Main conclusions of the three working groups at the Smallholder Rubber Agroforestry Project (SRAP) Workshop, September 1997

Penot E[1] and Gede Wibawa[2]

Key Words: Agronomics, policy issues, biodiversity, planting material

Introduction

Three working groups were formed at the Smallholder Rubber Agroforestry Project (SRAP) Workshop (September 1997) in order to brainstorm on the results and the future of the SRAP research programme. This paper presents the main conclusions of the three working groups as well as the main conclusions and recommendations concerning RAS systems. The working three groups were organized as follows.

Group 1: Agronomics of RAS systems. This group was further divided into two sub groups:

1.1 RAS Agronomic and Gap Replacement Issues (addressing RAS 1)
1.2 Agro-economic and Landscape: Dynamics of Rubber Agroforestry Systems and Oil Palm

Group 2: Policy Issues on RAS Adoption. This group was further divided into three sub groups:

2.1 Policy Issues

2.2 Adoption of RAS Development Support

2.3 Improved Planting Material Policy: Enhancing the Diffusion of Improved Planting Materials

Group 3: Research Topics - Biodiversity

[1] CIRAD/TERA-programme TH/ ICRAF Southeast Asia Regional programme
[2] International Rice Research Institute (IRRI)/Sembawa/South Sumatra

Group 1: Agronomics of RAS Systems

Subgroup 1.1: RAS Agronomic and Gap Replacement Issues (addressing RAS 1)

This group was led by Dennis Garrity (ICRAF) and Gede Wibawa (IRRI/Sembawa). The main conclusions are presented below per topic or cultural practice:

Vigor of clones

The clones' survival and growth may be very good in RAS, especially in RAS 1, compared to farmer unselected seedlings. This finding supports the hypothesis that clones may grow very well in an agroforestry environment under certain conditions. The on-farm experimentation has revealed these particular conditions in terms of cultural practices.

The key issue is in the type of planting material and planting method, in particular in using polybagged clonal planting material with adapted clones associated with very early planting in the rainy season (in October, for instance).

However, planting costs of rubber clones are high (compared with "no cost" for jungle rubber). Farming system surveys have shown that capital investment is not the primary constraint for smallholders. Most can afford to invest in an half-hectare planting every two years, particularly as RAS systems are less expensive than the monoculture package. Among RAS systems, RAS 1 is the least expensive, including the labour investment during the immature period.

Planting at normal density (around 500 trees/ha) has been confirmed as the best choice. Originally, two planting densities were used (550 and 750 trees/ha), but the extra cost for a higher planting density is not justified. A relatively high mortality rate (compared to jungle rubber) is observed due to root disease, which is directly linked with the quantity of tree burning before planting, that is, less burning is associated with a greater occurrence of root disease.

Weeding

For inter row weeding, the most important factor is to keep competing vegetation below the height of the rubber plant. According to local conditions, it might be appropriate to do a "selective cutting" of the highest plants in the inter row, six months after planting.

In the rubber row, weed control depends on the density of weed competition. Current weeding levels of 3-6-9 weeding operations/year need to be re-evaluated as they are too much work for smallholders. These weeding protocols are not followed in Jambi and are followed in Kalimantan only during the first year. As no statistical difference has been recorded between the monoculture control and 3 weeding/year (4 in West Kalimantan), three to four weedings are sufficient in the first year. It is recommended to use a glyphosate-based herbicide two out of the four weedings. Weeding protocols for the second year were discussed with the farmers as follows:

1, 3 and 6 weedings /year (herbicide such as Gramoxone are allowed) in Jambi and 2, 4 and 6 weedings /year in Kalimantan. The number of weedings is a pertinent factor in Kalimantan, due to the fact that *Imperata* is a constant pressure, but this might not be a pertinent factor in Jambi. New weed control recommendations should be based on either weed coverage (including herbaceous versus woody) or biomass. The use of a quadrate like the one recommended by Delabarre (Tree Crops Smallholder Development Project (TCSDP), (TCSDP/CIRAD Rubber book, 1995) might be a solution. Another solution is to develop visual criteria, which will identify the need (timing) for weeding in the Jambi region.

Fertilization & interaction of fertilization and weed control

Appropriateness of fertilization is based on soil fertility: In Jambi, it appears unnecessary in the plains. The current "light TCSDP fertilization package" for the first three years seems to be adapted in Kalimantan and West Sumatra. Both 'marginal soils' and 'fertile soils' require fertilizer in order for rubber to grow correctly. In other words, fertilization does not substitute for weed control. Current fertilizations rates based on estate rubber systems have been simplified and are only conducted for a period of three years. When possible, it is always better to re-evaluate fertilization amounts depending on soil type, past management of site, and previous and current vegetation cover.

Results of fertilization x weed control is not yet clear. Fertilization may boost weed growth rather than rubber growth, such as the case in the central plains of Jambi province where replanting occurred after old jungle rubber was removed. The outcome is different for *Imperata* grasslands, such as in Kalimantan where *Imperata* is a constant threat.

Slash & burn and planting time

Farmers state that planting one month after slash-and-burn is optimal because with high soil moisture, ashes from burning are well distributed and weed competition is not yet great. This confirms the importance of an early planting.

Pests (monkeys and pigs)

The proximity of forest is of critical importance to the presence of monkeys and pigs, particularly in Jambi. The presence of pigs and monkeys in farmers' fields is more common when forest is nearby and when population densities are low (e.g., when farmers' presence in their fields is low). This is the case in the piedmont area of the Barisan Mountains in Jambi. In other mountainous areas, such as East Pasaman in West Sumatra, this problem does not occur as long as farmers live near their fields. The location of rubber plants within a field is also important. The plants located close to boundaries are more likely to suffer damage than those planted in a scattered planting design (according to farmer opinion).

The farmer's strategy to control pests or to establish a fence is critical to the success rate of the pest control method. Plot fencing is one method of controlling pigs but is

not effective for monkeys. To date, there is no immediate solution for controlling monkeys, except for a farmer's frequent presence in the fields.

Recommendations

Recommendations for RAS 1

It would be an interesting exercise to refine rubber agronomy in respect to land classes (soils, past and current land use).

Data from weeding trials (and information from farmer and researcher experience) must be summarized to determine technical recommendations and, if necessary, design researcher-controlled trials to evaluate weeding regimes (including data collection on weed biomass production).

The use of herbicides to reduce labour inputs and obtain better implementation of weeding protocols in the trials has been agreed to and conditions of implementation need to be discussed with farmers.

Recommendations for RAS 2

For RAS 2, there are no major problems. Continuation of the current work and observations as well as data collection will continue.

Recommendations for RAS 3

The use of herbicides (Round Up) should be allowed and discussed with farmers to control *Imperata* in RAS 3.

With regard to the following question, "Can herbicide be used as a substitute for manual weed control?", the answer is definitively 'yes'. Therefore, herbicide use should be recommended and fully integrated into the trial protocols. It is recommended to intensify efforts in RAS 3 systems and to thoroughly review all findings to date. The current RAS 3 system is very promising, particularly with the use of selected cover crops (*Chromoloena odorata* and *Flemingia congesta*) and pulp trees *(Acacia mangium, Carcicarpa,* and *Gmelina arborea*) to control *Imperata*. However, further research and mid-term results are still required to assess the viability of the concept.

Recommendations for a new trial RAS 4: Gap replacement as a potential alternative planting method in some areas:

Gap replacement is the most common method of regeneration for many trees. Farmers currently do fill gaps in some complex agroforests, such as the damar agroforests (Pesisir area, Lampung). While gap replacement was envisaged back in 1994, its implementation was not prioritized as more attention has been given to more intensive RAS (1 to 3), which is better adapted to the current demand for jungle rubber improvements. It is important to note that gap replacement can be a potential solution in remote areas, or in areas with no land pressure, to maintain the

current system without using slash-and-burn and, in particular, to maintain the farmer's land rights. However, field observations and discussions with farmers indicate that slash-and-burn is still a necessary step in RAS and jungle rubber establishment because rubber does not grow in shade. While it is true that there are many young rubber seedlings in old jungle rubber, it is also true that most of them cannot reach a tappable size and will never produce any rubber. The debate is open to test this hypothesis. It is recommended to conduct a RAS 4 test in real conditions in the piedmont of the Barisan Mountains.

The potential advantages of a RAS 4 are:

- No slash-and-burn required
- Reduced erosion (as true for all RAS)
- Reduced pest damage (this is questionable)
- Spread of labor and capital inputs out over a greater time period
- Preservation of biodiversity
- Reduced need for weed control (grass)

The potential limitations are:

- Rubber is very sensitive to low light levels and may not grow sufficiently (slower growth and risk of no-production if growth is not sufficient to reach a sufficient girth to enable tapping.).
- The main hypothesis that all RAS 4 concepts rely on the fact that rubber might grow in a semi-shaded environment must be tested.
- White-root disease might be common and could seriously jeopardize the plantings.
- The environment could serve to increase the pest problem rather than minimize it.
- Nutrients and soil moisture competition increase with the existing vegetation.
- Economically, RAS 4 with step-by-step planting might keep production at the same level as jungle rubber but cannot significantly increase production in the mid-term.

Therefore, it is recommended to test RAS 4 as a pure research concept in order to: a) test the feasibility of the concept, and b) identify and quantify the competition factors.

General recommendations

Further research should be oriented towards the following topics:

- Survey farmer practices and ideas related to gap replacement ('*sisipan*' and other practices).
- Model gap size and shapes in terms of light availability and rubber tree growth.
- Establish experiments to test pest damage on various planting materials.

Subgroup 1.2: Agro-economic and Landscape: Dynamic for Rubber Agroforestry Systems and Oil Palm

This group was led by Fred Stolle (ICRAF) and consisted of eleven participants from IRRI, SRAP-Kalimantan, Indonesian Association of Rubber Producers (GAPKINDO), ProRLK, JICA, and ICRAF. The main issues discussed were:

- How does the competition between oil palm and rubber affect the landscape?
- What are the current dynamics between oil palm and rubber plantations?
- Do we want to interfere with these dynamics?
- How can we interfere with these dynamics?

Remarks and statements

A preliminary comparison of the current dynamics of oil palm and rubber can be conducted.

Jungle rubber

In Jambi province, there are 500,000 ha of rubber plantations from which a minimum of 10% must be replanted. Rubber has been present since 1910 and has a scattered distribution throughout the province along roads and rivers. A rubber farmer can tap 400 to 500 trees per day, equivalent to approximately one hectare per day.

A smallholder can manage 2 ha of rubber (in D/2) on his own; 4 ha with his wife and from 3 to 6 ha with clones (in D/3 with stimulation, low frequency tapping). A household can effectively manage 4 ha of jungle rubber or 6 ha of clonal rubber (in D/3) (with 2 tappers per household, generally wife and husband). Jungle rubber might remain of economic interest in remote areas.

Oil palm

In both Jambi and West Kalimantan provinces, oil palm is very new for smallholders. There is a strong dynamic of oil palm planting by private companies as well as by PTP (governmental companies) and additional planting programmes proposed to local farmers . Oil palm is planted in large areas in lowlands, primarily in estates and in transmigration **NES** projects (Nucleus Smallholder Estate Schemes), A household can manage 2 to 4 ha of oil palm. Oil palm can be planted in peat soils, while rubber cannot. Oil palm is restricted by access (e.g., roads) and plantations must be within a certain range of a factory (generally around 35 to 50 km) due to the necessity for rapid processing of bunches after harvest (within 24 hours). Technical information is mainly focused on oil palm plantations. Oil palm might replace jungle rubber in central areas (plains) if farmers do not use clonal rubber for replanting old jungle rubber. This is because oil palm productivity is 4-5 times greater than that of jungle rubber. Oil palm plantation productivity in Jambi and West Kalimantan is comparable to that of rubber monoculture or RAS systems. Investors are only interested in oil palm plantations. There are almost no more new rubber estates. Rubber will remain a smallholder production and oil palm will increase the dependence of farmers on a project or a factory.

General comments

Labour is a main constraint in Jambi and even more so in West Kalimantan. In West Kalimantan, only 2.6 million ha are currently being planted or replanted. While West Kalimantan poses some physical constraints for growing rubber (e.g., poor soils and excessive rainfall in the eastern part of the province), it is still suitable for rubber production. While there is active competition between oil palm and rubber, rubber is still very strong in Sumatra and Kalimantan. Most farmers fear a complete change in technology and cultural practices as well as lifestyle with oil palm and consider clonal rubber to be a better adapted and less disruptive alternative. On the other hand, oil palm can guarantee a certain income level (comparable or slightly above that of clonal rubber per ha) and becomes productive only three years after planting.

While farmers in Sumatra and West Kalimantan appear to be more interested in clonal rubber, oil palm with full credit is very promising and attractive for some communities, particularly those in transmigration areas.

Rubber and oil palm are both suitable for alang-alang land reclamation and rehabilitation. Rubber agroforestry systems consist of more than just rubber; income is generated by other agroforestry products as well (fruits, timber, rattan).

Farmers will remain interested in rubber if productivity can be increased or if they can use clonal rubber to obtain an income comparable to that from oil palm. Investors are interested in oil palm estates and, therefore, may provide more opportunities for farmers to join an integrated scheme or project with full credit. With rubber, the only existing projects are government sponsored and these will be partially stopped in 1998 due to the end of World Bank and Asian Development Bank funding.

Areas with steep slopes and/or remote areas are not involved in the competition for land use between oil palm and rubber as these areas are generally more suitable for rubber.

Oil palm is based on large-scale monoculture in estates or in projects. The presence of a factory in the vicinity of the plantation is necessary for production.

Rubber can be part of a complex agroforestry system (RAS) and an interesting alternative to monoculture in terms of biodiversity, environmental conservation, and income diversification. However, the positive features of oil palm (e.g., short-term, high profits, reduced immature period, fully integrated credit) are attractive to many farmers. The pros and cons of both rubber and oil palm systems are presented in Table 1.

Table 1. **Rubber vs. Oil Palm**

System	Access	Labour	Profit-ability	Suit-ability	Cultiva-tion	Infor-mation	Land	Capital	Farmers' interest
Sumatra	+++	-	+	++	++	+	++	0	++
Jungle Rubber:	+	++	+++	++	+	++	+	+	++++
RAS/Monoculture									
Oil Palm	+	++	+++	++	+	++	+	+++	+++
Kalimantan	++	-	+	++	++	+	++	0	++
Jungle Rubber:	+	++	++	++	+	+	+	+	+++++
RAS/Monoculture									
Oil Palm	-	++	+++	+	+	+	++	+++	++

The main constraints for RAS development: shortage of technical information

There is not enough accurate, reliable and up-to-date technical information available for farmers to base their decisions for various cropping patterns. This is clearly a time of change for most farmers, representing an evolution to more productive cropping systems. Among the current alternatives, RAS seems to be well placed in terms of affordability, adoptability, and productivity.

More information needs to be channeled to rubber farmers about various rubber cropping systems, and not only monoculture systems.

The integration of other profitable species (timber, pulp) in improved rubber agroforestry systems enables a certain level of income diversification. This is a priority in RAS technology.

The technical information that must be channeled to farmers requires an increase in the involvement of government agencies for RAS adoption. Among these institutions, service of plantations (Dinas Perkebunan or DISBUN), government projects, GAPKINDO, and IRRI are essential.

Some relevant questions that emerged from the subgroup discussion are as follows:

- Is the "trench experiment" (Sandy Williams's paper) representative of RAS 1 environment? No. The experiment is clearly focused on rubber and weed competition.

- *Why do farmers refuse oil palm?* The problem of dependency on oil palm projects and the complete change in labour organization that is required are clear constraints for Dayak farmers in Kalimantan. It is not as clear whether this is a problem for local Malayu farmers in Jambi.

- In North Sumatra, there are a sufficient number of oil palm factories that collect bunches of oil palm; this creates a real market where farmers can choose traders according to prices. Why is this not the same situation in other provinces in the mid-term? Oil palm plantation development has been booming over the last five years and factories must be built over the next few years to keep pace with the production

process. The situation in Jambi and Kalimantan could change in the next few years to become more similar to that of North Sumatra.

- *If the hypothesis is true that fertilization might serve to increase weed population in RAS 1 in Jambi, what is the best level of input?* In Jambi, there is no clear evidence that fertilization is required during the immature and production period of rubber. From observations in the Rantau Pandan and Seppunggur areas, it appears that a supply of rock phosphate at planting time and a minimum amount of N for the first three years is sufficient to achieve good growth of the rubber trees. While this might not be true in other areas, the Sepunggur area appears to be fairly representative of the plains in Jambi.

Group 2: Policy Issues on RAS Adoption

This group was led by Eric Penot and A.F.S. Budiman.

Subgroup 2.1: Policy Issues: Planting, Materials, Development Procedures, Innovation and Adoption Constraints, Institutional Constraints, and Land and Tree Tenure

Land and Tree Policy Issues

Origins, Impacts and Need for Change

Land tenure is clearly an essential concern for farmers who are currently witnessing one of the fastest and most extensive change in land use classifications with the expansion of oil palm and pulp trees plantations. Land that is officially classified as state forest land is being 'recuperated' by the government and 'given' to estates for the establishment of new plantations, even in cases where local farmers have long been living on a given location. A small portion of state forest land is dedicated to transmigration projects or smallholder projects. These land use decisions are giving rise to feelings of inequity among local farmers.

Perceptions

The top-down approach to policymaking that has been implemented in Indonesian since the 1950s has been the only extension method employed for decades. Clearly, policymakers must acquire a better understanding of community's strategies and objectives and farmers' capacities in order to produce more efficient and effective development programmes and extension.

Michael Dove's concept of 'political economy of ignorance' (1983) best explains the current ignorance caused by indifferent official institutions for agroforestry systems that are responsible for more than 500, 000 ha in the province of Jambi and more than 450,000 ha in the province of Kalimantan.

Development Planning

Comprehensive land use planning is urgently required to take into account all actors, such as farmers, projects, extension services, credit operators, government, private sector and estates. Spatial planning (*rencana tata ruang*) is required at both the national and local levels (*kabupaten*). Ecological and equity concerns that have been missing from the planning process to date must now be taken into careful consideration.

Economic Forces

The economic performance of RAS and Complex Agroforestry Systems (CAF) need to be measured against the performance of other land use systems, in particular smallholder oil palm and pulp tree cropping systems. A prospective economic analysis of RAS systems compared with other rubber systems was conducted in 1996 (Penot 1996) and a preliminary analysis comparing oil palm, foodcrops and rubber systems was conducted in 1997 (Penot 1997). However, this analysis has only been partially completed and further and more detailed analysis is still required.

Potential policy reforms must be explored in order to promote and develop RAS/CAF adoption and economic performance. Key policy issues requiring further attention include: 1) rights over timber sale and use, 2) use of improved planting material, 3) quality control of private nurseries, and 4) land use rights.

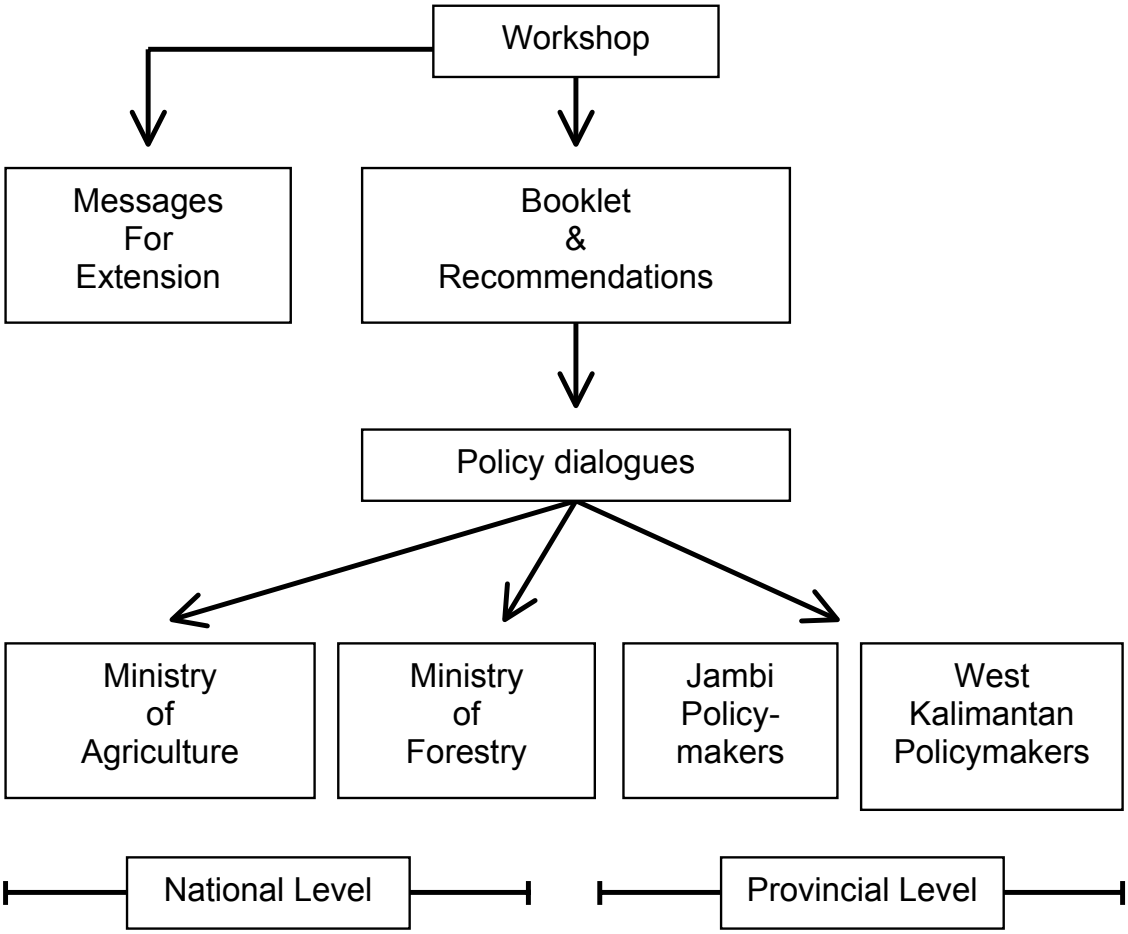
Resource security

Key policy issues include: 1) recognition/certification of land tenure, 2) development of land tenure instruments for systems located within the state-defined forest area (long-term/short term strategies), 3) definition of special use zones, 4) clarification of the government-sponsored community forestry program (Hutan Kemasyarakatan or HKM), and 5) change of forest zone borders.

The PT Finantara Intiga experience in West Kalimantan, (ENSO/HTI/PT Gudang Garam) as well as the SFDP/GTZ project can certainly provide a lot of information on how to address these issues with local communities.

This group identified the next steps for follow up action, which are illustrated in Figure 1.

Figure 1. **Where Do We Go From Here?**



Subgroup 2.2: Adoption of RAS and Development Support

This group identified three levels of implementation for RAS adoption:

I. Farmer Level
II. Regional Level
III. National Level

Farmer level

Constraints →	Development Support
1.Quality of Improved Genetic Planting Material (IGPM)	To private nurseries, control of clonal purity
2. Access to credit	Credit schemes through projects or associations
3. Lack of information	Training
4. Lack of trust in government services	

Regional level (*kecamatan, kabupaten*, province)

Constraints	Development Support
1. Land-use planning (*tata ruang*)	Information (identification of packages)
2.Regional development priorities (*Repelita*)	Intersectoral coordination (institution building)
3. Sectoral approach of agronomy line agencies	Training and information
4. Qualification and motivation of extension personal	Supporting **BIPP/BPP**

Agencies involved (stakeholders):

- regional government (*Bupati*)
- regional planning agencies (*Badan Perencanaan Daerah* or *Bappeda*)
- Agricultural line agencies (Dinas PKT)
- Extension (BIPP)
- **NEED ENGLISH** (BPTP)
- **NEED ENGLISH** (BPP)

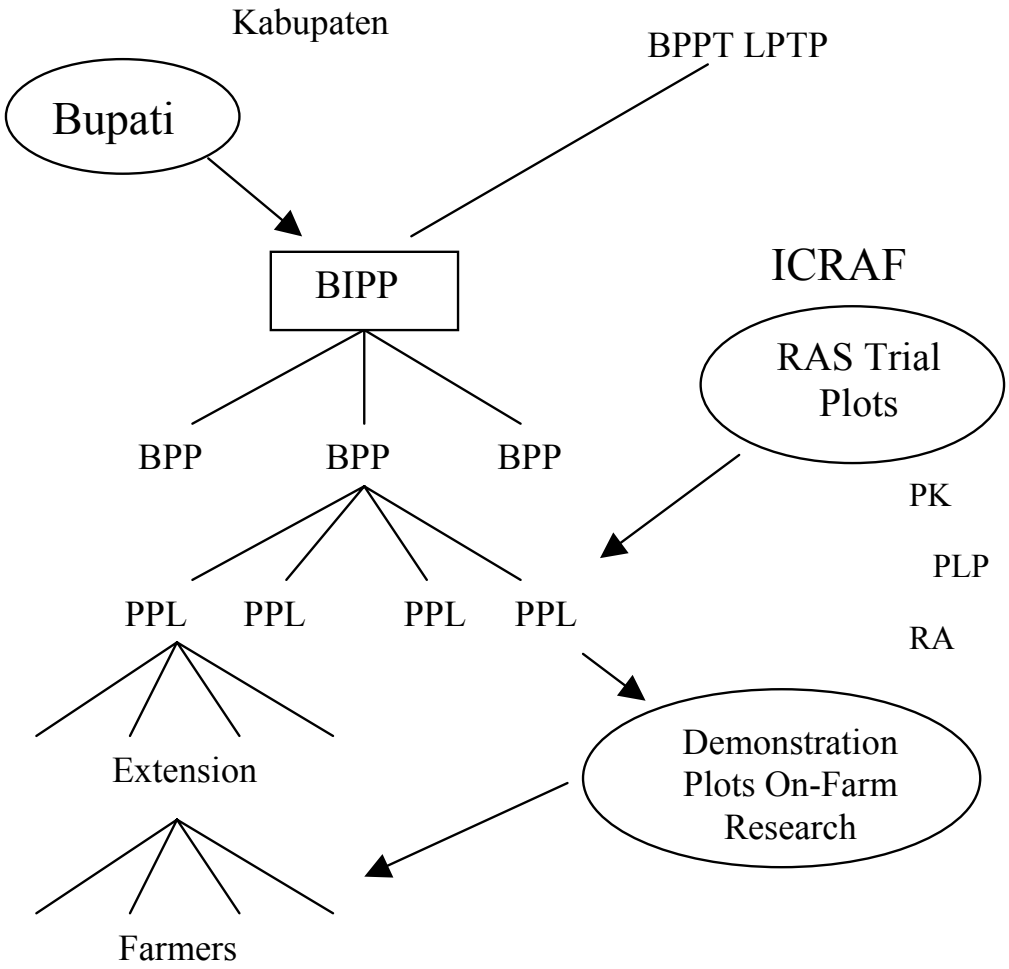
National Level

Constraints	Development Support
1. Funding	Funding
2. Policy Priorities	Information Lobbying
3. Economic interests	

Agencies involved:

- National Coordinating Agency (*Badan Perencanaan Nasional* or *BAP-PENAS*)
- Research agencies
- Development agencies
- Funding agencies
- Ministries of Agriculture and Forestry

Figure 2. **Information Flow**



Subgroup 2.3: Improved Planting Material Policy: Enhancing the Diffusion of Improved Planting Materials

The critical issue is the availability and quality of improved rubber planting material. Several types of improved planting material are currently available: clones (grafted plants) and polyclonal seedlings (seeds from a polyclonal garden). In a preliminary discussion in this subgroup, a question was posed regarding what kind of planting material is most adapted for RAS.

<u>Merits and demerits of distributing clonal vs. polyclonal seedlings</u>

Clonal and polyclonal seedlings will each require very different approaches with respect to diffusion to farmers.

Clonal Budgrafts:

- standard currently accepted method;

- demands better upkeep to obtain;
- higher yields (1500-2000 kg/ha/year);
- better secondary characteristics, such as resistance to leaf diseases;
- more established with certain clones already researched for use in RAS;
- cost equivalent to the use of seeds for the same level of selection;
- requires infrastructure (budwood gardens and nurseries) as well as technical skill for grafting;
- more homogeneous planting material.

Polyclonal seedlings:

- faster growth (not true if clones are planted in polybags which is recommended);
- easy distribution, but more possibilities of "fake" planting material;
- more tree to tree variations (a population of seedlings is heterogeneous);
- yield believed to be less than clones, depending on the level of visual selection made in nurseries: yield between 1000 and 1500 kg/ha;
- low availability of seeds: the only supplier is BLIG from London Sumatra estate in a monopolistic situation.

Tentative conclusion: There are two possible policies:

- make both clonal and polyclonal seedlings available for farmers to choose on their own, but provide them with information;
- emphasize clones because this is the most promising planting material if well used (current strategy of SRAP).

Setting up Nurseries and Budwood gardens

SRAP decided to put emphasis on clonal planting material, which is more reliable, more controllable, and has better secondary characteristics. There is currently no method of guaranteeing the purity of clonal materials. Certification of clonal plants should be done by independent agencies.

One approach to increase the availability of clones at the provincial level is to have GAPKINDO members in the regions set up commercial nurseries with the help of professionals recruited from government projects or retired employees from estates in Bengkulu, Jambi, and North Sumatra.

Distribution of improved planting material (clones)

In addition to limited clone availability in the provinces, another constraint is clone distribution in remote areas. Several possibilities to address this issue are: 1) distribution through rubber collectors (village traders), 2) open sale ('cash and carry') in village markets, and 3) creation of distribution channels by the respective project.

There is also a clear demand for improved planting material for associated crops in RAS: fruits, timber, rice, legumes, cover-crop seeds, etc.

Conclusions

Quality of IGPM

Clonal purity is essential to ensure the expected level of productivity. Certification and a multiplication network through private nurseries, non-governmental organizations, and projects nurseries are key elements in the dispersal of RAS.

Actors

The main actors in this network are as follows:

- private sector (private nurseries);
- projects (TCSDP, partial approach DISBUN projects);
- official extension agencies (DISBUN, BPP);
- self-production by farmers' groups (village budwood gardens operated by the communities).

A very important question remains as to which institution will implement the certification process for private nurseries and other operators? The selected institution should be an independent agency supported by smallholder rubber organizations.

Group 3: Research Topics - Biodiversity

This group was led by Hubert de Foresta (ICRAF/ORSTOM) and Genevieve Michon (ICRAF/ORSTOM)

Further extensive research has yet to be conducted to assess the biodiversity status and evolution in RAS, including the following areas:

- characterization of the mosaic of rubber plots around villages, along roads and rivers, including the spatial arrangement of age classes and intensity of management,
- analysis of the spatial intensification of rubber, including assessments of present levels, changes, conversions and projected future levels of biodiversity over the whole mosaic,
- sustainability of biodiversity in rubber, covering the following topics:

  -influence of surrounding land uses,

  -influence of the surrounding forest (as a source of genetic material, particularly in Kalimantan),

-the transitional state in Jambi with the very large development of Forestry and oil palm private plantationd.

-effect of being surrounded by oil palm plantations for a long time (in Malaysia).

-determination of what level of biodiversity can be sustained over the long-term without having a forest nearby.

Development of biodiversity in RAS and jungle rubber

- Expected biodiversity levels at the "end of cycle" for RAS 1, 2, and 3.
- Monitoring biodiversity in RAS.
- Assessing the effect of weeding on type of regrowth and weed problem analysis.
- Assessing the process of reestablishing forest biodiversity over time (comparing jungle rubber of different ages for biodiversity, as well as for improves agroforestry systems such as RAS).

What can be done to preserve the current reservoir of species in jungle rubber?

- rejuvenation through tree-per-tree replacement (RAS 4 experiment),
- credit swap with conservation at the village level (institutional arrangements),
- identification of target locations for credit swap projects (e.g., Bukit Tigapuluh, Bukit Tigabelas and Kerinci),
- targeting of cooperating institutions (e.g., World Wide Fund for Nature (WWF), Overseas Development Assistance (ODA), Biotrop, the Center for International Forestry Research (CIFOR), ORSTOM, and universities.

The following questions were raised:

-Is there a clear definition of jungle rubber as distinct from secondary forest? This question was posed to point out that jungle rubber is not officially recognized as a real rubber-based cropping system, but is still perceived to be an enriched long-term fallow.

A clear trade-off exists between biodiversity and production. In this regard, how has the relative productivity between biodiversity and production been assessed? To date, no such assessment has been made due to the fact that the status and dynamics of biodiversity in RAS has still to be reviewed. The current hypothesis is that biodiversity of RAS 1 will be very similar to that of jungle rubber. Assessment of biodiversity levels for RAS 2 and 3 will need to be made taking into account the cultural practices and the environment.

-*Is oil palm or rubber the best cropping system for smallholders?* The best cropping system for smallholders is the one that they select based on their review of sufficient information on each system. The SRAP team favors a farming system with a combination of oil palm monoculture, improved rubber systems (RAS and/or monoculture), and old jungle rubber as a stock of land to be rehabilitated.

Conclusions and Recommendations for RAS

The primary recommendations for RAS development are as follows:

1) Identification of RAS components is needed.

In particular through the release of "technology patterns " for improved agroforestry systems(Booklet, leaflet, RAS manual. Farming systems surveys implemented in 1997 should help to identify a relevant farm typology with relevant criteria to select recommendation domains.

2) The type of development programme selected should be adapted to local situations: partial approach versus full package project (such as TCSDP).

The type of development project and its methodology is very important. In remote areas with almost no previous contact with any rubber projects, full package projects are preferable. In other areas where various rubber projects have been developed, even on a scattered basis, partial approach projects may be more successful due to the effect of "demo plots" from previous projects. In all cases, relevant technical information must be provided to farmers. Training of trainers may be implemented to provide farmers with the most current information, particularly on RAS. Another possibility is to use current SRAP plots as a demo-plot network for training.

3) It is essential to access the right extension institutions at the right level.

This is particularly true for the following topics: credit, training information, monitoring tools, and land tenure. Relevant institutions involved in rubber development must take into account the following trade-offs: 'rubber versus oil palm' (but both can be harmoniously developed), and 'farmers versus government' (both are actors of rubber development, but with different strategies and expectations).

4) It is necessary to:

a) change extension institutions' perceptions of farmers.

b) assess and improve the economic profitability of RAS in comparison with other alternatives (such as oil palm),

c) select priorities and recommendation domains (population targets),

d) take into account social cohesion of communities for innovation adoption,

e) develop clear argumentation on the advantages of RAS.

Bibliography

Delabarre (Tree Crops Smallholder Development Project (TCSDP), CIRAD, Rubber book 1995)

Penot, E. (1996). Improving productivity in rubber based agroforestry systems (RAS) in Indonesia : a financial analysis of RAS systems. GAPKINDO annual seminar, Sipirok, North Sumatra, Indonesia, March 196.

Penot, E. (1997). From shifting agriculture to sustainable jungle rubber in Indonesia : a history of innovations integration for smallholders in peneplains of Sumatra and Kalimatan since the turn of the century. workshop on "indigenous strategies for intensification of shifting cultivation in Southeast Asia, January 1997.