Imperata* can survive fire, because it has many growing points on rhizomes below a soil depth of 5 cm, and fire does not increase soil temperature above a critical level below this depth.



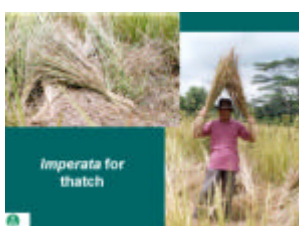
- 12 Oil palm trees with an undergrowth of *Imperata* have a high risk of fire damage. Damage due to fire can be survived, but will negatively affect the yield. According to farmer experience in N. Lampung, oil palm is slightly more fire resistant than rubber.



- 13 *Imperata* can thus regrow quickly after a fire event and it tends to flower and produce seed within 2 months after being burnt. Many other plants and trees are not so well adapted to fire and will be killed or will recover much slower. The leguminous tree *Peltophorum* was found to be resistant to fire as well, as it resprouted quickly after being burnt. The species is potentially useful for controlling *Imperata*.



- 14 Fire stimulates resprouting of young shoots of *Imperata*, which are more digestible for grazing cattle than the old shoots. Although it must be mentioned that *Imperata* is a rather poor fodder compared to many other grass species.



- 15 *Imperata* produces annually a shoot biomass of about 3-5 Mg ha⁻¹. It can be used as mulch or as thatch.



- 16 House roofing made of *Imperata* biomass keeps the house cool, although it has a high risk of fire and requires a lot of labour to maintain it.



- 17 This bare soil area is heavily eroded, in contrast to the nearby land, which is protected by a dense *Imperata* cover.



- 18 The most convincing reason to rehabilitate *Imperata* grassland is to make the land more **economically productive**. In this slide the farmer is enriching the established hedgerows with fruit tree species he desires like mango, *Zapota*, *Parkia*.



- 19 *Imperata* grassland rehabilitation can succeed only when four critical conditions are met!!!
- Clear and secure tree or land tenure
 - Effective local community fire prevention and control
 - Technical know-how of shade based control and soil fertility improvement
 - Market access, both physically and economically



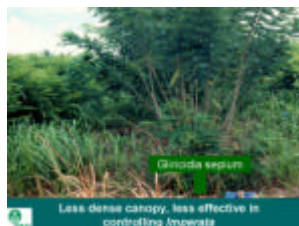
- 20 There are many farmer practices to control *Imperata*. The methods chosen depend on the resources available (mainly labour) and access to credit for the farmer.
- If labour is cheap and available for poorer farmers, **hoeing** is recommended.
 - If labour would have to be paid for, it is mostly used for planting food crops such as upland rice, maize or soybean. **Spraying herbicide** is also commonly used by farmers due to shortage of labour.



- 21 Within *Imperata* grasslands, trees and shrubs (e.g. *Peltoporum* and *Dillenia*) may continue to grow and once the canopy is dense enough or closed, it will shade-out *Imperata*.



- 22 Basically two approaches are used by the farmers for initial clearance of *Imperata* fallow:
- no-till techniques based on systemic herbicide (e.g. glyphosate), applied on young regrowth after burning existing biomass or slashing and removing it,
 - soil tillage a) by hoeing (manual) or b) ploughing (using animal or tractor power), usually after the *Imperata* aboveground biomass was burnt to make the work easier.



- 23 Biological control methods for *Imperata* are mostly based on providing shade. This slide shows a field experiment in N. Lampung – Indonesia, using *Gliricidia* as a hedgerow. *Gliricidia* has a not so dense canopy, which makes it less effective for controlling *Imperata*.



- 24 *Peltophorum* has a denser canopy than *Gliricidia*, so it is more effective for controlling *Imperata*. For research purposes *Peltophorum* was established in lines in an *Imperata* field as a first step toward a rotational hedgerow intercropping system. It must be mentioned that it is unlikely that farmers will adopt this labour intensive technique.

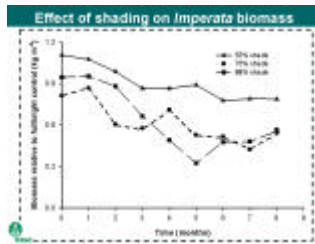


- 25 To answer this question the light intensity reduction by trees and the amount of *Imperata* was measured and an experiment using artificial shading on *Imperata* field was set up. This slide shows the measurement of light interception by trees (*Gliricidia* and *Peltophorum*) compared to an open area (without trees) at the same experimental site as shown in the two former slides.

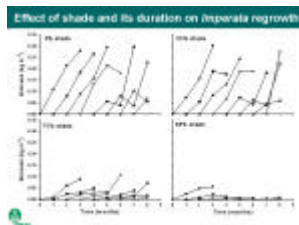


- 26 This shade-intensity experiment was carried out to quantify the response of well-established *Imperata* to shade with a controlled, known light intensity reduction and different duration. Artificial shade (nets) were used. The treatments were:
- 0 % shade = full sunlight
 - 55 % shade = 45 % sunlight
 - 75 % shade = 25 % sunlight
 - 88 % shade = 12 % sunlight

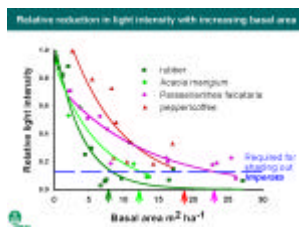
The decline of standing *Imperata* biomass over time and the regrowth ability from rhizomes were quantified by weighing the biomass, which was removed on a monthly basis.



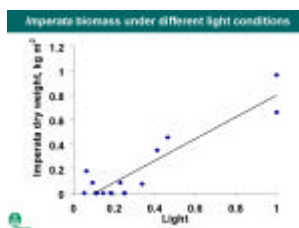
- 27 The artificial shade-intensity experiment showed that even if light levels were reduced to about 10% of full sunlight, an established *Imperata* stand would only gradually decline. A 50 % shade reduction for up to 8 months had little effect on the *Imperata* (re-) growth.



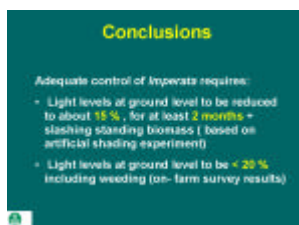
- 28 Re-growth **after removing all *Imperata*** aboveground biomass was more affected by shading than was the standing biomass. A 55% shade treatment, that would be considered problematic for most food crops, had no effect on the ability of *Imperata* rhizomes to re-sprout. Only when an 88% shade was applied for more than two months, did the ability of rhizomes to re-sprout decline to a negligible amount.



- 29 The various tree and plantation crops differ in age and tree basal area. Light intensity reduces more quickly for a given stem basal area in rubber and *Acacia mangium* systems than in a pepper agroforestry system (using *Gliricidia sepium* and other trees as support and shade trees) or under *Paraserianthes falcataria*.



- 30 The results of the artificial shade experiment was then compared with results of the survey of *Imperata* occurrence versus light intensity under a range of agroforestry systems. *Imperata* biomass decreased drastically when relative light intensity was reduced to 20 %. This suggests that farmers were weeding the *Imperata*, as we learnt from the artificial shade experiment that shade has much more effect on the regrowth (after slaying and removing the *Imperata*) than on the standing biomass. When more than 20% of sunlight still reaches the ground, *Imperata* still has a chance in these agroforestry systems.



- 31 Artificial shading experiments and on-farm surveys showed similar results with regard to the requirement for light interception to control *Imperata*. To control *Imperata*, light intensity at ground level needs to be reduced to < 20%, for at least 2 months after slashing of standing biomass.



- 32** Farmers in N. Lampung, Indonesia got interested in planting timber trees such as teak, mahogany, *Paraserianthes* etc. on their *Imperata* grassland. Many farmers noticed, however, that teak and *Imperata* litter will be easily subject to fire during the dry season as they are very slow to decompose.

Farmers will explore a range of options for *Imperata* reclamation when some conditions can match their expectations such as security of tenure and village level rules on use and control of fire.



- 33** ... and high enough benefits and/or profits from firewood or timber.

Further Reading

Lecture notes

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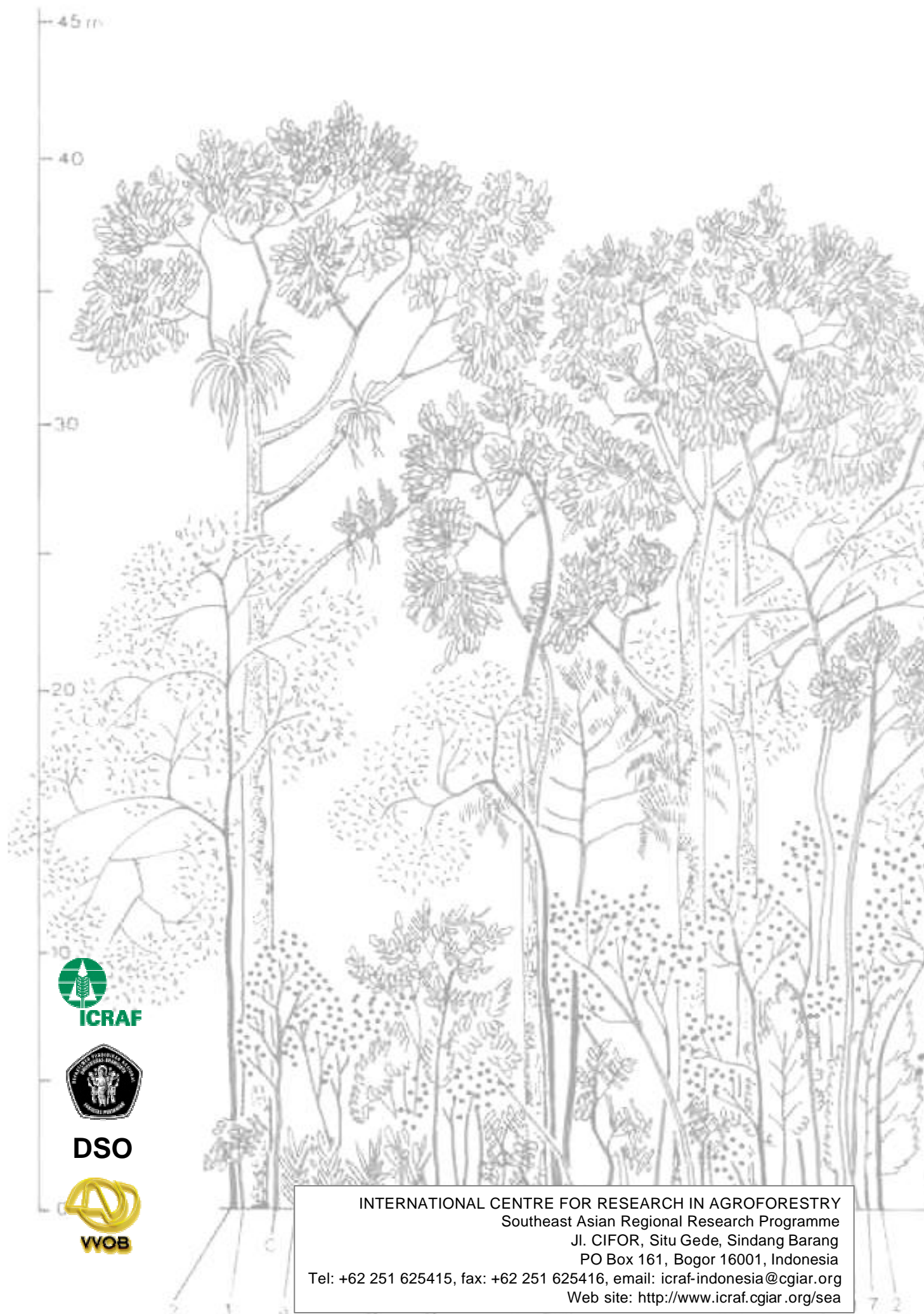
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