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Chairman
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The Quarter

The production of natural rubber, the wonder raw material of nature, is concentrated in three or four South East Asian countries. India too has a remarkable position both in production and consumption of this strategic raw material. Compared to the recent developements in the rubber goods manufacturing sectors in major rubber producing countries like Malaysia, Indonesia and Thailand, India is far behind in exploiting the vast returns from natural rubber. Malaysian experiment shows that they could make almost four times value addition on their primary produce by resorting to manufacturing activities.

A recent study conducted by the Association of Natural Rubber Producing Countries (ANRPC) to evolve strategies for modernising rubber based manufacturing industries in rubber producing countries reveals that producing countries together account for only 12 percent of world natural rubber consumption although 85 percent of NR is produced in these countries. Since the cost of manufacture of rubber products in developed countries, especially in USA and European countries has become prohibitively high, the producing countries should by all means exploit the situation.

In the article published elsewhere in this issue on Rubber good manufacturing industry in Natural Rubber producing Countries, Smt. J. Lalithambika, IAS, Chairman, Rubber Board has emphasised the need to give due importance for the manufacture of value added products both for internal consumption and exports. The Chairman also pointed out the strict quality requirements of importing countries in the West. While aiming for exports of rubber goods, it has to be well understood that rubber goods for export must be produced with consistency in quality and in conformity with international standards and specifications.

The article also highlights the true picture of vast outputs that could be earned by the NR producing countries. This will open new avenues for profits to the small rubber growers in these producing countries.

Rubber Goods Manufacturing Industry in Natural Rubber Producing Countries - Recent Developments

J. LALITHAMBIKA
Chairman
Rubber Board

Natural rubber accounts for almost thirty percent of elastomers used in the rubber industry today. Production of natural rubber is concentrated in three or four South-East Asian countries. Till recently these countries concentrated only on producing more natural rubber as per the demands in world rubber industry. But the position changed in the eighties. Some of the rubber producing countries found it essential to convert their raw materials to value added products and export to consuming centres. The manufacturers in developing countries also found it advantageous to tap the cheap labour and abundant availability of raw materials in rubber producing countries. Coupled with this favourable environment came the massive demand for latex based examination gloves in developed countries. The result was a remarkable growth in rubber goods, manufacturing industry in natural rubber producing countries.

DEVELOPMENTS IN RUBBER INDUSTRY OF MALAYSIA

Malaysia has played a key role in the impressive growth of the world's rubber manufacturing industry by being a major supplier

of quality natural rubber to the consuming industries. Rubber manufacturing activities started in Malaysia around 1932. There was no noticeable growth in rubber goods manufacturing activities in this country till 1970. Till then the objective of the manufacturing industry was only to produce essential products like tyres needed for local consumption. This position changed by the eighties and Malaysia is today the world's largest producer of examination gloves, latex thread and catheters. In 1985 the export earnings from rubber products in Malaysia was as low as II percent of that from raw natural rubber export. But by 1990 the value of product export rose to 55 percent of that for natural rubber export. Malaysian experience shows that they could make almost four times value addition on their primary produce by resorting to manufacturing activities.

The growth in rubber consumption in Malaysia between 1985 and 1990 was at an astonishingly high rate of 21.6 percent per annum. The growth in latex goods industry during this period was at the rate of 39 percent per year. Growth rate in different segments of Malaysian industry during the period 1985-90 is given in Table 1.

TABLE 1 AVERAGE ANNUAL GROWTH RATE BETWEEN 1985-90 IN RUBBER INDUSTRY IN MALAYSIA

TYPE OF INDUSTRY	ANNUAL GROWTH RATE / AVERAGE PERCENT
Latex Industry	39.0
Tyre	12.1
General Rubber Goods	9.4
Industrial Rubber Goods	17.5
Footwear	8.5

Malaysia is now world's largest user of natural rubber latex and accounts for 18.7 percent of world natural rubber latex consumption.

From a study of value of rubber goods it is seen that gloves as a group accounts for 63.3 percent of value of goods exported. Almost 79 percent of earnings in rubber goods units is through export of products.

TABLE 2 GROWTH OF TYRE AND SELECTED NON- TYRE PRODUCTS IN MALAYSIA

	YEAR		
	1985	1990	CHANGE PERCENTAGE
Tyre (all types '000 tonnes)	3662	6764	86.7
Inner Tubes (all types '000 tonnes)	5948	12224	105.5
Rubber Gloves ('000 pairs)	255450	1796112	603.1
Catheters ('000 Nos.)	14242	50623	255.4
Rubber Footwear ('000 pairs)	19766	21632	9.4

The USA is the main market for Malaysian rubber products. Malaysia has set a target of 300000 tonnes rubber consumption by 1995. So far the targets set for the industry were surpassed. Malaysia is now concentrating on enhancing export of tyres. The target set in this area is to triple the export earnings on tyres in the course of next three years. Table 2 gives the details of the growth of tyre and non-tyre sector in Malaysia.

The success of Malaysian rubber goods manufacturing industry is due to the sound government policies, effective technology supporting facilities and the full participation of various sectors of the industry.

DEVELOPMENTS IN INDONESIAN RUBBER INDUSTRY

Indonesia has shown remarkable growth in tyre industry and foot wear manufacture. The export value of footwear from Indonesia has exceeded that of the tyre sector. Indonesian motor ve hicle tyre industry consists of 13 separate enterprises with a total installed capacity of 11.8 million tyres for four wheeled vehicles and 10.1 million tyres for two wheelers per year. Export of motor ve hicle tyres from Indonesia recorded a growth rate of 99.4 percent per year between 86 and 1989. Cycle tyres also recorded an impressive growth during the period and in 1989-90 the growth rate in export value of cycle tyres was 31 percent.

Production and export of different types of tyres from Indonesia is given in Table 3.

TABLE 3 PRODUCTION AND EXPORT OF TYRES FROM INDONESIA

TYRE TYPE PRODUCTION	('000 UNITS)	EXPORT VALUE (US $ '000)
Four Wheelers	8204	10288
Two Wheelers	6052	64 367
Bicycle Tyres -	–	12 955
Inner Tubes -	–	2 656

Footwear industry in Indonesia has shown maximum growth during the last 5 years. There are 270 companies in Indonesia engaged in footwear manufacture. The total installed capacity is 311 million pairs. The growth of footwear export was at an astonishing rate of 285 percent. The position of footwear export for two years is:

Year	Export Value (Us $ '000)
1989	58 437
1990	225 483

The growth in export of industrial and general rubber goods in Indonesia is given in Table 4.

TABLE 4 INDONESIAN EXPORT OF INDUSTRIAL AND GENERAL RUBBER GOODS

PRODUCT	VALUE (US $ '000)
V Belts	2 666.0
Conveyer and Transmission Belts	114.1
Pipes and Hoses	977.6
Other Automotive Goods	168.2
General Rubber Goods	5 934.9

The important latex products exported from Indonesia are examination gloves and surgical gloves. This country is importing both condoms and latex thread. Some companies are trying to establish units for manufacture of these products also in Indonesia. Total natural rubber consumption in Indonesia is only around 12 percent of their production.

DEVELOPMENT IN THAI RUBBER INDUSTRY

There are over 300 rubber goods manufacturing units in Thailand

TABLE 5 CONSUMPTION OF RUBBER IN THAILAND (IN '000 TONNES)

PRODUCT	YEAR 1989	1990
Tyres	37.1	45.0
Tread Rubber	1.2	1.2
Vehicle Parts	2.3	3.3
Rubber Band	10.1	11.4
Shoe and Parts	7.0	9.5
Tube and Hose	0.6	5.2
Battery Box	0.6	0.5
Elastic Thread	4.0	4.8
Gloves	11.8	14.0
Foam Products	0.8	1.3
General Rubber Products	2.1	3.1

including four big tyre factories which produce a variety of tyres required both for domestic consumption and international market. Thailand has shown remarkable growth in rubber manufacturing activities during the last two years. Table 5 gives the consumption of rubber in different rubber products.

SRI LANKAN RUBBER INDUSTRY

Sri Lanka is consuming around 23600 tonnes of rubber annually for product manufacturing in the country. Most of the industrial units in the country are very small. There is only one tyre factory in Sri Lanka. There are five solid tyre manufaturing units and six glove units. The country has ambitious programmes to enhance rubber consumption to 70000 tonnes by 2000 AD.

RUBBER INDUSTRY IN INDIA

Indian rubber industry has a history of over seven decades. There are over 5000 rubber goods manufacturing units in the country consuming over 500 000 tonnes of rubber per year. Among rubber producing countries, India has the distinction of being the only country which consumes all the rubber produced by it. Table 6 gives the size distribution of manufacturing units in India.

TABLE 6 SIZE OF MANUFACTURING UNITS IN INDIA

CONSUMPTION IN TONNES/ANNUM	NO. OF UNITS
10 tonne and below	2 568
Between 10 and 50 tonne	1 614
Between 50 and 100 tonne	349
Between 100 and 500 tonne	269
Between 500 and 1000 tonne	36
Above 1000 tonne	45

Although there are 5 000 units in the country nearly 45 percent of rubber consumed is through the thirty tyre factories. Most of the non-tyre units are small scale manufactures. The industrial growth in the country was around 8 percent during the past few years although the position changed in 1991-92.

Consumption of rubber in India in different products is given in Table 7.

TABLE 7 CONSUMPTION OF RUBBER IN INDIA

PRODUCT	CONSUMPTION IN TONNES 1990-91	1991-92
Automotive Tyres and Tubes	222 120	226 207
Cycle Tyres and Tubes	77 453	81 059
Camel back	34 352	35 517
Footwears	63 654	67 204
Belts and Hoses	36 387	38 029
Latex Foam	19 598	20 750
Dipped Goods	15 578	17 067
Others	37 879	39 515

Almost 45 percent of the rubber consumed in Indian rubber industry is in tyre sector. Cycle tyres is the next important product. Export of cycle tyres from India is fast picking up. Most of the other non-tyre products manufactured are used for domestic consumption. Export value of rubber products from India is given in Table 8.

The value of tyres exported from India has almost doubled by 1991-92 thereby indicating almost hundred percent growth. Similar results are shown by some latex products and cycle tyres.

TABLE 8 EXPORT VALUE OF RUBBER PRODUCTS FROM INDIA

PRODUCT	EXPORT VALUE 1990-91 (Rs. MILLION)
Automotive Tyres and Tubes	1795.0
Rubber Footwear	117.5
Belting	241.0
Cycle Tyres and Tubes	120.0
Ho ses	77.0
Medical Products including Gloves	139.0
Cots and Aprons	11.0
Others	97.0
Total	2597.0

OTHER RUBBER PRODUCERS

The other major rubber producing countries are China, Vietnam, Nigeria, Ivory Coast and Liberia. China has a well developed rubber goods manufacturing industry and is an important exporter of examination gloves. Vietnam is slowly developing its vast damaged plantations and the manufacturing industry in that country is yet to make its impact in the international market.

CHALLENGES AHEAD

Unhealthy Competition

All natural rubber producing countries are now manufactures of rubber products required in the international market. These are being sold to more or less the same users by different producers. This situation has resulted in unhealthy competition and the price realised for some products has become unremunerative. Examination glove manufacturing units in some countries had to be closed down because of this situation. The position can improve only if the producers in different countries enter into some kind of agreement in capacity utilisation and market

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AN ECONOMIC STUDY OF LATEX GLOVE INDUSTRY IN INDIA

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Half a decade ago latex gloves were the hottest things in the rubber industry because of concern over the spread of AIDS. In advanced countries whole set of medical staff, military personnel and even super market workers have started using gloves as a protective measure against AIDS. Use of gloves in USA and North America became routine in mid 1988. All these created a world-wide boom in the market for gloves. Many investors in USA, China, Malaysia, Indonesia and Thaiwan rushed their money for glove production. Price of gloves touched its peak level of 110 US dollars per 1000 pcs during that period. But in later years ie; in 1989 and 90's the trend began to reverse due to overproduction and price of gloves fell in the range of 15–18 US dollars per 1000 pieces. Many latex gloves units in USA, China and other European countries have closed in 1990. This situation lead to healthy demand supply balance and finally the industry has revived and international price has improved to the range of 25 to 30 US dollars.

In India also more licences were issued to establish glove units. However only a few licensees have started production and other left the field. The units which started production faced teething troubles when the world glove market was gloomy. The Indian manufactures are still in dilemma though the units in Malaysia and Indonesia are setting for a take-off. In order to know about India's response to the changing situation and to examine the cause and significance of these upheavals a study was undertaken and the finding of the study are presented in this report.

METHOD OF STUDY

Surgical gloves (sterile & non-sterile) disposable examination gloves, household gloves, industrial, electrical and postmortem gloves are the different types of gloves made from natural rubber. Of these examination and surgical gloves are the most sophisticated and sensitive items. Demand is also more for these items not only in the world market but also in the domestic market. The units manufacturing examination gloves can also make surgical gloves with the same type of machinery and technology.

In India there are about 150 glove manufacturing units of which 47 are engaged in production of surgical and examination gloves. All these units are using automatic dipping plants whether imported or indigenously fabricated. Of these 47 units majority are concentrating in a single item ie., either surgical or examination gloves. However a few are producing both the items.

The present study is confined only to the surgical and examination glove manufacturing industry. All the required details were collected from the producers in a pre-tested questionnaire through interview method. Secondary details were collected from the periodicals and other published sources.

GLOVE INDUSTRY – A WORLD SCENARIO

On the global scale Malaysia tops in the production taking a major share in the world market. It is reported that the total installed capacity of the country is about 15.5 billion gloves per year. More than 80 units have registered as members in the Malaysian Rubber Glove Manufactures Association

In addition some big and small units are also producing gloves. Production of rubber gloves in Malaysia for the year 1987 was 396.74 million pairs and this increased to 1345 million pairs in 1988, 1593 million pairs in 1989 and 1796 million pairs in 1990. In 1991 production was 2227 million pairs accounting 24% increase over the previous year's production. Export earnings of rubber gloves from Malaysia also increased from 848 million dollars in 1990 to 1033 million dollars in 1991 accounting 22% increase .

In Thailand about 50 units have started production though licences were given to 140 units to form latex glove plants. Total installed capacity of glove industry in Thailand is understood to be not less than 5.5 million . Installed capacity in Indonesia also rose from 0.4 billion in 1987 to 3.2 billion in 1988 and was expected to increase 9.8 billion in 1990. The installed capacity in Srilanka is limited to produce 400 million pieces of gloves per annum. Srilanka's export of rubber gloves jumped to 222 million pcs in 1991 from a mere 3.8 million pcs in 1990 . Similar rates of growth have accrued in other key producing countries like Taiwan Philippines UK and China.

GLOVE INDUSTRY IN INDIA

Government of India also issued more than 100 licences to establish glove units for export production. Of this about one third of the licences have established their factories. In addition some units in domestic tariff area (DTA) have also developed their capacities to produce gloves using automatic plants. The status of glove industry is given in table–1.

Table 1. Glove Units in India using atomatic Dipping Plants

Status	No. of Units	Total Installed Capacity	
		Examination Gloves (million pcs)	Surgical Gloves (million pairs)
FTZ	19	690	72
EOU	15	745	132
DTA	13	174	82
Total	47	1609	286

Though 47 units have started ventures (see table–1), all have not enjoyed the expected levels of business. Many units are closed or on the verge of closure due to the glut in the world market. A few have gone out of business. There was a major set back in the entire glove industry in 1989–90, 1990–91 and first half of 91–92. Recently the performance showed that the industry is well on the way to progress. Good inquiries are coming up from Unites States and European countries as the world glove market is picking up. Many units in India have got orders for the next one to two years. Those units who were in dilemma for the last two years have also started production.

During the period of study there are only 40 units actively engaged in production of gloves. Of these 26 are exclusively engaged in production of examination gloves 8 units on surgical gloves and the remaining 6 are manufacturing both surgical and examination gloves. All these units have a total installed capacity for producing 1369 million pieces of examination gloves and 144 million pairs of surgical gloves. Summarised details of these units are given in table–2.

In addition to the existing units three more units are planning to start production by the end of 1992 with a capacity of 120 million pieces of examination gloves. Therefore the production capacity of examination gloves by the end of the year will be 1489 million pcs.

PRODUCTION AND EXPORT

Production and export made by the units for the last 3 years are given in table–3. Table shows an upward trend in production indicating good progress in the

Table 2. Summarised details of Glove Units

Status	No. of Units	No. of Plants	Production Capacity	
			Examination Gloves (million nos.)	Surgical Gloves (million pairs)
FTZ	14	18	540	24
EOU	14	21	715	34
DTA	12	12	114	86
Total	40	51	1369	144

industry. 1991–92 production is more than doubled campared to the previous year's production. In this period seven units started production taking advantage of the market potential which collapsed earlier.

Regarding exports it is noted that major share of examination gloves produced is exported (98.4% in 1991–92) whereas surgical gloves are mainly marketed within the country. The export figure given in table–3 will not tally with the actual made as there are few more units in the small scale sector which are not covered in this study.

Underutilisation

Capacity utilisation of the industry is very low ie; about 15% in examination gloves and 62% in surgical gloves. Low capacity utilisation which is common throughout the industry is mainly due to the surplus capacity available in general particularly in examination gloves. This underutilisation of capacity implies increased cost of production which make the glove industry incompetent in the world market. Therefore all units should increase their production, at least to cover the break even, so that they can compete with international gaints in the world market.

MARKET FOR GLOVES

US Germany Canada UK South Africa and other European countries are the important marketing centres for gloves. The ANRPC reported that US itself requires up to 8,000 million pairs of gloves in a year.

According to the General Agreement on Trade and Tariffs (GATT), the world import of rubber gloves is estimated to reach around 30 billion pcs per annum. Studies also projected that requirement of latex gloves in US will go up to 10 billion by the end of 1992 and global demand will go up to 35 billion pcs Another projection made very recently showed that global market for gloves at the current period is estimated at around 9 billion pcs and it should cross to 10 billion pcs by 1994. The US market is all set to absorb 6.5 billion pcs in 1992 and is expected to stabilise at the range of 7.5 to 8 billion pcs by 1993–94. The requirement of latex gloves in Germany should also increase to 1.5 billion pcs by the later half of the Decade. Germany's import in 1991 was 955 million pcs of gloves. However, on contradictory to the expectation, import of gloves in these countries remained subdued for over one year particularly in 1989 due to over production and dumping of second quality gloves. But in later years import trend has improved when the world economy faced shortage of quality gloves with FDA regulation. The index of import of rubber gloves in USA Japan and EC have strengthened during this period. The US also imported 5975 million pcs of gloves in 1991 accounting an increase of 57.36% over the previous year's import of 3797 million pcs. In the first two months of 1992 US imported 1.67 billion pcs an increase of 176% over the same period in 1991. Table–4 gives country–wise import of rubber gloves in US for the years 1990 and 1991.

Table reveals that Malaysia's share in US market has increased from 63.05% in 1990 to 64.52% in 1991. Thailand also has improved the position from 12.23% in 1990 to 14.33% in 1991. India's share in 1991 was doubled from the previous year's share of 0.59%.

Domestic Markets

Demand for latex gloves in India has also increased in view of the increasing incidence of AIDS in the country which has been realised by the medical profession recently. Experts in WHO argued that AIDS is spreading in India as quickly as in Africa and the country's situation is more complex. WHO conducted a survey which revealed that highest number of AIDS cases and zero–positivity rates have been reported from Bombay and Calcutta and the nation–wise average HIV prevalance rate has gone up from 0,2% in 1986 to 1.3% in 1990 accounting a seven–fold increase within the five years. The study also estimated that current infection in India varies between 3 lakh and 5 lakh this will go over one million by the turn of the Century . Considering this Union Cabinet has recently established a national AIDS Control Authority (NACA) for quick implementation of AIDS control programme.

As stated earlier gloves can also be applied in other areas like food, meat packing industry,landry, catering etc...The rise of such industries in India should definitely give gloves a greater share in the domestic market. People engaged in chemical handling, food processing, automotive, hazardous waste and beauty parlour are often wearing surgical gloves which are costlier than examination gloves. Many of these people are not aware of the availability of examination gloves. They simply buy gloves whatever is available in medical shops without considering its price and quality. They are also buying gloves from platform vendors who are trading second quality gloves and rejections made from the export trade.

All these shows that there is good market for examination gloves in India. The only thing is to exploit the market. For that, our manufactures should create an awareness among the consumers about the various applications of gloves and popularise its uses through proper media. Appendix-1 gives a rough idea of the market segment for gloves in India.

PROSPECTS

Prospects of glove units in India looks bright. For surgical gloves market is very stable and demand is going up. Demand for examination gloves is going up as the world market is now experiencing a shortage of quality product of new FDA regulation. Awareness of the continuing spread of AIDS and other lethal diseases has caused the world market for gloves to expand at the rate of about 10% per annum. Price realisation has also increased to the range of 25-30 US dollars (C.I.F.) as against 15-18 US dollars during the slum period. Quality of Indian gloves are noway inferior to gloves made from Malaysia and other key producing countries. However our manufacturers should take into account all the developments & regulations made in USA and other European countries on import of latex gloves.

Table 3. Production and Export of Glove

Year	Production		Export	
	Exam. Gloves (millionNos.)	Surgical Gloves (million pairs)	Examination Gloves (million nos)	Surgical Gloves (million pairs)
1989-90	56.086	9.749	19.098	2.846
1990-91	80.958	38.176	55.543	5.390
1991-92	208.470	89.442	205.132	33.081

FDA Regulations on Latex Gloves

In the past US buyers were sticking on to ASTM standards and consignments that failed to meet ASTM specifications were rejected. Later, for assuring safety and effectiveness of medical gloves, the US FDA has reviewed the glove testing proceedures. A more stringent leak testing methodology was introduced which differs from ASTM's testing methodology by adopting a 1000ml water test. According to the Federal Food, Drug and Cosmetic (FD and C) Act all medical gloves including patient examination and surgeon's gloves either produced domestically or imported/traded in USA are subjected to the following controls.

1. Registration

the US glove manufacturers are required to register with FDA and foreign glove manufacturers are encouraged to do so.

2. Devise listing

all glove manufacturers are required to list with FDA by completing the medical devise listing form.

3. Pre-market Notification [510 (k)]

Manufacturers of gloves are required to submit a pre-market notification, also known as 510 (k),

Table 4. Country-Wise Import of Rubber Gloves in US for the Years 1990 and 1991

Country	Quantity Imported (million numbers)	
	1990	1991
Malaysia	2393.7 (63.05)	3855 (64.52)
Thailand	464.3 (12.23)	856 (14.33)
United Kingdom	395.5 (10.42)	NA
China	218.8 (5.76)	NA
Taiwan	136.8 (3.60)	NA
Indonesia	70.8 (1.86)	NA
India	22.6 (0.59)	64 (1.07)
Others	93.9 (2.47)	NA
Total	3796.4 (100.00)	5975 (100.00)

to the FDA indicating all details of gloves including the type and source of power or other donning lubricant used and its specific-\ation. A statement/summary of the safety and effectiveness information should also be submited alongwith the 510(k).

4. Labelling

display of written, printed or graphic matter upon the immediate container of glove is strictly required. Name and places of business, statements of identity and net quantity content, country of origin, lot number & expiry date, donning powder identification and caution, adequate direction for use etc.... are important to be noted in labelling.

5. Good Manufacturing Practices (GMP)

Manufacturers of medical gloves are required to meet the current GMP regulations for medical devises. The GMP regulation requires that every finished glove manufacturer shall prepare and implement a Quality Assurance (OA) Programme which should include the following:

-adequate organisation and sufficient trained personnel

-formal and documented QA Programme

-designated QA management

-review of all records

-approval or rejection of materials, components and finished products

-adequate and controlled equipment, environment and facilities

-assure adequate and correct quality assurance checks

-identification of QA problems and corrective actions

-periodic audits with corrective actions.

All these five regulations are common to both patient examination and surgical gloves. However in the case of marketing surgical gloves in USA, FDA requires a few more restrictions. They are,

1. Supply data on skin irritation and Dermal Sensitization studies of surgeon's gloves.

2. Dusting power used for surgeon's gloves must be cleared for marketing by the Pre-market Approval (PMA) process and this should meet the specifications of absorbable powder (made from cornstarch) in United States Pharmacopea (U.S.P).

3. A sterility assurance level (SAL) of 10^{-6} is also required for surgeon's gloves. That is the sterilization process designed so that the probability of a glove being non-sterile is 1 in one million even if the gloves originally contained highly resistant micro-organisms[8].

Recently it is found that the use of latex containing medical devises caused various allergic reactions resulting in death, urticaria, rhinitis and respiratory symtoms such as asthma[9]. The American College of Allergv and Immunology in May 1992 provided a board list of recommendations of latex allergy. since most of the allergic reactions are caused by extractable proteins that occure in latex, FDA has instructed to make protein levels in latex medical devices as low as possible. FDA also published an advisory document to all manufacturers of latex devices suggesting various steps to minimize the leachable proteins. A brief review of FDA's suggestions are given below[10].

1. Leaching

removal of as much of water soluble proteins as possible from latex devices by controlling leaching process.

2. Post cure Processing

off-line washing of latex devices with hot water after completion of curing process and surface treatment of the cured device with chlorine or other agents.

3. Latex Specification

manufacturers should specify the water soluble protein content of the raw latex to be purchased which can be reduced by centrifugation and other techniques.

4. Manufacturing and Quality Assurance Process Validation

the process for measuring proteins must be validated and documented and assure that the leaching, cleaning or treating process being used adequately reduce water soluble proteins to or below the level in the company's specification.

PROBLEMS AND SUGGESTIONS

One of the important problems faced by the Indian Glove industry is low price realisation. It is reported that Malaysian gloves are sold at higher prices because of the goodwill and govt. support these people are not aware of the availability of examination gloves. They simply buy gloves whatever is available in medical shops without considering its price and quality. They are also buying gloves from platform vendors who are trading second quality gloves and rejections made from the export trade.

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display of written, printed or graphic matter upon the immediate container of glove is strictly required. Name and places of business, statements of identity and net quantity content, country of origin, lot number & expiry date, donning powder identification and caution, adequate direction for use etc.... are important to be noted in labelling.

5. Good Manufacturing Practices (GMP)

Manufacturers of medical gloves are required to meet the current GMP regulations for medical devises. The GMP regulation requires that every finished glove manufacturer shall prepare and implement a Quality Assurance (OA) Programme which should include the following:

-adequate organisation and sufficient trained personnel

-formal and documented QA Programme

-designated QA management

-review of all records

-approval or rejection of materials, components and finished products

-adequate and controlled equipment, environment and facilities

-assure adequate and correct quality assurance checks

-identification of QA problems and corrective actions

-periodic audits with corrective actions.

All these five regulations are common to both patient examination and surgical gloves. However in the case of marketing surgical gloves in USA, FDA requires a few more restrictions. They are,

1. Supply data on skin irritation and Dermal Sensitization studies of surgeon's gloves.

2. Dusting power used for surgeon's gloves must be cleared for marketing by the Pre-market Approval (PMA) process and this should meet the specifications of absorbable powder (made from cornstarch) in United States Pharmacopea (U.S.P).

3. A sterility assurance level (SAL) of 10^{-6} is also required for surgeon's gloves. That is the sterilization process designed so that the probability of a glove being non-sterile is 1 in one million even if the gloves originally contained highly resistant micro-organisms[8].

Recently it is found that the use of latex containing medical devises caused various allergic reactions resulting in death, urticaria, rhinitis and respiratory symtoms such as asthma[9]. The American College of Allergy and Immunology in May 1992 provided a board list of recommendations of latex allergy. since most of the allergic reactions are caused by extractable proteins that occure in latex, FDA has instructed to make protein levels in latex medical devices as low as possible. FDA also published an advisory document to all manufacturers of latex devices suggesting various steps to minimize the leachable proteins. A brief review of FDA's suggestions are given below[10].

1. Leaching

removal of as much of water soluble proteins as possible from latex devices by controlling leaching process.

2. Post cure Processing

off-line washing of latex devices with hot water after completion of curing process and surface treatment of the cured device with chlorine or other agents.

3. Latex Specification

manufacturers should specify the water soluble protein content of the raw latex to be purchased which can be reduced by centrifugation and other techniques.

4. Manufacturing and Quality Assurance Process Validation

the process for measuring proteins must be validated and documented and assure that the leaching, cleaning or treating process being used adequately reduce water soluble proteins to or below the level in the company's specification.

PROBLEMS AND SUGGESTIONS

One of the important problems faced by the Indian Glove industry is low price realisation. It is reported that Malaysian gloves are sold at higher prices because of the goodwill and govt. support they earned. The price they get is about 4000 US dollars (10–15%) more than what we get per million pcs. Beside market information is provided by the Trade Attaches of the Malaysian Embassies in Europe and USA which enable the Malaysian glove manufacturers to take part directly in tenders. Since these facilities are not available to the Indian glove manufacturers, it is suggested that, the Indian Embassies attached to European countries should collect market information and pass on to the manufacturers. A consortium of manufacturers should also be set up in US or Canada to organise marketing of Indian gloves. This consortium should collect international prices of gloves and on that basis fix lowest price for Indian gloves below which no manufacturer should sell and higher price should be targetted on the basis of quality. Similarly trade mission, trade expositions and individual visits are also useful for making trade relations.

Lack of collective marketing is another limitation. As the manufacturers in Malaysia & Indonesia have established a joint marketing agency, our manufacturers should also work collectively forgetting best prices so that they can win larger share in the world market.

International buyers are still worried about the quality of

Annexure. I

DOMESTIC MARKET FOR SURGICAL/EXAM GLOVES

HOUSE WIVES →	WASHING CLEANING MIXING BIOGAS COOKING
LABORATORIES →	DENTIST PHYSICIANS LABORATORIES PAINTERS CHEMICAL/PESTICIDE MIXING
FOOD PROCESSING →	CASHEW PROCESSING SPICES PROCESSING PROCESSING OF PICKLE FISH PROCESSING
HOTELS →	STAR HOTELS BARS CLEANING IN RESTAURANTS
BEAUTY PARLOUR →	HAIR DRESSING HAIR DYEING MASSAGE OF CREAMS

Indian gloves to FDA rules. Therefore to challenge the new FDA regulations, it is necessary to create an awareness among the Indian manufacturers of FDA rules and GMP.

Efforts should be made to provide a forum for the latex glove manufacturers in India to exchange knowledge and views developed in advanced countries about the allergic reaction of latex medical devices and its hazards to the medical community. Here it is worthwhile to mention the "International Latex Conference conducted in the first week of November 1992 in USA which was mainly sponsored by the Food & Drug Administration and the Center for Devices and Radiological Health. The reports and papers presented in the conference revealed that frequency of reporting latex allergy in different parts of the world has been increasing in recent years. Considering this manufacturers in Malaysia reviewed various methods for reducing protein during the production of medical devices such as gloves and condoms. It is reported that the typical "on-line or off-line leaching" treatments removes approximately 50% of the water extractable protein. Chlorination, Steam Sterilisation, Enzyme treatment of latex and use of barrier coatings have also been found effective in reducing protein levels or denaturing the protein as part of the manufacturing process. The level of protein in the serum phase of latex can also be reduced through double centrifugation."

FDA's alert on latex allergy incited many glove manufacturers in USA to produce TPE gloves (Thermoplastic Elastomer Gloves) which are reported to be free from NR latex skin irritants[12]. They also started to produce Powderfree Gloves and Clean Room Gloves as the demand for these items has considerably increased in the international market. It is estimated that the use of powderfree gloves may grow from the current estimated 150 million pcs to around 1000 million pcs in the next two to three years. This type of gloves also fetch a better price of atleast 8 to 12 US dollars per 1000 pieces extra than the price for examination gloves. India can produce powderfree gloves ore economically than Malaysia and Indonesiabecause of less labour cost in India as high labour component is required to produce this type of gloves particularly in the stage of chlorination and inspection.

To tap the domestic market it is suggested to establish a marketing network with individuals approaching the important marketing segments. Gloves can also be marketed in small pouches through super markets so that they can be popularised easily.

CONCLUSION

The success of glove units in India is beyond doubt optimistic atleast for the next few years. The price is moving towards better realisation and profitability. Practical convertability of export proceeds is also favourable factor. The manufacturers should take heed of all these aspects and co-operate closely with FDA administration. They should also make liberal advertisement campaign to establish an image for Indian gloves in abroad so that they can develop good trade relations in the international market.

Bibliography

1. International Rubber Digest, IRSG February 1992.

2. Figures collected from various issues of Malaysian Rubber Review, Malaysian Rubber Research and Development Board.

3. ANRPC News - A letter of the Association of Natural Rubber Producing Countries Kuala Lumpur Vol.7 No.1 March 1992.

4. Rubber Development Incorporating NR Technology, A Quarterly Journal of MRRDB Vol.43 No.1/2 1990.

5. Rubber Asia, Dhanam Publication Cochin.

6. ANRPC NEWS, March 1989.

7. AIDS specialists like Dr. Pols Jansegers at Geneva based WHO conducted a study and revealed the results in various dailies.

8. Summary of FDA Good Manufacturing Practices, Published by the Center for Devices and Radiological Health (DSMA) USA August 1989.

9. Rubber & Plastic News, The Rubber Industry's International Newspaper, A Crain Publication 28th October 1991.

10. Regulatory Requirements for Medical Gloves prepared by Center for Devices & Radiological Health USA October 1992.

11. Proceedings of International Latex Conference; Sensitivity to Latex in Medical Gloves, conducted in November 5 - 7 1992 at Meryland USA.

12. Rubber Research Institute of Malaysia, Annual Report 1990.

RRIMFLOW: A PROMISING RADICAL METHOD OF CROP PRODUCTION IN *Hevea*

The current scenario in the natural rubber industry in Malaysia dictates the necessity for radical technologies of crop production in *Hevea*. These techniques should have attributes which could overcome several constraints associated with existing conventional exploitation systems and contribute to higher labour and tree productivity. This will ensure that the returns per unit area are more remunerative, with improved man/land ratios that are comparable to other plantation crops.

It is generally known that processes occurring in latex vessels following excision tapping and the activity of bark coagulants on latex as it flows down the tapping cut contribute to cessation of flow, 2-3 h after tapping. Although the flow time is enhanced by several hours in stimulated trees, it is, however, confined to the initial few tappings after application of stimulants. It is obvious that much higher yields with long hours of latex flow can only be achieved if methods could be developed to circumvent these restrictive mechanisms on latex flow.

The RRIM has, therefore, developed a novel and radical technique of exploitation of *Hevea* known as 'RRIMFLOW". This technique, which is an incision method, is combined with application of a potent stimulant which keeps the latex vessels unplugged for considerable length of time over an extensive area of bark on the panel. The latex is extracted in a closed system into

Figure 1a. Components of RRIMFLOW – a PVC applicator for stimulant application, with LIL.ECS sets for collection of latex in a sealed container, which in this case is a polybag.

Figure 1b. Extraction of latex through a plastic tubing (2mm diameter x 60mm length), with one end fitted into the puncture and the other end leading into the sealed polybag through a 2mm aperture.

sealed receptacles containing a powerful anti-coagulant, with the dual function of aiding flow and preventing coagulation of the latex. The latex is extracted from the tree with minimal exposure to the atmosphere in order to reduce bacterial contamination which is considered as one of the contributory factors to cessation of flow. The characteristics of this method, namely the slow rate of crop extraction which allows the tree to adjust physiologically to the outflow, the long intervals between tappings providing enough time for regenaration in the vessels and the drainage of latex from an extensive area of the tree trunk suggest that the *Hevea* tree can tolerate this novel method of exploitation.

METHOD

The method involves single punctures once a week (1PI d/6) coupled with stimulant application weekly into applicators fixed over a scraped area of bark at the desired position on the tapping panel *(Figure 1)*.

The applicators, made of suitable materials such as heavy duty polyethylene, PVC, polystyrene or rubber, are secured over the scraped area of bark on the tapping panel with common contact adhesives and appropriate sealants. The same site of application is used for six to eight months, with re-application of sealant two to three months after initial fixing. The RRIMFLOW stimulant is applied into the applicator at concentrations of 25-30% a.i. at weekly intervals and generally 48 h prior to puncture tapping.

A single puncture is made in the bark at each tapping with a 2mm diameter needle mounted on a wooden handle, above or below the stimulated area of bark on the panel, up to distances of 1 m. The latex is collected into a closed receptacle or polybag containing a preservative with the aid of plastic tubes (60 mm length × 2 mm diameter), one end fitted into the puncture and the other leading through a 2mm diameter aperture into the closed receptacle. The closed receptacle could be of various types of any desired geometric shape or size provided they are functional and can prevent entry of rain water or other external adulterants. The anti-coagulant used in the receptacle is 8-10% ammonia solution (20-30 ml).

The crop is collected as latex between 48 and 72h after tapping to ensure that the VFA content is kept within acceptable levels.

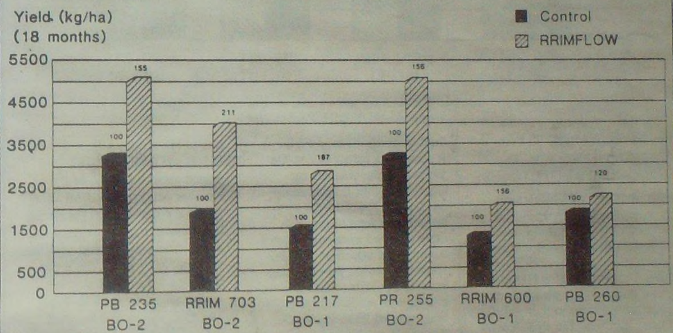


Figure 2. Yield responses of various clones to RRIMFLOW system in RRIM trials. (Control trees were tapped on 1/2S d/3 system. d/6 - 81 tappings; d/3 - 156 tappings)

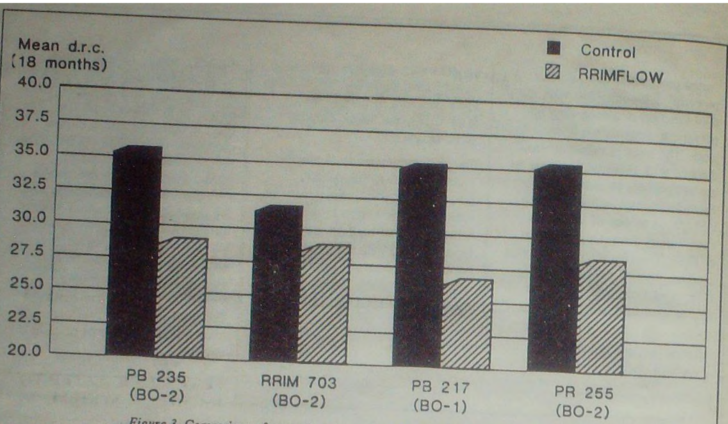


Figure 3. Comparison of mean d.r.c. between trees of different clones tapped on conventional and RRIMFLOW SYSTEMS.

PERFORMANCE IN RELATION TO YIELD, D.R.C. AND FLOW TIMES

The RRIMFLOW system has now been evaluated in comparison with conventional tapping system in several field trails on various clones and materials of different ages. Data presented previously show that the yield obtained per puncture are three to four times higher than that of conventionally tapped and stimulated trees. The dry rubber content (d.r.c) values for trees tapped on RRIMFLOW are generally lower than those of the control trees, although the magnitude of differences is influenced by type of cultivar and age of trees. The mean flow time for most clones ranges from 36 to 44 h after each puncture, although there is a progressive decline in the flow rates, particularly after the initial 24 h of flow.

The yield data on clonal responses obtained from RRIM field trials are given in *Figure* 2. It shows that for all clones, the yields in kg/ha obtained for eighteen months from trees tapped on RRIMFLOW (1PI d/6 + stimulation) were higher than those obtained from unstimulated control trees tapped on 1/2S d/3 system. However, the percentage increase in yields varied between clones, with additional crop ranging from 20 to 111%. The d.r.c. of latex obtained from trees of different clones tapped on the novel system was all lower than that of the corresponding control trees tapped on conventional systems (*Figure 3*). However, the extent of drop in d.r.c. values varied between clones.

It was also observed that the RRIMFLOW system was equally effective on both the virgin and renewed panels of various cultivars. Data summarised in *Table 1* show that the mean yield per tree per tapping in respect of clones PR 255 (BO-2), RRIM 600 (BI-2) and RRIM 701 (BI-2) tapped either on virgin or renewed panel with RRIMFLOW (1PI d/6 + stimulation) for twenty four months was several fold higher than that obtained with the conventional system. The mean flow time for trees of all three clones ranged from 38 to 44h. The d.r.c. values of latex from trees of all three clones tapped on the novel system were lower than those from the corresponding conventionally- tapped trees by 4.5 to 8.0 units.

RRIMFLOW is now being evaluated in several joint commercial task- size trials with various estates/agencies of the industry. In six of the oldest trials on clones RRIM 600, PB 217, GT 1, PR 261, RRIM 600 and PB 260, tapped on panel HO-1, early results for six months show that the mean yields per tapping per

TABLE 1

Comparative yield performance of virgin (BO-2) and renewed (B1-1) panels

Clone/ panels	Tapping system	Mean yield for 24 months (g/t/t)	Flow time (h)	Mean d.r.c.
PR 255	1P d/6	191	39	27.8
BO-2	1/2S d/3	45		35.8
RRIM 600	1P d/6	446	44	30.5
B1-2	1/2S d/2	52		35.0
RRIM 701	1P d/6	246	41	28.5
B1-2	1/2S d/2	53		33.3

Control trees of clones RRIM 600 and RRIM 701 were stimulated with 10% a.i. ethephon application to groove (6m/12).
Data for RRIM 600 given for twelve months only
Trees tapped on 1P d/6 system were stimulated weekly.
d/2 - 288 tappings; d/3 - 216 tappings; d/6 - 96 tappings for 24 months.

task (kg) from trees tapped with the novel technique are, with the exception of clone PB 260, more than twice those of the respective control trees (*Figure 4*). The total yields (in kg/ha) given in *Figure* 5 for the six clones show that they were all higher than those of the respective 1/2S d/2-tapped control trees, with excess yields ranging from 19-139%. These yields for trees tapped on RRIMFLOW were obtained for 24 tappings while control trees over the same period had 72-84 tappings.

The variation in yield performance between the six estates could largely be attributed to possible differences in past exploitation practices, likely variations in agronomic status of fields concerned and influence of available drainage area on panels exploited.

FEATURES RELATED TO RRIMFLOW SYSTEM

With the RRIMFLOW system of exploitation, trees can be expected to respond with good yields and

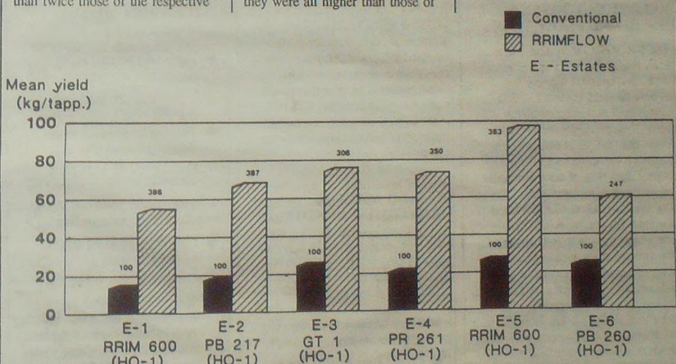
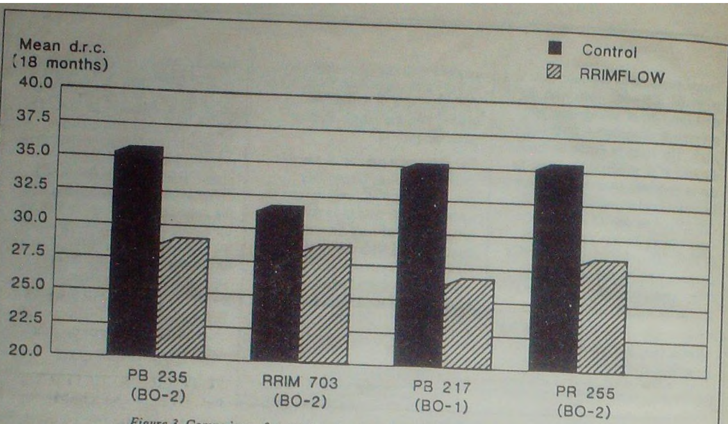


Figure 4. Comparison of task yields per tapping in commercial task - size trials evaluating RRIMFLOW system.

Figures within histograms refer to respective percentage responses relative to control trees tapped on conventional systems. Control trees on Estates 1, 2, 4 and 5 were tapped on panel BO - 2, while on Estates 3 and 6, they were tapped on double cut on panels HO - 1 and BI - 1.



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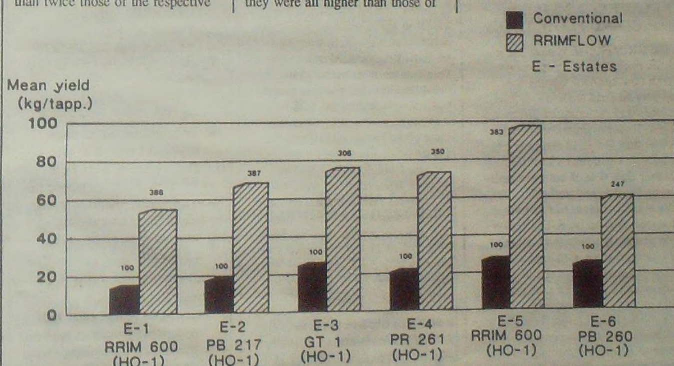

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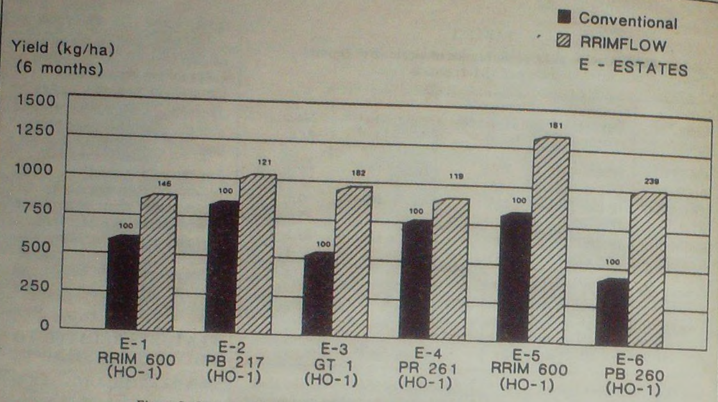

Figure 5. Comparison of total yields on estates evaluating RRIMFLOW system

Figures within histograms refer to respective percentage responses relative to control trees tapped on conventional systems Control trees on Estates 1, 2, 4, and 5 were tapped on panel BO - 2, while on Estates 3 and 6 they were tapped on double cut on panels HO - 1 and BI - 1. Assumed stand per hectare is 300 trees.

prolonged flow time after an initial lag period of one or two tappings. There may be some variations in yield responses between trees of a given clone and between trees with successive puncture tappings on account of the differences in their girth sizes and the efficiency of the stimulant applicators. However, for good yields, it is important to ensure that bark is of adequate thickness with sufficient drainage areas on the panel. A good canopy is also necessary to ensure sustained rates of latex flow and high yields.

Although past exploitation history of the tree and clonal variations can have an influence on the magnitude of yield responses, strict adherence to stipulated procedures should ensure realisation of potential yields. In addition, it is critical that proper planning, organisation and supervision of labour be carried out to derive maximum benefits from this system.

OTHER ASPECTS RELATED TO RRIMFLOW

RRIMFLOW has several advantages when compared to conventional tapping systems. These are namely:

- Trees can be exploited using unskilled labour.
- Costs of production can be reduced provided labour utilisation is strictly regulated.
- There will be no loss of crop due to rain interference as tapping can be completed after the rain.
- Trees can be tapped after over-night rains thus maximising productivity and ensuring adequate returns for wages paid.
- There is flexibility of tapping at any desired time in the day.
- Unproductive trees such as brown-bast trees and trees of low girth sizes can be exploited.
- The entire crop can be harvested as latex thus fetching better returns, provided correct concentrations of preservative are used and collection completed within 72 h of puncture tapping.

The long-term effects of stimulant usage on the trees needs to be ascertained particularly with regard to its possible effects on anatomy of the bark and physiology of the tree, inclusive of metabolic changes in the latex. In addition some adverse effects have been noted and practical problems encountered, although most of these can be overcome. These are:

- Bleeding from previous puncture points and from renewed bark.
- Occurrence of bark cracks, flaking and bark bursts resembling petch canker though this appears to be largely a clonal response.
- Damage to applicators by pests, in particular monkeys.
- Prospect of theft of crop in the field.
- Necessity for constant repair of applicators due to normal process of bark expansion/contraction and growth in young mature trees.
- Need to ensure that applicators remain leak-proof to obtain expected high yields.
- Need to adhere to crop collection schedules to avoid problems with processing.

It is apparent that besides influence of genetic factors and past exploitation history, which are beyond control, problems such as occurrence of bleeding and bark bursts can be tackled by reducing frequency or stopping stimulation temporarily until the trees recover, without disrupting tapping. Management in puts with absolute commitment and active participation are deemed necessary for the successful development of this system of exploitation. The tremendous potentials of this radical technique cannot be realized if its adoption is to be guided by practices associated with conventional tapping systems. Thus, comprehensive changes in all related aspects are necessary if the method is to evolve as an alternative and viable mode of crop production in *Hevea*

CONCLUSION

RRIMFLOW is a radical approach to exploitation of *Hevea* trees. It promises to provide the necessary impetus and offer practical solutions to major problems affecting the rubber industry.

The technique can be used to exploit trees which are to be replanted in four to five years, provided there is sufficient bark remaining on the high panels (HO-3 + HO-4). Further, using this technique, yield productivity of a given tapping task can be enhanced by exploiting dry or brown-bast trees and low-girthed trees without concern for long-term effects. Large-scale adoption of this technique as a routine commercial practice on young mature and premium rubber can, however, only be recommended after its evaluation over a longer period.

The technique can be targeted for immediate use in specific areas requiring urgent solutions to prevailing problems, provided there are absolutely no other alternatives. These are:

- Areas with young mature rubber of tappable age (more than six years) but not opened for exploitation owing to acute scarcity of skilled labour and the pressing need to off-set expenses for field upkeep and maintainence. Data available confirm that notwithstanding the long-term effects, it is a viable and practical alternative to conventional tapping systems.
- Inability to maximise crop extraction from mature premium and old rubber owing to shortage of tappers. The method is suitable for this group of trees although modifications may be necessary to further enhance yields by increasing the number of puncture tappings per month from existing four to six or seven at intervals of four to five days.

In addition, the technique has tremendous potentials which can be developed to provide greater muscle and viability to the rubber industry. These include among others:

- Reduction of the uneconomic immature phase of *Hevea* trees with exploitation at smaller girth sizes (35cm - 40cm)
- Tapping of only virgin panels without recourse to renewed panels, thus enabling accelerated replanting and earlier returns from sale of timber.
- It is likely that in the not too distant future, the labour requirements for crop harvesting in the rubber industry may be comparable or lower than that of oil palm if trees exploited once a month with four punctures per tapping with monthly stimulation can give yield as much as that obtained with ten to twelve conventional tappings.
- With the RRIMFLOW system of exploitation harvesting of rubber could become a part-time occupation, with the non-resident labour working normal hours in factories and exploiting *Hevea* in the evening.

Article credit: S. Sivakumaran, Chong Kewi and Ahmad Zarin bin Mat Tasi (Planter's Bulletin)

PRESENT QUALITY OF INDIAN STANDARD NATURAL RUBBER

M. Sunny Sebastian and Treasa Cherian
Quality Control Division

Before the second world war, the only commercially available rubber was NR, and synthetic rubbers reached the market in the 1940s. The early synthetic rubbers had many drawbacks. Any drawbacks associated with NR were tolerated due to the limitations of synthetic rubber. However, in the 1950s, due to the introduction of Zeigler Natta Catalyst system, stereo specific synthetic rubbers could be produced easily. Their molecular size, average molecular weight, gel content, size and extent of side chains, viscosity etc. could be controlled easily. That is the synthetic rubbers were assuming a 'tailor cut' state. In other words, a consumer of synthetic rubber could demand for a rubber of specific mooney viscosity or having a desired cure time or rate of cure when compounded using a standard formulation. Moreover, synthetic rubbers were marketed in standard packages in a very attractive form.

Such developments in the field of synthetic rubbers reduced the market share of NR. NR marketed in sheet or crepe form were graded only by visual methods and were not properly packed. Hence, attempts were made to grade and market NR based on some specific properties. The first attempt in this line was the technical classification (TC) scheme, originated in Vietnam and Combodia in 1951. In addition to visual examination, vulcanisation rate and mooney viscosity were in the main parameters in the TC scheme. The specification of mooney viscosity was abandoned in 1953 due to the discovery of storage hardening of NR. The classification based on vulcanisation rate was found to be effected the variations in non-rubber constituents present in NR. Thus the TC scheme was found to be inadequate. Hence following the developments of new processing technology, Malaysia in 1965 introduced and improved scheme, popularly known as the SMR scheme for marketing NR with more meaningful specifications. The main features of the SMR Scheme are

1. Good and clean presentation of NR in small handled bales.

2. Guaranteed limits for contaminants and certain basic raw rubber properties.

3. Consistency in technical properties.

TABLE-1. IS:4588-1986 Physical and Chemical Requirements for Natural Rubber

Characteristics	Requirements for					
	ISNR-3CV	ISNR-3L	ISNR-5	ISNR-10	ISNR-20	ISNR-50
1. Dirt Content,% by mass (Max)	0.03	0.03	0.05	0.10	0.20	0.50
2. Volatile Matter by mass (Max)	0.80	0.80	0.80	0.80	0.80	0.80
3. Ash by mass (Max)	0.50	0.50	0.60	0.75	1.00	1.50
4. Nitrogen by mass(Max)	0.6	0.6	0.6	0.6	0.6	0.6
5. Initial Plasticity (Po)	40 ± 5	30 (min)	30 (min)	30 (min)	30 (min)	30 (min)
6. Plasticity Retention Index (PRI) (Min)	60	60	60	50	40	30
7. Colour (Lovibond Scale) Max.	–	6	–	–	–	–

TABLE–2 Results of analysis of TSR produced in Estate Sector

Batch	Bale No.	Dirt Content %	Po	PRI
A	10	0.07	35	80
	20	0.05	38	74
	30	0.09	37	76
	40	0.06	39	72
B	10	0.05	37	62
	20	0.06	36	67
	30	0.10	34	53
	40	0.08	39	62
C	10	0.06	37	62
	20	0.08	32	72
	30	0.09	32	75
	40	0.10	35	73

4. Better and easier adaptation to consumer needs.

This new technically specified rubber (TSR) scheme was adapted in several NR producing countries and the Indian version is the ISNR (Indian Standard Natural Rubber) The SMR scheme has undergone periodic revisions and the present grades and specifications limits are described in SMR bulletin No 11(2). In India specifications for NR were originally introduced in 1968 and subsequently revised in 1975. The current specifications are given in IS: 4588–1986(3) (Table–I).

Consistency of TSR is a rather ill–defined term. Initial plasticity (Po) is an important property describing the properties of TSR. But, different batches of NR in a narrow range of Po can show wide variations.

When NR was graded by the 'Green book' (4) specifications, lot of variability was observed in prossesibility within and between consignments of NR which fall on to a particular grade when visually examined. The situation has not much improved even with the introduction of the TSR Scheme. Increasing automation and computerisation in rubber industry require the use of more consistent NR. Consistency in properties of NR has acquired great importance in all the NR producing countries (5). Better consistency is observed in TSR produced from latex compared to TSR processed from field coagulum grade raw material. Hence a study was conducted to look into consistency of TSR produced in India.

MATERIALS AND METHODS

The following aspects were taken into considerations while studying the consistency of crumb rubber.

a. clonal variations

b. climatic conditions

c. agronomic practices

TABLE –3 Results of analysis of TSR Produced in units procure Raw Materials.

Batch	Bale No.	Dirt Content %	Po	PRI
A	5	0.11	39	59
	15	0.15	37	57
	25	0.14	31	65
	35	0.16	33	61
	45	0.18	32	59
	55	0.17	32	47
	65	0.17	30	64
	75	0.18	32	53
B	5	0.20	30	57
	15	0.15	31	65
	25	0.20	34	59
	35	0.20	34	65
	45	0.19	30	50
	55	0.20	31	58
	65	0.20	31	55
	75	0.17	30	50
C	5	0.16	40	65
	15	0.22	38	66
	25	0.16	39	64
	35	0.15	41	59
	45	0.17	37	62
	55	0.22	35	60
	65	0.16	35	68
	75	0.16	38	63

TABLE-4 Test report of sample from Consecutive Bales.

Batch	Bale No.	Dirt Content %	Po	PRI
A	61	0.19	35	66
	62	0.18	35	63
	63	0.17	36	61
	64	0.16	37	59
	65	0.18	35	49
	66	0.17	34	59
	67	0.18	35	54
	68	0.15	23	52
	69	0.16	32	56
	70	0.17	37	50
B	821	0.18	28	61
	822	0.15	28	57
	823	0.18	30	70
	824	0.15	29	69
	825	0.17	31	66
	826	0.16	37	61
	827	0.12	37	59
	828	0.12	37	59
	829	0.14	37	59
	830	0.12	37	59

d. tapping and collection conditions

e. pre-processing operations

f. processing practices

TSR-20 grade material in the largest volume TSR produced and is derived from field coagulum grade materials and the results reported in this paper mainly covers ISNR-20.

The TSR who producing units in India can be broadly classified as

1. Category I 'who process own estates' field coagulum

2. Category II who process field coagulum grade raw materials collected mostly from small growers and dealers.

In India about 80% of TSR is produced by the latter group.

In a large estate, the earlier cited variability factors a to d are almost constant, factors e and f are more or less constant, whereas for the processors of purchased raw materials, a to e are very different and have control over processing practice alone. For a large estate processor, accumulation of raw materials in seldom experience. The storing conditions of the raw materials considerably affect the quality(6) and consistency of NR.

PRESENT SYSTEM OF TESTING & GRADING.

In India, each ISNR block weights 25kg and every 10th bale is selected for sample collection. The selected bales are individually tested for dirt content, Po and PRI and a composite sample of 4 bales representing 1000 Kg is tested for volatile matter, ash and nitrogen. By simple observation of the test results, grading is done. The present study covered 5 processing units in the estate sector and 20 units who process purchased raw materials.

Typical tests results for 3 batches of TSR produced by the 2 categories are given in table 2 & 3. These tables indicate that generally better quality TSR is produced in the estate sector.

Examining the results of table 3 indicate wide variability in properties. Each of the results in part A & B corresponds to ISNR-20 and the whole batch is graded as ISNR-20. In part C the test result of bale nos 15 and 55 corresponds to ISNR-50 and the common practice of present grading system is to grade bale nos 11-20 and 51-60 as ISNR-50 and others as ISNR 20.

This is an unscientific way of grading TSR. Considering the variations in parameters, especially the dirt content, there is likely chance that atleast some of the untested bales can have dirt content above the maximum permissible limit of 0.20 for ISNR-20. Further some bales between 11 to 14 and 51 to 60 of batch C may fall within the specifications for ISNR-20. Hence the system of grading by simply examining the numerical values of the tested bales is quite unscientific and inadequate.

Inorder to overcome this situation the 'Mean+3SD' system based on statistical methods is applied to the grading batch of TSR in other countries. The mean and standard deviation (SD) are calculated using the formula

$$\text{Mean} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n} Z x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)}{n-1}}$$

The value of 'mean ± 3SD' is computed for each batch, whose maximum value for dirt content for TSR 20 grade is 0.20.

In the present study different batches, graded as ISNR–20 in the conventional way, were collected from 25 processing units for a period covering 6 months, at the rate of 4 batches per month. In addition, samples were collected from every tenth bale of selected batch for testing. The data thus obtained were statistically analysed. Considerable variations are observed even in the successive bales of ISNR processed from raw material obtained from a single source. The test reports for 2 such batches are given in table 4. Since the raw material is from a single source, these variations are introduced due to the lack of proper blending.

RESULTS AND DISCUSSIONS.

1. GRADING.

For the purpose of grading the mean and standard deviation (SD) were calculated for 4 batches each randomly selected from units belonging to category 1 and 2. The test report of the batches and the statistical analysis are given in table 5 & 6 respectively. Statistical analysis indicates the inadequacy of our present grading system.

2.EXTENT OF CONSISTENCY.

Confidence limits, having only 5% probability that the average property will be outside these limits, are calculated using the equation

$$\text{Confidence limits} = \bar{x}_i \pm \frac{t \times SD}{\sqrt{n}}$$

were xi is the mean, t is a statistical constant equal to 2.36 for 5% probability, n is the number of samples tested. The wider the range between the upper and lower confidence limits, larger the; number of values falling out of this range and larger their deviations from the boundary value, the lower is the level of consistency.

Examination of the data indicates large extent of variability in the field coagulum grade TSR. However, better quality and somewhat consistency are observed in the TSR produced in the units belonging to category 1.

REASONS FOR VARIABILITY

The primary factors contributing to inconsistency are the variability of the raw material and lack proper blending at processing end. The different factors contributing to inconsistency would have imparted varying contributions to the quality of the raw material.

CONCLUSIONS.

The system commonly followed at present in grading ISNR has to be modified based on statistical methods.

Extend of consistency in raw NR can be evaluated by determining the upper and lower confidence limits, its range, number of individual values falling outside the range, and determining the extent by which an individual value is far from the boundary.

ACKNOWLEDGMENT

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REFERENCES

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TABLE–4 Test report of sample from Consecutive Bales.

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$$\text{Mean} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n} Z x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)}{n-1}}$$

The value of 'mean ± 3SD' is computed for each batch, whose maximum value for dirt content for TSR 20 grade is 0.20.

In the present study different batches, graded as ISNR-20 in the conventional way, were collected from 25 processing units for a period covering 6 months, at the rate of 4 batches per month. In addition, samples were collected from every tenth bale of selected batch for testing. The data thus obtained were statistically analysed. Considerable variations are observed even in the successive bales of ISNR processed from raw material obtained from a single source. The test reports for 2 such batches are given in table 4. Since the raw material is from a single source, these variations are introduced due to the lack of proper blending.

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TABLE–5 Test results of TSR Processed at units belonging to category I.

Batch No.		1				2				3				4			
		Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI
		10	0.08	39	41	10	0.08	34	62	10	0.05	39	74	10	0.06	36	67
		20	0.06	39	46	20	0.05	35	63	20	0.09	39	69	20	0.05	35	60
		30	0.07	38	36	30	0.05	34	59	30	0.05	37	70	30	0.07	37	57
		40	0.07	37	30	40	0.06	36	56	40	0.07	37	76	40	0.05	36	64
Mean			0.07	38.25	38.25		0.06	34.75	60.00		0.065	38.00	72.25		0.058	36.00	62.00
SD			0.008	0.957	6.85		0.014	0.957	3.16		0.019	1.15	3.30		0.010	0.816	4.40
Mean ± SD			0.095	35.38	17.70		0.102	31.88	50.5		0.122	34.54	62.33		0.086	33.55	48.81
Factory Grade		Bale No.1–20 as ISNR–20 " 21–40 as ISNR–50				ISNR–10				ISNR–10				ISNR–10			
Grade assigned based on statistical analysis		off				ISNR–10				ISNR–10				ISNR–10			
Confidence limits with 5%	lower		0.061	37.12	22.08		0.043	33.62	56.27		0.043	36.64	68.36		0.046	35.03	56.81
	upper		0.079	39.38	54.42		0.077	35.88	63.73		0.087	39.36	76.14		0.070	36.96	67.19
Probability to be out of range.	Range		0.018	2.26	32.34		0.028	2.26	7.46		0.044	2.71	7.79		0.024	1.93	10.38

TABLE–6 Test results of TSR Processed at units belonging to category II

Batch No.	1				2				3				4			
	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI
	5	0.09	38	53	10	0.19	37	68	10	0.16	34	76	10	0.11	32	81
	15	0.09	39	46	20	0.18	37	59	20	0.10	33	72	20	0.13	38	63
	25	0.08	39	54	30	0.16	34	74	30	0.15	34	76	30	0.12	38	60
	35	0.09	36	50	40	0.12	37	68	40	0.10	34	76	40	0.12	37	75
	45	0.09	35	43	50	0.15	37	68	50	0.20	32	81	50	0.13	36	66
	55	0.10	30	54	60	0.09	36	69	60	0.18	32	75	60	0.14	38	73
	65	0.14	30	50	70	0.10	33	74	70	0.16	33	81	70	0.12	37	81
	75	0.11	30	48	80	0.09	32	68	80	0.19	38	81	80	0.10	36	80
Mean		0.099	34.63	49.75		0.135	35.38	68.5		0.155	33.75	77.25		0.121	36.5	72.38
SD		0.029	4.07	3.96		0.040	2.07	4.66		0.038	1.91	3.37		0.013	2.00	8.42
Mean ± SD		0.185	22.42	37.88		0.256	29.18	54.52		0.268	28.02	67.14		0.159	30.5	47.13
Factory Grade			ISNR–20				ISNR–20				ISNR–20				ISNR–20	
Grade assigned based on statistical analysis			ISNR–50				ISNR–50				off				ISNR–20	
Confidence limits with 5%	lower	0.075	31.23	46.45		0.102	33.65	64.61		0.123	32.16	74.43		0.110	35.67	65.35
	upper	0.123	38.03	53.05		0.168	37.11	72.38		0.187	35.34	80.06		0.132	37.33	79.41
Probability of being outside the limits	Range	0.048	6.79	6.61		0.067	3.45	7.78		0.063	3.19	5.62		0.022	1.67	14.05

TABLE–5 Test results of TSR Processed at units belonging to category I.

Batch No.		1				2				3				4		
		Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI
		10	0.08	39	41	10	0.08	34	62	10	0.05	39	74	10	0.06	36	67
		20	0.06	39	46	20	0.05	35	63	20	0.09	39	69	20	0.05	35	60
		30	0.07	38	36	30	0.05	34	59	30	0.05	37	70	30	0.07	37	57
		40	0.07	37	30	40	0.06	36	56	40	0.07	37	76	40	0.05	36	64
Mean			0.07	38.25	38.25		0.06	34.75	60.00		0.065	38.00	72.25		0.058	36.00	62.00
SD			0.008	0.957	6.85		0.014	0.957	3.16		0.019	1.15	3.30		0.010	0.816	4.40
Mean ± SD			0.095	35.38	17.70		0.102	31.88	50.5		0.122	34.54	62.33		0.086	33.55	48.81
Factory Grade		Bale No.1–20 as ISNR–20					ISNR–10				ISNR–10				ISNR–10		
		″ 21–40 as ISNR–50															
Grade assigned based on statistical analysis			off				ISNR–10				ISNR–10				ISNR–10		
Confidence limits with 5%	lower		0.061	37.12	22.08		0.043	33.62	56.27		0.043	36.64	68.36		0.046	35.03	56.81
	upper		0.079	39.38	54.42		0.077	35.88	63.73		0.087	39.36	76.14		0.070	36.96	67.19
Probability to be out of range.	Range		0.018	2.26	32.34		0.028	2.26	7.46		0.044	2.71	7.79		0.024	1.93	10.38

TABLE–6 Test results of TSR Processed at units belonging to category II

Batch No.		1				2				3				4			
		Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI
		5	0.09	38	53	10	0.19	37	68	10	0.16	34	76	10	0.11	32	81
		15	0.09	39	46	20	0.18	37	59	20	0.10	33	72	20	0.13	38	63
		25	0.08	39	54	30	0.16	34	74	30	0.15	34	76	30	0.12	38	60
		35	0.09	36	50	40	0.12	37	68	40	0.10	34	76	40	0.12	37	75
		45	0.09	35	43	50	0.15	37	68	50	0.20	32	81	50	0.13	36	66
		55	0.10	30	54	60	0.09	36	69	60	0.18	32	75	60	0.14	38	73
		65	0.14	30	50	70	0.10	33	74	70	0.16	33	81	70	0.12	37	81
		75	0.11	30	48	80	0.09	32	68	80	0.19	38	81	80	0.10	36	80
Mean			0.099	34.63	49.75		0.135	35.38	68.5		0.155	33.75	77.25		0.121	36.5	72.38
SD			0.029	4.07	3.96		0.040	2.07	4.66		0.038	1.91	3.37		0.013	2.00	8.42
Mean ± SD			0.185	22.42	37.88		0.256	29.18	54.52		0.268	28.02	67.14		0.159	30.5	47.13
Factory Grade				ISNR–20				ISNR–20				ISNR–20				ISNR–20	
Grade assigned based on statistical analysis				ISNR–50				ISNR–50				off				ISNR–20	
Confidence limits with 5%	lower		0.075	31.23	46.45		0.102	33.65	64.61		0.123	32.16	74.43		0.110	35.67	65.35
	upper		0.123	38.03	53.05		0.168	37.11	72.38		0.187	35.34	80.06		0.132	37.33	79.41
Probability of being outside the limits	Range		0.048	6.79	6.61		0.067	3.45	7.78		0.063	3.19	5.62		0.022	1.67	14.05

STEM FASCIATION IN HEVEA

VINOTH THOMAS,
RUBBER RESEARCH INSTITUTE OF INDIA

"Fasciation" is a morphological term applied most commonly to an abnormal stem condition in vascular plants in which the affected regions become flattened, banded or ribbon shapped (Dave et al. 1986). The term fasciation is derived from the latin, 'fascia'-a banding. More or less typical fasciation have been recorded from 107 of the 303 plant families as per Englers' plant classification. When fasciation occurs in stem, the early growth stages are cylindrical or normal and as the branch approaches maturity, the growing point becomes broader and broader. The most striking characteristics of fasciation are the increase by weight and volume of tissue over that of the normal type of the same variety of species.

It is noted that fasciation is very common in certain genera and species than in others, for eg., members of Euphorbiaceae which Hevea belongs to. In the budwood nursery, cut back of the shoots will be done and the new sprouts develop, among these few shows flattening and coiling of the stem (figure) with branches of leaves nearer to the shoot apex.

(Radhakrishna Pillay, 1980). Some of the sprouts arised from the wind damaged region also fasciated. Side branches arise from the banded region are rounded with suficient internodal length between petioles.

Fasciation may be due to various reasons like physiological, pathological, ecological or genetic. This ranges from hard water, severe pruning, mutation by insects, bacterial or fungal infection, nematodes, soil friction, short day length, chromosome aberrations, highly manured soil, insufficient nutrition, 2,3 -D etc. (Kundu and Rao 1960; Dave et al. 1989). In any case the basic cause for fasciation is disturbed metabolism involving excessive nutrient, which moblizes more energy leading to abnormal tissue production. Grafting also has been suggested as a possible cause for fasciation. From the above point it is assumed that the real reason for fasciation in Hevea may be due to severe pruning.

According to Chen. et al. (1991) fasciation in Hevea is a symptom

(contd. on Page 31)

CEARA RUBBER (Manihot glaziovii Muell. Arg.): A DROUGHT RESISTANT TREE FOR SEMI ARID AND MARGINAL AREAS

P.J. George
Deputy Director
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The Ceara rubber tree (*Manihot glaziovii* Muell. Arg.), a native of the Brazilian province Ceara, was one of the sources of natural rubber in the early part of the Century. The tree was exploited in Brazil as wild rubber for a long period, even before it was botanically identified.[14] The species was discovered by Dr. glaziovii, a French Botanist, in the neighbourhood of Rio de Janeiro, and was described and named after him by Mueller.

M. glaziovii is a member of the family Euphorbiaceae to which the *Hevea* rubber tree belongs. Though the origin of the genus *Manihot* is in the Ceara Province and the nearly Piaui and Bahia provinces of north-East Brazil, its geographical distribution extends from California Bay up to Peru[15]. The best known species of the genus is *Manihot esculenta*, otherwise known as Cassava or tapioca. Though the earlier investigators, reported that there are 200 species under the genus 12, Rogers and Appan (1970) reported that there are only 98 species under the genus *Manihot*.

The certain regions of the north-east Brazil, to which *Manihot* belongs are characterised by irregular rainfall and very harsh climate. The annual average rainfall of this regions is 600-700mm with the

Ceara Rubber Trees

STEM FASCIATION IN HEVEA

VINOTH THOMAS,
RUBBER RESEARCH INSTITUTE OF INDIA

"Fasciation" is a morphological term applied most commonly to an abnormal stem condition in vascular plants in which the affected regions become flattened, banded or ribbon shapped (Dave et al. 1986). The term fasciation is derived from the latin, 'fascia'-a banding. More or less typical fasciation have been recorded from 107 of the 303 plant families as per Englers' plant classification. When fasciation occurs in stem, the early growth stages are cylindrical or normal and as the branch approaches maturity, the growing point becomes broader and broader. The most striking characteristics of fasciation are the increase by weight and volume of tissue over that of the normal type of the same variety of species.

It is noted that fasciation is very common in certain genera and species than in others, for eg., members of Euphorbiaceae which Hevea belongs to. In the budwood nursery, cut back of the shoots will be done and the new sprouts develop, among these few shows flattening and coiling of the stem (figure) with branches of leaves nearer to the shoot apex.

(Radhakrishna Pillay, 1980). Some of the sprouts arised from the wind damaged region also fasciated. Side branches arise from the banded region are rounded with suficient internodal length between petioles.

Fasciation may be due to various reasons like physiological, pathological, ecological or genetic. This ranges from hard water, severe pruning, mutation by insects, bacterial or fungal infection, nematodes, soil friction, short day length, chromosome aberrations, highly manured soil, insufficient nutrition, 2,3 -D etc. (Kundu and Rao 1960; Dave et al. 1989). In any case the basic cause for fasciation is disturbed metabolism involving excessive nutrient, which moblizes more energy leading to abnormal tissue production. Grafting also has been suggested as a possible cause for fasciation. From the above point it is assumed that the real reason for fasciation in Hevea may be due to severe pruning.

According to Chen. et al. (1991) fasciation in Hevea is a symptom

(contd. on Page 31)

CEARA RUBBER (Manihot glaziovii Muell. Arg.): A DROUGHT RESISTANT TREE FOR SEMI ARID AND MARGINAL AREAS

P.J. George
Deputy Director
Germplasm Division

The Ceara rubber tree (*Manihot glaziovii* Muell. Arg.), a native of the Brazilian province Ceara, was one of the sources of natural rubber in the early part of the Century. The tree was exploited in Brazil as wild rubber for a long period, even before it was botanically identified.[14] The species was discovered by Dr. glaziovii, a French Botanist, in the neighbourhood of Rio de Janeiro, and was described and named after him by Mueller.

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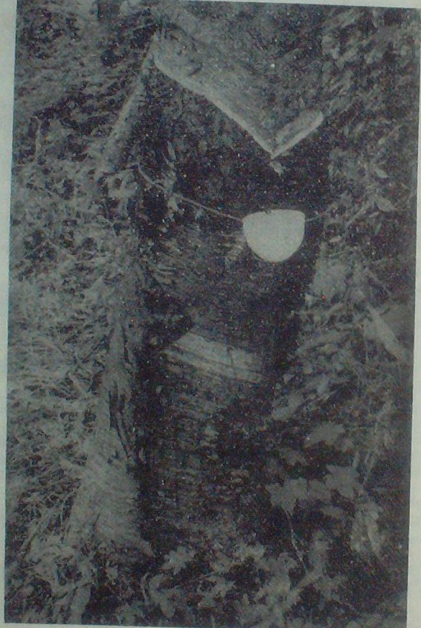
Ceara Rubber Trees

extremes ranging from 0-1400mm. The altitude goes up to 1000 mm.sl.

Manihot grows well in dry rocky ground, and so can be cultivated in areas unsuitable for most other crops [5]. In the province of Ceara, it is reported that the plant thrives well in semi arid regions and even in granitic rocky areas. The plant resists the driest weather, and when every other form of vegetation is destroyed under the influence of the scorching wind, it thrives and yields generously a profitable quantity of latex [14].

Manihot glaziovii has been introduced to India during 1877-78. It was brought to Kew in 1876 by Robert Cross, and later in 1877 and plants were sent to Singapore, Calcutta and Ceylon. Again in 1878, planting materials were brought from Kew to Madras and Calcutta [15]. The quick growth and easy propagation of Ceara rubber attracted the attention of many. The only literature available on its cultivation in India is the reports appeared in the Bulletin of the Imperial Institute 1. The report contains the analytical results of ceara rubber samples collected from Kallar and Burliar Estates in the Nilgiris.

Certain drawbacks of ceara rubber compared to the advantages of para rubber pushed aside its cultivation and caused gradual disappearance from the scene. Though the plant thrives well, humid climate is unfavourable for rubber production, while under the same climate *Hevea* gives more rubber. The spontaneous coagulation of the latex is another drawback. In this context, it is worth mentioning the opinion of sir Henry Wickham, "the Ceara, named after the Brazilian province of that name, is a tree of quite different character. Its native locality is high, stony, arid and in places almost semi desert, "scrub" covered country. The latex from ceara rubber tree is like that of *Hevea*, and if property cured, the rubber resultant there from is remarkable for its strength and tenacity. In the East it has never,as yet, I think, had justice done by it. It has too often been set out on land, and under rainfall, totally unsuited to it. In Ceylon especially, there are large areas of dry forest lands, which should be admirably adapted to this tree, and considering the high quality of the rubber when well cured, it would surely, better planted out in such districts, closely resembling as thereby do the natural requirements and conditions of this tree, rather than try to plant the *Hevea*, a tree native to the heavy rainfall of the Amazon Valley" [17].



Experimental Tapping of Ceara Rubber Tree

During 1903 to 1912 a considerable quality of ceara rubber had been exported from Brazil. This was mainly due to the attention given to ceara rubber, when the Hevea plantations were badly affected by SALB (South American leaf Blight).

Manihot glaziovii, Muell. Arg. is a tall tree attains a height of 10 to 15 m, with a ramified branches and branchlets. The leaves are palmately lobbed with three lobes, rarely 2-7 lobes of oblong oval shape, glabrous and light green in colour. It produces profuse flowers in about 1 1/2 years. Flowering is usually seen after the prolonged wintering period. Flowering commences by june, after the full refoliation. Flowers are unisexual with the male flowers clustered at the top of the panicle. The fruit is a three lobed globular capsule distinguished by six grooves. The seeds are comparatively small, oval plano-convex about 12-15 mm long and 7-8 mm broad, with a tough, brilliant mottled integument. 100 gm of seeds contains about 175 nos. of fresh seeds. *Manihot* can be propagated through seeds and vegetative cuttings.

A medium size tree of *Manihot* is commonly used in Kerala as a share tree, is known as 'tree cassava' which is hybrid of *M. Glaziovii* and *m. esculenta*.

The tree attains an average girth of about 50 cm within a period of around 4 years. The bark of the mature trunk is covered by a peelable Rhytidome, which is thin and leathery. Beneath the rhytidome, the smooth and soft bark appears which scattered lenticells.

The rhytidome helps the tree to retains moisture in the bark, even during the hottest weather. The bark is sufficiently thick that tapping cut can be done easily. Though the trees were exploited longback, there is no record of a proper tapping system followed for ceara rubber. However it withstands a half spiral alternate daily tapping and gives a quick flow of latex but coagulates within few minutes. The response of the tree to different tapping intensities and stimulation is yet to be studied in detail.

The latex is white, thick with an average drc of 27. For processing, no need of adding acid. Just bulk the latex with sufficient water and keep in a dish for overnight, and the latex coagulates perfectly. Preliminary studies and previous reports. 1,8 showed that the dry rubber is exactly similar to *Hevea* rubber in its properties, except for its slightly higher percentage of resin content.

M. glaziovii gives only a very low quantity of latex per tree per tapping. The earlier report gives an indication that its potential is 415Kg, per hectare per year. Unlike in *Hevea* and Guayule, there are only wild trees in *Manihot*. No high yielding strain is developed through breeding and selection for as vitroplants.

During our exploration to the Mettur forests, we came across wild trees with yield variation from 8gm to 10gm dry rubber per tap. This preliminary survey indicates that there are genetic materials having a potential of around 500kg/h/year. Five hundred kilograms potential exhibited by stray trees growing in a drought affected granitic hill of 3500ft., with scanty rain fall, without undergoing any crop improvement attempts, points to the chances of giving more economic yield if proper crop improvement programmes are attempted.

Besides rubber, the wood also is good for similar use as that of *Hevea*. The seeds contain more than 40% oil, which was once used as fuel for the Brazilian motor vehicles. The leaves of ceara rubber contain 25-30% protein in dry matter, which after the removal of hydrocyanic acid, is considered to be a good cattle fodder [15].

M. glaziovii is now being used in India by the Tuber Crops Scientists as a sources of Cassava Mossaic Virus (CMV) resistance [6,11] and as an alternate host-plant for honey-bee, at the Rubber Research Institute of India [10].

The once discarded guayule (*Parthenium argentatum*) with all its low production potential and cumbersome process of extraction is now gaining attention in USA, with huge research backing 3, as an alternative source of natural rubber. Why not we too have an alternative source for NR? The accidental introduction of a spore of *Microcyclus ulei* (SALB) can easily bring down our rubber production from Hevea plantations 2, 16 to the lowest level. This is evident from the report that the *Hevea* plantations of the Amzon basin, even up to 1978 gave only 250kg/ha due to the infection of SALB [15]. We have not reserved any life support plant to overcome such situations [4].

The xerothermic character of M. glaziovii is well evident from reports and from the experience we had during out exploration. If one could pinpoint the gene responsible for the 'xerothermic' character in such plant species, it may be valuable tool for the genetic engineering in the field of gene transfer technology to synthesise transgenic plants adapted to environmental stress including green house effect 9

The tree needs the immediate attention of the rubber researchers to investigates the possibilities in the following fields:

1. Selection of plus trees from the available semi-wild seedling population located in Tamilnadu.

2. Breeding value of the plant and its multiplication techniques..

3. Suitable tapping method and stimulants.

4. Investigations to overcome the problems of spontaneous coalgulation and low rubber synthesis etc.

5. Testing the selected genotypes in the drought prone marginal lands.

6. Technological properties of rubber.

7. Economic utilisation of the bye-products like wood and seed oil.

The vast stretches of semi-arid barren land with its thousands of starving human population, is waiting for a suitable parasol. It may be rewarding if selected strains of M.glaziovii are planted and evaluated in such locations

References cited:

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2. Anon (1977). Guayule: An alternate source of natural rubber. National Academy of Sciences.

3. Barid, L.E. (1975). Under utilized plants programme in India- Concept and future perspective. In 'Life Support Plant Species Diversity and Conservation': NBPGR, New Delhi.

5. Hill, A.F. (1952). 2nd Ed. Economics Botany. Mc Graw-Hill Book Company, New York.

6. Hahn, S.K., Terry, E.R. and Leuschner, K. (1980). Breeding Cassava for resistance to Cassava mosaic disease. Euphytica - 29.pp. 667-83

7. Jennings, D.L. (1957). Further studies in Cassava for virus resistances. East AFR, Agric. J.22: pp. 213-19

8. Judith, F., Rodrigus, Anjelos Rodrigus and Andrew L.H. Cardoso. (1991). Characterisation of natural rubber from Manicoba M. glaziovii); Micro structure and average molecular weight. J. Nat. Rubb. Res. 6(2): 134-36

9. Mohan Jain, S (1993): RE cent advances in plant genetic engineering. Current Science, Vol. 64. No. 10.pp. 715-723.

10. Nehru, C.R. Thankamony, S., Jayarathnam, K. and Joseph, P.ML. (1989). Nectar and pollen plants for excluding the flow period in rubber growing areas of India. B. World Cardiff: International B Research Association. V. 70: pp. 118-119.

11. Nicholos, R.F.W. (1947). Breeding Cassava for virus resistance. East AFR Agric. J. 13: 184-94.

12. Rogers, D.J. (1963). Studies of Manihot esculenta crantz and related species. Bulletin of the Torrey Botanical Club. Vol. 90. No.1.pp. 43-54.

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15. Serier, J.B. (1988). Le Manicoba: historic, biologic, culture, interet economique. Caoutchoues et Plastiques n 677 pp. 177-122.

16. Thomson, T. edathil (1986)). South American Leaf Blight - a potential threat to the natural rubber industry in Asia and Africa, Trop. Pest Management. 32:4. pp. 294-303.

17. Wickham, H.A. (1908).On the plantation, cultivation and curing of Para Indian Rubber. (Hevea brasiliensis). Kegan Paul; Trench, Trubner & Co., London.

Killer mat for fungus

Malaysia's Kuala Lumpur airport is using a killer welcome mat in a bid to stop fungus which can destroy rubber trees.

Arriving passengers from the American tropics must now pass over a large rubber mat treated with chemicals to disinfect their shoes.

Baggage is also being treated for 15 minutes by fungus-killing ultraviolet rays. These precautions are aimed at stopping South American Leaf Blight, which is rampant in Brazil, from reaching the country.

(Contd. from Page 4)

exploitation. Some efforts in these lines are being taken by the Association of Natural Rubber Producing Countries (ANRPC).

Strict Quality Requirements of Consumers

Importing countries in the West have becoming highly quality conscious and some of the measures appear to be protectionist in nature. Products exported to the USA should meet FDA regulations- and those exported to Europe should conform to ISO 9000 systems of certification. Manufacturers in some of the producing countries have already risen to the occasion and strengthened their quality certification base. India has adopted the ISO 9000 series of standards as IS 14000 series of standards. The Bureau of Indian Standards (BIS) is also helping manufacturers in getting certification under IS 14000/ISO 9000. The expertise available in this area with BIS can be shared by other rubber producing countries also. Very recently some reports of allergic effects of proteins present in natural rubber based products are finding place in specification drafted by some countries. It is surprising to note that products which were successfully used for several decades with the proteins in them are suddenly becoming source for allergic reactions. But producers have to make very effort to supply products as per consumer expectations. When International standards are evolved the producing countries have to adhere to them. They should impress upon the standards body the producer capability. Thus the standards evolved should be a compromise of consumer requirement and producer capability. Very often these are finalised for ideal conditions of consumer requirements.

Need for Scientific Market Assessment

Rubber goods manufacturing industry is comparatively a new activity in many natural rubber producing countries. A study was recently conducted by the ANRPC to evolve strategies for modernising rubber based manufacturing industries in these countries. From the study it become clear that all rubber producing countries together account for only 12 percent of world natural rubber consumption although 85 percent of natural rubber is produced in their territory. So the manufacturers in these countries will have to complete with their counterparts in other areas for successful marketing operations. So, successful producing countries are always associating their manufacturing activities with major multinational product manufacturers. Such collaborations will ensure not only production of articles as per needs of users but also guaranteed market. Producing countries also will have to asses market requirements and changes occurring in markets at various intervals for making modifications in their production operations. Natural rubber producing countries other than India have no good market within their territory for the rubber products. Although free market economy will help all countries to produce goods and market anywere, tariff protection and other trade barriers will exist at various consuming points in different countries. There should be a data bank giving details of trade regulations in different consuming countries.

Rubber industry in natural rubber producing countries has very bright future. Some of the industries in Taiwan and Korea are getting relocated to countries like Thailand, Indonesia and Malaysia. But these small countries were only exporters and had no good market for the products within their territory. The position is different for the major rubber product manufacturers in the USA, Europe and Japan. For them rubber product from other countries are not welcome materials. They cannot also stop their business as is being done by manufacturers in Taiwan or Korea. But the cost of manufacture of products in developed countries is becoming prohibitively high. Table 9 shows the cost of tyre manufacture in the USA.

TABLE 9 COST OF TYRE MANUFACTURE IN THE USA (US $ PER TYRE)

ITEM	CAR TYRE	TRUCK TYRE
Natural Rubber	0.9 (3.4%)	9.5 (6.1%)
Other Inputs	9.3	43.4
En ergy	1.0	3.7
Labour	8.4	57.1
Capital Changes	6.9	41.4
Total	26.5	155.1

From the table it is clear that the labour component in cost of production of tyre in developed countries is several times the cost of rubber used in it. So the manufacturers in these countries are eager to shift their fatories to low wage countries. This will be a slow process and the countries who move last in accepting industries thus getting shifted will be benefited. All the rubber producing countries in South-East Asia are eager to welcome industries from the developed world and in that process the multi-national companies are able to extract attractive terms from

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CONCLUSION

There is a need, on the part of natural rubber producing countries to accelerate the pace of utilizing the wonder raw material, namely natural rubber, for the manufacture of value added rubber products for internal consumption as well as for exports. While aiming for exports it has to be well understood that goods for export must be produced with consistency in quality and in conformity with the international standards and specifications. It has to be borne in mind that exporting is not a causal business and that international markets are not places to get rid of occasional surplus. The enormous wealth of information available on rubber goods manufacture and marketing in different natural rubber producing countries can be pooled for mutual gains. The natural rubber industry had passed through troubles and struggles in the past but had always emerges successful and it will continue to overcome any challenge it may have to encounter through co-operation among the natural rubber producing countries.

ANRPC Meeting at Goa.

Smt. J. Lalithambika addressing the delegates   Along side is sitting Mr. Sucharit Prom Dej secretary general ANRPC.

The fifth meeting of ANRPC (Association of Natural Rubber Producing Countries) Committee on NR statistics was held at Goa from 18th to 21st August 1993. The aim of the meeting was to exchange the methods adopted in improving NR statistics in different natural rubber producing countries.

Smt. J. Lalithambia IAS Chairman Rubber Board presided over the meeting. Mr. R.G. Unni Joint Director Mr. G. Subbarayalu Deputy Director, Mr. G. Mohana Chandran Asst. Statistican and Mr. Joseph Alexander, Statistical Inspector attended the meeting. Thirteen delegates including Mr. Sucharit Prom Dej, Secretary General of ANRPC also participated in the discussion.

Addressing the delegates Smt. J. Lalithambika explained the primary objective of the ANRPC in bringing Co-ordination in production and marketing of natural rubber in different countries.

WORLD BANK LOAN TO VIETNAM

The World Bank has granted a loan to Vietnam's rubber industry also. The loan amount will be utilised to increase the area under rubber in Vietnam.

Vietnam is earning a sizeable amount of foreign exchange by exporting rubber latex and rubber wood.

HML RUBBER MARK LINK

Kerala State Co-operative Rubber Marketing Federation (Rubber Mark) has signed a memorandum of understanding with Harrisons Malayalam Ltd. for marketing of high quality nautural rubber in the global market. The federation has six crumb rubber factories with a total capacity of 15000 tonnes per annum. It would go into production of high quality technically specified rubber of international standard with HML's Research and Development support.

Mr KA Kuttaiah, HML's Exective Director said that the link would tap global market demands by establishing a market channel abroad.

SEMINAR ON PROTEIN ALLERGY

One day seminar was held at Madras by the Rubber Board on 28th September 93 to discuss the ways to overcome protein allergy in the use of latex products. Protein present in the latex products used in medical applications have been found to be the primary source for severe allergic reaction reported in USA and Europe. Glove manufacturers, raw material producers, Scientists and experts from medical field from different parts of the country participated in the seminar.

The seminar was inagurated by Smt.J.Lalithambika, Chairman, Rubber Board. Dr.P.George Babu, PHD, Head of the Department of Immunology of Velloor Christian Medical College delivered the key note address. In the technical session chaired by Dr.E.V.Thomas, Director (P & PD), Rubber Board, papers were presented by Mr.S.K.Kammath, AVT Rubber Products Ltd., Mr.K.S.Gopala Krishnan, Mr. Sunny Sebastian and Smt.G.Rajammal of Rubber Board.

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coming under the witches broom disease. Infected budded trees showed different degree of dryness of the tapping panel. They have reported mycoplasma like organisms (MLO) and some globular and elliptic shape rickettsia like organism (RLO) in the phloem tissue, especially in sieve tubes and latex vessels of small petioles. Witches' broom budstock are considered as one of the most important primary sources of rubber brown bast in the field. However, the relationship if exist between tapping panel dryness and fasciation is not yet established in rubber (Anonymous, 1992a). When the infected branches and buds were treated with Tetracycline or penicillium, could effectively inhibit the causative agent.

The fasciation has always been sporadic and they have never been found to persist after cutting back (Anonymous, 1992b). If let alone the fasciated branch becomes woody, normal branches overtake it in growth and it develops off.

Acknowledgment

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References

Anonymous 1992 a. Tapping panel Dryness. IRRDB Information quarterly IRRDB, Britain.

Anonymous 1992 b. Rubber growers companion, Rubber Board, Kottayam.

Chen, M. Yang, s., Zheng, G., Chen, Z and Shen, J. 1991. Identification of causative agent of rubber Witches "broom disease and relation with brown bast. Chinese J. Trop. Crops 12: 65-73.

Dave, Y. Menon, A.R.S. and Thomas, V. 1986. Stem fasciation in hibisus rosa - sinensis L.J. Pl. Ant. Morph. 3: 151-155.

Dave, Y., Thomas, V. and Menon, a.R.S. 1989. stem fasciation in Gaillardia aristata Pursh Acta Bot Indica 17: 214-217.

Kundu, B.C. and Rao, N.S. 1960. Anatomy of fasciated stem in jute. Bot. Gaz. 121: 257-266.

Radhakrishna Pillay, P.N. 1980. Non-parastic maladies. In: handbook of natural rubber production in India. (ed.) P.N. Radhakrishna Pillay. The Rubber Board, Kottayam.

IDA CREDIT FOR RUBBER DEVELOPMENT

The International Development Association (IDA), the soft lending affiliate of the World Bank, is extending an interest free credit of US $ 92 million (Rs.290.08 crores equivalent) for rubber development in India. Agreements in this regard have been signed between IDA on the one hand and Government of India, Rubber Board and NABARD on the other. Shri P.Mukundan Menon, who has earlier served as Rubber Production Commissioner has now been appointed in the Rubber Board as Project Co-Ordinator for the Project.

The Rubber Project approved for implementation would be a time slice covering the period 1993-94 to 1997-98 of the long term rubber plantation development programme of the Government of India and the Rubber Board. The main objectives are to expand and strengthen the rubber plantation sector to step up production and productivity, improve processing and increase on-farm and off- farm employment. The project also aims at strengthening Rubber Board's research, extension and training activities.

The main components of the project are:-

i) Replanting of old and uneconimic rubber in 40,000 hectares is traditional areas.

ii) New planting in 30,000 hectares consisting 23,000 hectares in Kerala and Tamil Nadu, 5,000 hectares in Tripura and 2,000 hectares in other non-traditional areas, namely, Assam, Meghalaya, Mizoram and Nagaland.

iii) Productivity enhancement in 60,000 hectares of mature areas of small holdings in traditional areas through adoption of improved agro-management and exploitation.

iv) Expansion/upgradation of rubber and rubber wood processing facilities.

v) Institutional support for Rubber Board for project co-ordination, research, extension, trainng and technical assistance.

vi) Development of women and tribal people amongst participating populations, particularly in Tripura.

With the launching of this project, the rate of planting grant given by the Rubber Board to small holders for replantation and new plantation has been raised from the earlier Rs.5,000 per hectare to Rs.8,000. Cash incentive paid to all categories of growers for use of polybagged plants of advanced growth has been retained at Rs.6 per plant but the upper limit of hectare-wise stand has been raised from 450 to 500. Therefore, growers can now derive the benefit of the incentive upto Rs.3,000 per hectare instead of Rs.2.700 hitherto allowed. Bank loans also would be available to growers to enable them to meet plantation development cost outside Board's grants.

P. Mukundan Menon

The productivity enhancement programme would cover more than one lakh small growers. In order to reach and service them effectively, the programme would be implemented through rubber producer's societies of which there are about 1,500 already functioning in all rubber growing areas. More of such societies would be encouraged to be registered and operated progressively. Apart from helping member growers to appreciate and adopt cultivation and production innovations, the societies would also act as nodal agencies for procurement and distribution of needed agro-inputs at concessional prices.

Expansion and upgradation of rubber and rubber wood processing factories would be promoted through grant of bank loans and extension of Rubber Board's engineering support. The programme under this component comprises setting up of 3 new latex centrifuging factories, expansion of 25 existing factories, establishment of 10 block rubber factories, upgrading of 7 existing ones, developing 30 medium scale facilities for production of smoked sheets and conversion of 5 existing crepe rubber factories into 10-12 tonne per day block rubber factories. Additionally, the project would finance 5 rubber wood processing factories and one factory for production of innovative produce like pre- vulcanised latex.

A novel feature of the rubber project is its programme for involving women and tribal people extensively in planting activites, especially in Tripura. While doing this, they will be helped to engage themselves in additional income generating activities such as inter-cropping, sericulture, medicinal plant cultivation etc. Services of suitable non-government organisations (NGOs) would be enlisted to make this a success.

RUBBER BOARD BULLETIN

Vol. 27, Number – 2 June-August 1995

Chairman

K. J. Mathew I. A. S.

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Cover: Reghu

THE QUARTER

Rubber occupies over 20 per cent of the cultivated area in the state of Kerala. With the sole exception of coconut it is the most important crop of Kerala in terms of area, income and employment. About one-third of the agricultural income of the State is accounted by rubber.

In India over a crore of people depends on this crop directly or indirectly for their livelihood. The productivity in India is the highest with an average yield of 1265 kilograms per hectre. With all the favourable factors at its credit, the Rubber Plantation Industry is unable to produce enough rubber to meet the requirements of the country.

The anticipated production for 1995-96 is 5.11 lakh tonnes, against a consumption of 5.30 lakh tonnes. The deficit is 19,000 tonnes.

The rubber prices have been steadily increasing from the very beginning of this year and the NR price in India should be considered to have already scaled the peak this year. Though the events indicate fluctuations then and there, good prospects lie ahead. As long as there are no drastic changes in the market situation, the prices will never climb down from a reasonable level. The growers also will have no reason to complain of a price crash.

A remunerative price now prevailing in the market augurs well for a more dedicated attempt to enhance productivity from the existing holdings. While the ultimate goal is to enhance total production in the country, new areas are also to be identified in non-traditional areas for new planting. Let us strive hard to achieve self sufficiency in this vital raw material at least by 2000 AD.

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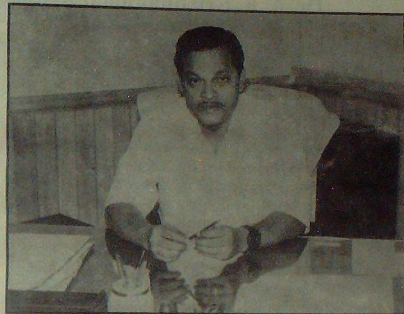
K. J. MATHEW New Chairman



Shri K. J. Mathew (45) erstwhile Secretary, Department of Co-operatives, Government of Kerala, took over as Chairman of the Rubber Board, on 7th June 1995. Sri Mathew who hails from Chennadu in Meenachil Taluk of Kottayam District, is the son of Sri. Joseph Kappalumakkal. Sri.Mathew, who is a Post-Graduate in English literature started his career as a Lecturer in Kerala-Varma College, Thrissur. Later he was selected to the IAS, IFS in 1974. He has held several prestigious positions under Government of Kerala as Managing Director of Kerala Civil Supplies Corporation, Director of Public Instructions, Joint Secretary of the Planning Board and District Collector, Kottayam. He had served for four years as Director of Information & Broadcasting Ministry also. He has also acquired Diploma in Development Studies from the Cambridge University.

His wife is Smt. Molly, daughter of Sri. K. P. Benjamin of Kollam. He has two children.

Smt. J. LALITHAMBIKA

Secretary General of ANRPC

Former Chairman of the Rubber Board, Smt. J. Lalithambika I.A.S took charge as the Secretary-General of the Association of Natural Rubber Producing Countries (ANRPC) based in Kualalumpur on 11th May, 1995. She had been appointed as the Chairman of the Board in July 1990.

Dr. A. K. Krishnakumar assumes charge

Dr. A. K. Krishnakumar has taken charge as Rubber Production Commissioner on 5th May, 1995.

Dr. Krishnakumar, who had his MSc from the College of Agriculture, Vellayani has taken his doctorate from the Indian Insititute of Technology, Kharagpur. He joined the Rubber Board in 1979 as Junior Scientist and later took charge as the Deputy Director in the Research station in Tripura. He became Jt. Rubber Production Commissioner in 1991.

Dr. Krishnakumar is the son of late Kunjunni Nair of Mavelikkara. His wife Smt. Rajeswari Meenattoor is a Scientist in the Rubber Research Institute of India.

P. K. NARAYANAN retires.

Shri. P. K. Narayanan, after 33 years of service in the Board, retired as Rubber Production Commissioner on 30th April, 1995. He had served the Rubber Board in various capacities as Editor-Cum-Information Officer, Publicity officer, P.R.O., Dy. Director and Jt. Director. He was the Chief Editor of 'Rubber' magazine for 27 years.

His wife is Smt.Sreedevi of Kumaramangalam, Thodupuzha. His son Shri. Vasudevan is running own business in the US and daughter Lakshmi is doing her postgraduation in Madras.

Following the retirement he has joined the Nagurjuna Herbal Concentrates (P) Ltd as its Executive Director.

STUDIES ON THE MANAGEMENT OF THE INDIAN HONEY BEE, *APIS CERANA INDICA* F. AND THE EUROPEAN HONEY BEE, *APIS MELLIFERA* L. IN RUBBER PLANTATIONS

C. R. Nehru, P. M. Levi Joseph, K. Jayarathnam, M.R. Sethuraj,
AO.N. Panikkar & R. Kothandaraman
Rubber Research Institute of India.

The honey flow period of rubber plants (*Hevea brasiliensis* Muell. Arg.) ranges from January to March and during this period honey bees collect large quantities of nectar from the extra-floral nectary glands at the distal end of petioles where the leaflets join. Early in the morning (6 a.m. to 8 a.m.) and late in the evening (5 p.m. to 7 p.m.) the foraging activity on *Hevea* becomes quite intense and the bees devote long hours on this crop. Lack of nectar during the period from April to December in rubber plantations in India necessitates interim bee flora for off-seasonal arrangements for the Indian honey bee, *Apis cerana indica* F. Introduction of five major alternative bee forage plants viz. *Antigonon leptopus* Hook & Arn., *Callistemon lanceolatus* DC, *Manihot glaziovii* Muell. Arg., *Pongamia glabra* Vent. and *Thunbergia* spp. in association with twenty-one major sources of nectar and pollen made a full complement of alternative bee flora for off-seasonal management of honey bee colonies in rubber plantations. (Nehru 1983; Nehru *et al.* 1984; Neheru *et. al.* 1985; Nehru *et al*, 1989) Observations on the start, peak and decline of the blossoming of the different plants highlight a synchronisation in the activities of bees and the flowering periods of plants throughout the year. *Hevea brasiliensis* Muell. Arg. records a decline in honey flow in late March, while the introduced alternative bee flora maintain their flowering till December resulting in a shift in the foraging rhythm of bees from the former to the latter. About ten important pollen sources and eleven important nectar sources, if suitably tapped, can provide surplus honey to the rubber plantation- based bee-keepers. The non-availability of alternative bee flora tends to suspend the brood-rearing activity during the April to December period in rubber plantation-based apiaries. To overcome this drawback, five useful bee forage plants have been successfully established at the Rubber Research Institute of India farm and found to be best suited for off-seasonal bee management in rubber plantations. Details of five useful off-seasonal bee flora, their methods of propagation, period of maturity as bee forage plants, etc. are given (Table 1).

Thus rubber plantations are best suited for commercial bee-keeping which account for 42-47% of the total honey produced

Table 1

BEE FLORA FOR OFF-SEASONAL BEE MANAGEMENT IN RUBBER PLANTATION-BASED APIARIES

Plant species	Family	Propagation	Mature as bee forage plants (years)	Period of flowering (months)	Blossoming peaks (months)	Type of food source
Antigonon leptopus[a]	Polygonaceae	Vegetative and generative	1½-2	Jan-Dec.	Jul.-Sep	P_1N_1
Callistemon lanceolatus[a]	Myrtaceae	Generative but commonly vegetative (air-layering)	3	Jan.-Dec.	Sep.-Oct.	P_3N_1
Manihot glaziovii	Euphorbiaceae	Vegetative and generative (stem-cuttings)	1	Apr.-Nov. and[b]	Sep.-mid-Nov	P_1N_2
				Jan.-Dec.	May-June	N_1
Pongamia glabra	Leguminosae	Generative	4-5	Apr.-Jun.	Apr. and	
Thunbergia spp[a]	Acanthaceae	Vegetative	1	Jan.-Dec.	Nov.-Jan	P_3N_1

[a]The plants are in flower throughout the year
bVarieties with wintering and without wintering

P=Pollen: p_1 major, P_2 medium, P_3 minor
N=Nectar: N_1 major, N_2 medium, N_3 minor

in India. Losses of colonies of *Apis cerana indica* due to severe outbreak of Thai sacbrood viral (TSBV) disease caused an alarming situation recently in rubber plantation - based apiaries in Kerala, Tamil Nadu and Karnataka states. Continuous death of brood in prepupal but unsealed stage followed by complete desertion of infected colonies was reported by the beekeepers in the rubber growing areas during November and December, 1991. The causative agent was identified as Thai sacbrood virus. Studies on the occurrence and devastation of TSBV disease revealed that 76.71% colonies of *Apis cerana indica* were lost due to the disease (Nehru *et al*, 1994). In Kerala state Kozhikode, Thiruvananthapuram and Kottayam districts accounted for 95.36%, 94.27% and 93.65% loss of bee colonies respectively. In Tamil Nadu, Kanya Kumari district accounted for 90.04% loss of bee colonies. In Karnataka state, D.K. district accounted for 40.32% loss of colonies. In rubber plantations, where migratory beekeeping is commonly practised, potential danger of spread of this brood disease, therefore, cannot be ignored. However, studies are in progress at RRII to identify and establish Indian honey bee colonies which are unaffected by the disease. It may be noted that Thai sacbrood disease cannot be controlled by chemotherapeutic means.

Studies on the management of the European honey bee, Apis mellifera L.

RRII, with the introduction of the European honey bee *Apis mellifera* L. has a full complement of both the Indian and European honey bees. Ten colonies of *Apis mellifera* L. newly introduced in January, 1993 were kept in rubber plantations for experimental rearing. *Apis mellifera* bees are found to collect large quantities of pollen from *Manihot glaziovii, Casuarina equisetifolia, Cinnamomum ineris, Cocos nucifera, Couropita guianensis, Cassia fistula and Oreodoxa regia* and to collect nectar and pollen from *Antigonon leptopus, Glyricidia maculata, Callistemon lanceolatus, Thunbergia, sp, Ailanthus malabarica and Albizzia-lebbe- k and Salviasp*. Studies on the foraging rhythm of *Apis mellifera* on *Hevea brasiliensis* are in progress. The European honey bees showed peak foraging activity between 7 a.m. and 10 a.m. and between 3 p.m. and 5 p.m. their activity showed a declining trend between 12 noon and 2 p.m. Maximum pollen loads were collected during the forenoon period and nectar collection reached its peak during the afternoon. *Apis mellifera* colonies are highly susceptible to the attack of predators such as birds (*Merops* sp.) and wasps (*Vespa* sp.) The greater waxmoth (*Galleria mellonella* L.) infests colonies of *Apis mellifera* L. and *Apis cerana indica* F. Studies on the foraging activity of A. *mellifera* on proven bee forage plants for *A. c. indica* are in progress. Feeding of pollen substitutes (powdered bengal gram, powdered sugar, natural pollen and yeast in 4:4:1:1 ratio) seem to increase the brood rearing activity to a great extent. For the successful introduction of *Apis mellifera* in rubber plantations, a continuous source of nectar and pollen is a must as in the case of *Apis cerana indica*.

ACKNOWLEDGEMENT

The authors are grateful to Dr. C.K. Saraswathyamma, Dy. Director, Botany Division and to Sri. Joseph G. Marattukalam, Botanist for their help in the identification of plant species.

References

1. Nehru C R 1983 Highlights on the diseases and pests of rubber; *Rubb. Bd Bull. 18* 5-6
2. Nehru CR, Thankamony S, Jayarathnam K and Levi Joseph P M 1994 Studies on off-seasonal bee forage plants in rubber plantations; *Indian Bee J 46* 23-25
3. Nehru C R and Jayarathnam K 1995 Beekeeping and its offseasonal management in rubber plantation-based apiaries in India; *Proc. Int. Rubb. Conf.* Malaysia 3 762-770
4. Nehru CR, Thankamony S, Jayarathnam K and Levi Joseph P M 1989 Nectar and pollen plants for extending the flow period in rubber growing areas of India; *Bee Wld.* (U.K) *70* 118-119
5. Nehru C R, Jose V T, Thankamony S, Jayarathnam K, Sethuraj M R and Kothandaraman R 1994 Studies on the occurrence of Thai sacbrood viral disease in rubber plantations-based Indian honey bee colonies (*Apis cerana indica F*) and its impact on the devastation of colonies; *Paper presented at the National Seminar-Cum-Workshop on Honey Bee Diseases, their Diagnosis and Management* held at Bangalore, December 6-9, 1994.

RUBBER BOARD BULLETTIN - VOL. 27 No.2 1995

PERFORMANCE OF EIGHT POPULAR CLONES OF RUBBER *(HEVEA BRASILIENSIS)* FROM CERTAIN LARGE ESTATES

V.C.Mercykutty, C. K Saraswathy Amma, M.R.Sethuraj and Y.Annamma Varghese
Rubber Research Institute of India

Choice of the right planting materials is the most essential prerequisite for high production in any crop species. In a perennial plantation crop like *Hevea,* with a long economic life span of 30-35 years, this is of utmost significance. A large number of newer and better clones developed in different rubber producing countries, with wide variations in yield and secondary characteristics are being planted in our country. A knowledge of the performance of clones with respect to yield and important secondary characters in estates sector will enable a better assessment and subsequent selection of clones adapted to varying agroclimatic conditions. Earlier reports of such evaluation of clones available in India are based mainly on yield 2, 3, 8, 9. With a view to evaluate the general performance of eight popular clones, data on yield and secondary characters were collected from ten large estates representing the major rubber growing tract of Kerala. Three estates were chosen from Idukki Dist., two each from Trissur and Pathanamthitta and one each from Kottayam, Quilon and Kanyakumari Districts. The clones evaluated include RRII 105, PB 217, PB 235, PB 260, PB 311, PB 28/59, RRIM 600 and GT1.

Clones planted more or less in the same period were selected so as to facilitate a meaningful comparison among them. The selected fields were visited periodically during the past three years. Data on yield and secondary characters were collected during these visits either directly from the field or from the estates records. Secondary characters recorded were girth at opening, girth increment on tapping, incidence of *Phytophthora, Oidium,* Pink, occurance of brownbast (Tapping Panel Dryness), wind damage etc. Yield obtained without stimulation alone was utilized for the evaluation. Data on yield were available for a period of ten years in the case of clones PB 217, PB 28/59, RRIM 600 and GT1, for nine years in RRII 105 and for eight years in PB 235 and in PB 260.PB 260 and PB 311 being relatively recent plantings, the data for initial few years from a limited number of fields alone were available.

YIELD

The data were summarised on a per year and per hectare basis. Table 1 presents the average yield and range of eight clones, recommended by the Rubber Board. Mean yield based on less than five fields are not much reliable and must be taken with caution.

Over the first three years of tapping, clone RRII 105 exhibited relatively consistent yield trend and was the highest yielder too.

Over the fourth year PB 260 recorded the highest yield (mean yield in one estate only) and gave exceptionally good yield in the later years also. During the fourth year of tapping, clones RRII 105, PB 235, PB 260, PB 311 and PB 28/59 were high yielding and these clones continued to be high yielders in the fifth year also. Over nine years of tapping RRII 105 recorded the highest yield followed by PB 28/59. However, in the case of clones PB 217, PB 28/59 and GT1, the average yield for 10 years did not differ much. The yield of RRIM 600 and GT 1 was rather low during the first few years of tapping. But in the fifth year of tapping, it reaches 1680 kg ha^{-1} $year^{-1}$ and 1477 kg ha^{-1} $year^{-1}$ respectively, indicating the rising yield trend of these clones.

The average yield of the eight clones for first five years was 1358 kg ha^{-1} $year^{-1}$ ranging from 1151 kg ha^{-1} $year^{-1}$(GT 1) to 1618 kg ha^{-1} $year^{-1}$ (PB 260)(Table 2). Clones which showed above average yield per hectare include PB 260 (1618 kg), PB 311 (1451 kg), PB 28/59 (1406 kg) RRII 105 (1396 kg) and PB 235 (1369 kg)and those yielding below the average value were PB 217 (1266 kg), RRIM 600 (1214 kg) and GT 1 (1151 kg). However, yield of RRII 105 is considered to be more reliable than those from other clones because the number of fields involved in the study are more.

The average yield from fifth to tenth years of tapping was 1784 kg ha^{-1} $year^{-1}$ excluding clones PB 235, PB 260 and PB 311. In the case of PB 235 and PB 260 the data was available for 5-8 years only and for PB 311 it was nil. The yield data from fifth to tenth year ranged from 1673 kg ha^{-1} $year^{-1}$ (PB 28/59) to 1889 kg ha^{-1} $year^{-1}$ (GT 1). The yield pattern of GT 1 confirm its rising yield trend. Clones yielding above average included GT 1 (1889 kg), RRII 105 (1886 kg) and PB 217 (1786 kg) while clones yielding below average value were PB 28/59 (1673 kg) and RRIM 600 (1685 kg).

The yield over 10 years of five clones were tabulated (RRII 105 for nine years). The mean yield per hectare per year in descending order were RRII 105 (1614 kg), PB 28/59 (1540 kg), PB 217 (1526 kg), GT 1 (1520 kg) and RRIM 600 (1449 kg). The average yield for the first ten years of tapping on virgin bark for five clones was 1530 kg ha^{-1} $year^{-1}$.

The yield over first five years was generally lower than that during the subsequent five years and the magnitude of increase in yield from five to ten years varied with the clones. In majority of the clones, highest yield was recorded during the second year of tapping in B panel (BO-2).

SECONDARY CHARACTERISTICS

The vigour at the time of opening varied among the clones in the selected estates. The girth at opening ranged from 45.75 cm in RRIM 600 to 53.25 cm in PB 235 at a height of 125 cm from the bud union with an immaturity period ranging from five to nine years. Such wide range obviously would be due to different factors like forms of planting materials used (Field budding, budded stumps and polybag planting), clonal difference in growth as well as soil and climatic factors. The percentage of tappable trees at opening ranged from 50 to 70.

In the present survey it was observed that though the year of opening for RRIM 600 ranged between six to nine years after planting, the majority of the fields were opened between six and seven years. Clones GT 1, PB 217 and PB 28/59 also showed similar difference. PB 235 and PB 260 being more vigorous, were opened earlier i.e. between five and six years after planting. Girth increment on tapping also varied among the clones.

The clones were scored for their relative susceptibility to *Phytophthora, Oidium* and Pink diseases. None of the clones were found to be completely resistant to these three common diseases, although variation existed in the degree of susceptibility.

In the case of resistance to wind damage formed by trunk snap and uprooting some differences were observed among the clones. Of the nine clones observed, the most susceptible was PB 311. Majority of the clones were rated as of average tolerance to wind damage.

Occurence of brown bast (tapping panel dryness) tends to increase with the years of tapping and intensity of tapping. On tapping in Panel A (BO-1) a relatively low average incidence of brown bast was noticed. From the overall assessment of the rating, RRII 105, PB 28/59 and PB 235 tends to have above average brown bast incidence especially in the later years.

OBSERVATIONS OF CLONES

RRII 105

This is a high yielding hybrid clone evolved by the Rubber Research Institute of India and is vey popular in the traditional rubber growing tract especially among the small holders. This clone has recorded high initial and subsequent yield in all the estates, indicating the suitability in different regions of the traditional tract. It also shows low yield depression during summer months. Average production from seven large estates over five years was 1396kg ha^{-1} $year^{-1}$ and over nine years was 1614 kg ha^{-1} $year^{-1}$.

Trunk is tall and straight, branching is good with strong union. Vigour before and after tapping average with dense canopy. Foliage dark green with glossy leaves which is characteristic of this clone. Overall, mean girth in different estates at the time of opening was 49.81 cm.. Girth increment on tapping was average. Mean girth at 17th year after planting recorded to be 68.92cm.

In gerneral, this clone showed a fair degree of tolerance to abnormal leaf fall under normal prophylactic measures and moderate resistance to *Oidium*. High susceptibility to Pink is also reported.

It has shown average panel dryness and tends to increase with the years of tapping and intensive system of tapping. During the fourth year of tapping average incidence of brown bast was reported to be 5.26% under 1/2 S d/3 system of tapping, whereas 10.0% brownbast was noted in 1/2 S d/2 system of tapping. In the tenth year of tapping about 26% brown bast was recorded under 1/2 S d/3 system of tapping. This observation agrees with the trial results in which RRII 105 was reported to have above average occurrence of brown bast.

There was some indication of an increase in wind damage incidence. On tapping Panel A (BO-1) the average tree loss due to wind damage was 2.2 trees ha^{-1} 13.3% wind damage was rated during the 10th year of tapping in an estate near Trichur. Low incidence of patch canker also was noticed in certain areas.

PB217

The first commercial planting was done by Cheruvally estate, Erumeli (Harrisons and Malayalam Ltd.,) in 1970. This clone was developed by the Prang Besar Station in

Malaysia. Average yield over five years and ten years from six estates were 1266 kg ha^{-1} year^{-1} and 1526 kg ha^{-1} year^{-1} respectively. Yield during summer months is high for this clone. Comparatively high yield in estates located at Pathanamthitta and Trichur Districts, indicating the suitability of this clone in relatively dry regions, where drought period is long extending over a period of four to five months. Its better adaptability to dry climate and high summer yield is also reported 1, 6.

Trunk is tall and straight, with uniform girthing. Canopy high with dense foliage and light branches. Average girth at opening from different estates was 51.87 cm (range 50.41 cm -53.90 cm) with good girth increment on tapping (3.85cm mean over five years).

Incidence of abnormal leaf fall due to *Phytophthora* is mild in Indian conditions; whereas it is reported to be very severe in Malaysia. Very high incidence of Pink during earlier stages is noticed. In several fields less *Oidium* was reported. But in an estate in Idukki district, *Oidium* infection was severe, possibly due to relative high elevation and humidity in that area. Occurrence of panel dryness was average and wind damage was low. Under 1/2 S d/2 system of tapping only 4.27% dryness was recorded in the A panel (BO-1). The percentage scrap on tapping is very low.

PB 235

This is a high yielding clone, developed by Prang Besar Station of Malaysia. In India commercial planting of this clone was initiated in 1970. This is one of the high yielding popular clones in Malaysia. Production potential of this clone is high in India, recording 1369 kg ha^{-1} year^{-1} and 1591 kg ha^{-1} year^{-1} over five and eight years respectively. But in recent years very severe stem bleeding and attack of bark feeding caterpillar on the trees is reported in many estates, where incidence of *Phytophthora* is severe.

This clone is vigorous and can be opened early. Trunk is very tall and straight with long light branches. Girth at opening was high (Mean of five estates 53.26 cm; range 51.72cm-58.31 cm). Average girth increment on tapping was 3.20 cm for the first five years. Owing to its soft bark, generally bark consumption on tapping is high.

In general this clone was showing more than 75% leaf retention during rainy months under normal prophylactic measures against *Phytophthora*. But in a few estates high susceptibility to *Phytophthora* was reported. *Oidium* infection was severe and was susceptible to panel dryness also. In one field, 5.7% dryness had recorded in the fourth year of tapping, which was on 1/2 S d/3 tapping system. 20-25% more scrap was recorded due to late dripping.

PB 260

This is a high yielding hybrid clone developed by the Prang Besar Station of Malaysia. In India, the clone is in the early years of tapping and the yield data was available from a few fields only. Mean yield over five years was 1618 kg ha^{-1} year^{-1} (two estates) and that over eight years was 1951 kg ha^{-1} year^{-1} (one estate). In Malaysia average commercial yield is reported to be 1584 kg ha^{-1} year^{-1} and 2200 kg ha^{-1} year^{-1} for five and ten years respectively.[4]

This clone possesses good branching habit and canopy. Trunk is tall and straight; branches spreading with light side branches and dense folige. It has uniform early vigour and comes to tapping very early. Among three large estates, planted with this clone, two were opened for tapping during the fifth year and the third, during the sixth year. In three estates, average girth at opening was 53.15 cm with the range value 50.00 cm-57.00 cm. Bark thickness is high. Though virgin bark is smooth, renewed bark is flaky and bulging.

In general this clone showed average tolerance to *Phytophthora*, *Oidium* and Pink. In Malaysia this is reported to be highly susceptible to tapping panel dryness.[4] In the present study in two estates, incidence of dryness was relatively lower in the A panel (BO-1). However, in the oldest plantation in Pathanamthitta District about 15% trees were affected by panel dryness during the third year of tapping in B panel (B0-2) under 1/2 S d/2 system of tapping. Incidence of wind damage has not so far been observed except a few branch snaps. PB 260 is at present, upgraded to class 1 of Rubber Research Institute of Malaysia because of its high yield performance and relatively wind fast characteristics.[6]

PB 311

In India tapping of this Malaysian clone commenced in 1989 at Kumbazha estate, Pathanamthitta and Mooply estate, Trissur (both are Harrisons & Malayalam Ltd., Plantations). Mean yield over first five years in India was 1451 kg ha^{-1} $year^{-1}$.

The clone is of average vigour. In most of the cases the main stem looses its prominence after 4-5 metre height and diffuses into many secondary branches with small leaves.

The mean girth at opening from five estates was 52.06 cm ranging from 48.33cm to 57.00 cm. Average girth increment on tapping was 4.80 cm over five years. Thickness of virgin bark at opening is below average (4.0- 5.0mm). Hence extreme care should be taken during tapping in order to avoid the injury of cambium.

Pink disease has not been a problem and was relatively more tolerant to *Oidium* than *Phytophthora*. But one of the three fields in Pathanamthitta District was severely affected by *Oidium*. This clone is reported to be highly susceptible to wind damage in Malaysia[7]. Wind damage was relatively higher in the present study too. In the oldest plantation about 22.0% trees were badly affected by wind till the fifth year of tapping. In an estate near Mundakkayam about 4.1% of the trees were damaged by wind over the third year of tapping. Hence care should be taken not to plant this clone in wind prone areas.

Late dripping is a major problem, resulting in very high scrap percentage. In certain cases second collection of latex in the afternoon is also practised due to the high level of late dripping.

Among the clones, PB 311 reported lowest DRC (about 25%) especially during the early years of tapping.

PB 28/59

This Prang Besar primary clone was planted as early as in 1966 at Cheruvally estate, Erumeli (Harrisons and Malayalm Ltd.)

The response of agro-climatic condition is highly pronounced in this clone. First five years yield ranged from 744 kg ha^{-1} $year^{-1}$ (Idukki District) to 1548 kg ha^{-1} $year^{-1}$ (Pathanamthitta District). Generally its growth and yield are very high in Kanykumari region, with an average yield of 1806 kg ha^{-1} $year^{-1}$ over eight years. Higher yield possibly due to relatively low incidence of *Phytophthora* and *Oidium* in those regions. In the present investigation average commercial yield over five and ten years were 1406 kg ha^{-1} $year^{-1}$ and 1540 kg ha^{-1} $year^{-1}$ respectively.

Trunk is fluted and crooked. Trunk bending is common in this clone. Canopy has moderate to heavy branches. Average girth at opening was 50.50 cm. Girth increment on tapping was below average.

This clone is highly suceptible to *Phytophthora* especially in *Phytophthora* endemic areas. The incidence of *Oidium* and panel dryness was also high. But wind damage was low. Incidence of brown bast was very high affecting 6.61% trees after five years of tapping. Number of trees that dried due to this malady was above 30% after 15 years of tapping.

RRIM 600

This is a popular high yielding clone developed by Rubber Research Institute of Malaya in 1932. In general this clone showed a steady rising yield trend. In present case, over five and ten years yield was reported to be 1214 kg ha^{-1} $year^{-1}$ and 1449 kg ha^{-1} $year^{-1}$ respectively. This clone perform well especially in Kanyakumari region, where yield over ten years of tapping was 1637 kg ha^{-1} $year^{-1}$. Relatively good growth performance has been reported in non-traditional tract also.[5]

Stem tall and straight with moderate heavy branches. During immaturity the main stem is typically tall and slender. Trees have a high level first fork. Hence induction of branching is desirable in this clone. Crown narrow and broom shaped; foliage sparse with small yellowish green leaves. Though girth at opening was low (Mean value 45.75 cm), girth increment on tapping was high.

Because of its high susceptibility to *Phytophthora* abnormal leaf fall disease, severe crop loss is experienced in *Phytophthora* endemic areas unless timely prophylactic measues are adopted. Average resistance to *Oidium* and pink is reported. Incidence of wind damage and brown bast is mild. But in a few estates, occurrence of above average brown bast was recorded. In a study on the long term performance of RRIM 600, it was recorded about 25% panel dryness in the later years of tapping.[1]

GT 1

Commercial planting of this early Indonesian clone was done by Cheruvally estate, Erumely in 1968. Studies revealed that the yield of GT 1 is rather low during the first few years of tapping. Average commercial yield over five and ten years of tapping is 1151 kg ha^{-1} $year^{-1}$ and 1520 kg ha^{-1} $year^{-1}$ respectively. In general, summer yield during the months from February to May, is high. This clone is also better adapted to dry regions.

Trunk upright and slightly kinked. Its branching habit is variable. Canopy narrow, open and globular with dense dark green leaves. Girth at opening in different estates was average (Mean 50.40 cm; range 47.90-52.19 cm). But girth increment on tapping was high. Over the three years of tapping average girth increment was 4.11 cm.

In general this clone has above average resistance to *Phytophthora* and Pink; whereas *Oidium* infection was observed from average to above average. Incidence of wind damage and panel dryness was relatively very low.

The data in the present survey reveals that the clones differ widely with respect to yield potential as well as secondary characters. A knowledge of the performance of both indegenous and exotic

Table 1. Yield (kg ha^{-1}) of various popular clones form certain large estates in India

Clones		Year of Tapping 1	2	3	4	5	6	7	8	9	10
RRII 105	a	926	1262	1531	1646	1614	1848	2158	1965	1573	
	b	604-1420 (18)	825-1986 (18)	1088-2301 (18)	1180-2578 (17)	1312-2249 (13)	1325-3192 (11)	1596-3894 (8)	1481-2815 (4)	1488 1736 (3)	
PB 217	a	709	1103	1414	1454	1652	1637	1720	1327	1809	2437
	b	454-1530 (8)	834-1519 (8)	973-1839 (8)	906-2194 (8)	988-2233 (7)	1217-2050 (3)	1531-2010 (3)	1042-1617 (3)	1359-2289 (2)	(1)
PB 235	a	670	1093	1598	1816	1668	1581	2752	1552		
	b	246-1088 (7)	833-1497 (7)	1242-2085 (7)	1516-2193 (7)	1304-2232 (7)	1255-2123 (3)	(1)	(1)		
PB 260	a	639	1439	1524	1665	2826	2413	2826	2280		
	b	494-723 (3)	1136-1741 (2)	1188-1859 (2)	(1)	(1)	(1)	(1)	(1)		
PB 311	a	880	1086	1504	1953	1833					
	b	525-1086 (6)	697-1344 (5)	1225-2185 (5)	1558-2708 (4)	1534-2017 (3)					
PB 28/59	a	645	1257	1472	1753	1904	1681	1540	2034	1925	1187
	b	335-963 (10)	723-1655 (10)	790-2029 (10)	964-2099 (10)	925-2480 (10)	910-2473 (10)	1067-2246 (8)	1305-3215 (8)	1365-3265 (4)	(1)
RRIM 600	a	580	785	1457	1569	1680	1490	1867	1887	1384	1795
	b	414-702 (5)	698-886 (5)	953-2368 (5)	1128-2357 (5)	966-2781 (5)	1114-2403 (5)	1523-2633 (5)	1228-2617 (5)	963-2197 (5)	1033-2440 (5)
GT 1	a	623	997	1228	1431	1477	1627	2044	1971	1763	2039
	b	328-1100 (9)	552-1390 (9)	947-1270 (9)	931-1858 (9)	1113-1916 (8)	1134-2094 (6)	1887-2355 (5)	1430-3195 (4)	1608-1917 (2)	1974-2104 (2)

a. Mean yield (kg ha^{-1} $year^{-1}$) b. Range (kg ha^{-1} $year^{-1}$)

Values given in parentheses relate to number of fields recorded. Data from a minimum of five fields are more reliable.

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Table 2. Yield (kg ha^{-1} $year^{-1}$) of various popular clones from certain large estates in India.

Clones	Mean yield over first five years of tapping	Mean yield over five to ten years of tapping	Mean yield over ten years of tapping
RRII 105	1396	1886#	1614*
PB 217	1266	1786	1526
PB 235	1369	1962+	1591@
PB 260	1618	2506+	1951@
PB 311	1451	–	1451x
PB 28/59	1406	1673	1540
RRIM 600	1214	1685	1449
GT 1	1151	1889	1520
Mean	1356	1784	1530

 # Data from four years of tapping
+ Data from three years of tapping
** Data from nine years of tapping*
@ Data from eight years of tapping
x Data from five years of tapping

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REFERENCES

1. Joseph G. Marattukalam, Panikar, A.O.N. and Saraswathyamma, C.K. (1992). Long term performance of a few clones of *Hevea brasiliensis* in large scale trial. Placrosym IX Vol.20.
2. Krishnankutty, P.N. Georage Jacob and Haridasan, V. (1982). Evaluation of planting materials under commericial planting- First report. Rubb. Board Bull. 17:4.
3. Krishnankutty, P.N. and Sreenivasan, K.G. (1985). Evaluation of planting materials under commercial planting- Second report. Rubb. Board Bull. 20:2.
4. Performance of Clones in commercial practice 1990. Planter's Bulletin. 205.
5. RRII Annual report. 1991-92.
6. RRIM planting recommendation -1992 - 94 (1992). Planter's Bulletin :211.
7. RRIM 800 Series clone trials (Second selection (1990). Second report. Planter's Bulletin. 205.
8 Saraswathyamma, C.K. George, P.J. and Panikkar, A.O.N. (1987). Performance of a few RRII clones in the estate trials. Rubb.Board Bull. 23 :5-9.
9. Toms Joseph and Haridasan, V. (1990). Evaluation of planting materials under commercial planting. Third report.Rubb. Board Bull. 26:1.

Sunlight Improves Quality of Rubber

Contrary to the popularly held belief that the drying of sheet rubber in direct sunlight causes defects, it has been found that drying in sunlight results in good quality rubber produced in a shorter time.

Dr. LMK Tillekeratne, director of the Rubber Institute of Sri Lanka (RRISL) said it was traditional to protect both sheets and crepe laces from sunlight, even going to the extent of painting factory windows black to prevent the entry of sunlight.

However, Dr. Tillekeratne said that according to the research of the RRISL, sheet rubber can be dried in hot sunlight in four to five days. He recommends the use of smoking for one day to produce the requisite honey brown colour and prevent mould contamination. In the case of unfractioned, unbleached crepe rubber, he says, it has been possible to completely dry them in two days by exposing to direct sunlight from 10 am to 4 pm continuously.

Dr. Tillekeratne says if sunlight is not available on the first day, a drying tower of smoke house should be used.

– (International Rubber Digest)

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Dodder *(Cuscuta campestris* Yuncker) Infestation in Rubber Plantations

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ABSTRACT

Parasitic infestation extensively on *Pueraria phaseoloides*- and sporadically on *Hevea brasiliensis* and *Mucuna bracteata* by *Cuscuta campestris* has been reported for the first time. The wide host range, lack of host specificity, quick spreading nature, lack of toxin production to trigger host's defense mechanism and ability to establish organic connection with the host, all contribute to its potential threat as a noxious weed menace to rubber plantations. The parasitic weed at first infests the cover crop and gets access to the rubber canopy through the cover crop vines. Through its innumerable haustoria the parasite extracts nutrients from the host parts gradually weakening it and ultimately killing the affected branches. The parasite is devoid of leaves and roots but profusely flowers and sets seeds which readily germinate. As it is difficult to eradicate it once it has established in a rubber plantation, preventive measures and early control by manual removal of infested plant parts are to be resorted to.

Introduction

Parasitic infestation of dodder, the noxious flowering plant parasite, has been reported on a number of economic crops in several countries. The weed has got a very wide host range like horticultural crops (including fruits and vegetables), field and forage crops and also ornamental plants. (Mamluk & Weltzein 1978; Beuret 1981; Rao & Gupta 1981; Takabayashi *et. al.* 1981). Among the 100 species of the parasite reported worldwide the three most widely distributed species are *C. australis* R. Br (distributed through Central South and East Asian Region to Australia), *C. campestris* Yuncker (a native of N. America, now common in the Malaysian region) and *C. reflexa* Roxb. (widely distributed in central and South Asia). In Malaysia the presence of the parasite has been reported, (Rajan & Hashim, M.D Noor 1989) but only as a nuisance weed. In

Profuse flowering of dodder

India the occurrence of the parasite has been recorded on a large number of hosts. Coffee plantations have of late been plagued by this plant parasite. Recently the outbreak of the infestation in rubber plantations has been noticed on rubber tree *Hevea brasiliensis* and cover crops *Pueraria phaseoloides* and *Mucuna bracteata*. The parasite has been identified as *C. campestris* Yuncker.

Occurrence of *Cuscuta campestris* on rubber trees

Cuscuta sp. belonging to Cuscutaceae has been found to twine round the young green shoots all over around the stem, petioles and petiolules with the growing tips of the vine hanging downwards in large number of parallel streaks. After vigorously growing for sometime on a twig the vine turns to the next twig and repeats the process, ultimately forming a tangled mass. All along the vine, on the side in contact with the host large number of haustoria are produced. Drops of latex are found oozing out from the point of contact. The parasitic vine alone or at times both the parasite and the host tissues are found swollen due to host parasite interaction. No necrosis of host around the haustorial attachment or abcission of the affected leaf is ever noticed. Leaves at the time of wintering remain attached to the vine in tangled mass. The vine continues growth to the next storey when it unfolds. It is observed that infestation on rubber tree is either from *Pueraria* or *Mucuna* vines climbing on the tree with the parasite on it or from other hosts of the parasite like *Mallotus* sp or *Cerbera odalam* etc. growing on the border of estates. Once the parasite covers the canopy of the tree it is difficult to eradicate it. Once the green tender stem is found to callus at places of attachment of the parasite and later, the green stem turns to brown stem, the portion of the parasite gets killed, but the tip of the vine immediately continues growth to attack the newly developing tender stem and leaves.

Infestation of *Pueraria phaseoloides*

On vigorously growing thick carpet of *Pueraria phaseoloides* in young rubber plantations, the parasitic infestation is initially noticed as a fine net work of golden yellow vines of the weed colony usually circular in outline at the beginning either growing above the cover crop leaves visible even from a distance or underneath on cover crop vines and petioles, unnoticed from a distance. The colony grows outwards in circumference. The thin strands of the parasite extend outwards twining round the host initially as if for support and once it gets a firm hold, then twines round and round repeatedly until the whole host portion is practically covered by the coils. When the parasitic vine comes in contact with the host, large number of tooth - like projections or prohaustoria are produced on the surface facing the host, which pierce the host tissues and establish permanent organic connection between the two. It is interesting to note that the parasitic infestation does not trigger the defense mechanism of the host

Table

Height of plants and size of leaves of dodder infested and healthy seedlings of *Hevea brasiliensis*

Treatment	Height of plants in cm.	Size of leaves in cm.		Colour of leaves etc.
		Length	Breadth	
Dodder infested plants	21.17	8.45	2.55	Leaves turned yellowish, withered and dried. Consequently major part of the parasite is also dead. Flowering and fruiting noticed in the parasite.
Control plants	39.93	10.28	3.40	Leaves dark green and healthy.

and the absence of necrosis of the host tissue indicates absence of production of toxins by the parasite. After completing growth on the host part for a while, the parasite branches and the branches come in contact with other host parts and repeat the process and as a result the whole growth of *Pueraria* vines in the affected area becomes a single entangled mass, the leaflets sometimes held together in an upright position, not free to maintain their horizontal position. Movement of the leaflets according to the changing position of the sun is made impossible. In areas exposed to the sun the vine at times assumes an yellowish orange tinge. The parasitic plant is devoid of leaves and has no roots, but possesses scale leaves from the axils of which new branches arise. The plant is found to flower profusely from April to September, the flowers produced in panicles, creamy white in colour, pentamerous with four carpels and are insect pollinated. The fruits are small measuring 4 mm across with 4 locules having one seed in each locule. While the infested areas extend in circumference, the central part of the cover crop gets perished along with the parasite, the parasite on the marginal portion continues growth outwards. In young plantations, the covercrop vines were found to climb on to rubber canopies with the parasitic vine on it either by twining round the main stem or through coir ropes tied to plants to keep in erect position against wind damage.

The leguminous ground cover *Mucuna bracteata* also has been parasitised by the parasitic weed dodder in the same manner. At portions where large number of coils of the parasite are formed resulting in larger number of haustorial penetration, the host tissues are enlarged owing to the defense mechanism of the host. Vine is also swollen and flattened laterally because of host parasite interaction triggered possibly by the phenolic content of *Mucuna*.

Dodder twining round rubber leaves and stem

Seed germination

The seeds of *Cuscuta* sp. measure 1 mm in dia. and are brownish in colour. The seeds when incubated inside moist chamber germinated within 72 hr. Small colourless thread like seedlings emerged with neither cotyledons nor radicle. The meristematic tip of the thread - like stem was golden yellow in colour. The seedlings when transferred to pots containing 2 month old seedlings of rubber grew towards them as if attracted and twined round them within 24 hr. Within 48 hr they produced haustoria. After coiling round one seedling for a while the vine branched and the branch grew towards nearby seedlings. Within a week's time, all the 8 numbers of rubber seedlings were covered with the parasitic vine and a good number of growing tips extended outwards in search of new unparasitised seedlings. From many points of attachment through haustoria, latex exuded and the drops coagulated there immediately. In a

India the occurrence of the parasite has been recorded on a large number of hosts. Coffee plantations have of late been plagued by this plant parasite. Recently the outbreak of the infestation in rubber plantations has been noticed on rubber tree *Hevea brasiliensis* and cover crops *Pueraria phaseoloides* and *Mucuna bracteata*. The parasite has been identified as *C. campestris* Yuncker.

Occurrence of *Cuscuta campestris* on rubber trees

Cuscuta sp. belonging to Cuscutaceae has been found to twine round the young green shoots all over around the stem, petioles and petiolules with the growing tips of the vine hanging downwards in large number of parallel streaks. After vigorously growing for sometime on a twig the vine turns to the next twig and repeats the process, ultimately forming a tangled mass. All along the vine, on the side in contact with the host large number of haustoria are produced. Drops of latex are found oozing out from the point of contact. The parasitic vine alone or at times both the parasite and the host tissues are found swollen due to host parasite interaction. No necrosis of host around the haustorial attachment or abcission of the affected leaf is ever noticed. Leaves at the time of wintering remain attached to the vine in tangled mass. The vine continues growth to the next storey when it unfolds. It is observed that infestation on rubber tree is either from *Pueraria* or *Mucuna* vines climbing on the tree with the parasite on it or from other hosts of the parasite like *Mallotus* sp or *Cerbera odalam* etc. growing on the border of estates. Once the parasite covers the canopy of the tree it is difficult to eradicate it. Once the green tender stem is found to callus at places of attachment of the parasite and later, the green stem turns to brown stem, the portion of the parasite gets killed, but the tip of the vine immediately continues growth to attack the newly developing tender stem and leaves.

Infestation of *Pueraria phaseoloides*

On vigorously growing thick carpet of *Pueraria phaseoloides* in young rubber plantations, the parasitic infestation is initially noticed as a fine net work of golden yellow vines of the weed colony usually circular in outline at the beginning either growing above the cover crop leaves visible even from a distance or underneath on cover crop vines and petioles, unnoticed from a distance. The colony grows outwards in circumference. The thin strands of the parasite extend outwards twining round the host initially as if for support and once it gets a firm hold, then twines round and round repeatedly until the whole host portion is practically covered by the coils. When the parasitic vine comes in contact with the host, large number of tooth - like projections or prohaustoria are produced on the surface facing the host, which pierce the host tissues and establish permanent organic connection between the two. It is interesting to note that the parasitic infestation does not trigger the defense mechanism of the host

Table

Height of plants and size of leaves of dodder infested and healthy seedlings of *Hevea brasiliensis*

Treatment	Height of plants in cm.	Size of leaves in cm.		Colour of leaves etc.
		Length	Breadth	
Dodder infested plants	21.17	8.45	2.55	Leaves turned yellowish, withered and dried. Consequently major part of the parasite is also dead. Flowering and fruiting noticed in the parasite.
Control plants	39.93	10.28	3.40	Leaves dark green and healthy.

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Flowers of *cuscuta*

few cases even leaf blades were parasitised by dodder. The tooth like projections from the dodder vine produced droplets of some clear fluid, perhaps digestive enzymes which helped to dissolve off the tissues of the host whereby entry of the parasite into the host is made easier. After growth for 4 weeks, the parasite produced flowers and later fruits on the vines. All the host seedlings were held together in a single mass by the parasitic vine. The reduction in height, growth and leaf size of the dodder infested plants in comparison to healthy uninfested control are recorded in the table.

Anatomical Investigations

It was revealed that the parasite stem is composed of simple parenchyma cells and very poorly developed conducting tissues. The haustorium composed of loosely packed elongated cells with very few strands of xylem and phloem, were seen to pierce the host tissues and come in contact with the xylem and phloem of the host stem and petiole. The parasite and the host established organic connection enabling the former to drain the latter off the assimilates from the phloem and water and minerals from the xylem.

Identification of the species as *Cuscuta campestris* was done by the Botanical Survey of India, Coimbatore.

Pest status

Eventhough generally these parasites have only nuisance value, since the parasite has been observed to infest *Pueraria* in the rubber plantations on a very serious proportion and rubber plants and *Mucuna* sporadically, there is every possibility that this pest may assume the status of a noxious weed in the near future. Moreover the absence of production of toxic principles which are capable of triggering the defense mechanism of the host plant is yet another unique property of the parasite which may pose a potential threat to the rubber plantations.

Control Measures

The pest has to be readily controlled by manual methods while still on the ground on the cover crop. Once established on the cover crop, due to its capacity to regenerate from stem fragments prevention of the pest or eradication in the early stage by cutting and burning has to be resorted to. If it has reached the canopy of rubber, careful cutting and burning of infested branches have to be resorted to taking care not to contaminate healthy plants and ground cover. This parasitic weed should never be used as a biocontrol agent to suppress other weeds.

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WOUNDING IN *HEVEA* TREES

Vinoth Thomas, K.K.Vinod & Jacob Pothen.
Rubber Research Institute of India

Wounding of plants can be defined a incisions, abrasions or other injuries due to external violence like cutting, shooting, tearing and attack in any part of a tree or plant. Wounding can be fatal, in which case the plant succumbs to the injuries, sub-fatal when the damage goes deep inside the system causing internal as well as external damages but plant survives, and superficial where the plant recovers almost to the normal state.

Broadly the wounds can also be grouped into two categories viz., open wounds and closed wounds. Open wounds often permit the entry of foreign materials into the tissues, and in contrast, the closed wounds do not expose the damaged tissues to the exterior. Further classification of wounds is also possible based on how they are inflicted in the plant system (Kramer and Kozlowski, 1979).

Wounding is generally followed by the wound healing process. The mechanism and rapidity of healing depend upon the extent of damage, habit of the species, age, type of tissues damaged, nature of damage, environmental conditions and infection by pathogens if any.

In a wounded plant the physiological and biochemical activities are altered drastically. The protein matabolism is changed, the production of enzymes like polyphenol oxidases and peroxidases are enhanced and growth regulating substances like ethylene are produced excessively (Dekhuijzen, 1976). Wounding in general, also involves death of severed cells and damaged parts of tissue systems. At the onset of healing process, superficial cell layers of the wound become suberised and lignified which check the entry of microbes from out side and prevent loss of water from the tissues beneath. This follows a sequential production of callus tissues to cover up the wound. In instances where the injury has gone upto the cambium a new meristematic region is formed from the callus. A phellogen is also regenerated, producing phellem towards the exterior and phelloderm towards the interior.

In woody plants callus formation is mainly controlled by vascular rays alone and the amount and rate of callus production depend on size and depth of wound. Shallow wounds heal more rapidly and in some cases no callus is produced.

In biological system, nevertheless, all plants are subjected to wounding mainly by natural means. However, man made woundings are confined to a few species which can exude economically important substances on wounding. Examples are resins from *Pinus* spp., gums from *Acacia arabica*, oleoresins from *Pinus elliotti*, rubber from *Hevea brasiliensis*, etc.

Unlike other species, *Hevea brasiliensis* is the only species which undergoes systematic and controlled wounding called 'tapping' to extract latex containing natural rubber. Moreover, the *Hevea* trees may also suffer from many other wounding injuries both man made as well as

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Unlike other species, *Hevea brasiliensis* is the only species which undergoes systematic and controlled wounding called 'tapping' to extract latex containing natural rubber. Moreover, the *Hevea* trees may also suffer from many other wounding injuries both man made as well as

Figure: Effects of various types of wounding in *Hevea*.
1. Pecking
2. Trunk split due to wind
3. Hailtorm inflicted bark injury
4. Tapping panel dryness

from other factors which can adversely affect the growth and yield of the trees. This article focuses on wounding suffered by Heavea trees described under three catagories viz., man-made wounding, natural wounding and wounding by other factors.

I. Man-made Wounding:-

The major man-made wounding in *Hevea* trees is tapping. Besides normal tapping, slaughter trapping and wound caused by unawareness are also included in this group.

a. Tapping

Hevea yields latex through a specialised structure called laticifers which are net-worked in bark tissues and mainly concentrated in the inner bark region (Bobilioff, 1923). While tapping a thin shaving of bark is removed just to cut open the laticifers transversely without damaaging the cambial zone. The activity of cork cambium and vascular cambium helps in healing of wound caused by tapping and restore the original bark structure (Thomas *et.al.*, 1994). This regenerated region will come under tapping again after 10-12 years (Sethuraj, 1992).

Tapping is a skilled job, and a slight error may inflict damage to the cambium. Trees respond quite abnormally to cambial damage by putting forth extra callus growth which later develop as bulges on the regenerated trunk. Such damages are common in areas where inexperienced tappers are employed, such as non-traditional rubber growing regions.

Injury to cambium also exposed the underlying wood making it vulnerable to wood decaying microbes. If the damage area is large, the wound may not be closed by the new tissues and the wood would remain exposed for long time (Dijkman, 1951). The development of knotty bark and uncovered wood generally hinder the tapping process in the renewed area. The decay of the underlying wood often make trees vulnerable to trunk snaps during heavy winds.

b. Slaughter Tapping:-

At the end of the economic life, the *Hevea* trees are subjected to extensive uncontrolled tapping called 'slaughtering'. Slaughtering is done to extract maximum latex out of a tree before it is felled (Paardekooper, 1989). This wounding is one of the most severe injuries experienced by a tree in its lifetime, but has little significance as far as healing is concerned since trees are felled within a short period.

c. Other man-induced wounding:-

As a related operation before tapping, metallic spouts and cup hangers are fixed on to the trunk below the tapping panel. This pracatice often damage cambium and as a relult bulges develop in this region.

Another type of wounding inflicted by the people is pecking, cutting, hitting the bark with stones and pollarding, cutting, hitting the bark with stones and pollarding. The first three acativities are done for the sake of curiosity to see latex flowing out or to make rubber balls for children and the latter is done for firewood purpose. This type of damages are common in Sukna and Sipchu of West Bengal where rubber plantations are taken up in forest lands by the Sylvicultural Division of Forest department. The trunk of these trees are badly mutilated and swollen and are unsuitable for tapping (Fig.1).

II. Natural Wounding:-

Natural factors imposing extensive wounding in rubber plantations are mainly wind, fire, hailstorms and lightning.

a. Damaging effect of wind:-

The most catastrophic form of wind damage is caused by storms and tropical cyclones. Nothing can be done to prevent the damage. Mostly the branches and trunks are snapped at the basal region destroying the entire tree (Wycherley *et. al.*, 1962). In many cases uprooting of entire trees could be seen.

Cyclonic storms can inflict both internal and external wounds. If the trees are not broken, the trunks are twisted and resultant stress crush the internal tissues including wood, splitting and cracking the bark (Fig.2). These wounds are most harmful, since they help invasion of pathogenic microbes and foreign bodies deep into the plant system. This causes considerable decay of wood and such trees are most vaulnerable to wind damage subsequently. As time advances these wounds heal from inside but never close. The healed trunks are generally unsuitable for tapping.

b. Damage by fire:-

Fire damage can occur in rubber plantations during wintering months when the floor is covered with dry leaves. The general reasons for fire hazards in non-traditional regions like Tripura is the traditional slash and burn practised by tribals in the vicinity of rubber plantations. Fire damage often causes the death of the whole tree, since all the conducting cells and cambial cells at the collar region are killed. However, partially burnt trees recoup by putting forth callus and new conducting tissues from sides, leaving the burnt area uncovered. Later the died bark at the burnt area flake off exposing the wood and make it more vulnerable to wood borers, and wood decaying microbes. This generally weaken the tree at collar region and trees collapse during wind.

c. Damaging effect of hailstorms:-

Hailstorms are common phenomenon in subtropical regions including North-Eastern India (Pushpadas and Karthikakutty Amma, 1980). Reports of severe hail damages on other crops are available from elsewhere (Evans, 1978). However, the report on extensive damage of rubber by violent hailstorms is quite rare except for the one which hit experimental farm at Agartala during April, 1986 (RRII,1987). The high velocity hail fall usually chip of the bark inflicting considerable damages to one side of the trunk. The depth of wounding generally varies from superficial to deep into the cambial zone and size of damaged patches vary from small spots to large patches. The opposite side of the tree generally stay intact, however the trees in addition suffer from all common wind inflicted damages. Studies show that the recovery of the tree is very slow and many trees fail to restore its original bark structure, causing considerable yield depression from the damaged sides (unpublised data). The regenerated areas are interspersed with protuberances, longitudinal wound scars, cavities and islands of virgin bark which cause considerable difficulty while tapping (Fig.3)

d. Lightning damages:-

The upward stroke of each lightning causes a current of almost 100,000 A to pass through the tree, causing excessive internal heating. This generally result in splitting up of vascular tissues and cracking of trunk. Lightning hit wounds are always fatal, and even if any trees survive they are totally unsuitable for tapping (Steinmann, 1925).

III. Wounding by other factors:-

Animals, pests and diseases and physiological abnormalities are other factors which induce wound and/or wound reaction in *Hevea* trees.

a. Damage caused by animals

Animals damage on *Hevea* trees are not common. However animals like monkeys are reported to cause branch snaps. Wild pigs cause bark damage by sharpening their tusks and porcupines damage roots by digging into the soils. All these wounds permit entry to pathogens and cause subsequent damage to the trees.

b. Wounds caused by pests and diseases:-

By and large, no pest induced wounds are seen in *Hevea*. On the other side disease like patch canker (*Phytophthora palmivora*), Pink disease (*Corticium salmonicolor*), Collar rot (*Ustulina deusta*), Black stripe (*Phytophthora* spp.), mouldy rot (*Ceratocystis fimbriata*), white root disease (*Tigidoporus lignosus*), Red root disease (*Ganoderma pseudoferreum*) and brown root disease (*Phellinus noxius*) cause considerable damage, inducing wound related reactions. In case of trunk and branch diseases the entire affected bark is destroyed in severe cases and underlying wood is exposed. If tree recovers the exposed wood is not covered fully rendering trees unsuitable for tapping. In many cases, including root diseases the trees die due to infection if not treated properly (Johnston, 1989).

c. Wound reactions due to physiological disorders:-

The most spectacular physiological disorder in *Hevea* is tapping panel dryness (TPD). TPD generally triggers severe wound induced reaction in affected trees. Most of the old tissues are destroyed and new abnormal tissues develop (Fig. 4), resulting in warty and swollen trunk which is unsuitable for exploitation, and often devoid of latex (Fay and Jacob, 1989; Gomez and Ghandimathi, 1990).

Wounds in general, adversely affect the growth and yield of *Hevea* tree. Many of the instances of wounding can be controlled/minimised except in the case of those resulting due to natural factors. Therefore, precautionary measures should be taken,

- to reduce the frequencey of tapping.
- not to injure cambial zone,
- not burn slashes in the vicinity of plantation,
- to prevent illegitimate wounding by trespassers, to prevent wild animals by erecting fencings,
- to control pest and diseases, and
- to prevent damage to collar region while weeding.

However, in the event of any wound occurrence the trees are to be given rest to recoup and to increase the cambial activity. Damaged trees should be well fertilized and irrigated (Kramer and Kozlowski, 1979). The application of wound dressing compounds may be skipped since it is reported to have no effect on wound healing (Neely, 1970) and it infact may reduce the wound healing process (Kramer and Kozlowski, 1979). However, in India wound dressing compounds are being used by many planters as panel protectant and wound dressing material as they feel that they promote the healing process (Radhakrishna Pillay and George, 1980).

References:

Bobilioff, W. 1923. Anatomy and Physiology of *Hevea brasiliensis*. I. Anatomy of *Hevea brasiliensis*. Zurich: Art. Institute. Orell Fussli 150p.

Dekhuijzen, H. M. 1976. Endogenous, cytokinins in healthy and diseased plants. Encycl. plant physiol. New Ser. 4:526-559

Dijkman, M. J. 1951. Hevea: Thirty Years of Research in the Far-East. Unversity of Miami Press, Florida. 329 p.

Evans, J. 1978. Some growth effects of low rain fall and hail damage in *Pinus patula* plantations. S. Afr. For. J. 105: 8-12.

de Fay, E and Jacob, J. L. 1989. Symptomatology, Histological and cytological aspects, In: J. D Auzac, J. L. Jacob and H. Chrestin (eds). Physiology of Rubber Tree Latex, CRC Press, Florida. pp. 407-430.

Gomez, J. B. and Ghandimathi, 1990. The brown bast syndrome of *Hevea. I. Morphological observations. J. Nat. Rub. Res. 5:81-89.*

Johnston, a. 1989. Diseases and pests. In: C. C. Webster and W. J. Baulkwill (eds.) Rubber. Longman Scientific and Technical, England. pp. 415-458.

Kramer, P. J. and Kozlowski, T. T. 1979. Physiology of Woody Plants. Academic Press, New York. 811p.

Neely D.E. 1970. Healing of wounds on trees. J. Am. Soc. Hortic. Sci. 95: 536-540.

Paardekooper, E. C. 1989. Exploitation of the rubber tree. In: C. C. Webster and W. J. Baulkwill (eds.) Rubber. Longman Scientific and Technical. England p. 349-414.

Pushpadas, M. V. and Karthikakutty Amma, M 1980. Agroecological requirements. In: P. N. Radhakrishna Pillay (ed.) Hand Book of Natural Rubber Production in India. The Rubber Board, Kottayam. pp 87-110.

(Continued on Page 34)

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III. Wounding by other factors:-

Animals, pests and diseases and physiological abnormalities are other factors which induce wound and/or wound reaction in *Hevea* trees.

a. Damage caused by animals

Animals damage on *Hevea* trees are not common. However animals like monkeys are reported to cause branch snaps. Wild pigs cause bark damage by sharpening their tusks and porcupines damage roots by digging into the soils. All these wounds permit entry to pathogens and cause subsequent damage to the trees.

b. Wounds caused by pests and diseases:-

By and large, no pest induced wounds are seen in *Hevea*. On the other side disease like patch canker (*Phytophthora palmivora*), Pink disease (*Corticium salmonicolor*), Collar rot (*Ustulina deusta*), Black stripe (*Phytophthora* spp.), mouldy rot (*Ceratocystis fimbriata*), white root disease (*Tigidoporus lignosus*), Red root disease (*Ganoderma pseudoferreum*) and brown root disease (*Phellinus noxius*) cause considerable damage, inducing wound related reactions. In case of trunk and branch diseases the entire affected bark is destroyed in severe cases and underlying wood is exposed. If tree recovers the exposed wood is not covered fully rendering trees unsuitable for tapping. In many cases, including root diseases the trees die due to infection if not treated properly (Johnston, 1989).

c. Wound reactions due to physiological disorders:-

The most spectacular physiological disorder in *Hevea* is tapping panel dryness (TPD). TPD generally triggers severe wound induced reaction in affected trees. Most of the old tissues are destroyed and new abnormal tissues develop (Fig. 4), resulting in warty and swollen trunk which is unsuitable for exploitation, and often devoid of latex (Fay and Jacob, 1989; Gomez and Ghandimathi, 1990).

Wounds in general, adversely affect the growth and yield of *Hevea* tree. Many of the instances of wounding can be controlled/minimised except in the case of those resulting due to natural factors. Therefore, precautionary measures should be taken,

- to reduce the frequencey of tapping.
- not to injure cambial zone,
- not burn slashes in the vicinity of plantation,
- to prevent illegitimate wounding by trespassers, to prevent wild animals by erecting fencings,
- to control pest and diseases, and
- to prevent damage to collar region while weeding.

However, in the event of any wound occurrence the trees are to be given rest to recoup and to increase the cambial activity. Damaged trees should be well fertilized and irrigated (Kramer and Kozlowski, 1979). The application of wound dressing compounds may be skipped since it is reported to have no effect on wound healing (Neely, 1970) and it infact may reduce the wound healing process (Kramer and Kozlowski, 1979). However, in India wound dressing compounds are being used by many planters as panel protectant and wound dressing material as they feel that they promote the healing process (Radhakrishna Pillay and George, 1980).

References:

Bobilioff, W. 1923. Anatomy and Physiology of *Hevea brasiliensis*. I. Anatomy of *Hevea brasiliensis*. Zurich: Art. Institute. Orell Fussli 150p.

Dekhuijzen, H. M. 1976. Endogenous, cytokinins in healthy and diseased plants. Encycl. plant physiol. New Ser. 4:526-559

Dijkman, M. J. 1951. Hevea: Thirty Years of Research in the Far-East. Unversity of Miami Press, Florida. 329 p.

Evans, J. 1978. Some growth effects of low rain fall and hail damage in *Pinus patula* plantations. S. Afr. For. J. 105: 8-12.

de Fay, E and Jacob, J. L. 1989. Symptomatology, Histological and cytological aspects, In: J. D Auzac, J. L. Jacob and H. Chrestin (eds). Physiology of Rubber Tree Latex, CRC Press, Florida. pp. 407-430.

Gomez, J. B. and Ghandimathi, 1990. The brown bast syndrome of *Hevea. I. Morphological observations. J. Nat. Rub. Res. 5:81-89.*

Johnston, a. 1989. Diseases and pests. In: C. C. Webster and W. J. Baulkwill (eds.) Rubber. Longman Scientific and Technical, England. pp. 415-458.

Kramer, P. J. and Kozlowski, T. T. 1979. Physiology of Woody Plants. Academic Press, New York. 811p.

Neely D.E. 1970. Healing of wounds on trees. J. Am. Soc. Hortic. Sci. 95: 536-540.

Paardekooper, E. C. 1989. Exploitation of the rubber tree. In: C. C. Webster and W. J. Baulkwill (eds.) Rubber. Longman Scientific and Technical. England p. 349-414.

Pushpadas, M. V. and Karthikakutty Amma, M 1980. Agroecological requirements. In: P. N. Radhakrishna Pillay (ed.) Hand Book of Natural Rubber Production in India. The Rubber Board, Kottayam. pp 87-110.

(Continued on Page 34)

APPLICATION OF REMOTELY SENSED DATA IN RUBBER CULTIVATION

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Rubber Research Institute of India.

Programmes using satellites have established the combined use of sophisticated space and remote sensing technology for both measurement and monitoring of natural resources on the earth's surface. Satellite imagery provides better and economical data than the conventional methods as it facilitates synoptic viewing of large land areas. Thus satellite imagery can speed up survey of natural resources which could prove to be very beneficial in certain research and developmental actvities.

Remote sensing is the art and science of acquiring data about an object from a remote point without being in physical contact with the object of interest. The sensors employed in remote sensing, record the reflectance/emittance from the objects after they interact with the incident energy i.e. electromagnetic radiation (EMR), coming from the sun. The present day remote sensors operate from visible region to microwave region of the electromagnetic spectrum (EMS) (Fig.1).

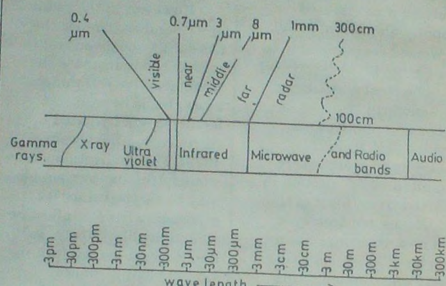


Fig 1 Electromagnetic spectrum

Source :

Mulders, M.A.. Remote sensing in Soil Science, 1987: page No. 15 by permission of Elsevier Science Publishers BV, Amsterdam.

There are two types of sensors which are presently in use viz., Image oriented sensors and Numerical oriented sensors. Image oriented systems are used by mounting them to aircrafts. Here the data of an object is recorded as an image i.e. photographs. Whereas the numerical oriented systems can be mounted to both aircrafts and satellites which record the data in digital format. Both types of sensors operate in visible, infrared and microwave regions of the EMS. The advantage of aerial photographs is that stereoscopic vision is possible while the satellite sensors do not provide for stereoscopic vision with the exception of the French satellite, SPOT. The great advantage with numerical data is that it gives scope for multiple enhancements for better image. Wheras image oriented data has less flexibility for being enhanced.

Typical for present time remote sensing research is the multiconcept approach which comprises:

- multispectral (or multiband) observation which is in different wave lengths to enable spectral signatures of objects.
- multistation observation which is from different stations at the same altitude (for stereoscopy) or at different altitudes.
- multipolarisd observation (for polarising properties) of objects.
- multidate (or multitemporal) observation which is of same area or object at different times or seasons.
- multienhancement or enhancemtnof imagery derived from digital processing or photographic recording. (Mulders, 1987)

POSSIBLE APPLICATIONS OF REMOTELY SENSED DATA RELATED TO RUBBER:

Rubber is a deciduous tree species introduced first to tropical India in early 20th century and this region is designated as the traditional region of rubber cultivation. Owing to increased demand for natural rubber, it paved its way to other non-traditional regions. There are however, continuous efforts to identify new potential areas which can be brought under rubber in both traditional and non-traditional regions. This paper is an effort to identify different aspects which could be looked into with the help of remotely sensed data. Following are some or the areas where remote sensing technology could prove useful.

1. Soil surveys for identification of suitable soils
2. Identification and distribution of rubber and area under plantations
3. Identification of different rubber clones
4. Assessment of moisture status
5. Detection of damage caused by diseases, insect pests and other hazards
6. Agronomic conditions
7. Application of GIS module

1. Soil surveys for identification of suitable soils:

The importance of soil surveys in identifying areas suitable for specific crops has long been proved. While the traditional soil survey techniques are time consuming, remotely sensed data will help in conducting soil surveys in much less time with considerable accuracy. The non-traditional areas of India could be surveyed to identify potential soils, suitable for rubber.

There are certain methods of image analysis with reference to identification of soils as described by Bennema and Gelens (1969). These methods include aspect of element analysis, physiographic or physiognomic analysis and morphogenetic analysis. By the utilisation of apporpriate method of interpretation, the basic aspects, compound aspects and inferred aspects of soils can be derived, depending on the factors of soil formation. For example, in humid tropical or sub-tropical areas it is not possible to identify the soils directly as it will be covered by vegetation and by physiographic analysis only it can be interpreted. Whereas in arid and semiarid regions there could be direct exposure of surface soils and it is easy to identify the soils.

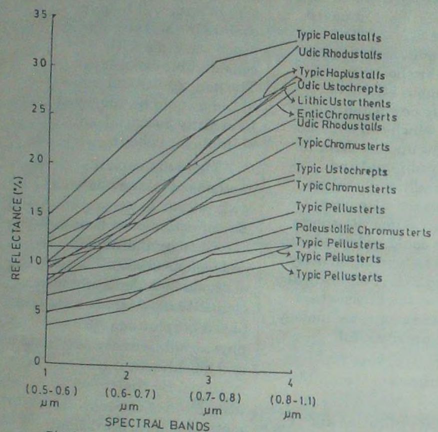


Fig 2 Spectal reflectance of soils

Source :

Dwivedi, R.S. et al. Spectral reflectance of some typical Indian soils as affected by tillage and cover crops. 1981. J. Photo-Int. and remote sensing, Vol.9(2) : 33-40 by permission of authors

Similarly, the inferred aspects like parent material, soil depth and erosion condition etc. can be detected only by physiographic analysis and morphogenetic analysis and element analysis may not be much helpful particularly in humid regions where rubber is normally grown.

For successful cultivation of rubber all aspects of soils are to be looked into. i.e. slope, depth, chemical nature of soils, erosion conditions etc. which influence nutrition and anchorage etc.. Application of remote sensing techniques will enable us to identify and to quantify the suitable soils over large areas for rubber cultivation by using appropriate image interpretation method.

Literature is available on delination of different soils by analysing spectral reflectances. Dwivedi *et al* (1981) could separate different soil series using spectral reflectance values recorded using field radiometer corresponding to Landsat MSS. (Fig. 2). Similar report was given by Govardhan (1991) on delineation of soils based on field radiometer studies. Kashiram and Nageswara Rao (1993) reported separation of more number of physiographic units and corresponding soil associations by using IRS data than the conventional method of soil survey.

In NE states, particularly in Tripura, shifting cultivation is in practice which poses a potential threat of land degradation. NRSA (1991) had estimated the extent of jhummed areas in entire Tripura state using Landsat imagery. Such data can very well be used for extension of rubber in these areas for not only rehabilitating jhumias (who

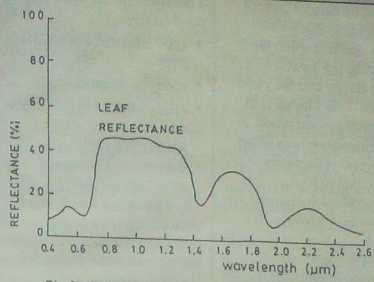


Fig 3a Reflectance spectrum of typical green leaf

Source : Mulders, M.A.. Remote sensing in Soil Science, 1987. page No.77 by permission of Elsevier Science Publishers BV, Amsterdam

practice shifting cultivation) but also for arresting further degradation of land.

It is evident that remote sensing could help us to identify areas where ruber could possibly be grown. This could be done on a very large scale in a comparatively shorter period of time and with much lesser effort.

2. Identification and distribution of rubber and area under plantations:

It is evident that under a given set of conditions, it is easy to distinguish different plant species with their specific reflectances. Fig.3a indicates the spectral signature of a typical leaf over a range of different wavelengths. This curve shows highest absorbance in red region and highest reflectance in near infrared region which is mainly due to chlorophyll content.

Fig.3b gives an idea as to how different plant species vary in their spectral reflectances. Similarly rubber can also be identified by its specific brick red tone on the image.

The extent of area under rubber is a data which is of great importance to both the planner as well as the person concerned with research and development. Although we have data on the total area under rubber, it is difficult to verify its accuracy periodically. The data on area under rubber helps the planner and policy maker to predict the yield in a particular year which in turn helps in deciding important matters like

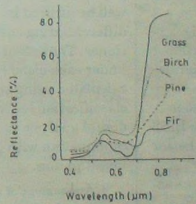
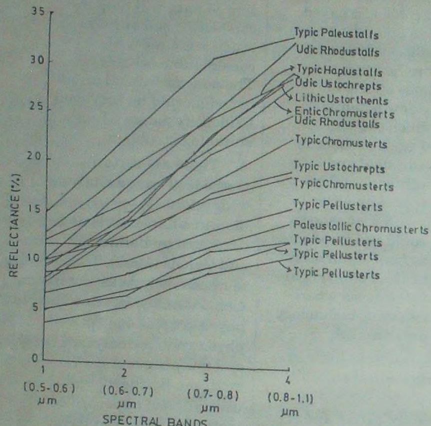


Fig 3b Reflectance spectra of four types of canopies

Source : Mulders, M.A.. Remote sensing in Soil Science. 1987 : page No.81 by permission of Elsevier Publishers BV. Amsterdam.



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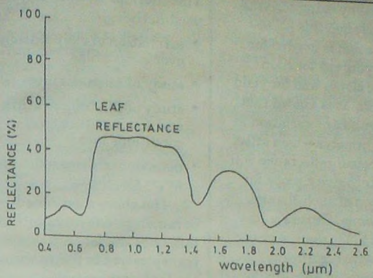

Fig 3a Reflectance spectrum of typical green leaf

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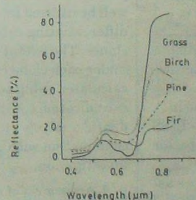

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The extent of area under rubber is a data which is of great importance to both the planner as well as the person concerned with research and development. Although we have data on the total area under rubber, it is difficult to verify its accuracy periodically. The data on area under rubber helps the planner and policy maker to predict the yield in a particular year which in turn helps in deciding important matters like imports and support price etc.. It is also essential to have details of the extent of area under rubber in a given geographic area for monitoring different growth conditions. This estimation of area under rubber can be achieved using satellite data by digital analysis. Digital analysis enables us to analyse each pixel (picture element) so that higher accuracies can be obtained. Normally, the supervised classification will help in area estimation which uses independent information e.g. spectral reflectance to define training - data for establishing classification (Sabins, 1978). To enable supervised classification, it is necessary to do interactive processing with computer, visual interpretation and ground investigation. There was a report by Menon (1991) about the area under rubber in Trissur district of Kerala using supervised classification technique in digital analysis of IRS- LISS I data. For obtraining better image, there are other enhancement techniques as described by Sabins (1978).

3. Identification of different rubber clones:

Identification of different clones and their distribution can better be achieved by using satellite data. As such this information is needed for identifying the location specific clones and for yield statistics. It is known that any significant variation in any parameter which affect the spectral reflectance will definetely give a scope for detection of such change. For examle, Gururaja Rao *et. al.* (1988) showed that there were significant differences in epicuticular wax contents in leaf among some clones they studied viz., GI 1, RRII 308, RRII 105, RRIM 43 and Tjir 1 which led to significant variations in their spectral reflectances recorded by spectro radiometer. Similarly, other parameters with established significannt variations in certain morphological and physiological features may well be utilised in differentiating rubber clones. The extent of area under each clone can be calculated using supervised classification technique in digital analysis in combination with ground investigation.

4. Assessment of moisture status:

Thermal infrared band data pertains to thermal properties of the objects of interest in the environment. This thermal IR data can be used in the

- estimation of evaporation over large areas
- study of microclimate
- study of soil temperature and soil moisture conditions and
- detection of diseased crop areas etc. (Mulders, 1987).

The above mentioned parameters however, influence the leaf transpiration to maintain the leaf temperature at optimum level. These changes in temperature which are influenced by transpiration can be measured by sensors working in middle IR region of EMS. This information gives an idea about the soil moisture status as a whole for further monitoring to maintain optimum moisture conditions.

5. Detection of damage caused by diseases, insect pests and other hazards:

There will be differences between healthy plants and plants acted upon by damage agents like insects, diseases, fire, water deficit, floods and storms etc. with reference to their spectral reflectances. The manifestation of damage may be

- a morphological change like stunted growth, defoliation, loss of branches and wilted look etc.

- a physiological change like decrease in photosynthates, deterioration of chloroplasts etc.
- or both

A morphological change imparts a decrease in reflectance in especially IR region. Whereas the case of physiological change mainfests a shift in green peak towads yellow peak due to deteriotation of chloroplasts and finally a shift towards red region. These changes in spectral reflectance can be detected and quantified with digital image analysis. Reports are available pertaining to damage detection and quantification of the damage caused by different agents. Vogelmann and Rock (1989) used Landsat TM data for detection as well as quantification of damage caused by pear thrips in forests. They had made use of single band data and ratio-based transformations for detection and classification of the extent of damage. Similarly, such detection techniques can be extended to the case of rubber also for the estimation and to know the spread of damage because of outbreak of pests and diseases so that timely control measures can be adopted, using satellite data.

6. Agronomic conditions:

Early reserch work on relationship between spectral reflectance and agronomic conditions had led to the development of transformations or vegetation indices where ratio-based transformation data are related to the vegetation parameteres. Common ratio vegetation indices include green/red index, NIR/VIS index and Normalised Difference Vegetation Index (NDVI = NIR- VIS/NIR + VIS). With the above indices, it is possible to assess agronomic conditions which inturn affect the reflectance properties. Much of the work was done on field crops in which spectral reflectance values were used in assessing crop conditions. Walburg *et. al* (1982) were able to distinguish four levels of N fertilisation in corn. The reflectance differences were related to leaf chlorophyll, leaf total N concentration, LAI and soil percentage cover. Similarly, Hinzman *et. al.* (1986) conducted experiments with winter wheat with three levels of N fertilization. They were able to delineate two extreme levels of N fertilization with spectral reflectance at four

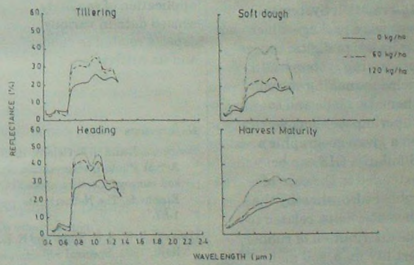

Fig 4 Spectral reflectance of winter Wheat at four stages of development with three levels of N fertilization

Source : Hinzman, L.D. et al. Effects of nitrogen fertilization or growth and reflectance characteristics of winter wheat. 1986. Remote sensing of environment. 19 : 47-61 by permission of the Director, Laboratory for applications of Remote sensing. Purdue University.

different stages of growth namely tillering, heading, soft dough and harvest maturity (Fig. 4). They concluded that near IR reflectance, IR/Red ratio and greenness index performed best for discriminating treatment levels. Perhaps such indices can be developed in case of rubber also to assess the agronomic conditions at varied growth stages which will help in monitoring the optimum growth conditions. This is possible with satellite imagery aided by digital analysis, visual interpretation and ground truth survey.

7. Application of GIS module:

GIS (Geographical Information System) is a soft ware package which can be linked to digital image processing systems. GIS helps in making various thematic maps and to superimpose them vertically on a given geographic area. Similarly, GIS can be extended to the case of rubber also whereby the thematic maps related to the distribution of rubber, fertility map, soil map, agronomic conditions and yield etc. can be generated and can be superimposed vertically to get a comprehensive picture of rubber in one given geogrphic area like one subdivision or a district or at a state level.

Besides the above mentioned major applications, remotely sensed data can be interpreted for patterns of wintering, clonal variations in wintering by using multispectral and multitemporal data. A lot of work is going on with reference to above ground biomass estimations and crop yield modelling by using satellite data. Such works can be taken up in rubber too which can help us in predicting yield under a given set of agronomic conditions. It can be positively concluded that there is a lot of potential for application of remotely sensed data in various aspects related to rubber and its cultivation.

References

Bennema, J. and H. F. Gelens, 1969. Aerial Photo-Interpretation for soil surveys. Lecture notes ITC, Enschede, The Netherlands. pp. 1-87.

Dwivedi, R. S., A. N. Singh and K. K. Raju, 1981. Spectral reflectance of some typical Indian soils as affected by tillage and cover types. J. Phot-int. and remote sensing, Vol. 9(2): 33- 40.

Govardhan, V., 1991. Spectral reflectance characterisation of different soils of Deccan Plateau. J. Indian soc. Remote Sensing, Vol.19(3):175-185.

Gururaja Rao, G., A. S. Devakumar, R. Rajagopal, Y. Annamma, K. R. Vijayakumar and M. R. Sethuraj, 1988.Clonal variations in leaf epicuticular waxes and reflectance: Possible role in drought tolerance. Indian J. Nat. Rubb. Res. Vol. 1(2): 84-87

Hinzman, L.D., M.E.Bauer and C.S.T.Daughtry, 1986. Effects of nitrogen fertilization on growth and reflectance characteristics of winter wheat. Remote Sensing of Enviornment. 19:47-61

Kashiram and D.V.K.Nageswara Rao, 1993. Report on soils of part of Nalgonda district, Andhra Pradesh. Project report submitted to N.R.S.A., Hyderabad on 28-1-93

Menon, A.R.R., 1991. Digital mapping of rubber area using IRS data. Indian J. Nat. Rubb. Res. Vol.4 (1): 68-71

Mulders, M.A., 1987. Remote sensing in Soil science. Elsevier Science Publishing Inc., New York. PP.1-379

N.R.S.A., 1991. Report on land use/land cover: Tripura state. Report published by NRSA, Dept.of Space, Hyderabad

Sabins, F.F.Jr., 1978. Remote sensing. Principles and interpretation. W.H.Freeman and Cy.San Francico.PP.426

Vogelmann, J.E. and Barret N.Rock.,1989. Use of Thematic mapper data for the detection of forest damage caused by the pear thrips. Remote sens.Environ.30:217-225

Walburg, G., Bauer, M.E., Daughtry, C.S.T. and Housley, T.L., 1982. Effects of nitrogen fertilization on the growth, yield and reflectance characteristics of corn. Agron.J.74: 677-683.

CONTACT SHADING OF IMMATURE *HEVEA* PLANTS.

Young plants of rubber when field planted experience photoinjury due to direct exposure to sunlight, specially so after the rainy season. The newly emerged shoot is shaded after the rainy season using plaited coconut leaves or bamboo baskets. In situation where advanced planting materials viz: the ones raised in poly bags, are field planted, there is no need of such artificial shading of the shoot. Brown stem is white washed with lime to protect it from sun scorching. However, these plants also experience partial damage of leaves due to direct exposure to sun light as evidenced by leaf yellowing. This can lead to reduction in growth in spite of moisture availability. Providing of shade using coconut leaves or other materials is costly due to the larger size of the plants. Nevertheless contact shading of the leaves using china clay was found effective in providing shade.

Spray dried clay (china clay) commercially known as Bombay clay can be used as contact shading material. In this method, ten per cent solution of spray dried clay (1 kg spray dried clay in 10 litres of water) is mixed with 3 percent gum arabica solution (commercially available as Dealer Vet). On an average, one year old plant would require 45ml of the solution for each spray. The suspension can be sprayed on leaves and tender portions of the plant. Spraying is done using a Knap sack sprayer. Before spraying,the solution should be mixed thoroughly to get a uniform suspension of the clay particles.

Usually contact shading is done once the post monsoon showers are over. Two rounds of spraying is required for effective shading in a season. Second spraying is done after 45-60 days. The young flush that emerges after the first spraying will be shaded by the second spraying. Spraying has to be done in such a way that a thin uniform sprinkle is given on the entire upper surface of the leaf and tender portion of the stem. Spraying on the lower surface of leaves should be avoided as far as possible. Since the particle size of china clay is very small (<0.1 mm), it provides a close and thin spray on the leaf surface. Care should taken not to spray on the leaf surface. Care should be taken not to spray against the wind direction and when the wind speeds are high. This method is more useful in Karntaka, Goa, Maharashtra and other regions where extreme drought is experienced. In such situations contact shading has to be combined with life saving irrigations. In the traditional rubber growing areas contact shading can be done under rainfed conditions also. Here white washing may be done soon after the cessation of monsoon and the contact shading can be done after the cessation of post monsoon showers also.

Requirement of the materials, labour and cost of spraying

A suspension of 2.5 kg Bombay clay in 25 litres of water mixed with 625 ml dealer vet would be sufficient for spraying 550

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BROWN BAST DISEASE OF RUBBER TREES

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Brown bast disease, indigenously known as 'Pattamarappu', occurs in all the rubber growing countries of the world and is one of the most important diseases adversely affecting the productivity of rubber trees. High yielding clones like RRII 105, PB 311, PB 235, RRIM 600, PB 28/59 etc. are more susceptible to the disease. Complete prevention of the disease or cure still eludes the research seluths.

Symptoms of the disease

One of the earliest symptoms of Brown bast disease in many cases, though not in all, is late dripping of latex. Normally, after tapping a rubber tree, latex flows for a period of one to three hours. A short duration of flow signifies an attenuated yield and a prolonged duration of flow heralds the onset on Brown bast. Reduction in dry rubber contect (d.r.c) of latex also portends the advent of the disease. The inner sides of the bark turn brown and on tapping, latex will not drip from part of the length of tapping cut or the whole length of cut, as the disease advances.

> **NOTE**
>
> Brown bast or Tapping Panel Dryness (TPD) as it is called now, is considered to be a physiological disorder.
>
> The views expressed in the article are the author's own and not necessarily of the Rubber Board. The relationship between the girth of the tree and incidence of TPD is not proved. The preventive/curative measures recommended are also not fully supported by the Board.
>
> – Editor

Splitting of bark and formation of burrs, bulges and other deformations of the tapping panels appear in the advanced stages of the disease. Though initially the symptoms of dryness are restricted to the panel under current tapping, the disease may spread to the opposite panel and even upper panels in later stages.

Causes of the disease

The disease is not considered to be caused by any fungus or other micro-organisms and is deemed as a physiological disease resulting from the inability of the latex vessels to produce latex on tapping. High intensity of tapping like daily or once in two days tapping in the case high yielding clones like RRII 105 is usually one of the main reasons for the incidence of the disease. Deep tapping resulting in severe wounding of the tapping panel also contributes to the incidence of the disease. It usually first appears on trees with the highest girth (within the same clone) giving the largest quantity of latex per tapping. Trees which lose the sun-exposed terminal branches through wind damage just before or after the commencement of tapping also develop Brown bast. Imbalance in mineral nutrition resulting from faulty use of fertilizers can cause very high stability of latex and prolonged duration of its flow after tapping, and this condition leads to the development of Brown bast. In very rare cases, trees fail to give latex at the commencement of tapping or go dry after tapping only for a few days.This baffling observation defies a rational explanation and is usually attributed to genetic factors.

Mechanism of the incidence

It has already been indicated earlier that the cause of Brown bast appears to be the inability of the trees to regenerate the latex, which has been removed in the previous tapping. This inability may be the result of functional or anatomical factors which adversely affect the synthesis of latex or its flow from the latex vessels. The functional factors may result from lack of availability of food materials or essential biochemical or mineral constituents required for the synthesis or flow of latex. The anatomical factors may stem from the nonavailability of biochemical or mineral constituents which may cause a derangement of anatomical or structural integrity of the latex vessels or the adjacent cells. The exact mechanism by which the tree goes dry, however, still remains in the realm of hypothesis and conjecture.

Girth of tree and incidence of disease

Observations made by the author in a large number of estates in India, Malaysia and Indonesia have shown that the incidence of disease is more for trees with relatively larger girth. The larger girth may result from positional advantage of the tree or from favourable interaction between stock and scion if the tree is a budded one. As stated earlier, in any block of tapping trees of the same clone, the earliest symptoms of Brown bast are noticed in trees with the highest girth.

Nonuniformity in growth will favour the incidence of disease. If a high percentage of failure occurs in the establishment of plants in the year of planting itself, there will be a large number of supplies in subsequent years, with the result, that at the time of commencement of tapping, those plants which survived during the year of planting will have attained much higher girth, and such trees will become more susceptible to the disease. It has been observed that, in the case of Brown bast affected trees with higher girths than normal trees in the same tapping block, the length of tapping cut is usually about one third more than the length of tapping cut of normal trees. The longer the tapping cut, the larger number of latex vessels cut and hence greater the yield of latex. Although the output of latex in the case of trees with larger girth is more, the inputs such as water, mineral nutrients, sunlight, food materials and other essential biochemical constituents required for the production and flow of latex may not be higher than those of trees with normal girth. This disparity in outputs and inputs may trigger the mechanism which brings about the onset of Brown bast at higher rate than is the case with trees of normal girth.

Prevention and cure

1. High yielding clones and in particular PB 311, should be planted adopting a minimum spacing of 22 ft x11 ft in hilly terrain and 16 ft x 15 ft in flat areas.
2. Manuring may be done on the basis of soil and leaf analysis.
3. At the time of opening of the trees, those with girth of 25 inches (63.5 cm) or more at a height of 50 inches (127 cm) from bud union may be given a special marking. Such trees

may be tapped using one third spiral tapping or may be tapped on half spiral tapping at shallower depth so that the quantity of latex obtained from such trees is more or less the same as that obtained from trees of normal girth. If yield obtained from one third spiral tapping is much less than that obtained from half spiral tapping of normal trees, occasional stimulation using 2.5 per cent Ethephon could be done by lace application to make up the deficit in yield.

4. High yielding trees like RRII 105, PB 311, PB 235 etc. should be tapped only once in three days. Trees like RRIM 600 and PB 28/59 may also be tapped once in three days at least for the first five years of tapping. Extra or double tapping may be avoided. Rainguarding may be done to get adequate number of tapping days. Alternatively, once in two days tapping may be done without rainguarding but with tapping rest for two months during the rainy season and one month during the peak of summer.

5. Late dripping trees and trees with partial dryness may be given tapping rest for a period of three months to one year, and tapping may be resumed when the trees are found to have recovered on test tapping.

6. Completely dry bark may be tapped off or otherwise removed to facilitate regeneration of good bark. Burrs and bulges could also be chopped off and levelled if the operation is economic, and Bordeaux paste may be applied on the surface thus levelled.

(Continued form 24)

WOUNDING.......

Radhakrishna Pilly, P. N. and George, M. K. 1980. Stem diseases. In: P. N. Radhakrishnan Pilly(ed.) Hand Book of Natural Rubber Production in India. The Rubber Board, Kottayam. pp 281-292.

Rubber Research Institute of India, 1987. Annual Report 1986-87. Rubber Research Institute of India, Kottaym. 100p.

Sethuraj, M. R. 1992. Yield Components in *Heveabrasiliensis*. In: M. R. Sethuraj and N. M. Mathew (eds.) Natural Rubber: Biology, Cultivation and Technology. Elsevier, Amsterdam. p. 137-163.

Steinmann, A. 1925. Deziektenen plagenvan *Hevea brasiliensis* in Ned. India Buitenzorg, Rubber Profestation "West Java".

Thomas, V., Premakumari, D., Reghu C. P., Panikkar, A. O. N. and Saraswathy Amma, C. K. 1994. Anatomical and histochemical aspects of bark regeneration in *Hevea brasiliensis*. Presented at the 81st Indian Science Congress, Jan.3-8, Jaipur.

Wycherley, P. R., Buttery, B. R. and Templeton, J. K. 1962. Trunk snap in *Hevea brasiliensis*. Proceedings of the Sixteenth International Horticultural Congress, Brussels. Vol. 4 pp. 474-480.

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CONTACT.......

plants. The costs of Bombay clay and dealer vet are Rs. 12-50 kg^{-1} and Rs 35-00 kg^{-1} respectively. One men worker can spray 450 plants in a day. One round of spraying would cost Rs.90.50 ha^{-1} cost of Bombay clay and dealer vet are as per the existing market rates.

The advantages of contact shading are:

- the method is very cheap when compared to plaited coconut leaves
- China clay being an inert material, it does not cause any damage to the plant.
- Two rounds of spray will give complete protection to the plants against photoinjury
- It is easy to apply (using a Knap sack sprayer) and does not require any additional labour to remove as it is easily washed off by rains

PINK DISEASE OF RUBBER CAN BE PREVENTED

L. Thankamma, Joseph G. Marattukalam, Annakutty Joseph
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Pink disease caused by the fungus *Corticium salmonicolor* is a major stem disease of the rubber tree in its immaturity phase. This disease affecting the main stem, branching region or the branches may kill the tree partially or as a whole gradually, thereby reducing the productivity of the plantation to a great extent and hence it is considered as one of the serious diseases affecting the rubber tree in India at present. This disease is prevalent in areas where the rainfall is very high.

Eventhough this disease has been noticed on all clones available, this is most serious on high yielding modern clones like RRII 105, RRIM 600 and PB 217.

Historical background

Towards the commencement of this century when rubber plantations came into existence in the country the planting material consisted of seedling populations alone and at that time the occurrence of this disease was only sporadic. This was due to the genetic diversity exhibited by the seedlings. But the situation changed along with the introduction of clones in the place of seed lings. Since a clone is developed from a single mother plant by vegetative multiplication all the progenies exhibit genetic uniformity. This uniformity is being exhibited in the case of susceptibility to diseases also. Along with the development of highly susceptible modern clones like RRII 105 the incidence of the disease appeared on large number of plants. Under highly conducive climatic conditions in disease prone areas a large number of trees in an estate with clone RRII - 105 get infected by the disease. Eventhough the conventional curative method by tracing and treating the infected plants by Bordeaux paste application could very well manage the disease in the early years, at present on a clone like RRII - 105 which is highly susceptible to the disease this conventional method is found to be highly impracticable and hence inadequate. Therefore efforts at evolving a more effective, easy, practicable and cheap method for managing this disease have been under way for the last few years in the RRII. As a result a method of preventing the trees from disease incidence by prophylactic premonsoon Bordeaux paste application from the ground has been evolved. It is always desirable to prevent a disease which is likely to affect a large number of trees in a plantation rather than to control them after infection.

Climatic conditions favouring disease incidence.

High and continuous rainfall, low atmospheric temperature and high relative humidity are favourable for the disease incidence. Once the disease incidence has been noticed in a plantation the disease will spread quickly and kill tree crowns or branches even though the rainfall is not at all continuous but only intermittent. The disease will subside only with the complete cesation of rains during the month of December. Once the causative fungus has established deeper inside the wood, eventhough the fungus will stop further growth, it will remain dormant inside the wood tissues until the onset of favourable climatic conditions during the monsoon next year when suddenly it will get activated and continue further growth until the affected part and the portions above are killed.

When the disease makes its appearance

The disease is normally noticed on rubber plants when they are two years old. Eventhough plants in the age group of two to ten years are usually affected by the disease the severity of the disease is more during the second and third years of growth of the trees. The disease incidence is normally noticed during the months of June and July. The visible symptoms like branch drying and development of necator and corticium stages of the fungus appear usually during the months of September - October after the southwest monsoon. The symptoms of the disease persist until the northeast monsoon months of October - November or even December are over. Though the disease makes its appearance on two year old plants during the months of June or July, on three year old plants the disease may appear even during the month of May owing to the spread of the disease from last year's infected plants and on such plants the necator or corticium stages may appear during June or July itself.

Clonal susceptibility

All clones are susceptible to the disease but the disease incidence is highest on RRII 105, PB 217 and RRIM 600. Clone GT I is relatively tolerant to the disease.

Symptoms

The initial symptom makes its appearance in the form of a white cobweb like mycelial growth on the mainstem, first forking region or on branches on two year old plants. This will be visible only during bright breaks on rainy days. When the surface is wet this will not be clear. This mycelial growth spreads rapidly upwards and downwards alround the affected stem portion and when it penetrates deeper into the bark latex exudation is noticed. When infection advances the lenticels in and around the affected area enlarge and small cushion shaped mycelial clusters appear through them or through bark cracks in lines. These are called pustules. The bark at the infected area rots and once the bark all around the stem rots ringing effect will be caused and owing to the choking of the tissues beneath, side shoot development will be noticed from below and later the whole of the portions above will dry up. In favourable climatic conditions, within one or two months, drying up of the distal portions may take place. Either the whole crown or branches; dead and dried up, with dead brownish leaves still sticking on them and a number of side shoots from below the dead portion of the stem together is a typical symptom of pink disease incidence. Such later symptom of the disease will normally be noticed during the months of Semptember - October when the S.W. Monsoon is over and when there is bright sunshine. On the shaded under- surface of affected branches a thick salmon pink coloured thick crust appears as if painted with pink colour. This develops cracks and this is the Corticuim or basidial stage of the fungus. It is from this salmon pink colour of the basidial stage that the fungus has derived its name *C. salmonicolor*. On such branches, on the lighted upper surface small orange red pustules appear which produce irregularly polygonal celled spores celled necator spores. This is the necator stage of the fungus. The necator spores and the basidiospores produced on the pink crust are highly viable and they, along with mycelial bits on contact with susceptible host part, can very well cause new infections on healthy plants.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

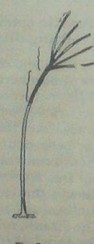

Fig. 5

How the disease can be managed

The new disease management technique by prophylaxis

The Rubber Board has been recommending only curative treatment for pink disease upto 1992. But from 1993 season onwards the Board has started recommending prophylactic Bordeaux paste application before the Monsoon for preventing incidence of the disease.

The new method of preventive Bordeaux application to be carried out on highly disease susceptible clones growing in disease prone areas is described below:

Two year old polybag plants in the field are to be applied with Bordeaux paste as a preventive measure before the continuous rainfall during June - July on days when there is no rainfall. By this prophylactic measure the plants can be protected from the ravages due to pink disease to a great extent. This treatment has to be repeated during the third year also. The method of Bordeaux paste application on two year old plants against pink disease incidence is given below.

1) On plants having no branches

Apply Bordeaux paste on the stem at the portion where brown colour of the bark merges with green colour in a 30 cm wide band all around. (Fig. 1)

2) On plants with branches

Apply Bordeaux paste at the branching region and also at the portion where brown and green bark merge with each other on the leader in 30 cm wide bands

(Fig. 2)

3) On plants with two or more branches of equal importance from the branching region.

Apply Bordeaux paste at the branching region and also at the top most brown portion of all the major branches from the fork (Fig. 3&4)

4) In plants which are not straight and which bend towards one side.

In estates in the neighbourhood of mature rubber trees the plants may grow with a bend away from the trees in search of sunlight. In the case of polybag plants also some of the plants may be bending towards one side due to weight of canopy. In such cases in addition to the usual method of Bordeaux application on the forking region and above, the fungicide has to be applied on the convex surface of the bent portion to an additional 30 cm length downwards. (Fig. 5)

Prophylactic Bordeaux paste application on 3 year old plants

On three year old plants prophylactic Bordeaux application has to be continued on all major forking regions except the lower most one and also on all the leaders at the regions where brown and green portions of the bark merge with each other in 30 cm bands all around (Fig. 5, 6 & 7).

Bordeaux paste application can be done using a long handled brush, as the one being used for the whitewashing of walls, from the ground. Climbing on the trees with or without ladder is not required.

How to prepare Bordeaux paste

Dissolve 1 kg copper sulphate in 5 litres of water. Shake 1 kg of quick lime with a small quantity

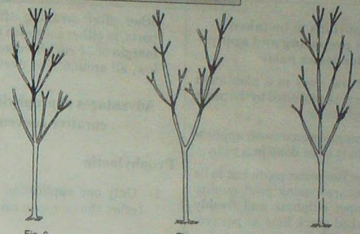

Fig. 6 Fig. 7 Fig. 8

of water and make it upto 5 litres. For dissolving copper sulphate it can be tied loosely in a cloth or a gunny bag and left hanging from a horizontal rod with the chemical just touching the surface of water taken in a suitable vessel and kept as such overnight. Copper sulphate solution has to be slowly added to the lime solution while vigorously stirring the mixture being formed. For prepartion of Bordeaux in earthen ware, wooden or copper vessels are to be used.

No sticker should be added to the Bordeaux paste

When it rains, after Bordeaux paste applied prophylactically on the bark surface has dried up, redistribution of the paste takes place. Owing to reaction with the rain water the active copper ions are liberated which are washed down to form a protective covering on the whole of the bark below the treated area. If an infective propagule of the fungus in the form of a spore or mycelium lands on this it will germinate but will soon get killed owing to the toxicity of the active copper present there.

Bordeaux paste which gets washed down in the rain water will get lodged inside small cracks on the bark surface and in the lenticels. This process will go on throughout the rainy months and as a result the surface of the stem of treated plants will assume a dark brown colour compared to the untreated control. Interestingly the lichen growth common on stem surface of rubber trees will be absent on such treated plants. So this process of continuous downward transportation of copper should go on uninterrupted so that the plant can defend itself against the invasion of *Corticium* attack. In order to prevent the germinating spores from entering the bark should have active copper already present over the whole surface.

But if a sticker has been added to the Bordeaux paste it may hold the fungicide firmly on the treated surface itself, not allowing it to leach down freely, thereby preventing the lower stem portions from aquiring resistance against infection, eventhough that may protect the treated area from infection.

Therefore when Bordeaux paste is being used for preventing pink disease incidence no form of sticker should be mixed with it.

For prophylactic premonsoon Bordeaux paste application on rubber trees for pink disease management the cost involved was Re 0.56 for a two year old plant and Re 1.68 for a three year old one.

Precautions to be taken while preparing and applying Bordeaux paste

1) All the trees in a plantation are to be protected by the paste application.

2) A single premonsoon application is to be done in a year.

3) The Bordeaux paste has to be prepared using good quality copper sulphate and freshly slaked quick lime as per recommendation

4) Containers for Bordeaux preparation should be ear then, copper or woodenware.

5) Paste application has to be done before the onset of continuous rains of south west Monsoon.

6) The bark surface should be dry at the time of application.

7) There should be a minimum of one hour's bright sunshine after application as well as before so that the paste dries up on the treated surface.

8) No scraping should be done before application.

9) No sticker has to be added with the paste.

10) Application has to be done using a long handled brush from the ground. No ladder is required.

11) The treated plants need not be observed during the months of June to September to trace infected plants.

12) During October and November one observation each has to be made so as to trace infected plants and they are to be treated curatively using Bordeaux according to the stage of infection. If in the cobweb stage a single application, if further advanced two application, one before and another after scraping affected parts, in either case with a safe margin of 30 cm above and below, all around. The dead portions if any has to be cut off with a margin of 30 cm and the cut end treated with Bordeaux up to 30 cm length.

Advantages of prophylactic Bordeaux application vis-a-vis curative conventional Bordeaux application

Prophylactic	Therapeutic
1) Only one application done before the monsoon rains.	At least 10 tracings and fungicide applications are to be done at for- tnightly intervals. That means each and every plant in the estate has to be observed 10 times during 6 months. In the case of large estates involving thousands of trees the practical difficulty and expense will be very high. Hence impracticable.
2) Since the operation is done on bright days no intervention due to rain.	Since the operation is to be carried out during rainy months interference by rain likely.
3) Since the operation can be done from the ground the process is quite easy.	Difficult plant protection operation as climbing with or without ladder is essential.
4) No scraping is required.	In most cases scraping and in many cutting of dead branches essential.
5) No technical expertise required. Easy operation requiring no skill at all.	Detecting the disease in its early stage requires expertise and good experience. Only skilled labourers can do.
6) Disease is either much less or scarce. It is very mild.	Disease incidence severe. Repeated infection on the same trees due to extension of previous lessions or reinfection. New infections from last years' treated areas.
7) Total expense for 2nd year and 3rd year paste application is only Rs 2.24.	Total expense for 2nd and 3rd year alone Rs 1.80.
8) Preventive Bordeaux paste application for prophylaxis is comparatively effective and rather easy.	Pink disease treatment is a six month long difficult cultural operation which is the most worrying head- ache for the rubber grower.