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Agroforestry innovations for *Imperata* grassland rehabilitation: workshop recommendations

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This paper contains the reports submitted by the working groups based on two days of deliberations during the International Workshop on Agrorofestry Innovations for *Imperata* Grassland Rehabilitation in Banjarmasin, Indonesia, 23–27 January 1995. There are eight reports:

I. The Mega Grasslands.
II. Characterization of Grassland Areas.
III. Modeling Agroforestry Systems for the Grasslands.
IV. Fire and Land Use in the Grasslands: Community Control Mechanisms.
V. Research Plans for International Collaboration.
VI. Policy Brief for Jakarta Seminar.
VII. Summary of Workshop Field Trips.
VIII. Followup Activities.

They contain statements of the issues, analyses, and recommendations for action.

I. The Mega grasslands

Problem identification

Mega *Imperata* grasslands are those of at least 10,000 ha of contiguous and essentially 'pure' *Imperata* with only minor components of other species. A size of 10,000 ha is the present minimum size for practical mapping. Using commercially available satellite remote sensing, it is possible to obtain images down to 10 ha or lower. It would be appropriate for the various governments in Asia where *Imperata* is a concern to obtain such imagery. Large areas of pure *Imperata* are *underutilized* – the base problem. More diverse vegetation would provide a higher benefit to society. Fire in *Imperata* tends to expand the grasslands and enhance the production of *Imperata*. Sub-problems of large areas of *Imperata* include soil erosion, water and air pollution, and decreased soil fertility.

Research priorities

- inventory how much and where *Imperata* exists;
- determine the soil and land capability of *Imperata* lands;
- history of the grasslands – what and why of the large expanses of *Imperata*;

- demographics of grasslands communities;
- present land-use;
- land-use planning (set priorities);
- economic analysis of current and alternative land use systems;
- technical research in:
  - fire science,
  - fire behavior,
  - fire effects,
  - climate;
- research in uses for *Imperata*.

Policy implications

- Clarify responsibilities between and among governmental entities (fire management in Indonesia is an example whereby several different agencies have responsibility in dealing with the problem of burning *Imperata*, smoke production, etc.).
- Community-based initiatives and incentives are a necessary component of fire management strategies. It is necessary to begin now to collect and analyze fire data: numbers of fires, area damaged, cause, damages, dates of fire, etc.

Technical solutions

Additional effort toward alternative technical solutions to the 'problem' are less important. There are more solutions now available than are being effectively used. It is necessary to deal with the tenure issue. Little progress will be made in reducing adverse effects of fire on *Imperata* until the persons living in or adjacent to the grasslands have an interest in and concern for the land. Self-interest is likely to be the biggest possible factor in the prevention of fire. A suitable site-specific infrastructure development plan that is funded and well executed is needed for the mega *Imperata* grasslands areas.

II. Characterization of grassland areas

Research activities

1. Inventories:
   - acquisition of better base-line data is needed on the nature and extent of grasslands (including grass taxonomy especially *Imperata*/non-*Imperata*) and on their physical environment;
   - all agencies using remote sensing need to collaborate to map the vegetation of the grassland areas;
   - two phases of work may be envisioned:
     - macro-grassland analysis, then
     - meso/micro grassland analysis;
   - ground truth analysis will be essential to the effort.

2. History and evolution of the grasslands will need to be documented.
3. Demography/human ecology, including tenure systems and ethnic interactions.
4. Utilization of the grasslands must be documented – past and present.

Implementation
Baseline data is more readily available in some countries than others. Identify key individuals from each country in the region (SE Asia) to coordinate the work at the national level. An international agency such as ICRAF or CIFOR may be requested to provide leadership to coordinate the work.

Main priority
It is essential to know where the grassland is, how and when it evolved, what are the present human populations, and past and present land uses, before a scientific basis is established for reclamation at the macro- or micro-level.

III. Modeling agroforestry systems for the grasslands

Background
Modeling provides opportunities to address some of the most complex problems in farming systems evolution in the grasslands, enabling better problem identification, identifying key knowledge gaps, and providing practical recommendations on technology and policy. The group developed a framework for international collaboration in the modeling of agroforestry solutions to grassland rehabilitation. The issues examined were:

- definition of the work currently in progress, its objectives, and the key players (institutions and individuals);
- exploration of the most critical agenda in agroforestry modeling, with emphasis on both process-oriented and empirical/spreadsheet models;
- articulation of what problems modeling can help to solve, and indications of how work will be done, and who will collaborate in it;
- examination of the concept of a more coordinated networking among agroforestry modelers in tropical Asia.

The working group identified the general objective of modeling activities 'to provide guidance to institutions whose responsibility it is to advise decision-makers at both farmer and national level as to the viability of options open to them under conditions of change'. In suggesting this objective members were keen to emphasize that the term model should not be interpreted as some prescriptive system applicable under a wide range of climatic, edaphic and socio-economic settings. On the contrary, the modeling process should enhance the examination and recommendation of a diversity of options through systematic evaluation of designs and concomitant resource requirements.

The following tasks were recognized:

1. The initial focus should be on models at the plot and farm level.
2. Develop robust enterprise-level models of tree, crop and livestock components for the following tree-based systems:
   - rubber,
   - fruit trees,
   - woodlots,
   - hedgerow systems.
3. Derive simple indices that describe the suitability of particular types of trees to be grown in association with crops and livestock on a particular site. These indices will encompass both above-and below ground interactions.
4. Identify generic rules and use these to design systems which suit characteristic sites and farmers.
5. Identify relevant expertise and institutions in the region and establish a network to address the tasks.
6. Review the existing modeling approaches and adapt them as necessary.
7. Establish requirements, protocols and appropriate information networks.
8. Build a model of a limited number of characteristic systems.
9. Evaluate its robustness in terms of providing guidance to target groups of decision makers.

IV. Fire and land use in the grasslands: community control mechanisms

In Indonesia over 5 m hectares of land were burned in uncontrolled fires in 1994. Much of this was forest land. It is ironic that such fires occur in one of the highest rainfall countries in the world. This is a strategic disaster. Could it have been prevented? The question is directly related to the issue of *Imperata* and its role in major fires in the tropics. The forces of land transformation acting on the ground throughout the archipelago are creating enormous and rapid change. The fires are one signal that the landscape is being drastically transformed.

The working group assessed the causation of fires in the grasslands, and the status of current and prospective mechanisms by which communities can take a more active leadership in their prevention. The group developed recommendations on practical directions that are based on successful examples of community control mechanisms that can be employed on a wider scale. An agenda for action research was also developed.

Fire control is the first step in realizing economic development
Community fire control in *Imperata* ecosystems: outline for an umbrella project.

Rationale
Fire is a major determinant of *Imperata* ecosystems, seriously limiting land use options. The key to control and prevention is in community-level resolution of conflicts between groups benefiting and those suffering from fire, providing effective prevention at the landscape level, and fire control mechanisms.

Hypotheses
1. Effective village-level mechanisms are needed to resolve potential conflicts between those benefiting and those suffering from fire; where these do not (or no longer) exist, they can be reinforced/ developed.
2. Diversified landscape mosaics offer more opportunities and incentives for fire prevention and control than simple ones.

Extrapolation domains/site selection
Research locations should be chosen in the major strata in order to extrapolate results. Fire risks depend on the scale of the grasslands (micro/meso/ macro/mega), the climatic conditions, and other factors.

Community-level solutions probably differ between
- Indigenous farmer communities, with little outside pressure,
- Communities with increased market integration,
- Government transmigrant schemes,
- Spontaneous settlers.

Links with existing projects are desirable for synergy. Possible research areas in Indonesia are: Jambi and N. Lampung (Alternatives to Slash-and-Burn Program), S. Sumatra (Rubber Research Institute Sembawa-ODA), E. and W. Kalimantan (GTZ), S. Kalimantan (Finnida).

Research activities
- Village-level maps of fire risks and control (landscape mosaics).
- Interviews: why do people burn and when?
- Interviews: traditional methods of fire prevention and control, including various semi-developed models integrating the human dimension and biophysical aspects of fire prevention in landscape mosaics.
- Analyze remote sensing data for larger areas to extrapolate from 'ground-truthed' villages.

Expected outputs
- Better understanding of fire prevention and control at the village level (who benefits, who suffers, how to prevent and resolve conflicts, time of burning).
- Mechanisms for mobilizing communities to reduce *fire risk.*

- Strengthen local fire *control* abilities.
- Evaluate landscape mosaics as a fire prevention/suppressing technique.
- Appreciate new land use options that alleviate poverty, made possible with adequate fire management.
- Appreciate effects on global C balance and greenhouse gas emissions of adequate fire prevention and management (i.e. environmental benefits).

A number of sub-proposals with different funding sources can be developed under this umbrella.

V. Research plans for international collaboration

This group examined how the international community of institutions could work together more effectively to solve the problems of developing and implementing alternative agroforestry systems for *Imperata* grasslands. First a set of research questions were posed for each of the various systems.

Priority research areas	Research questions
1. Rubber based	• How can improved system design produce options which lead to increased productivity and generate sustainable income?
2. Woodlot-based	• Is woodlot technology adopted by smallholders? • What relevant information is available for smallholders?
3. Tree crop-based	• What current information is available on: – physical conditions – interactions – design optimization
4. Improved fallows	• What are the current systems in practice? • What are the nutrient flows in improved and un-improved fallow types? • How does this nutrient flow influence crop yield and economics? • What are the primary constraints to adoption?
5. Livestock-based	• What is the carrying capacity in the existing system? • What multi-objective management strategy(ies) for integrated crop-livestock system is/are appropriate?

Further research is also needed on the appropriate integration of these alternatives in farming systems.

The group then developed the following table that indicates what systems are being emphasized in the work of different institutions and countries.

System	Institution				Country						
	ICRAF	CIFOR	BEAM	ACIAR	Indonesia	Thailand	Philippines	Malaysia	Vietnam	India	Laos
1. Rubber based	**	–	**	–	**	*	–	–	*	–	–
2. Woodlot-based	**	**	*	–	**	**	**	**	**	**	–
3. Tree crop-based	**	–	*	–	**	**	**	**	**	**	**
4. Improved fallows	**	–	*	**	**	**	**	**	**	**	*
5. Livestock-based	–	–	–	**	**	*	*	–	*	*	*
6. Smallhold annual crop-based	**	–	*	**	**	**	**	–	*	**	*

** On-going work.
* Work may be initiated.
ICRAF – International Centre for Research in Agroforestry; CIFOR – Centre for International Forestry Research; BEAM – Bangor Agroforestry Modeling; ACIAR – Australian Centre for International Agricultural Research.

VI. Policy brief for Jakarta seminar

1. *The area of* Imperata *grasslands*

Estimates of *Imperata* grassland area depend on the scale of measurement.

- mega: larger than 10,000 ha,
- macro: spanning more than one community,
- meso: community scale,
- micro: patches in a farmer's field.

Sheet *Imperata* covers 8.6 million ha in Indonesia (these are the mega-scale grasslands in continuous areas of 10,000 ha or more). This estimate would increase if the area of smaller patches were added to sheet *Imperata*. But data are not available to provide a comprehensive estimate at a finer scale. There are big differences between control of small patches in farmers' fields compared to conversion of *Imperata* sheets.

Imperata grassland has decreased gradually in some regions through farmers' efforts. This is most likely where land is scarce and market links are good. Conversion of *Imperata* to other uses by farmers has been documented in Java, Sumatra, and Kalimantan.

Imperata grasslands are not 'wastelands'. They have a number of uses for local people. Even if these uses are of relatively low value, they are important to the people who use them.

It is hard to find large blocks of grassland that are not used. For example, a 300,000 ha block of grassland in Kalimantan that was believed to be 'empty' was designated for an industrial timber plantation. After the project started, it was discovered that the entire block was claimed and managed by local villagers.

Research priorities

1. An international project is needed to map *Imperata* grassland in other countries of Southeast Asia using methods similar to those used in Indonesia.
2. Estimation and mapping of the smaller *Imperata* grasslands in Indonesia.
3. Study of the number of people using *Imperata* grasslands in Indonesia, how they use the grasslands, and the extent of existing claims.

2. *Proven systems and methods for* Imperata *grassland rehabilitation*

What are the alternative systems?

Many land use systems could be sustainable alternatives for smallholders. Most of the main alternatives are agroforestry systems. Examples are:

- smallholder rubber-based agroforestry,
- smallholder fruit-based agroforestry,
- some smallholder timber-based systems.

Research priorities

1. Adaptive research to improve the productivity and profitability of existing agroforestry systems.
2. Biological and economic evaluation of agroforestry systems in order to guide programs that support farmers' initiatives.

Priorities for action

1. A major problem is lack of research on multi-purpose tree species (MPTS). Recommendation: The Department of Forestry should revive and reinvigorate its program for research and its national network on multipurpose tree improvement.
2. For most tree species, there is not enough planting material that is of reliable quality.
   Recommendation: Provide smallholders with practical information they can use to become more discriminating consumers of planting material. This would improve the incentives for nurseries to market reliable planting material. The information could be supplied to farmers through government, private, and/or NGO channels.

What techniques work for rehabilitation and control of Imperata *in farmers' fields?*

There are numerous techniques available. Examples are:

- rolling and pressing,
- animal-drawn or tractor-drawn cultivation,
- hoeing,
- herbicides.

Many of these techniques are used by smallholders. Herbicide adoption has not been widespread. But there is intensive herbicide use by smallholders in some specific locations. Intercropping of annuals in early years while trees are established in agroforestry systems helps control *Imperata* (intercropping also helps meet household food needs and puts money in farmers pockets!). Shade from mature trees controls *Imperata* in agroforestry and other tree-based systems. Shade from young trees contributes to *Imperata* control, but usually needs to be supplemented by other forms of control during establishment of agroforestry systems.

Techniques for rehabilitation and control in farmers' fields

Research priorities

Much more work is needed to adapt *Imperata* control techniques to smallholders' constraints.

Priorities for action

Problem 1: re-orienting the research agenda.

Recommendation: increase capacity for farming systems research (with an on-farm perspective) to complement commodity-based research. The decision to establish regionally-focused research centers in the Agency for Agricultural Research and Development is a step in this direction.

Problem 2: fertility in upland soils.
Recommendation: economic and administrative feasibility studies of strategies to promote soil amendment with rock phosphate are need before any programs are undertaken.

Problem 3: useful technical information on *Imperata* control is not available at the farm level.
Recommendation: a manual is being prepared on *Imperata* grassland rehabilitation. We recommend that the Department of Forestry and the Department of Agriculture support the translation of the manual to Bahasa Indonesia and assist in distributing these manuals to extensionists, NGOs, and farmers. [Ed. note: this was subsequently done.]

Problem 4: demonstrations on *Imperata* control are currently ineffective because of short-term funding (one year budgets).
Recommendation: demonstration activities should be funded for at least 3–4 years, especially in areas with sheet *Imperata.*

3. *Community-based fire control and property rights*

Converting Imperata *sheet grassland*
Profitability of a land use system depends on:

1) biophysical conditions,
2) social conditions,
3) economic conditions.

Success of any effort to establish trees to rehabilitate grasslands depends on:

1) access to markets,
2) fire control,
3) clear, secure tenure.

Community-based fire control. Effective fire control is prerequisite to establishment of trees on *Imperata* grasslands. Community-based initiative is necessary for effective fire control. Public fire services are needed to assist with big fires.

Research priority
Research is essential to understand existing community-based initiatives and to identify ways in which government can help strengthen those efforts.

Property rights
Problem: Large areas of sheet *Imperata* are on land designated as production forest. Tenure security is needed for community-based fire control, and for people to establish trees.

Policy recommendations
1. Agroforestry should be a legitimate activity where Production Forest land is covered by sheet *Imperata.*
2. Where Production Forest land is covered by sheet *Imperata,* farmers who convert that *Imperata* grassland by planting and managing trees should receive property rights over all the products, including the timber.

VII. Summary of workshop field trips

Twenty-two participants joined a pre-workshop field trip to Palembang, South Sumatra, hosted by the Indonesian Rubber Research Institute and the Natural Resources Institute, UK. They visited farmer fields at six locations to examine different problems and methods of *Imperata* control: fields with traditional manual control of *Imperata*; an agroforestry system; high value cash crops to control *Imperata*; and a rubber replanting project. The group also visited a field experiment on rubber-based inter-cropping systems conducted the Sembawa Rubber Research Station in collaboration with CIRAD (France).

The meeting itself was located in Banjarmasin, Kalimantan, near one of the largest areas of sheet *Imperata* in Southeast Asia. This venue provided the participants with the opportunity to visit this grassland during the mid-workshop field trip. One group of participants visited the Indonesia-Finland project in Riam Kiwa where since 1981 a range of models have been tested for tree establishment in areas dominated by *Imperata.* They viewed on-going work that has made substantive progress on four options: Timber-based systems, reintroduction of local forest trees, assisted natural regeneration, and timber trees in agroforestry systems. Experimental test plots of numerous candidate tree species are being monitored, along with trials on practical management techniques. The work includes more than 160 hectares of test plots, and collaborative planting work with farmers in the surrounding villages. Fire is a constant threat because the site is located within an enormous sheet *Imperata* grassland.

A second group visited a transmigration project in the grasslands of Pleihari, South Kalimantan. Participants examined how farmers coped with the infertile soils on their two hectare farms allocated by the Ministry of Transmigration. They visited the experimental farm developed by Indonesian researchers collaborating with the Japanese Agricultural Land Development Agency, where a number of agroforestry systems where being tested.