## 5. Towards sustainable and integrated rubber agroforestry

### *5.1 The necessary increase of productivity of rubber farmers*

Albeit a great effort from various rubber developement project, and in particular SRDP/TCSDP since the 80's, most of the farmers still do not have access to any improved rubber cropping system, due to the high cost of the SRDP/TCSDP package rubber cropping pattern, currently adopted in smallholders projects (TCSDP[6] and TCSSP[7]), showing the need to an internediate low cost but with high productivity rubber cropping system based on agroforestry. The constraints and opportunities to enable such increase of productivity have to be fully identified and resolved through the followings research themes :

- 1- the acquisition of a good knowledge of the smallholders sector, through the analysis of the existing bibliography and the implementation of surveys in not well known production zones (mainly Central and West-Sumatra and Kalimantan). This should enable the identification of an operationnal typology of situations and farmers (see table 2). Some topics still have to be well identified such as : the definition of a rubber grower, land tenure and property, labour relation and contracts betwen farmers, owners and labourers, credit schemes by midlemen, the risk management depending ecology and economic situation...
- 2 - after an analysis of the various situations of the smallholders sector : the identification of research topics and guidelines for on-farm experimentation, with priorities (see table 3).
- 3 - appropriate on-farm-experimentation in order to produce adapted RAS patterns. The objective is to create the good conditions for the evolution of the current rubber based farming systems (mainly jungle rubber with poor productivity) and to identify the adapted technologies for this evolution depending on environment, geographical and economical situations.
- 4 - an analysis of the indonesian rubber commodity system to produce recommendations in terms of rubber pricing policy and quality pricing policy to be adopted by rubber professionals in Indonesia and development objectives for non-projects smallholders in Indonesia.

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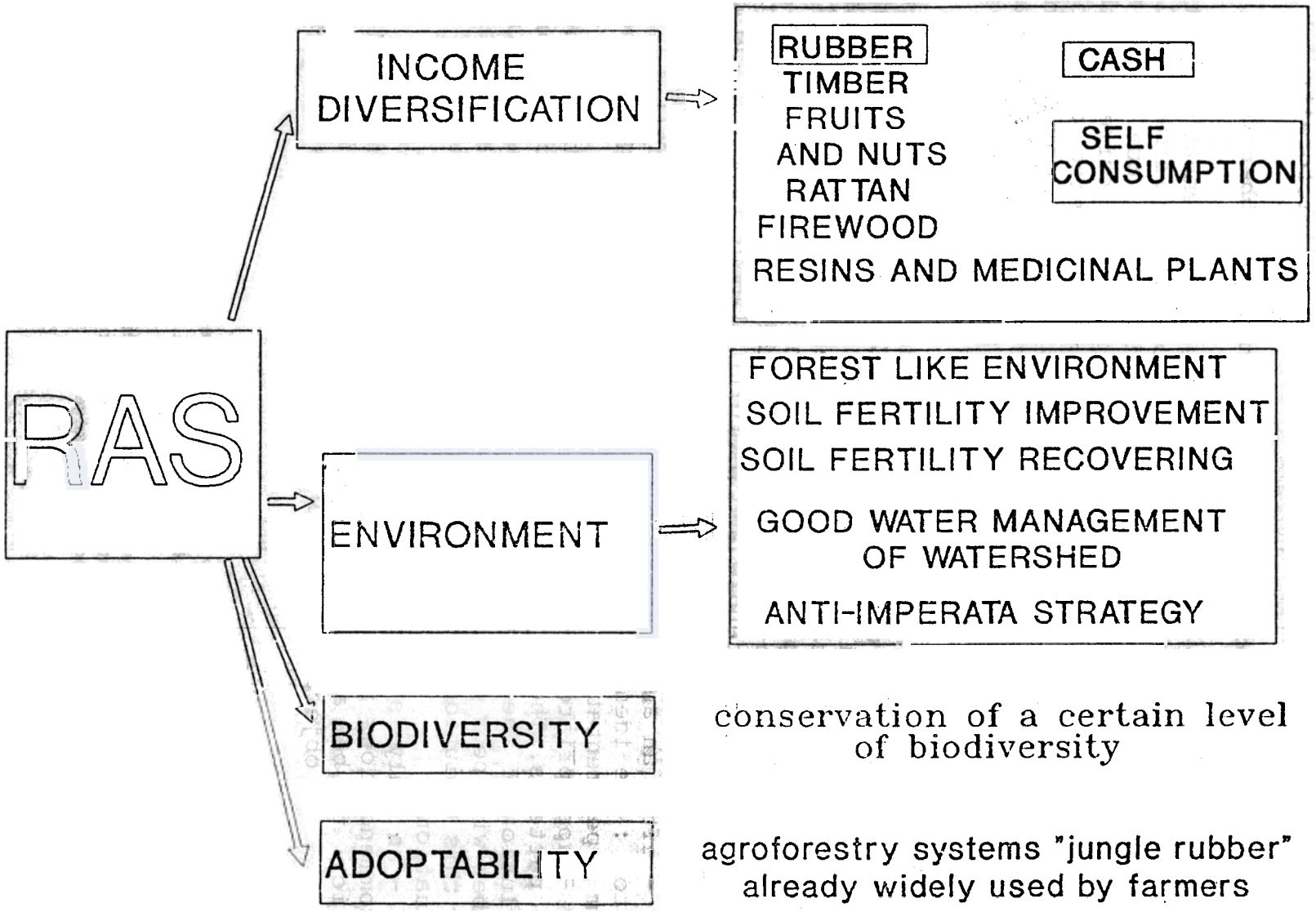
[6]TCSDP is funded by World bank and developed in the following provinces Bengkulu, West-Sumatra, Riau, South-Sumatra, Jambi, Maluku and West-Sumatra.

[7]TCSSP is funded by ADB and developed in the following provinces : Aceh, North-Sumatra, Lampung, South and East-Kalimantan. Both projects TSCDP and TCSSP are based on the same technological package for rubber.

table 1 ADVANTAGES OF RUBBER AGROFORESTRY SYSTEMS



**Rationale for a RAS concept definition**

RAS patterns are linked with the hypothesis of work which consists in the fact that the general increase of the productivity of the rubber based cropping systems, including rubber in itself as the driving force cashcrop but also side-products (fruits, timber, rattan....), and quality of rubber raw material are linked in a spin of intensification and necessary for rubber based systems sustainability. The various possible levels of intensification of RAS systems, should fit the farmers strategies and limited cash possibilities, with a low to medium level of input and labor in order to give an intermediate RAS patterns as an alternative to the current jungle rubber and the "estate like" technological package for rubber monospecific plot such as SRDP/TCSDP. As farmers already implement complex agroforestry systems such as jungle rubber, RAS patterns which management patterns are close to the current systems, are expected to have a high level of adoptability by farmers. Rubber based agroforestry systems have the advantages of beeing a source of income diversification as well as respecting environment and biodiversity.

Consequently, improving the current jungle rubber through conserving the very nature of an agroforestry system, that fits the farmers strategies and the local environement, appears as the very solution for a particular type of farmers, the class III farmers (see farmers typology), those who have a limited access to information, innovations, improved planting material and cash and credit, but have a strategy of intensification through the increase of their production, therefore of their income ; not only rubber, but also side-products from jungle rubber or improved agroforestry system.

RAS enable a certain flexibility and fit a strategy of farmer's income diversification through various level of production, outside rubber, in time during the RAS lifespan and in side-products (fruits, timber, rattan.....). RAS also may conserve a certain level of biodiversity and fits environmental concerns such as soil fertility and water conservation, forest-like environment and a sustainable and productive alternative to slash and burn process.

Two main situations have been so far identified leading to two main types of On-Farm-Trials (OFT)

- a) the improvement of jungle rubber where IPM, improved planting material, clones or CS/PCS, replace seedlings : a very basic level of intensification (with RAS 1), and
- b) the establishment of a complete complex agroforestry system,

after slash and burn and a first year of upland rice cropping, where rubber is associated with other perennial crops : this concept is very close to the current local existing agroforestry systems such as tembawang, based on Tenkawang ( RAS 2 and 3). The idea is to base the system on a valuable crop : rubber, that permit a reliable weekly source of income, added by perennials products (fruits, nuts , timbern ratan...).

RAS 1 is basicaly a jungle rubber system where rubber seedlings are replaced by adapted IPM. The main issue here is to assess the ability of clones to compete with this particular environment that is basicaly a secondary forest regrowth. Emphasis is put on IPM, and in particular some selected clones, adaptability to this particular environment where maintainance is at the lowest possible level. The second issue here is to assess the relevance of using CS/PCS in jungle rubber as a very low cost alternative IPM with a medium level of productivity. Emphasis is put on clonal material.

RAS 2 & 3 are real complex agroforestry systems established by the farmer after a slash and burn and first year of upland rice cropping (that is common to all RAS in fact), with a selection of perennials associated to rubber, a selection made by the farmer dependig on agro-ecological conditions as well as economic outlet and marketing channel. RAS 2 & 3 have basicaly the same frame during mature period of rubber. Instead of selecting some perennials in the natural forest regrowth as it is the case in jungle rubber, the farmer decides right from the beginning the combination of associated perenials with rubber. RAS 2 is aimed to good or correct soils conditions, where the trees are intercropped during immature phase of rubber by foodcrops, annuals such as rice, corn and leguminosae, or others such as banana, chili or pineapple. The maintainance of these foodcrops will enable a good establishment of the combination rubber + perenials. RAS 3 is aimed to degraded lands, poor soils, invasion of Imperata... where foodcrops are replaced by a combination of MPT's[8] and covercrops that enable to retore the soil fertility and to to create good conditions (shading, few or limited competition with rubber....) for rubber and associated perennials to grow correctly with a minimum of maintainance. Basically, RAS 3 is an anti-Imperata strategy RAS pattern where MPT's and covercrops should create a suitable environment for RAS establishent during immature period of rubber. RAS 2 & 3 are more intensified systems with different management patterns during establishment and immature

[8]MPT's = MultiPurpose Trees

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**FARMERS PRIMARY CLASSIFICATION**
TABLE 2

| FARMERS SITUATION | ACCESS TO TECHNICAL INNOVATIONS | TYPE OF ZONE | QUALITY OF RUBBER | TYPE OF PLANTATION | TYPE OF ZONE | AVAILABLE DOCUMENTATION | RESEARCH TOPICS |
|---|---|---|---|---|---|---|---|
| PROJECT FARMERS TCSDP/SRDP NES/PIR 13 % | +++ | PROJECTS | latex cup lump<br>generally good | estate like<br>full technological package | South Sumatra (Prabumulih...)<br>West Kalimantan (Sanggau, Sambas....) | yes | bibliography synthesis and analysis |
| NON PROJECT FARMERS 87 % | | | | | | | |
| Non isolated : close to projects access to credit, information and clones PARTIAL APPROACH 10 to 12 % estimated | ++ | CLOSE TO PROJECTS | latex cup lump<br>fair to low | partial technological package<br>tendancy to the estate like model plot)r rubbefic speci(mono | South Sumatra Lampung<br>western part of West kalimantan<br>North Sumatra | yes<br>some<br>some | bibliography synthesis<br>surveys On Farm Trials : "rubber monospecific plot oriented" |
| moderately isolated intermediate situation 50 % estimated | + | REPLANTING ZONES | low | jungle rubber<br>plots planted with clones in some places | Jambi Riau Bengkulu West Sumatra Aceh South and<br>Central Kalimantan | few | surveys On Farm Trials : "rubber monospecific plot oriented" and "rubber agroforestry system oriented" |
| isolated no access to credit extension and clones 25 % estimated | - | PIONNER ZONES | low | jungle rubber | Ceram Irian Jaya<br>Pionner zones ial zones | very few to non existant | surveys On Farm Trials : "rubber agroforestry system oriented" |

rubber phase.

Eventually, a trial, RAS 4, looks at the possibility of a tree by tree replacement for very low input RAS. The RAS 4 is a trial that permit a smooth shift from an existing jungle rubber to an improved jungle rubber type RAS 1 through a replacement of the old trees by clones, tree by tree. This technique is very low cost and adapted to farmers with very limited cash or credit opportunities, those who are in very remote areas or class IV farmers. The idea is also to test the capacity of integration of improved planting material in an existing agroforestry.

All OFT considered in SRAP are participatory approach OFT where the final design of each trial is discussed with the farmer and where the trial is fully under farmer's management. Participatory approach includes discussions and assessment of the trials with the farmers at least every year in order to collect the farmer's feedback on RAS implementation. Basicaly, each farmer will have a basic plot of 1 hectare, including several treatments in term of labour input and planting density, or in perennials distribution in association with rubber, but with one clone only. Each farmer's plot may be considered as a replication.

RAS are not fully fixed rubber based technological packages. They are basically composed of some fixed components (panting density, IPM....) with variable components (associated perennials, MPT's....) depending on farmer's strategy, socio-economical context and agro-ecological environment. Therefore the generic word "RAS patterns" seems to reflect better this open concept of RAS systems rather than "packages".

**Recommendation domains for RAS implementation**

The rubber farmers may be divided in 4 types as presented in the table 1. A methodology of analysis has to be identified[9] in order to deal with the variability of situations of the smallholders The productivity of such farmers has not significally change since the beginning of the century with the boom on rubber in Sumatra. The very first issue is to increase the productivity from the current rubber yield of 300/600 kg/ha in jungle rubber to a yield of 1300 to 1800 kg/ha (with clones), with a good quality of rubber raw material, through the adoption by farmers of low cost RAS patterns (Rubber Agroforestry Systems) close to their current cropping patterns.

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[9]The research done by Anne Gouyon and C Nancy in South-Sumatra (1988-1991 can be used for that purpose.

This increase of productivity implies the adoption of rubber IPM (Improved Planting Material), mainly clones, but also CS/PCS for specific situations. A lot of research has been done (IRCA-CIRAD-CP/France, RRIM/Malaysia, IRRI/Indonesia, RRIC/Sri Lanka.....) to improve rubber production in estate conditions, leading to the release of a well identified improved technological package for rubber. So far, basically, a similar to estate technological package has been adapted to smallholder. The best example is the one used by SRDP in the 80's in Indonesia (and still used by current projects). This package is based on the use of clonal rubber, in a rubber monospecific cropping system, with a high level of maintainence for the immature period and an adapted exploitation system for tapping[10]. It is a well-tried and well known package, but it is an expensive one, that does not fit the farmers capacities without technical and financial help from governmental projects[11].

So far, no adaptive research has been done to improve the productivity of such systems without destroying their very nature : an agroforestry system based on rubber, where rubber is the main cash-crop, but not the only source of income, beside other advantages. Basically, the key question is wether high yielding IPM, and in particular the clones, can be cultivated in RAS or do require monoculture conditions. RAS patterns will be tested through OFT keeping in mind that RAS are only "open" models. Through participatory approcah, farmers will have the final decision for some RAS components such as the type of perennials associates with rubber or the level of maintainance, depending on local factors, both ecologic or economic. RAS 1[12] pattern will have the advantage of a very high level of adoptability by farmers as RAS 1 is very close, in term of management, to the current jungle rubber system and as farmers express a strong demand for a clonal planting material adapted to these conditions. RAS 2 and 3 patterns are complex agroforestry systems where rubber is the main driving force in term of income and also the main component, established just after a ladang with various level of intensification and adaptation to degraded lands.

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[10]The rubber exploitation system includes the tapping patterns (frequency.. the panels management (downward and upward), the use of stimulation....

[11]The average cost for a plot of 1 ha for SRDP project was 2 000 US $.

[12]RAS 1 pattern is a system similar to jungle rubber where the rubber seedlings have been replaced by IPM, in particular clones (see the paper SRAP project proposals).

The key question for developers, and therefore for researchers, is the following : to which extend the jungle rubber system may contribute in the future to these multiple objectives : a) the increase of the farmer's income, b) the increase of the farmer's productivity, c) the increase of quality of the preprocessed rubber raw material and d) the preservation of forestry environment and biodiversity.

Regarding the productivity of an improved rubber agroforesty system (RAS) : what are the main components of the evolution of jungle rubber for a better productivity ? How to valorize this biodiversity ? which crops may be suitable with rubber in RAS ? What are the importance and the future of secondary use of rubber such as wood....?

### 5.2 *The need of intermediate rubber agroforestry systems (RAS) with various level of intensification.*

Two basic problematics have to be taken into account :
- *the pionner zones* : how to improve the jungle rubber pionner system, within the available means of farmers, or to which extend, and at which cost, it is possible to improve it, in order to give to the farmers the opportunity to have a better productivity for the new planting ?
- and *the replanting zones* : how to create the favorable conditions to the shift from an ancient jungle rubber plot, into an improved system : RMP (TCSDP policy) or RAS, at a low cost, with a partial approach ?.

In both cases, the need for technical innovation, information and training, level of cost and credit and development policy priorities should be assessed.

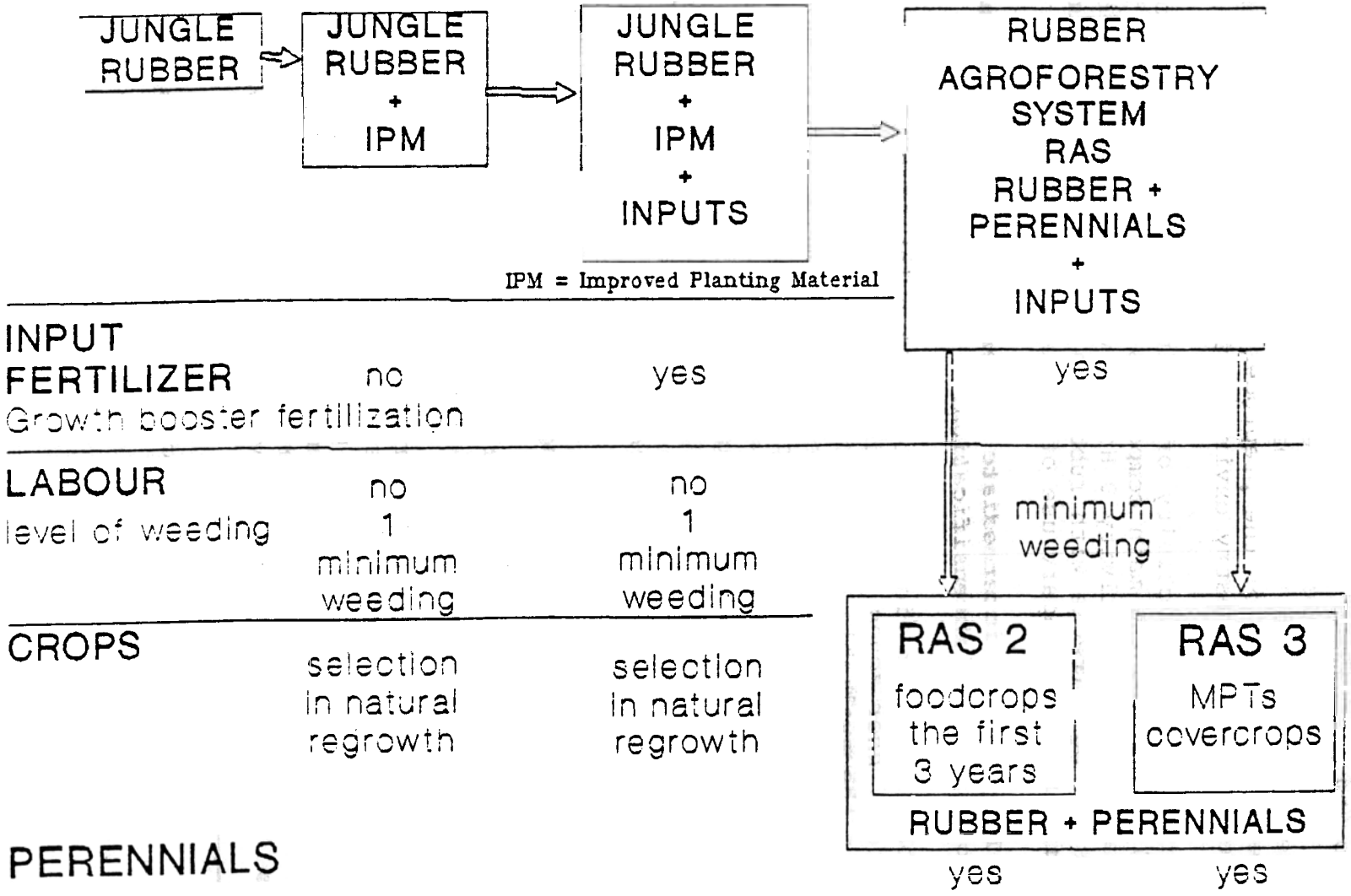
#### *Possible evolution of jungle rubber.*

Jungle rubber may have different paterns of evolution, depending on farmer's situation and on ecological features :

*- 1- The shift from rubber-forest to Rubber Monospecific Plot (RMP) :* the existing recommendations are clearly identified now in what could be considered as the "TCSDP package"[13]. The main component of this package is the clonal planting material. Projects (TCSDP, NES, GAPKINDO, DISBUN.....) and private nurseries operators have widespread a certain number of clones in some provinces since several years to class II

[13]Full technological package for rubber, considered as the "estate" package transplanted for farmers.

# RAS PATTERNS LEVEL OF INTENSIFICATION



farmers, however the purity of clones is not always guaranted.

- *2 - The shift from rubber-forest to an improved Rubber based Agroforestry System (RAS)* .The objective is to increase the global productivity of this complex agroforestry system, without destroying their very nature. This is clearly a priority objective that concerns the very majority of farmers. Environment aspects and biodiversity have to be taken into account. The different level of biodiversity (from the secondary forest to the introduction of associated crops, such as fruit and timber tress, firewood trees etc..) of such systems should be assessed and valorized. The use of IPM is the first component to be tried. The introduction of improved planting material is not the innovation in itself, but the innovation is in its use in improved RAS where the problem is the ability of clones to compete with secondary forest or the balance with other associated perenial crops. Differents levels of intensification should be studied

The IPM unavailability (in particular the clones), limited cash availability for IPM, the lack of credit, the lack of information force a vast majority of farmers to stick to the current jungle rubber system, without any improvment. The introduction of IPM into this sector may enable a consequent increase in production. The shift from jungle rubber to RAS and identification of such suitable RAS systems adapted to local ecological and economic situation is the main objective. The sustainability and the productivity of RAS should offers an alternative to slah and burn in deforestation and pionner zones, or in remote areas.

The level of intensification in RAS shoud fit the farmers possibilities in term of labour and financial input (therefore inferior to those required for a TCSDP plot for instance) and reach a level of RAS productivity that generates sufficient income to permit farmers to rely on cash from rubber and by-products such as fruits, timber, firewood, rattan, etc...The adoption of an rubber based agroforestry system (RAS) enabless the diversification of income sources as well as some different alternatives of evolution at the end of the RAS lifespan (or rubber plantation lifespan) : to remove the old RAS by a new RAS, the shift from RAS to a monospecific rubber plot, like in TSCDP, or to conserve a fruit and timber oriented agroforest (such as tengbawang system in West-Kalimantan).

The principal constraint in Indonesia rubber production has been identified as the quality and the potential of planting material. The clone remains one of the main reliable answer for increased production and productivity, but it requires a minimum of investment (cost of the planting material and labor for maintainance). The use of clones may

enable the latex production to be doubled or tripled. Equally, it is recommended also to test clonal, or polyclonal seedlings, such as BLIG (Bah Lias Isolated Garden, North-Sumatra), in order to test their behavior and their real potential. Previous surveys of smallholders and estates show a great demand and interest in IPM, in particular if they are adapted to their specific local conditions. It is thus necessary to have a better knowledge about the performance potential of these IPM in various situations, including the rubber-forest situations. This must be based on experimentation in real conditions in non-project farmers (RAS).

**The improvment of productivity through the adoption of IPM.**

Historicaly, the presence in the very early beginning of the rubber planting boom in Sumatra, of active Research Centers (AVROS in Indonesia) enabless Indonesia, in particular the estate sector, to profit from the release of famous clone[14]. The adoption of IPM is the very first step to improve productivity. But the smallholder sector still did not do this "varietal revolution", as adoption of IPM has been limited to development projects and, in some areas, to wealthy farmers able to buy clonal planting material where nurseries have been developped by the private sector (mainly South and North-Sumatra). Developing and improving RAS systems means the adoption of adapted IPM with a low cost of production for the farmers, and probably, by the farmers themself. Adaptive research has to be done in order to identify the IPM component of RAS package ad low production cost techniques. *Concerning On-farm-trials (OFT), emphasis should be put on clonal testing and then recommendations adapted to the farmers conditions.*

The availability of clones, or CS/PCS, should be improved in various locations through the implementation farmers nurseries programmes (A Gouyon 1990, C Barlow 1993, C Bennet-Quizon-Mawardi 1991..). Then, it is an important issue to guarantee to the farmers the quality and purity of the improved planting material, in particular in the case of private nurseries. *The supply of certified clonal planting material[15] to smallholders is a major issue.*

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[14]Such as GT 1, PR 107, PR 255, PR 261, AVROS 2037 in the past (and still grown but not all yet recommended), and, more recently : BPM 1, 24, 107, 109, the PR serie : PR 255, 261, 300, 302, 303, 307, 309, 311, 314, and TM series.

[15]These clones may be : RRIC 100, BPM 1, PB 260, PR 261, RRIM 600, and TM 8 or 9....depending on agro-ecological zones (pressure of diseases and wind-damage).

The cost effectiveness and growth effectiveness of the use of economical doses of fertilizers to boost growth have to be assessed. BLIG planting material has also to be assessed in such conditions.

The goal, in term of rubber production as the main cash crop, is to reach a yield of 1 000 to 1500 kg/ha (as also maximization of other associated perennial crops) in order to create a real improvment from the existing situation in trem of productivity. It is assessed that a slight increase od rubber yield may not be sufficient for the farmers to modify their current practices.

The goal for RAS as a whole is to increase the farmer's income by raising productivity of RAS, including others production as well as rubber. Other crops, naturaly grown (wood species) or introduced (rattan...) have to be tried under farmers conditions[16]. This experimentation is clearly very new as there is no experimentation already done in other countries. The objective of these experimentation is to give the possibility to the farmer to stand an agro-forestry system, in suitable locations (pionner zones, isolated zones, buffer zones .....), with a high level of productivity in term of rubber production.

The sustainability of RAS depends on the best compromise between the required and available labour, the RAS cost and the real cash availability, the technical feasability of clone introduction, and the increase of productivity in this particular environment. Optimization of other crops depending on situations has to be tried. This experimentation should take into account the limited means of the farmer, so, the limited RAS patterns that will fit both the strategy and the means of the farmer. Labour is one of the main factor to be analyzed, depending on typology. Rattan should be emphasized as there is already some experimentation in research stations that gives a good scope for that crop. The economical outlet of each crop should be assessed under the local conditions (in particular for wood and fruits...). Firedwoods and fast growing trees with possible side-use (*Leuceana, Glyricidia...*) may be tried....like other wood species (*Albizzia Falcata....*) or timber trees.
The biodiversity and forest-like environment of RAS system is also a factor to be taken into account, in particular for RAS type identification.

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[16]Some interesting results came out from experimentation done in Sungei Putih (North-Sumatra).

The farmers and situations typology will enable to identify which toppic, in which situations, has to be emphasized in experimentation. Other toppics taken into account for the set-up of the OFTs may be: the problem of Imperata, the levels of intensification, the economic outlet and opportunities for by-products, the labour use.....

Rubber cropping patterns, including associated crops, sustainability and productivity, biodiversity and environment conservation are key-words in this process of shifting from the current non-project smallholders situation, characterized mainly by "jungle rubber system", to improved rubber cropping patterns taking into acount the available means of farmers and ecological and economic environment. OFT have to be defined (protocoles and methodology...) and implemented in order to give answers regarding the improvment and evolution of such systems. The identification of suitable evolution of the jungle rubber depends on geographical and economical situations. An operational typology of both situations and farmers should help us to obtain a zoning, identification of priorities, OFA priorities and, future, development policy recommendations based on technical recommendations.

There is no doubt that RAS systems are one of the possible rubber development policy tool, as an alternative both to the increase of rubber planting almost everywhere in Sumatra and Kalimantan by smallholder with few input capacity that leads to a low productivity for the next 40 years of the newly planted jungle rubber plot, and also to the current rubber development projects, relatively successfull in term of implementation, but far too expensive for beeing able to reach a consequent number of farmers in the mid-term. RAS constitutes an intermediate low input technology, adapted to the farmers current cropping patterns, with a probable high level of adoptability by farmers by conserving the very nature of agroforestry, with a high productivity for rubber and also other associated perennial crops. Emphasis should be put in the identification of RAS components.

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