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A PROJECT PROPOSAL TO INCREASE INCOME FROM INDONESIAN RUBBER-BASED FARMING SYSTEM SMALLHOLDINGS

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1. BRIEF REMINDER OF THE RUBBER SMALLHOLDERS' SITUATION IN INDONESIA.

Rubber is an important tree crop in Indonesia, contributing some 4-5% of total export revenue (or 12-19% of non-petroleum export revenue) in the 1980s (Bank Indonesia, 1987). About two thirds of Indonesian rubber output comes from smallholdings, which are chiefly located in Sumatra and Kalimantan (Table 1). The total planting of 2,117,900 hectares of rubber smallholdings in 1983 involved some 4 millions people in 674,200 households, 1.9 hectares of which were being tapped, 0.7 hectares were immature an 0.5 hectares were "old and unproductive" (Direcktorat Jenderal Perkebunan 1986). About 800,000 hectares are more than 30 years old and should be replaced within the next 10 years.

Rubber is an excellent crop for smallholders, being labour-intensive, able to provide a regular source of income, and reasonably tolerant of indifferent upkeep, provided initial establishment is successful. It is also a crop where Indonesia, with its relatively low wages and ample land has a comparative advantage over the other two major rubber producing countries, Malaysia and Thailand. Currently, however, smallholding yields (including the immature portion) came from the unselected seedling materials of cultivated at a deficient technical level. The quality of smallholding rubber output is also inferior, with extensive further processing being generally needed to produce a low grade product for international markets.

The situation in South Sumatra and in Kalimantan reflects more than 50% of the overall situation in Indonesia.

Several limiting factors for rubber development have already been mentioned (Barlow *et al.*, 1982, 1987):

a) The continued planting of unselected seedlings which results in poor performance.

b) The indifferent or lacking upkeep of both immature and mature rubber trees.

c) The low tapping standards.

d) The general limitation of cash preventing any minimal purchase inputs.

e) The lack of training and information concerning possible technical improvements.

f) The poor roads and access to major towns.

Table 1 Planted Area (ha) and Production (tons) of Smallholder Rubber in Kalimantan and South Sumatra

Location	Immature	Mature tapped	Old and unproduc	Total	Total Produc
S. Sumatra	129,423	287,696	73,020	490,139	154,669 (538)
W. Kaliman	52,963	229,491	38,261	370,715	107,853 (470)
C. Kaliman	14,129	87,744	19,465	121,338	38,677 (441)
S. Kaliman	23,674	48,805	7,384	79,863	26,113 (535)
Total for the two provinces	220,189	653,736	138,130	1,062,059	327,312
Aceh	7,015	20,981	3,002	30,998	11,351
N. Sumatra	38,536	193,829	35,442	267,807	105,791
Riau	71,907	148,710	59,584	280,201	69,938
W. Sumatra	4,598	49,343	606	54,547	28,250
Jambi	106,425	208,727	67,750	382,902	107,294
Bengkulu	11,678	17,478	4,776	33,932	7,769
Lampung	4,246	13,488	2,826	20,560	6,077
W. Java	6,972	13,956	1,063	21,991	7,068
Others	2,288	8,880	1,715	12,883	2,705
Grand Total	473,854	1,329,128	314,894	2,117,876	673,555

Figures in () brackets are yields in kg per ha of mature tapped area.

Source : Direktorat Jenderal Perkebunan (1986)

2. PROJECT JUSTIFICATION

2.1. Support Justification from EEC

In 1988, with world consumption of around 5 million tonnes of natural rubber, the EEC imported over 850,000 tonnes to meet the requirements of its industry. Europe is therefore an important natural rubber consumer and it would seem necessary for all the European professional organizations in the rubber sector (including IRCA) to pay particular attention to supply sources, both as regards quantity and quality.

With production reaching over 1.2 million tonnes in 1988, Indonesia is the second largest producer of rubber. 80% of its production comes from smallholders. It is important for this sector to continue producing good quality rubber under attractive economic conditions.

Most of the *Hevea* development projects have so far been funded by the World Bank. In view of Europe's importance as a consumer, Indonesia would like to receive Community support in this field, to help it produce better.

2.2. Technical and economic justification

As already seen, hevea smallholdings in Indonesia cover over 2,000,000 ha, 800,000 ha of which are over 30 years old. Production per hectare is low, with an average of 500 kg per ha.

Development officials will be faced with two problems in the coming years :

- How to improve the tapping of existing trees,
- How to ensure the success of replantings which commit smallholders for 25 to 30 years.

Only a limited number of smallholders benefit from supervision and receive technical assistance from national agencies.

Moreover, the research resources devoted to smallholders are not enough to produce results and apply them.

The aim of the project is specifically to go to the limits of research and development, so as to strengthen the structure for finding technical solutions, and to ensure that they are applied.

The best way to reach smallholders is to set up pilot plots under the conditions encountered by the smallholders themselves.

Demonstration plots will therefore be set up with smallholders at several locations in South Sumatra and West Kalimantan.

The relations between Research Centres and this project will enable techniques to be developed whose results can be tested in the field. The unquestionable results will then be put forward in recommendations made available to development organizations and smallholders.

The impact of such a Research/Development pilot project on hevea smallholdings should have considerable positive consequences which to beyond this project alone.

2.3. Existing Research Availability

The Ministry of Agriculture is responsible for planning, implementing, monitoring and evaluating agricultural development programmes and policies in Indonesia. The main objectives of these programmes are to increase agricultural output to improve farm income and to contribute to capital formation. The Ministry has a number of sub-units: the directorates, The Agency for Agricultural Research and Development (AARD), the Agency for Agricultural Education, Training and Extension (AAETE), the Secretariat and the Inspectorate General. The Ministry has regional offices with coordinating responsibilities, and in the provinces, districts and sub-districts there are regional Agricultural Services under the provincial governments, which have close links with the directorates.

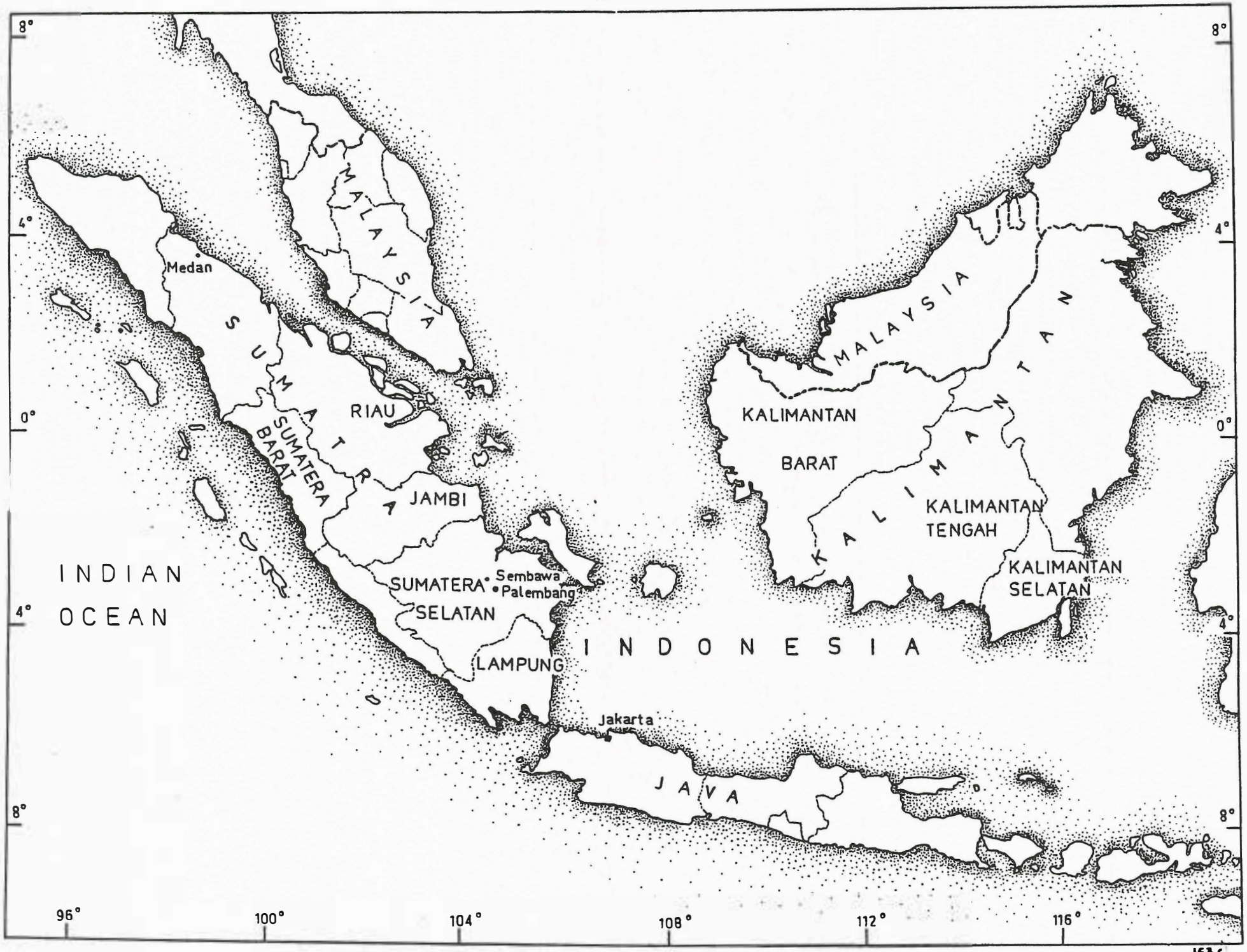
In this structure there are four directorates with the separate responsibilities: food crops, animal husbandry, fisheries, and estate crops. There are also four possible Regional Agricultural Services.

Other bodies such as Dinas Pertanian (Agricultural Advisory Service) also play an important role, since about 30 non-administrative staff are employed to take care of almost 300,000 tree-crops farmers of various kinds in South Sumatra.

Recently, the organization of estate crops research (oil palm, coconut, *hevea*, etc.) was modified and led to the creation of the Indonesian Planters' Association for Research and Development (IPARD).

The establishment of IPARD was a long-overdue response to a need to improve the specific research efforts of the ten (10) Institutes involved with these commodities and to improve the coordination of these Institutes as a group. The research programme for these commodities is for the benefit of public and private estates, as well as smallholders and, historically, had not kept place with the development and expansion of these crops in Indonesia.

The proposed project sets out to reinforce, if not inspire, a certain dynamism at IPARD in the smallholder sector.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3. PROJECT COMPONENT

The Sembawa experimental station in South Sumatra will be the main project location. It is right in the middle of a smallholder type hevea growing development zone and will have an important role to play in setting up experimental plots and testing the transfer of the results obtained to the surrounding smallholdings.

However, as ecological conditions in Indonesia differ considerably, demonstration and observation plots need to be set up wherever a hevea growing effort is being made in the country.

The installations would be based on the local development network they would be located as follows :

- South Sumatra or Sumatera Selatan
- Jambi
- West Sumatra or Sumatera Barat
- Riau
- Lampung
- West Kalimantan or Kalimantan Barat
- South Kalimantan or Kalimantan Selatan
- Central Kalimantan or Kalimantan Tengah.

The project's different themes are described in this section.

3.1. **Studies of farming system models and farming system technology for smallholders.**

- The problems posed by tree planting density per hectare, along with the tree planting design have been covered in numerous studies since the start of hevea growing.

A synopsis of these studies and an exhaustive bibliography have been compiled in the latest works on hevea growing

1. Le Caoutchouc Naturel - P. Compagnon, 1986, pp 201/206.
2. Rubber - cc Webster and Wj Baulkwill, 1989, pp 186/192.

However, whilst a clear distinction is made between the problems posed by hevea grown exclusively on large estates and those posed on smallholdings, trials have particularly concentrated on planting density on large estates and on temporary intercrops, though always with hevea as the long-term dominant monoculture. Few trials have been conducted on a long-term basis, with permanent intercrops and few reliable recommendations have been made in this field.

° On large crop-single estates almost everywhere in this world, the main aim is to achieve approximately 400 trees/ha at the start of tapping. Gradually, as the estate grows old, according to the observations made, it is accepted for many reasons, that this number of trees can gradually drop by 2% per year, leading to a density of around 300 tapped trees for a 25 year-old plantation.

This situation is a compromise between production per hectare and production per days work, two constraints much associated with a large estate.

Nonetheless, these recommendations are only valid for known clones, the example of GT1 is typical. This clone, which is the most extensively used, offers good average development (trunk and crown). With the arrival of clones offering rapid growth and well developed crowns in extension work, planting density and planting design projects need to be determined in accordance with the clonal typology in question.

° As regards permanent intercropping on smallholdings or large estates, consideration has to be given to planting density and planting design, with a view to :

* either establishing a long-term balance between hevea and the intercrop, whether this be from a crop development point of view, or from an economic angle, by taking into account all the parameters having an effect on income, including the sharing of risks between one crop and the other.

* or considering hevea as an occasional crop, allowing the intercrop to become the main resource, with hevea only being tapped in favourable periods.

° As regards to the strict point of view concerning planting designs and planting density, bearing in mind that, in this case, production per hectare becomes the main objective and taking into account the rapid main objective and taking into account the rapid ground cover, clear recommendations need to be made.

° Already, in certain smallholder projects, the densities recommended are on the increase compared to the densities used so far.

The conventional planting density is 450 to 500 trees/ha, whereas the recommendation for the DGE's TCSDPet and TSSDP projects is 600 trees/ha.

The densities adopted for the SRDP smallholdings are 555 trees/ha.

Nevertheless, this tendency needs to be brought under control, so that smallholdings can benefit from reliable and optimum recommendations. Should densities be increased according to the clones used ?

° In order to increase the income of hevea smallholders limited by the area of land available to them, the optimum production per hectare needs to be found, either with hevea monoculture, or with rubber based permanent farming system.

In the case of monoculture, endeavours are made to increase rubber production per hectare, even if the number of days work increases. In the second case, attempt are made to find the best balance in the permanent intercropping of hevea with another perennial or annual crop.

A multi-site trial on smallholding in South Sumatra and in Kalimantan is necessary it should lead reliable recommendations for development officials.

- Research activities also include studies on the technology for smallholders such as low cost land preparation, low cost weeding management, fertilizer application as well as intercrops adaptation.

3.2. Adaptation of planting material

- Clonal diversity is virtually essential to guarantee the long-term future of hevea plantations on a regional scale. The economic lifetime of hevea is around 30 years. Differences in planting material characteristics and performance are the only ways of coping with sudden accidents that threaten a plantation made up of genetically identical individuals. Moreover, only clonal diversification can provide a response to any developments in techniques that were still unknown when the trees were planted and which would not be adapted to all the clones. In this respect, the example of how clones react to stimulation and a reduction in tapping frequency provides a very clear demonstration.

- Given these remarks, there are certain problems in hevea growing in Indonesia. Indeed, large-scale smallholder development projects such as SRDPI, NES/PIR and PRPTE, which involve tens of thousands of hectares in South Sumatra and Kalimantan, only used a single clone, GT1.

  It is true that other clones were recommended, such as PR 261, AVROS 2037, BPM 1, BPM 21, BPM 24, PR 255, PR 228, PR 300, etc, but these recommendations are not backed up by regional results, in long-term projects. These recommendations therefore lack reliability, hence the caution of development officials who hesitate to use a planting material whose performance is little known, or not at all, in the region where they operate.

  This does not mean that the clones mentioned, and others too no doubt, are not valid under the conditions of the project, but in view of the lack of information at a regional level, no-one can take the risk of diversifying planting material, especially in smallholder type projects where the risk for small farmers is intolerable.

- In the context of a research/development project oriented towards small farmers in South Sumatra and Kalimantan, it is thus important to test high-performance clones, to confirm (or otherwise) their performance depending on local ecological conditions and cropping techniques.

If there were conclusive evidence, at least in the early years, that the planting material performed well, reliable recommendations could be made.

° In order to arrive at these recommendations, a selection/recommendations programme should be set up rapidly, with a view to providing estates with planting material whose agricultural characteristics provide the best performance and are best suited to the environmental conditions and the utilization in question.

The characteristics of interest to estates are

* very rapid immature growth, making it possible to reduce the tree's non-productive period,

* Quick starter,

* high production per hectare obtained through high yields per tree, good plantation homogeneity and resistance to destructive factors, such as wind damage, or production limiting factors (dry cuts, poor bark regeneration, leaf diseases, etc.),

* high output per tapper, obtained by having planting material that is well adapted to the tapping systems which meets the country's economic requirements.

The main priority of the selection/recommendations programme is thus to provide farmers with planting material, but also to incorporate new data concerning farming and tapping techniques, in liaison with other research disciplines.

° Catalogue of Selection/recommendations programme activities

* **Distribution activities**

These include providing farmers with the currently available clones, whose agricultural characteristics offer the best performance and are best adapted to the environmental conditions and utilization in question.

At present, this means clones grafted onto illegitimate families of stumps.

In order to satisfy demand, breeder activity is required on two levels

1. Collection and distribution of planting material

This involves turning collections into "living" collections by directing them towards development activities.

In this respect, three types of budwood gardens can be envisaged :

- **"collection"** budwood gardens, containing all the clones existing in the country, but regularly enlarged through new introductions from national and international hevea breeding centres,

- **"holding"** budwood gardens, reserved for clones likely to be planted, but whose characteristics are still not completely known,

- **"development"** budwood gardens, making it possible to supply a sufficient quantity of budwood to set up small plantations or commercial-scale budwood gardens for estates undergoing extension or rejuvenation.

2. Clone studies in comparative trials,

in which land is given over to assessing the agronomical qualities of the planting material, in accordance with a given protocol. This involves yield observations and measurement interpretation, but also the distribution of results and information to farmers. This activity is always a great success, since choosing clones is a tricky business. As we have already indicated, the particular type of production involved with hevea, characterized by latex collection on a continuous basis and an economic lifespan covering many years, means that good knowledge of clone characteristics is required, both in terms of their production potential and their secondary characteristics.

The information obtained concerns growth, production, susceptibility to breakage and to leaf and trunk diseases, susceptibility to dry cuts, wound resistance, etc. The experimental designs should take account of hevea sensitivity to land heterogeneity and to the stump and should therefore be on a sufficiently large scale (small-scale comparative trial, large-scale comparative trial, monoclonal trial).

Each type of experiment should be standardized and satisfy carefully defined objectives. Experience has too often showed that the extrapolation of results obtained on inadequatly size plots to a commercial scale is meangless and can even be dangerous. The knowledge acquired of a clone's agricultural value can only be valid if the necessary resources are brought into play.

* **Increasing knowledge of planting material**

Beyond the simple concept of distributing adequate planting material to farmers, improvement must also involve the integration of needs and the results of other disciplines, so as to provide a maximum amount of information about the different clones and facilitate their utilization.

For example, the progress made in stimulation has made it possible to recommend using AVROS 2037, whose slow-starter characteristics without stimulation were detrimental to profitability.

The different types of interaction with other discipline include :

- study of stump/scion relationship,
- tapping systems,
- planting density and design,
- study of the possibility of establishing crops in marginal zones.

3.3 Studies of low cost treatment against rubber tree diseases

Numerous cryptogamic diseases have been identified by phytopathologists in Indonesia. They occur in all parts of the tree : roots, trunk, branches and leaves. At least three of these types can now be considered as significant limiting factors : root rot, leaf anthracnoses and bark dryness.

Root Rot

Hevea brasiliensis is suceptible to several root diseases, but most of the damage caused in Indonesia is apparently only due to a single fungus, Rigidoporus lignosus, which is the agent responsible for white root rot. The losses caused by this parasite throughout the country are difficult to estimate with any accuracy. However, records kept on young plantings in North Sumatra since 1987 show that they can reach a mortality rate of 5% per year. Likewise, observations made in Kalimantan indicate very high parasite pressure in this region. Certain plots planted in 1985 already had over 20% losses by the end of 1989.

The development of an effective control method has already been the object of much research in Indonesia and more or less was successfully developed on a commercial estate in West Africa in 1985. Attempts were made to transpose this technique directly to North Sumatra, also on commercial estates. The initial results obtained show that this method first needed to be adapted to Indonesian conditions, so as to be able to apply these control methods to smallholdings.

The use of sulphur for root disease prevention has also been used by planters. This also need to be studied under smallholder condition.

Leaf Anthracnoses

In North Sumatra and West Kalimantan, the main leaf parasite is currently Colletotrichum gloeosporioides. This fungus attacks young shoots and can cause total defoliation at sensitive stages. The tree then emits new leaves, which are immediately attacked if conditions remain propitious to disease development. In West Kalimantan, up to 7 defoliation-refoliation cycles were observed in 1989. Tree growth and productivity are severely affected.

The existence of another leaf parasite, Corynespora cassiicola should also be noted. This disease recently proved to be particularly destructive in other countries, especially Sri Lanka. It should be wise to consider research into this disease right away.

The best method for long-term control of these leaf parasites seems to be genetic selection. This will require more in-depth studies of the resistance levels of the different clones, identifying, where possible, the factors that determine such resistance. This line of research should be accompanied by a pathogen population study and a study of host/parasite relationships, so as to recognize the types of resistance observed and assess their strength and the impact they are likely to have on parasite development.

The contribution to be made by the work involved in this project is to enable short and medium-term, profitable exploitation of the land areas already planted. Needless to say, the considerable amount of work already undertaken in Indonesia and elsewhere will have to be taken into account. At the moment, there is even a series of fungicide treatment experiments being conducted in west Kalimantan. They were set up under the National Plant Protection Project. The effectiveness of these initial trials has proved to be moderate. This work should be continued and should examine the possibilities of using new application equipment, new active ingredients and formulas adapted to be the types of treatment being tested.

Another potential line of research worth looking into is to adopt an anticipated artificial defoliation system, which has been successfully used for 5 years in Cameroon. Once again, the technique was developed on commercial estates. It would be worth examining the possibilities of adapting it for use in a smallholder sector.

Bark dryness

Smallholder farmers usually use high frequency tapping systems leading to disease called bark dryness (brown bast). The prevention and cure of the disease are so far unknown and need to be studied.

In addition to these main parasites, there are numerous other pathogens (Corticium sp., Phytophtora sp., Oidium sp., etc.), which, whilst not causing such serious damage as the main parasites, can be harmful to plantations on a localized scale.

First of all, the true incidence of each of these parasites should be estimated in smallholder regions, so as to subsequently set up an early warning programme for the most serious ones. Il appears to be essentiel for all this work to be continued, part of which has already been initiated in Indonesian Research Centres, if there is to be any hope of substantially improving the resources of farm with a rubber based farming system.

3.4. Improvement of the tapping systems used by Indonesian smallholders.

The tapping systems currently used by Indonesian smallholders cause problems in most cases. In fact, these systems are not usually adapted to be planting material,in question, so often harmful to the trees (excessive bark consumption, wounds, etc.), which jeopardizes the medium and long-term economic lifespan of the trees.

The improvement of tapping systems involves working in a network of pilot plots to find systems that are adapted both to the planting material used and to the socio-economic demands. Necessary either to introduce systems enabling maximum production in the years before replanting, or, if the planting material is worth it (recommended clone), to develop a better adapted system so as to keep the trees for longer.

The pilot plots will be returned on smallholdings. The tapping systems will all be aimed at

- reducing tapping work, for equivalent or superior production, which means increasing production per day's work,
- reducing bark consumption,
- improving tapping quality,
- using short cuts if possible, depending on the clones.

It is important to master tapping systems, since they enable the best possible use to be made of planting material and the economic repercussions are felt in the short term.

3.5. Postharvest programme

3.5.1. Improvement of collection methods and of pre-processing

Current situation

In the 1970's, there was a transfer from production of RSS grade or USS grade to technically specified grade of crumb rubber. Today, Indonesia produces mainly 80 to 85% of SIR 20, judged by end¬users as a non standardized TSR 20 and so underquoted. Nevertheless, some progress has been made by either nationally or internationally, these projects concern only 5% of the total smallholders and studies must be undertaken to improve rubber quality of smallholders and to increase their income.

Collection methods

* Sheet production

Depending on the water supply, it should be possible to standardize latex dilution and coagulation in order to obtain top quality rubber sheet (RSS 3).

Drying and smoking of rubber sheet should be carried out in Group Drying Centres (GDC), which will also be in charge of grading, baling and packing. Standardized small crying units (multi-purpose dryers) should be developed. This kind of cooperative system would lead to better consistency in sheet quality.

* Crumb production

In the event of water shortages, thin slab production should be planned for. The separation of different grades of raw humid rubber¬like thin slabs or acid coagulated latex will lead to SIR 5 or SIR 10 production.

As regards cup lump grades, the production of large lumps should be experimented with. Large lumps are defined as natural coagulation of the total volume of latex in the cup of one tapping-day, collected just before the next tapping. Group creping centres (GCC) should be looked into in villages far way from processing factories.

The new collection method should lead to production of top level SIR 10, often requested by European manufacturers.

* Latex production

In order to produce either centrifuged latex, SIR 5L or SIR 5CV, only smallholders close to processing factories should have the opportunity of liquid latex collection with or without stabilization.

3.5.2. Improvements in the consistency and quality of smallholders' rubber

Present situation

One of the targets of Indonesian rubber producers is to export more rubber to EEC countries. Improvement of quality and productivity by enhanced automation in rubber factories leads to requests for more constant and better quality natural rubber grades. Research for new specifications to complete the present ISO 2000 standard would be included in the development programme. GAPKINDO (Rubber Remillers' Association) and PTP (Indonesian State Plantation), presently in charge of processing smallholders' rubber, have already started to improve the selection of raw material, and this should be backed up by more applied research programmes. These programmes will involve raw material, rheological properties and curing characteristics.

Breakdown and performance of raw material

Only naturally coagulated grades of rubber are involved (SIR 10 and 20). Measurement of the Plasticity Retention Index (PRI) is no longer completely sufficient for rubber manufacturers and they need more information on mixing consistency, which is linked to the oxydizability of natural rubber ...

Several methods are currently being tested by international laboratories and rubber tyre manufacturers ; they should be applied in Indonesia on a larger scale by research institutions and remiller laboratories, in order to select one or two of them as standard.

Rheological properties

One of the main problems concerning the processability of natural rubber is the lack of consistency in viscoelastic properties. Research laboratories and manufacturers are currently still looking for a reliable test measurement which could predict the performance of natural rubber as a raw or compounded material. More research should be undertaken in EEC countries and in Indonesia to check NR variability according to its origins (latex or naturally coagulated grade) and raw material processing and drying methods.

Curing characterization

High-Tech end-uses of natural rubber results from its unique dynamic properties. Unfortunately, these properties are closely related tothe curing characteristics of NR, which are not consistent. Natural non¬rubber contents could be responsible for this inconsistency ; the composition and concentration of these products should be assessed. The parameters to be studies are primarily clonal influence, seasonal variation, tapping systems and stimulation, latex and lump collection, and processing methods.

3.6. The socio-economic studies of plantations

A distinction has to be made between smallholder plantations depending on whether or not they are integrated into project (NES or PIR), since production factors differ depending on the case.

Plantations outside projects include 80% of smallholdings. They are based on a system of hevea intercropping with a food crop for the first three years, subsequently followed by woody regrowth, which no doubt prevents the plantation from being overrun by Imperata, but this puts offinitial tapping to 10 years or later. Tapping is frequent (180 to 250 days/year).

Under the NES programmes, SRDP projects, plantations benefit from credit

Under the NES programmes, start-up costs, hence repayments are high. The allocation of plantations to farmers at the start of tapping and credit standardization appears to reduce smallholder motivation and the attention they pay to applying recommended techniques in particular, tapping is mediocre.

Under SRDP programmes, smallholder motivation is good and the hevea growing techniques used are satisfactory.

Generally speaking, the main constraints encountered involve

- The availability of good quality, cheap planting material.
- Relatively inexpensive weed control, combined with tree planting density.
- Improvement of tapping techniques and rubber quality, but forexisting plantations production potential is limited.

Finally, credit arrangements should be reviewed.

Upkeep problems during the immature period are more due to the fastidious nature of the work involved in the repeated uprooting of Imperata rhizomes, than to manpower shortages.

Generally speaking, manpower is not a limiting factor, though capital may be.

Whilst the number of farmers capable of contributing towards the investment required can be estimated at 40% in South Sumatra, 60% need to be totally assisted in the form of subsidies or credit. For the latter, the techniques proposed must not be costly.

Since there are some projects for rubber smallholder development e.g. NES, PIR, and SRDP we are also interested to compare those projects with non-project programmes. According to our consideration NES is too costly, while SRDP, although so far is the most suitable methods will only be able to reach small part of the smallholders community.

Beside comparisons between project and non-project farmers, another activities should be done :

- Multilocation survey of farmers conditions, to assess the particular constraints faced by farmers in each area, and to help choosing the proper technologies to be tested in each location.

- Evaluating each single technique from an economic point of view using marginal analysis.

- Daily monitoring of the farmers who are testing the proposed technique, to get information of the influence of the technique on the whole farm management, from an economic and socio-economic point of view.