REPORT ON MISSION IN INDIA

15th - 31st March 1991

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SOMMAIRE

INTRODUCTION

This mission to India, undertaken at the request of the World Bank, took place from 15th to 31st March 1991. Its purpose was to assess the terms of the rubber sector development and research aid project submitted to the World Bank by the Indian Government. The operations proposed under this project are as follows:

1. Expansion of rubber cultivation (New planting),

2. Replanting of old/uneconomic plantations,

3. Improvement of processing and marketing of smallholder rubber and by-products (rubber wood and honey),

4. Strengthening institutional support

   a) Research - tissue culture - germplasm multiplication and screening and rubber wood processing,
   b) Training in rubber cultivation, exploitation and processing,
   c) Monitoring and Evaluation Cell.

The project may operate for a 5-year period from 1992-93 to 1996–97 with due spill-overs for subsequent years.

The terms of reference for the consultancy mission were as follows:

1. You will carry out an identification mission for the proposed Rubber Project from 18th March to 3rd April, 1991, visiting the States of Kerala, Tamil Nadu and Tripura.

4. Mr. Venkataraman (who will be with the mission from 24th to 28th March) will, along with Mr. Nicolas, review the agronomic aspects of the project, paying particular attention to institutional issues of Rubber Board management of the project and coordination with state and national authorities in areas such as extension, use of Forest Department land and tribal area development.

5. Mr. Nicolas will review the agronomic issues of the project, paying particular attention to the availability of suitable planting material for the Rubber Board's new planting and replanting programme; the agro-climatic suitability of rubber cultivation in non-traditional areas, especially with respect to latitude, altitude and water availability; the environmental impact of the proposed rubber cultivation practices; the proposed rubber research and training components, and the proposed tapping systems.

1. Traditional Region

1.1. General Description

a) The zone in which Indian rubber cultivation is most widely developed is located in the Southwest of the country and covers two States of unequal importance: Kerala, which alone possesses 85.5% of the area planted, and Tamil Nadu, which has 3.8% of plantings. Kerala currently ensures 92.6% of India's natural rubber production. It is the Rubber State.

b) This zone is commonly known as the "Traditional Region for Rubber". It is true that rubber cultivation in India has almost totally been concentrated in this region, and is highly integrated into customs and landscape. However, agronomically speaking, this area does not combine all the favourable factors required for rubber cultivation and can be said to resemble a marginal zone in certain respects, when compared to rubber growing regions worldwide, as regards its very abundant rainfall (over 3,000 mm/yr) and its relatively hilly terrain. These "marginal" factors will have to be taken into account for improving cropping systems.

c) The rubber plantations, which cover almost 400,000 ha, have gradually replaced natural forest invaded by human activities. From a strictly environmental protection point of view, this can be regarded as positive. Indeed, even if the ecological wealth of a monospecific forest planted with *hevea* is considered to be less than that of natural forest, the experience acquired worldwide shows that natural forest is bound to disappear with very intense demographic expansion (the population density is this region is around 700 inhabitants/km2). Hence, replacing one forest by another is the best possible solution under the circumstances.

d) The population making up the smallholder sector is clearly technically and intellectually above the average level found in other rubber growing countries. An RRII study of Cooperative Societies shows that over half the farmers received secondary education and all read newspapers. The smallholder sector is ready to benefit from the agricultural innovations that can be offered; this sector is sufficiently densely populated and well organized to be targeted by vast replanting programmes. Average production is around 1,000 kg/ha, and substantial improvements should be possible.

e) Since the 1950s, the Estate sector has been overtaken by the Smallholder sector in terms of area planted. The Estates involved are relatively small and do not exceed a thousand or so hectares. This sector can be divided up into 2 categories: well-managed and economically profitable private estates and Governmental estates, where all sorts of political problems overshadow their technical management. Average production figures (national average, 1,174 kg/ha) always combine both types of estate, though all indications are that yields are better on the private estates.

1.2. Replanting of old plantations

a) Whilst average production per hectare is around 1 tonne/yr, there are no statistics to indicate into which productivity categories the current estates fall. However, it can be assumed that about 5% must be planted with very old seedlings, and yields must be around 300 to 400 kg/ha/yr. Approximately 10% of the estates are over 30 years old, 15% over 25 years old, i.e. over 100,000 ha for both age groups combined. S/2 d/2 tapping entails the major drawback of very quickly consuming virgin bark and it can also be confirmed that those estates over 25 years old have been tapped on renewed bark for several years and their production levels are consequently greatly reduced.

b) It can therefore be assumed that replanting these old estates would be a substantial contribution towards increasing natural rubber production in the Southwest region.

c) 5,000 hectares are currently being replanted per year. If it is assumed that one of the factors limiting smallholder commitment to renewing their plantations is lack of money, financial assistance for this operation should make it possible to double the areas replanted each year, i.e. 10,000 ha/yr.

d) With the new opportunity offered to those growers wishing to renew their plantations to sell their felled trees as hevea wood, it can be imagined that this money could, via an adequate banking system, help smallholders get through the difficult period of non-productive young plantations. We are not in a position to put forward figures as to the cost-effectiveness of such an operation, since the data provided were too sketchy.

e) Over 5 years, this would amount to 50,000 ha of replantings, i.e. almost half the plantations over 25 years old, which seems to be a desirable and realistic target.

1.3. The problems involved in this replanting programme

1.3.1. Planting material supplies

a) The region as a whole has an estimated network of over 2,000 small private nurseries. They vary greatly in size and the numbers of plants produced per year can vary from 10,000 to 150,000. Production quality varies substantially and there are no quality control inspections by the Rubber Board, which merely supplies the plants produced in its own nurseries, and supplies budwood to those nurserymen who request it.

b) Whilst the well managed Rubber Board budwood gardens were pure for each clone cultivated, we saw that this was not the case in the private nurseries: all in all, it is a free for all with several clones mixed up together. If these nurseries' customers are looking for RRIC 105, there is no great problem, because this clone can easily be identified and is well-known throughout the smallholder sector. This is not the case with the unfamiliar or totally unknown new clones.

c) We had the opportunity of visiting a large nursery belonging to a large industrial group, in which clone PB 217 was not true-to-type, or clones PB 235 and GT 1, which are relatively difficult to recognize in a budwood garden, were mixed together and clone PB 260 was somewhat dubious. In two other private nurseries with a production capacity of around 50,000 plants, 3 to 4 clones, including RRII 105, were very closely mixed together. The owners of these nurseries did not appear to be particularly worried about this situation. Significant lapses were also seen in the horticultural techniques used. Phytosanitary treatment is very often inadequate, which leads to severe cases of leaf disease; the polybags used for plant production vary in size and are sometimes too small; poor irrigation and mineral fertilization sometimes lead to runty plants.

d) Under the circumstances, the Rubber Board should play a greater role at this level. Whilst not condemning the existence of these private nurseries, which are an essential source of supplies in this region of Kerala, it can be suggested that the Rubber Board issue nurserymen with a quality certificate, so that they can supply planting material to a Project smallholder.

1.3.2. Planting Density

The recommended planting densities are relatively low, at around 450 trees/hectare, leading to a number of tapped trees fluctuating between 300 and 400 during the plantation's economic lifespan. Given that the factor limiting rubber cultivation development in this overpopulated zone is land availability, preference should be given to higher planting densities per hectare (510: 7 x 2.8 m; 550: 6 x 3 m), so as to favour production per hectare, as opposed to production per tapper-day, especially since the latter criterion could be dealt with by modifying the tapping method (see below).

1.3.3. Other Recommendations

As regards monitoring operations, so as to assess their quality and the appropriateness of continuing to fund them, the document entitled "Rubber Plantation Development Scheme, Phase III (1990–1994)", published by the Rubber Board, provides a set of technically very valid principles, though a few comments are called for:

a) The smallholders' difficulty in producing a fine plantation often stems from the number of trees planted. Replacements, which are sometimes limited, or even unnecessary, for a planter using plants in polybags and who manages his planting operations well, may prove essential for other less conscientious planters.

   A policy of systematic replacements should be recommended and criteria for assessment of new plantings should be introduced to check that they have been carried out correctly; e.g. under 5% dead plants 6 months after planting.

b) From what we saw, upkeep in young plantations in this region seems to be satisfactory. No weeds seem to be a direct threat to *hevea*. Even so, it would be wise to set up a cover crop when planting.

c) The growth assessment figures given in the document no doubt apply to clone RRII 105. These figures should be adjusted according to the clone chosen, as the age at which tapping begins may vary, depending on the clone, from 4½ to 7½ years.

d) It does not seem to be advisable to intercrop tapioca as a food crop with *hevea* and it should be excluded from the food crop possibilities.

1.4. Increasing the profitability of existing plantations

a) The tapping system used throughout the plantations in India is very conventional: unstimulated S/2 d/2, with the number of tapping days reduced by the number of days' rainfall (approximately -40 days). The tapper's task/day is limited to 300 trees. Stimulation is only considered for overproduction obtained on old trees. The disadvantages of the system are now well-known:

- very rapid consumption of virgin bark,
- low manpower cost-effectiveness,
- no flexibility for adaptation to different clone physiological typologies.

Even so, RRII, aware of the susceptibility of clone RRII 105 to Brown Bast, recommends d/3 tapping on this clone.

b) Considerable progress has been made over the last 20 years in *hevea* physiology and the use of stimulation as soon as tapping begins is now common and systematic practice in a large number of situations. The economic importance of this new concept is such that, in certain cases, it may be the determining factor in the development of certain rubber cultivation projects. Its principle is as follows: make it possible to obtain identical production with a reduced tapping frequency through hormonal stimulation, thereby making for bark savings (tapping for 25 years on virgin bark is a realistic concept) and ensuring greater manpower cost-effectiveness. It also makes it possible to adapt a given intensity to each type of clone.

In other words, it involves tapping less to tap better.

c) The following table illustrates these concepts. It compares the conventional system used in India with two other systems widely tested on thousands of hectares for many years.

Tapping frequency	d/2	d/2	d/3	d/4
Number of tappings/yr (270 days/yr)	135	135	90	67
Number of trees/task	300	600	600	600
Area tapped/tapper (300 trees/ha)	2 ha	4 ha	6 ha	8 ha
Number of tapper-days/ha	135	68	45	34
kg/tapper/day (1,600 kg/ha)	12	24	36	48

The Indian system is based on S/2 d/2 with 135 tappings per year taking into account losses due to rainy days and public holidays, and a task of 300 trees/tapper/day. The other two systems are based on S/2 d/3 d/4 and S/2 d/4 d/5, with 270 days' work per tapper per year, taking into account a 1½ month halt to tapping and Sundays, and a task of 600 trees/tapper/day. Productivity calculations are based on 300 tapped trees/ha and production of 1,600 kg/ha/yr.

d) Though the value of these new systems is obvious, adopting them within the Indian rubber cultivation context entails numerous problems:

- the force of tradition can be a powerful hindrance to evolution,
- stimulation may prove dangerous if not carried out correctly,
- the reaction of RRII clones to stimulation is not well known.

e) For these reasons, it might seem risky to propose stimulation on smallholdings before testing its advantages and its drawbacks in India's agro-economic context. However, these systems should be introduced in a context of very close collaboration between the Estates and the Research Institute . There is no doubt that this sector will greatly benefit from this development. Thereafter, the Estates could serve as bases for extending these new tapping methods to the smallholder sector.

2. RUBBER CULTIVATION IN TRIPURA

2.1. Agro-climatic Conditions

a) Tripura is one of the seven states in Northeastern India with a geographical area of 10,490 km² and located between 20°56' and 24°32' North and 91°0' and 92°20' East.

b) The State has a population of about 2.5 million with 80% living in rural areas. Tribal peoples make up 28% of the total population and the State government takes care of their integration into the economic development of the region. Some people come from Kerala to work in the rubber industry, but the government does not encourage large-scale migration.

c) The State is basically an agricultural one and has a net area under cultivation of 250,000 hectares. A large part of the tribal population still continues with its shifting cultivation practices, locally known as **"Jhuming"**. The Bengali population cultivates rice, bananas and other food crops in the valleys. Apart from small tea and coffee plantations, perennial crops are very limited.

d) The topographical feature of the State is its close association of undulating land interspersed with valleys. Most of the land is under 300 metres above sea level, which can be considered to have no effect on rubber. Most of the soils are deep, well drained and acid in nature. However, they are somewhat degraded due to continuous burning of the organic debris that precedes **Jhuming.**

e) Not so long ago, most of the land was under forest. It is now highly degraded by the Jhuming process. As a result, the State is facing a serious problem and the Government has adopted a drastic policy for land development. Most of the hilly terrain is covered with bamboo and thatch grass.

f) The State has a subtropical climate. The mean annual precipitation is 2,200 mm with 5 months under 60 mm (November, December, January, February, March). Rainfall is well balanced during the other 7 months. The mean maximum and minimum temperatures during the Winter are 27°C and 13°C and 35°C and 24°C in the Summer. The temperature goes as high as 40°C in the Summer and falls to about 3.5°C in the Winter. This very cold temperature period never lasts longer than 2 weeks and is generally recorded in January.

	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall (mm)	20	35	60	210	380	390	380	300	275	180	55	15
Mean T°C	18.0	20.2	25.4	27.8	27.6	28.0	27.9	28.0	26.9	26.1	22.9	19.6

g) In Tripura State, a common wind velocity recorded is 70 km/hr. Velocities of up to 240 km have been recorded. The wind has a cyclonic form. Occasional hailstorms are reported in this region which cause serious crop damage. The last very intensive storm was in April 1986 with hailstones up to 9 cm in diameter; however, such intense hailstorms are quite rare (every 20 years).

2.2. Rubber in Tripura

a) Rubber cultivation in this State was begun in 1963, on a trial basis, by the Forest Department. The plantations still exist and the rubber trees, old seedlings, are well established and look very healthy. A pilot project to control shifting cultivation was undertaken in 1978-79 at Warangbari, under Sudar Sub-Division, with a rubber plantation over 100 ha. A Regional Research Station was set up in 1979 at Mohanpur, on about 66 ha of land situated about 20 km from Agartala. As a result of good rubber tree growth, the State Government decided to set up a corporation for rehabilitating Jhumias, mainly on rubber plantations. 16,500 ha have already been planted with rubber, making Tripura the 4th largest rubber growing State in India.

b) In fact, agroclimatic conditions in this region are good for rubber.

c) The soils are deep and the root system can establish itself under good conditions, especially the tap root system, which can grow very well with no lateritic constraints.

d) The trends of the results in the trials at the RRII Station indicates that the soils are deficient in available phosphorus, nitrogen and potassium. The available magnesium is found to be good. In fact, preliminary results are borne out by plant growth; the nutrient status of the soil and leaves suggest that nitrogen and phosphorus have a significant effect on girth. However, after two years of tapping, the combination of various treatments has still to have an effect on rubber yields. A higher nutrient rate than that used in the traditional region can be recommended for Tripura to help the development of young trees, given that fertility may be decreased by the **Jhumias** practice.

e) Climatic conditions are quite good for rubber trees. Annual rainfall over 2,000 mm is largely sufficient and annual distribution is satisfactory: 5 months under 60 mm, but not a single month without rainfall. In fact, even in March, at the end of the dry season, the country is not very dry and has a green appearance.

f) Low temperatures may have a detrimental effect on growth and rubber yields, but in fact, the lowest temperatures do not drop as far as 0°C, which is really the lowest temperature that rubber can withstand. The period during which the average minimum temperature is around 10°C, does not exceed a week, two weeks in some years. This cannot be said to be a major constraint on rubber cultivation in the region. It may be wise, as a precaution, given the positive effect of cold on Brown Bast disease, to stop tapping during this period.

g) Relative humidity ranges from 60 to 95% and is suitable for rubber.

h) Hailstorms are a regular occurrence in the Northeastern region. However, normal hailstorms with hailstones of 1 cm or less, do not usually affect plants very much if the wind is not too strong. In the event of very severe hailstorms, such as the one in April 1986, new plantings risk severe damage, as does bark exposed to the hailstones. Severe bark damage can make it necessary to stop tapping for a certain period. A tapping system that is very economic in terms of bark consumption may be useful if it means that an unaffected tapping panel can be tapped for several years (S/4 d/4 upward tapping with stimulation, for example). The marked susceptibility of clone PB 217 to wounds needs to be mentioned here, as it could be particularly sensitive to hail.

i) After inspecting plantations which are now over 20 years old, it was seen that *hevea* disease incidence is low, or even negligible. Leaf diseases are virtually nonexistent, apart from a few slight mildew attacks. This situation is no doubt linked to the fact that defoliation/refoliation take place in January/February, i.e. during the dry season. A decisive climatic factor is dependent, in fact, on desynchronization of refoliation with the onset of the rainy season, as young *hevea* leaves are particularly susceptible to attack in wet climates. This phytosanitary condition could be attributed to the very recent past of rubber growing in this zone, and the fact that disease inoculums are as yet little developed. It has been seen that the incubation period only lasts a few years (4–5 years) in certain countries and that disease develops quite rapidly if the required conditions coincide. No root or tapping panel diseases have been seen as yet.

j) Wind, as has been seen on several occasions, has to be considered as a cause of mechanical damage to the plants. This is a very important factor to be taken into account. To date, wind cannot be considered to have been very severe, since all the plantations set up from 1963 onwards have not been damaged by wind, but it can still be considered as serious (an 8-year old RRIM 600 plantation has about 20% damaged trees following a cyclone). The only solution is to choose resistant clones for planting. However, as the wind is not so strong in the traditional zones, the Indian research sector has not concentrated much on this issue and

RRII clones are not renowned for their performance. The most popular clone in India, RRII 105, has a canopy with heavy branching and may not be suitable. Looking at the list of clones available in the RRII budwood nursery, clone classification can be as follows:

* Very good resistance : PR 107

* Good resistance : PB 5/51, PB 217, GT 1, SCATC 88/13, HK 1

* Average : PB 260, PB 310, SCATC 93/114

* Below average : RRIM 600, PB 235, GT 1, RRIC 105, RRIC 52, HARBEL 1, RRIM 501, PB 86, FX 516

* Poor : RRIM 605, RRIM 703, RRIM 612 PB 311, TJ 1

k) One of the research projects at RRII in Tripura is the study of the ecological impact of *Hevea* (effect of rubber plantations on micro-climates, soil properties, etc.). A comparison of soils in rubber plantings compared to fields subjected to shifting cultivation, indicates that rubber plantations, adopting proper agro-management practices, helped to enrich organic matter content, which consequently improved the physical properties such as bulk density, soil porosity, moisture retention and infiltration. Studies conducted in other countries have shown that compared to other forestry species, rubber plantations have a good effect on soil conservation.

2.3. Proposals

a) As regards wind problems, some clones need to be introduced as soon as possible and tested in clonal trials:

* RRIM 712 - 805 - 901
* PB 254 - 255 - 312 - 314 - 330
* RRIC 100
* IRCA 18 - 209 - 230
* PR 255 - 261 - 300 - 303 - 305 - 306
* BPM 1 - 24

b) *Imperata* (called alang-alang), which is a pernicious grassy weed with a bad reputation throughout the world, is already a very serious problem in Tripura and must be controlled. It would seem that this danger is not taken as seriously as it should be by local farmers, though it is known that once a *hevea* plantation has been invaded by *Imperata*, the start

of tapping can be put off by over 3 years and production potential can be seriously reduced. Two control methods can be considered:

* Choosing clones with a very dense canopy, which ensure that the soil is very well covered as quickly as possible. Certain clones can prevent weed growth as early as the 4th year after planting, such as:

  - PB 217 - 235 - 255 - 260,
  - IRCA 18 - 109 - 111 - 130 - 230,
  - AVROS 2037.

This factor may influence breeders in the choice of clones to be recommended.

* Systematic use of cover crops, with a very strong preference for *Pueraria* sp. This is the most effective control method, but it must be implemented as early as possible in the land preparation process; it is even recommended that the cover crop be established a year before planting.

This may be one of the World Bank's firm stipulations: help in setting up a plantation may be subject to the cover crop being established before planting and in accordance with the Board's recommendations (sowing in rows, 5 to 6 kg/ha). Establishment 1 year before *hevea* planting would be advisable. The very great danger posed by *Imperata* needs to be emphasized. It is undoubtedly the greatest limiting factor for setting up *hevea* plantations in this zone.

It is important to emphasize that one of the dangers of intercropping is enabling *Imperata* to establish itself as soon as the intercrops have been harvested; tilled land lends itself perfectly to very rapid *Imperata* invasion as cover crops are no longer able to establish themselves properly in the interrows of plantations aged 2 to 3 years.

c) Fire damage can be considerable in rubber plantations, whether during the immature period, or during the productive life of the trees. Such damage can be limited if young plantations are surrounded by firebreaks to protect them from advancing bush fires. This entails an additional work load, as firebreaks have to be carefully maintained and they take up land. It is obvious that the perimeter to be protected will be proportionally smaller the larger the actual plantation.

Some of the fires may be malicious. The Authorities do not hide the fact that some of the fires are started

intentionally, as the rubber plantations are contrary to the agricultural customs of the tribal peoples. Also according to the authorities, these intentional fires are tending to fall off, which may be due to better acceptance of rubber cultivation. It is true that little damage was seen during the visit to the region and, very often, the zones affected were planted with trees other than *hevea*. Whatever the case, this is a social problem to which there is no technical solution.

d) The same applies to animal damage (cows, goats, etc.). Growers need to fence in their plantations to stop animals getting in. Another solution is to dig trenches, but this can only be done on large estates with the means to do this mechanically. Indeed, if such trenches are to be effective they have to be trapezoidal, 2 m deep, 0.80 m wide at the bottom and 1.5 m wide at the top. Fences should also limit damage from accidental fires (a passer-by dropping a cigarette on a layer of dry leaves, for example). Such fences are expensive, between 1,500 and 2,500 rs/ha, but should nonetheless be an absolute requirement before a plantation is set up.

e) The quality of the planting material is very important in this region where people are just becoming familiar with rubber cultivation. Smallholders in these non-traditional areas have little idea about the clonal appearance and other characteristics of good planting material. The responsibility of the Rubber Board will therefore be considerable in this respect, and Rubber Board nurseries (as opposed to private nurseries) may be more required in Tripura than in Southern India.

Polybag techniques, which have been perfectly mastered in the traditional zone, should obviously be encouraged in this new development zone; the advantages go without saying and hardly need emphasizing here.

f) Similarly, Rubber Board technical supervision cannot be as close as in Southern India, given the staff available and the development possibilities. The projects therefore need to be grouped: scattering smallholdings would be highly detrimental to the supervision required and the advice they need to be given. This restriction will limit the areas that can be planted.

g) In this context of low technical capabilities, tapping quality was also seen to be very poor in this region, especially on State plantations, where the trees' economic

potential is already seriously jeopardized. Given the social restrictions encountered on these plantations, it will no doubt be difficult to make any substantial changes to tapping management. Even so, there is an urgent need to stop giving productivity bonuses and introduce a tapping inspection system based on tapping quality, if these plantations are not to be irrevocably damaged.

2.4. Clone recommendations, growth and production forecasts

a) In view of local restrictions and agro-ecological conditions in this sector, the clones which would seem best suited to the region, which is particularly characterized by strong winds, are:

GT 1, PB 217, PB 254, RRIC 100, PR 255

Clone RRIM 600 should be discounted due to its susceptibility to wind damage.

b) With normal clone growth under ideal agro-climatic conditions, tapping can start between 5½ and 6 years. Even so, given that the effect of cold on the growth of these clones is unknown, and as the technical level of the smallholders in the region is limited and lack of upkeep may lead to their being planted late, it would be wise to delay tapping these clones by 12 months. The age at which tapping can therefore be expected to start is 7 years.

c) The recommended clones are not "quick-starters", unlike clone RRII 105. Under normal growing conditions, the following mean values can be expected for all the clones cultivated in a zone with ideal agro-climatic conditions (see table below).

In view of the climatic conditions and unfamiliarity with tapping on smallholdings, it would be wise to reduce the expected yields by about 15%, i.e.:

	1 yr	2 yrs	3 yrs	4 yrs	5-10 yrs	11-20 yrs	21-30 yrs
Favourable conditions	700	1200	1500	1800	2000	1800	1600
Tripura Region	595	1020	1275	1530	1700	1530	1360

3. RESEARCH

3.1. Brief Description of RRII

a) Rubber research is the exclusive domain of the Rubber Research Institute of India. RRII is a large institute with approximately 80 researchers and assistants at its Kottayam Station in Kerala. In addition, it is highly decentralized, since it has set up a network of experimental plantations in marginal zones of the Centre-West (Dapschari, Maharastra State), the Centre-East (Bhubaneswar, Orissa State), the Northeast (with the Agartala complex, Tripura State, Guwahati, Assam State and Kolasib, Mizoram State).

b) RRII is a member of IRRDB (International Rubber Research Development Board), and regularly attends this organization's scientific meetings; Dr. Sethuraj, the Director of the Institute, is especially responsible for coordination of the Physiology Group.

c) According to various reports, principally RRII's annual report, the Institute's activities are very varied, covering all aspects of rubber cultivation (9 divisions, including one set up very recently: the **Genetic Resources Division**).

d) The researchers in charge of these Divisions have a great deal of imagination and their admirable knowledge of rubber cultivation means that the problems encountered are properly analyzed.

e) Even so, inadequate resources, especially land (the Kottayam station only covers 35 ha!; the Chetackal station, 50 km away from the Centre only covers 250 ha), mean that setting up experiments capable of providing answers to the problems posed is often difficult (a good example is the clone screening for development).

3.2. Research Proposals

In the document supplied by the Rubber Board authorities (India Rubber Development Project), several financial proposals were put forward. We shall go on to analyze each of the proposals. They were modified after discussions with RRII researchers. Two other proposals were also put forward and will be described and analyzed.

a) <u>Tissue Culture and Biotechnology</u>

Armed with its experience of around ½ ha of ramet plantings, RRII managed to convince the authorities to invest in a Tissue Culture and Biotechnology laboratory worthy of the name. This spacious laboratory (over 300 m2) is well equipped and managed by Dr. Asokan, who spent more than 15 years in the United States

before returning to Kottayam 5 years ago. The aims of the laboratory are very varied, with Dr. Asokam currently preferring to explore several lines of research (micro-cuttings, somatic embryogenesis, apex culture, protoplast culture, etc.), rather than closing off doors to the future.

This is reflected in the project, since it proposes to exploit current knowledge to propagate *hevea*, identify and propagate families with root systems able to help reduce Brown Bast incidence, develop protoplast culture techniques, so as to produce crosses *in vitro*, multiply tissues specialized in latex production *in vitro*, so as to enable *in vitro* rubber production, etc.).

Given the enormous technical difficulties involved, this project may seem ambitious (after 15 years' research, the Institutes of China and Malaysia are still far from mastering somatic embryogenesis; after 10 years of highly concentrated efforts on micro-cuttings, IRCA is barely beginning to envisage large-scale ramet production).

Care should therefore be taken not to distance tissue culture research too far from current rubber cultivation problems and concentrate the project on a single target: ramet production, their transfer to the field and their contribution towards crop improvement.

There are two possible approaches: micro-cuttings, which are technically easier and which enable a larger number of plants to be obtained for field propagation, in the short term, and somatic embryogenesis, which is technically more difficult, but which offers undoubted advantages for industrial production. A new project has been drawn up along these lines (annex No. 1). It seems to be much more realistic than the first possibility (though Brown Bast research requires a few clarifications).

The financial presentation for the project over 5 years seems to be well balanced and reasonable, though perhaps slightly underestimated. Indeed, a laboratory extension will be essential: large-scale ramet production and research into ramet production operations are relatively incompatible.

To conclude:

This project offers the opportunity for the Institute to be in the forefront of the latest technological developments, whilst remaining in touch with potential users of such research.

It would enable the current team to increase its work force, which is currently a limiting factor.

5 years of research should enable RRII to establish itself among the group of Institutes that have invested in ramet production.

Even so, it should be noted that international scientific exchanges are currently limited, due to the potential for developing laboratories aimed at economically profitable production and keen to ensure a certain level of confidentiality.

b) Evaluation and Documentation of *Hevea* Germplasm

Over the last 20 years, it has become clear to the Scientific Community working on rubber cultivation that research into Genetic Resources is of paramount importance. In fact, clonal production considerably accelerates the reduction in available genetic variability, which is estimated to be very limited at the outset (refer to historical studies of *hevea* introduction into the Far East by Wickham).

All the IRRDB member Institutes participated financially in a vast collection of Brazilian Amazonian planting material in 1981, which led to the creation of 2 international Germplasm Preservation Centres: Malaysia in Asia and Côte d'Ivoire in Africa.

After the obligatory period of transfer and multiplication of the material, RRII set up a network of germplasm collections and studies for India, introducing around 5,000 genotypes into its own collections and creating a new Division at the Institute, under the authority of Dr. S.N. Potti. RRII is therefore deeply committed to this Research operation.

RRII has a moral obligation to invest in such an operation. Its long-term responsibility to guarantee broader genetic variability for rubber cultivation in India depends upon it, if it is to solve the immediate development problems stemming from *hevea* adaptation to marginal zones, and also to ensure that the means are available to find solutions to future problems that are, as yet, unthought of.

This project is also of undoubted international scope. A corresponding scientific network has been set up, and geneticists from all the countries involved meet regularly under the aegis of IRRDB to exchange information.

A more detailed project than that initially presented in the first document has been drawn up and can be found in annex 2 to this report. It seems to be complete and balanced.

Total funding (392 lakhs rs) needs to be considered in 2 parts:

- Rs 175 lakhs for land
- Rs 217 lakhs for other expenditure

Even so, it should be borne in mind that the World Bank generally considers that the cost of land purchase cannot be included in such projects. Be that as it may, the land has to be acquired,

since the project cannot be implemented unless the *hevea* trees are planted. This land acquisition problem seems to be particularly acute in the traditional Indian rubber cultivation zone, i.e. Kerala. In the other geographical locations, it will no doubt be easier to find land and negotiate its acquisition. Two solutions could be considered:

1. Lobby the Indian Government for it to make a contribution, through the allocation of new land to the Institute.

2. Get National Rubber Estates to devote certain areas of their land to such operations; in exchange for such assistance, they could benefit from World Bank Project funding for replanting their own plantations.

The corresponding agreements need to be defined, but it has to be said again that project implementation depends on land acquisition.

Section G of the Project entitled "Interaction of Scientists" includes provisions for 2 Indian researchers to visit the Centres involved in this ***Hevea* Germplasm** operation. Indeed, if the international aspect of this research is to be fully achieved, it would seem essential for RRII researchers to actually see the performance of Germplasm under different conditions and have access to all the data required for their information.

In brief:

This is a research proposal of international scope.

It is RRII's duty to become closely integrated into the network set up and coordinated by IRRDB for genetic resources.

This is a long-term project because the benefits of this research for development will fall at the turn of the century, but the 5-year targets in the proposal are realistic and should make it possible to complete this initial stage of familiarization and assessment of this new planting material.

c) <u>Discriminatory fertilizer recommendation system</u>

This proposal, put forward by the Agronomy Soil Division, plans to step up assistance to smallholders by providing advice on fertilizer utilization.

When RRII was set up in 1956, *hevea* plantations received no fertilizer. Since 1966, fertilizer recommendations have been made in accordance with the types of soil encountered and any available analysis results. Recommendations fall into two categories: those specific to growth and those specific to plots

already producing. These fertilizers, referred to as maintenance fertilizers in adult plantations, are merely a precautionary measure because, apart from a few cases of obvious deficiencies, there has been no clear demonstration of their necessity. Only 5 to 10% of smallholders currently have access to assistance from the mobile laboratory system set up by the Institute. The aim is to increase potential so that 50% of smallholders can benefit from this assistance.

An additional document (annex No. 3) has been passed on for enclosure with the preparatory document.

It is obvious that the activities of the Rubber Board are directed towards smallholder support, especially in the traditional region of Kerala, and the Board's popularity greatly depends on the implementation and success of such projects. The technical level of rubber smallholders in Kerala is high and this sector can easily be targeted to benefit from such advice.

Even so, it may be wondered whether it is worthwhile making such a great effort in an area where it has not been clearly scientifically demonstrated that fertilizer applications on adult plantations are essential.

It would seem much wiser to concentrate efforts on young plantations, especially if the large-scale replanting programme goes ahead in Kerala.

It is also reasonable to ask whether it is worth continuing this operation after 5 years, given that operating costs have been estimated at 75% of total costs (153.00 lakhs rs/208.00 lakhs rs). Stopping such a service to smallholders would be very negative and careful consideration should be given to subsequent funding.

In brief:

This is a more a proposal for development aid and support to smallholders than for an actual research project.

The scientific validity of fertilizer applications on adult plantations is challenged.

d) Wood Technology

Less than 20 years ago, using *hevea* wood was unheard of. It has become widespread over recent years, as much in Malaysia, China and Indonesia, as in Kerala India. This is a considerable source of income, since smallholders will be able to consider that renewing their plantations can be partially, if not totally, covered by selling the wood from their old felled trees. The

figures and evaluations put forward are still imprecise, but this sheds a whole new light on rubber plantation valorization.

In addition, the pressure exerted on the environment in a State as populated as Kerala gradually leads to the disappearance of the traditional source of wood supplies - the natural forest. Hence, sawmills are now successfully using this new source of wood in many fields of application. *Hevea* wood can sometimes amount to 90% of these sawmills' raw material supplies.

Although the development aid proposal contained in the project is precise, the research proposal in the preparatory document needs to be expanded upon. It is undoubtedly a relatively modest project (50 lakhs rs over 5 years), but it is reasonable to ask whether it is RRII's role to tackle the technical aspects of this problem and whether it has the necessary skills.

Collaboration with 2 other organizations is mentioned: the Forest Research Institute at Dehra Dun and the Kerala Forest Research Institute at Peechi. What research has been devoted by these two Institutes to *hevea* wood? Is there any danger of overlapping programmes?

Given that *hevea* wood utilization techniques have now been perfectly well mastered in other Far Eastern countries, it would be very worthwhile for a consultancy mission to visit India. This would be organized under the aegis of RRII. Its composition and duration would need to be determined.

An economic study could be carried out at the same time as the technical mission, so as to determine the cost-effectiveness of *hevea* wood sales and consider the likelihood of a certain proportion of rubber production being lost to solve short-term financial problems.

e) Beekeeping Research

The same comments apply here too: the project described in the preparatory document is insufficiently developed for its content to be properly assessed and it is reasonable to ask whether it is RRII's role to undertake research in a field which is not really within its scope. Are there not more specialized organizations in this field that could be consulted?

3.3. New Research Proposals

After discussions with RRII officials, it was seen that two lines of research, whilst very important, had not been sufficiently investigated in the preparatory document; these were *hevea* tapping and clonal selection. Two documents were therefore drawn up and can be found in annexes 4 and 5 to this report.

a) Evaluation of high-yielding clone potential and development of their blends for multiclonal planting

This aspect is of concern both to the traditional Kerala zone and the marginal zones within India.

1. Kerala

The work undertaken by the RRII Botany and Genetics Department, currently run by Dr. Pannikar, began in 1954.

One of the primary objectives was to create and propagate planting material specifically adapted to the agro-climatic conditions in the Kerala region.

The success of the operation has exceeded all expectations: clone RRII 105, one of the results of the Institute's breeding operations, is now planted in over 80% of the areas set up over recent years! Whilst congratulations are in order for such a success, it is also reasonable to express certain worries for the future. Reducing Kerala's future *hevea* potential to one clone entails considerable risks that have been clearly perceived by those in charge at the Rubber Board and at RRII. Faced with such a situation, it is the Institute's duty to react decisively, but how?

Clonal recommendations can only be made based on the results of large-scale comparative trials conducted for many years in extensive networks. One of the basic problems faced by the Institute is the lack of available land, as already mentioned, and this type of experiment requires relatively large areas. As for the Germplasm operation, this problem will determine how the World Bank views this proposal and a solution has to be found somehow.

There is also another problem on the agenda: clone mixtures in the same area, to ensure clonal diversification which it is difficult to apply in an environment dominated by smallholders. Discussions have shown that, in theory, the advantage of such an arrangement is far from sure:

- There is considerable growth and bulk competition between clones, which will reduce the potential of these clones which will be hindered in their development.
- It will be impossible to adopt different tapping methods for each clone.
- Disease development in such a situation is totally unknown.

In accordance with RRIM recommendations, FELCRA in Malaysia set up a few trials with clone mixtures; this is now causing considerable problems for tapping rationalization in these plantings and FELCRA is in the process of abandoning them.

The only solution is full-scale testing of clone blends, in the same way as for pure clone plantings in large-scale comparative trials. The following proposal could be considered:

Taking 30 clones to be tested, 12 6-hectare large-scale comparative trials will be set up, i.e. 72 hectares in all.

Each trial will contain 5 clones planted alone at a rate of 1 hectare per clone, with 4 replications, along with a further 1 hectare reserved for a mixture of the 5 clones.

2. Marginal Zones

Each marginal zone represents a different adaptive situation for *hevea*. Certain situations are known in other countries: e.g. susceptibility to wind damage, susceptibility to certain diseases, and certain clones can be chosen in accordance with these characteristics, based on current knowledge. Other situations are new, such as resistance to cold, to heat, to drought; little is known about clonal adaptation to these situations.

It is therefore urgent to introduce (or complete) a large number of clones in collections (at least 50), at each experimental station in marginal zones, and to plant:

1. All the clones in small-scale comparative trials in the first 2 years (the same experiment is repeated in both years).

2. 2 large-scale clone trials every year (1 ha per clone, 5 clones, each clone planted in the two experiments), making it possible to test around 25 clones out of the most promising in 10 experiments.

If 3 zones are to be considered, it will require a network of 30 experiments covering a total area of around 150 hectares. <u>It is essential that the data gathered be computerized</u>.

Land acquisition should be less of a problem, but success will depend on researcher availability. This operation should be placed in the hands of one researcher at each site, helped by a plantation assistant, at least whilst the trials are being set up.

Finally, it would seem wise to certify the conformity of the clones in India. Certain are well known to users and breeders, others, especially those recently arrived from abroad, are much less familiar. Electrophoresis techniques can be used with confidence. IRCA should be asked to provide technical support in this field.

In brief:

Clonal diversification is one of the most important problems faced by development. It is worth noting that this problem is now being considered by the World Bank for its operations in Sri Lanka. It should be given priority.

b) All Indian Coordinated Project on *Hevea* exploitation

The traditional S/2 d/2 tapping method is in the process of being abandoned in numerous locations, both in Africa and Asia. Using stimulation, not as a way to obtain more, but to obtain better, is a technical advance which is proving its worth each year. In addition, latex production physiology studies reveal that clonal typology exists and that each type of clone should be tapped in a particular way.

Despite the good technical level seen in the Indian rubber growing sector, there is reluctance to change traditional practices (though it is worth noting a gradual move towards unstimulated S/2 d/3 for the RRII clone affected by Brown Bast).

In order to increase productivity on Indian *hevea* plantations, both in the traditional Kerala zone and in marginal zones, a project proposal has been drawn up by the Physiology and Exploitation Division run by Dr. Vijayakumar.

This Division seems to be primarily involved in adapting *hevea* to cultivation in marginal zones. The tree is consequently studied in its entirety.

The draft project (annex No. 5) clearly reveals the need to focus research on tree tapping.

The total funds required over 5 years, approximately 52 million rupees, may seem a lot (it is the most costly of all the projects proposed), but the budgetary distribution proposed seems to be well balanced and justified.

In view of the fact that this proposal involves undertaking a research operation for which RRII has already fallen behind other Institutes, due to a lack of resources, it is strongly advised that provisions be made for funding outside consultancy services. IRCA (French rubber research institute), which is highly respected in this field, could be called upon for consultancy services, the frequency and duration of which would need to be determined.

ANNEX

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March 30, 1991

PROPOSED RUBBER PROJECT

SUMMARY OF MR. D. NICOLAS'S FINDINGS

1. From the opinion of all the experts, the demand of natural rubber will increase during several years. That is true for the world, but especially for India which, although a large producer of natural rubber, must import a significant part of its consumption.

2. The excellent document from the Rubber Board, VIII Five Year Plan for Natural Rubber", gives a good idea of this situation: the target is to double the production in a brief time. How might a World Bank assisted natural rubber project help achieve this objective?

(a) New planting. The Rubber Board's latest proposal is to plant 60,000 ha in 5 years:

20,000 ha in traditional zones (Kerala and Tamil Nadu) seems realistic.

20,000 ha in Tripura alone seems technically feasible looking at the good growth of existing Hevea (rubber) in this zone, but may be overly optimistic considering the low technical level of the population. Perhaps a 15,000 ha target would be better.

20,000 ha in other non-traditional (marginal) zones seems to be excessive considering the risks unknown and looking a the low technical level of the population. Perhaps 10,000 ha would be better.

(b) Replanting. The Rubber Board's latest proposal is 50,000 ha in 5 years. This is certainly required considering the age structure of the trees and would also seem realistic considering the relatively high technical level and capacity of smallholders estates. The replanting program should be able to successfully increase average yields in this region.

(c) Processing. From the opinion of experts, the quality improvement of smallholder rubber is one element of the future of natural rubber. If the producers cannot

do that, the natural rubber will lose a lot of market. The proposed program, even though it may appear large, still seems to be inadequate considering the needs and capacities, and the processing needs in the future are likely to be even greater than what is proposed by the Rubber Board.

(d) Rubber wood and honey. These two activities are good to increase the revenue of smallholders, but will stay at a relatively marginal level in terms of overall income per ha. The honey production is largely dependent on the climate of the year. The value of rubber wood in Kerala was surprisingly high and may be able to finance most of the replanting costs in the future. But, paradoxically, one must be careful that the increasing value of rubber wood, which will make the overall economics of rubber cultivation even more favorable, does not encourage the premature destruction of rubber plantations because of short term cash flow problems.

(e) Institutional development. The training component proposed is interesting, but it is still unclear the precise responsibilities for training among the Rubber Board itself, the Rubber Research Institute and the proposed new Rubber Training Institute. Investment in research seems to be a real need to assure the future of natural rubber. The research proposals of the Rubber Research Institute are generally good, but it should be recognized that the results expected are not going to be all available in 5 years. More detailed comments on the research component will be in the main paper.

(f) Productivity enhancement. (?????????????)

Particular comments

3. Tripura. it is evident that rubber trees are well adapted to the regional environment. Soils are deep and of a good physical quality, and the climate is favorable. Altitude is not a problem as virtually all the rubber areas are below 200 m. Minimum temperatures in winter are not too bad, and, because of the protection of the Himalayas, warmer than rubber areas at the same latitude in other parts of the world such as Kunming in China. In fact, wintering of rubber trees in Tripura may have some positive impact because the defoliation/refoliation period coincides with the dry season and thus may be a factor causing a lower incidence of rubber diseases in Tripura compared to southern India. Rainfall in Tripura

is about 2,000 mm per year, which is good. Rainfall distribution is also good. There are 5 relatively dry months, but some rain falls every month. However, rainfall and temperature patterns in other proposed non-traditional areas may not be as favorable as in Tripura and would require further study. On average, yields in Tripura may average 10% less than in Kerala and tapping may start 12 months later, which should still be good economics. However, there are several points for special attention:

(a) Imperata (alang-alang; a pernicious grassy weed) is already a serious problem in Tripura and must be controlled by well-established cover crop.

(b) Cattle also appears to be a real danger to young rubber trees and will lead to expensive fencing costs.

(c) Fires are also a danger during the dry season, and require special measures such as an anti-fire barrier consisting of barren strip between the rubber planting plantings and scrub land which is particularly susceptible to fire. In some cases fire appears to be deliberately set as a result of political problems.

(d) Wind damage is a threat and the mission saw several plantations which were affected. There is only one answer to this problem: the development of wind resistant clones for rubber planting must be urgently increased.

4. The quality of the planting material is very important in this region where people are just becoming familiar with rubber cultivation. Smallholders in these non-traditional areas have little idea about the clonal appearance and other characteristics of good planting material. Therefore, the responsibility of the Rubber Board will be very important in this respect and Rubber Board nurseries (as opposed to private nurseries) may be more required in Tripura than in southern India.

5. A last point: the quality of the Government of Tripura plantations was quite bad, for example, for tapping. It may be difficult to reform these plantations given constraints common to government corporations. Therefore, the project may exclude such corporations from the project if the objective is high quality rubber cultivation. This may result in a reduction of planting targets.

6. Traditional zones. The most impressive aspect of rubber in traditional zones in India is the relatively high quality of smallholder areas compared to both Indian estates and to smallholders in other parts of the world. The popularity of rubber for smallholders must continue by the following:

(a) Avoid bad planting material coming from uncontrolled nurseries. In all nurseries visited (except those belonging to the Rubber Board) the clones were mixed. The Rubber Board should increase its vigilance for this.

(b) Avoid recommending or promoting poorly adapted or unproven clones. On the other hand, it is important to avoid an over-reliance on a single clone. In some areas visited up to 80% of recent planting has been for a single clone, RRI 105, which is dangerous. Nevertheless, new clones and clone mixes must be adequately proven before recommendation.

(c) Avoid lower profitability caused by the traditional tapping system. The S/2 d/2 is an old tapping system and new project areas can be encouraged to more profitable tapping systems, for example, involving the use of stimulation. More details on this will be in the main report. In particular, private estates can take the lead to promote more modern tapping systems.

Summary of 5-Year Planting Program

New planting	Rubber Board (ha)	Nicolas estimate (ha)
Kerala/TN	20,000	20,000
Tripura	20,000	15,000
other non-trad	20,000	10,000
subtotal	60,000	45,000
Replanting		
Kerala/TN	50,000	50,000
Total	110,000	95,000