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CONTENTS

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MEDICINAL PLANTS IN RUBBER PLANTATIONS IN TRIPURA, NORTH EAST INDIA

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Introduction

India is familiar as the world's botanical garden owing to its floristic diversity and richness. The wide range of altitudes (sea level to over 6,000 m), rainfall (100 m.m. to over 10,000 m.m.), temperature (upto about 49°C) etc. of the country has a conducive environment to the growth of around 15000 species of higher plants. The use of plants as food and medicines are observed by all ethnic groups in our country. The Plant kingdom can provide a variety of drugs to alleviate sufferings due to diseases. The use of plants in curing diseases have been mentioned in our ancient literature. The medical properties of some herbs are recorded in Rigveda (between 3500 and 1800 B C). The properties of medicinal plants have been described elaborately in Ayurveda, Susruta Samhita and Charaka Samhita. In ancient days and even now-a-days, in rural areas, practitioners like hermits and faqirs give a clue to use various plants or plant parts as medicines. Plant-originated drugs have important position in world pharmacopoeias. There is a good market for natural drugs instead of synthetic drugs even in developed countries. Herbal medicines are being used because of better compatibility with the human body, lesser side effects and better cultural acceptability. India occupies a remarkable position in respect of the use of herbal drugs as well as the supply of medicinal plants to developed countries. Maximum number of drugs used in curing human ailments in our country, originate from plant parts and the said drugs are about 1500 out of 2000 drugs used in India (Jain, 1966).

North East India is a rich source of medicinal plants and a large number of plant-originated drugs are being used in this region. The abundance of these plants is due to its varied topography, altitude and climate. This region lies in between the 21°57' and 28°30' N latitudes and 89°46' and 97°30' E longitudes and has an area of 2,55,037 sq. kms. accounting for 8 percent of the total area of the country. Scientists of different disciplines like Botany, Pharmacology, Chemistry, Clinical medicine (both Ayurveda and Modern systems) are studying medicinal plants to utilise these for the benefit of mankind in an integrated and co-ordinated manner. Due to the low availability of many of the medicinal plants, he drugs developed from them are also costly. In this context, the preservation, cultivation, management and proper utilisation of such plants assume great significance.

Medicinal plants in rubber plantations

The North eastern region is an excellent potential non-traditional area for rubber cultivation in this country. At the end of 2003-'04, the extent of rubber cultivation was 53,521 hectares. In Tripura, it was 30,270 hectares. Rubber plantation is an economically viable, sustainable and renewable agro-forestry system which contributes

Table 1

No.	Name of the Plant/Species	Family	Local name
1.	*Adhatoda zeylanica* Medik	Acanthaceae	Basaka
2.	*Ageratum conyzoides* L	Asteraceae	Uchandi
3.	*Alpinia galanga* (L) Wild	Zingiberaceae	Kulanjan
4.	*Alstonia scholaris* (L) R. Br.	Apocynaceae	Chhattim
5.	*Andrographis paniculata* (Burm.f.) Wall ex Nees	Acanthaceae	Kmalmegh, Chirayita
6.	*Azadirachta indica* A Juss	Meliaceae	Nim
7.	*Blechnum orientale* L	Blechnaceae	-
8.	*Centella asiatica* (L.) Urban	Apiaceae	Thankuni, Thunimankuni
9.	*Clerodendron viscosum* Vent.	Verbenaceae	-
10.	*Curculigo orchioides* Gaertn.	Amaryllidaceae	-
11.	*Curcuma zedoaria* Rosc.	Zingiberaceae	Shuit
12.	*Cyperus iria* L	Cyperaceae	-
13.	*Dioscorea pentaphylla* L	Dioscoreaceae	Jhun jhuna lata, Kanta alu
14.	*Dryopteris* sp.	Polypodiaceae	-
15.	*Elephantopus scaber* L	Asteraceae	-
16.	*Eleusine indica* (L.) Gaertn.	Poaceae	-
17.	*Eragrostis uniloides* (Retz.) Nees ex steud	Poaceae	-
18.	*Eupatorium odoratum* L.	Asteraceae	Maricha
19.	*Ficus hispida* L.f.	Moraceae	Dumar Dhaugri
20.	*Holarrhena antidysenterica* (Roth) A.D.C.	Apocynaceae	Kurchi
21.	*Hyptis suaveolens* (L.) piot	Lamiaceae	-
22.	*Ichnocarpus frutescens* (L.) R. Br.	Apocynaceae	Paralia lata
23.	*Lantana camara* L. Var. *aculeata* (L.) Moldenke	Verbenaceae	-
24.	*Leucas aspera Spreng*	Lamiaceae	-
25.	*Litsea glutinosa* (Lour.) C.B. Robinson	Lauraceae	Kukurchik, Garpur
26.	*Lygodium flexuosum* (L.) Sw.	Schizaeaceae	-
27.	*Melastoma malabathricum* L	Melastomaceae	Phutki, Ban Padam
28.	*Microcos paniculata* L.	Tiliaceae	Pichandi -
29.	*Mikania cordata* (Burm.) BL	Asteraceae	-
30.	*Mimosa pudica* L.	Mimosaceae	Chhoitemara, Lajjabati
31.	*Peporomia pellucida* (L.) H.B.K.	Piperaceae	-
32.	*Phyllanthus urinaria* L.	Euphorbiaceae	Hazar mani, Kala jutki
33.	*Piper longum* L	Piperaceae	Pipul
34.	*Plumbago zeylanica* L.	Plumbaginaceae	Chita
35.	*Pteris semipinnata* L.	Pteridaceae	-
36.	*Pteris Vittata* L	Pteridaceae	-
37.	*Rouvolfia serpentina* (L.) Benth. exkurz	Apocynaceae	Chandra, Sarpagandha
38.	*Scoparia dulcis* L.	Scrophulariaceae	Mashla
39.	*Sida acuta* Burn	Malvaceae	Berela
40.	*Smilax zeylanica* L	Smilacaceae	-
41.	*Streblus asper Lour*	Moraceae	-
42.	*Synedrella nudiflora* (L.) Gaertn.	Asteraceae	-
43.	*Zingiber zerumbet* (L.) Smith	Zingiberaceae	-

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8. *Elephantopus scaber* L.

Alongwith luperol and stigmasterol, a new germacranolide dilactone-11,13-dihydrodeoxyelephantopin is obtained from the plant.

9. *Hyptis suaveolens* (L.) Poit

The root of the plant contains oleanolic acid, b-sitosterol and a triterpene-3 b-hydroxylup-12-en-28-oic acid (I) alongwith α-and β-amyrins urs-12-en-3 β-ol-29-oic acid is obtained from aerial parts.

tion and syphilitic ulcerations of the mouth. Leaves and fruits are applied in small-pox and to swelling of the genital organs respectively.

13. *Mimosa pudica* L.

Leaves of the plant are used in treatment of hydrocele (external) and grandular swellings. The docoction of the root can be used in gravel and other urinary problems. A new compound 4-0-(3,5 -dihydroxybenzoic acid) -β-D- glucuronide is isolated from the plant.

14. *Piper longum* L.

It is used as a tonic and in making irritating snuffs, liniments for rheumatic pains and paralysis, chronic bronchitis. The leaves and fruits have antibiotic activity. The powder of the fruit is used for the recovery of the relaxed organs after delivery and ...

No.	Name of the Plant	Family	[illegible]
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5.	*Andrographis paniculata* (Burm f.) Wall ex Nees	[illegible]	
6.	*Azadirachta indica* A. Juss	[illegible]	
7.	*Blechnum orientale* L.	[illegible]	
8.	*Centella asiatica* (L.) Urban	[illegible]	
9.	*Clerodendrum* [illegible] Vent.	[illegible]	
10.	*Curculigo orchioides* Gaertn	[illegible]	
11.	*Curcuma zedoaria* Rosc	[illegible]	
12.	*Cyperus iria* L.	[illegible]	
13.	*Dioscorea pentaphylla* L.	[illegible]	
14.	*Dryopteris* sp.	[illegible]	
15.	*Elephantopus scaber* Linn.	[illegible]	
16.	*Eleusine indica* (L.) [illegible]	[illegible]	
17.	*Eragrostis* [illegible] Nees ex steud	[illegible]	
18.	*Eupatorium odoratum* L.	[illegible]	
19.	*Ficus hispida* L.f.	[illegible]	
20.	*Holarrhena antidysenterica* (Roth) A.D.C.	[illegible]	
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34.	*Plumbago zeylanica* L.	Plumbaginaceae	[illegible]
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36.	*Pteris Vittata* L.	Pteridaceae	
37.	*Rouvolfia serpentina* (L.) Benth. exkurz	Apocynaceae	[illegible]
38.	*Scoparia dulcis* L.	Scrophulariaceae	[illegible]
39.	*Sida acuta* Burm	Malvaceae	[illegible]
40.	*Smilax zeylanica* L.	Smilacaceae	
41.	*Streblus asper* Lour	Moraceae	
42.	*Synedrella nudiflora* (L.) Gaertn.	Asteraceae	
43.	*Zingiber zerumbet* (L.) Smith	Zingiberaceae	

significantly for ecological stability. In the acidic soil in which the rubber tree grows, many species can survive under the tree canopy. In addition to some medicinal herbs, a large number of other plants also grow inside rubber plantations in a normal way. It is not advisable to remove all the plants as clearing of such plants causes soil erosion due to the high rainfall, especially in undulating area and results in washing away of nutrient-rich surface soil. Successful inter-cropping of many commercially important medicinal herbs in the rubber plantation has been possible. Inter-cropping of crops like banana, pineapple, ginger, turmeric, tea, coffee, pepper etc. is a common practice in the initial years of planting.

Rubber Research Institute of India, Kottayam, carried out experiments on inter-cropping of some medicinal herbs in rubber planted areas. Medicinal herbs when well grown inside rubber plantations have yielded medicinal plant parts of economic importance. Moreover, rubber yield data showed no adverse effect of inter-cropping of medicinal herbs (Anonymous, 1992-93). Although revenue generation from this source is possible, the rubber growers of the traditional rubber growing region have not shown interest for commercial inter-cropping of medicinal herbs due to the market trends in that region.

The Regional Research Station of Rubber Research Institute of India, Agartala conducted a survey to identify common plant species in rubber plantations. A list of plants/species including some medicinal plants commonly found in rubber plantations in Tripura is shown in Table 1. It was observed that some tree species were also grown well inside plantation during monsoon months.

Generally the medicinal plants which grow under mature tree canopy are not effectively utilised to produce drugs. This trend should be changed. These plants also provide nutrient rich litter to the plantation. Some valuable contributions of some of the medicinal plants that grow along with rubber are furnished below:

1. *Adhatoda zeylanica* Medik

The main use of the plant is as an expectorant. The juice of the leaves is used in cold, cough, bronchial asthma etc. The leaves can also be used in packing or storing fruits as certain alkaloids present in it can offer protection from fungi and insects. Different parts of the plant contain the following chemical compounds.

Leaves : An alkaloid vasicine and an essential oil.

Root : Sitosterol-β-D-glucoside, galactose, deoxyvasicinone and vasicol

Flower : 2'-hydroxy-4-glucosyloxychalcone.

2. *Ageratum conyzoides* L

The plant parts have the following uses

Leaf : Styptic

Essential oil from leaves : Antifungal, antibacterial.

The stem and leaves of the plant produce a new flavone-5-methoxynobiletin, 7-methoxy-2, 2-dimethyl-3-chromene, ageratochromene, α-pinene, β-caryophyllene, γ-cadinene and eugenol are isolated from essential oil.

3. *Alpinia galanga* (L) Wild

It is used in diabetes, rheumatism, impotence and dyspepsia. It is also used to improve the voice. Rhizome of the plant contains camphoride, galangin and alpinine.

4. *Andrographis paniculata* (Burm.f) Wall. ex Nees

This plant is useful in curing fever, dysentery, weakness, worms and gas formation in stomach. A decoction of the whole plant is used as a cure for burning sensation. It has antityphoid and antibiotic properties. The following chemical compounds are available in different parts of the plant.

Aerial part : 3,14-dideoxyandrographolide, 14-deoxyandrographiside and andrographiside.

Root : 5-hydroxy-7, 8-dimethoxyflavanone(I) etc

The whole plant: Apigenin-7, 4-di-0-methyl ether, ninandrographolide, myristic acid, hentriacontane, carvacrol, eugenol, tritriacontane, neoandrographolide and andrographolide etc.

5. *Curcuma zedoaria* Rose

The root of the plant improves voice. The plant is also used in curing skin disease, Curzerenone, epicurzerenone and isocurzerenone are synthesised from this plant.

6. *Centella asiatica* (L) Urban

The leaves, stems, roots and seeds are used as medicines. The plant contains asiaticoside and the same is used in treatment of leprosy. It has the property of inducing fast growth of skin, hair and nails in animals. The plant is useful in certain kinds of tuberculosis and as a tonic for brain.

7. *Clerodendron viscosum* Vent

Different parts of the plant have following uses.

Leaf and Root: Antitumour, vermifuge, febrifuge, in skin diseases.

Leaf and Flower : Antidote for scorpion-sting.

Sprout : Antidote for snake-bite.

Fumaric acid, ethyl and methyl esters of caffeic acid, α-sitosterol and its glucoside are isolated from flowers of the plant. The roots and leaves are also medicinal.

8. *Elephantopus scaber* L

Alongwith luperol and stigmasterol, a new germacranolide dilactone-11,13-dihydrodeoxyelephantopin is obtained from the plant.

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10. *Lygodium flexuosum* (L.) Sw.

Tryptophan, tryptamine, indole-3-acetic acid, -3-propionic acid, -3-butyric acid and -3-acetonitrile are detected in leaves of the plant.

11. *Melastoma melabaricum* L

The leaf of the plant is used in diarrhoea, dysentery and mucus discharges. Flowers are used in piles and hemorrhage. Fruits give a black dye. A triterpenoid-melastomic acid and also a β-sitosterol are isolated from roots.

12. *Microcos paniculata* L

Decoction of leaves is useful in typhoid fever, indigestion and syphilitic ulcerations of the mouth. Leaves and fruits are applied in small-pox and to swelling of the genital organs respectively.

13. *Mimosa pudica* L

Leaves of the plant are used in treatment of hydrocele (external) and grandular swellings. The decoction of the root can be used in gravel and other urinary problems. A new compound 4-0-(3,5 - dihydroxybenzoic acid) -β-D- glucuronide is isolated from the plant.

14. *Piper longum* L

It is used as a tonic and in making irritating snuffs, liniments for rheumatic pains and paralysis, chronic bronchitis. The leaves and fruits have antibiotic activity. The powder of the fruit is used for the recovery of the relaxed organs after delivery and cleaning the uterus. It acts on liver and spleen, increases appetite and is useful in cough, breathing trouble and indigestion in children. The fruits isolate two new piperidine alkaloids-pipernonaline and piperundecalidine.

15. *Plumbago zeylanica* L

The root of the plant is used as abortifacient. The same is also used for treatment of ulcers, leprosy, enlarged spleen, rheumatism and paralysis.

The plant contains two new quinones - zeylanone & isozeylanone, plumbagin, plumbagic acid, vanillic acid and β-sitosterol. The enzymes protease and invertase, free glucose and fructose alongwith plumbagin were also obtained from root bark.

16. *Rauvolfia serpentina* (L) Benth, ex kurz

It is used as a sedative, hypnotic and for reducing blood pressure. This plant is largely used for the cure of insanity and high blood pressure. The root can be used in curing bowels and fever. The roots contain several alkaloids. Yohimbines synthesised and 7-dehydrositosterol obtained from roots.

17. *Smilax zeylanica* L

Diosgenin is identified in root, leaf and cultured callus tissues. It is used in treatment of venereal diseases, rheumatism, pains and dysentery.

18. *Scoparia dulcis* L

The plant gives friedelin, glutinol, α-amyrin, betulinic, ifflaionic and dulcioic acids. The root of the plant can produce mannitol, coixol and betulinic acid.

19. *Zingiber zerumbet* (L.) Smith

A new compound 3", 4" - 0-diacetylafzelin, zerumbone epoxide, zerumbone and diferuloylmeyhane obtained from rhizome of the plant exhibited cytotoxic activity.

Several of these plants cure ailments and contain valuable chemical compounds, and the cultivation of these assures a good monetary return.

Conclusion

Rubber plantation is an environmentally acceptable and economically viable agroforestry system. In addition to profits from products like rubber, wood, honey, non-edible oil etc. rubber plantations allow growth of beneficial plant species including medicinal plants which can also generate revenue. The rubber plantations in the north eastern region are endowed with a rich diversity of medicinal herbs. There fore, it is suggested that a systematic study be undertaken on the utilisation and marketing of the medicinal plants or plant parts in this region to inspire the rubber growers to take useful steps for inter-cropping of medicinal herbs in rubber plantations.

Acknowledgement

The authors thank Dr. N.K. Chakraborty, Retd. Reader, Dept. of Botany, M.B.B. College, Tripura for rendering help in identification of plants in Rubber Plantations.

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ANATOMICAL STUDIES ON REGENERATED BARK OF HAIL DAMAGED *HEVEA BRASILIENSIS* TREES – A CASE STUDY

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Hailstorms are a regular phenomenon in the North East India during the pre-monsooon period. Though their intensity used to be mild, occurrence of strong hailstorms causing severe damage is not unusual in this region. *Hevea brasiliensis* Muell Arg., the Para rubber tree is reported to suffer extensively under hailstorm damage. An incidence of such a devastating hailstorm was reported from rubber plantations at Agartala, Tripura in 1986 (RRII, 1987). A detailed description of this damage and its consequences were reported by Meenattoor *et.al.*, (1995), which described a yield reduction on regenerated bark, the production being about 36% less than that of the virgin bark. The present study was aimed at investigating the anatomical differences in hail damaged and virgin bark as a possibility of explaining the yield reduction experienced and other anatomical consequences of wound healing process.

A severely damaged clone evaluation trial, planted during 1980 at the Research Farm of the Rubber Research Institute of India at Taranagar, Agartala (91°15'E; 23°53'N; 30m MSL) constituting five clones *viz.*, RRII 105, RRII 118, RRII 203, RRIM 600 and RRIM 605 were selected for the study. The trial was planted in randomised blocks with three replications. Five trees were selected randomly from each clone and bark samples were collected at three different loci both at damaged and normal sides. The bark samples were fixed in Formaldehyde-Acetic acid-Alcohol (FAA) mixture. Sledge microtome sections of 25 µm thick were taken and stained with combination of Safranin-O and Fast green FCF for general histology, tannic acid-ferric chloride for tannins (Johansen, 1940) and Sudan III for latex vessels (Premakumari *et. al.*, 1996). Sections were examined through a projection light microscope for anatomical investigations. Data were analysed statistically.

Analysis of variance revealed that highly significant variation existed between normal and regenerated bark for all characters (table 1). Except for density of tannin filled cells, all other characters showed significant reduction in regenerated bark than normal bark, whereas tannin accumulation was high in regenerated bark. The clone × side affected interaction showed non-significant variation for all clones indicating that they suffered equally of hail damage.

The mean data on number of latex vessel rows (NLVR), density and diameter of latex vessels and density of tannin filled cells are given in table 2. Data on NLVR and density of latex vessels showed no significant variation among clones in virgin bark. However, on regeneration these two traits showed significant variation among clones. In renewed bark, RRIM 605 had the highest average number of 7.93 rows of latex vessels while RRIM 600 recorded the lowest of 6.07 rows. On the contrary, RRIM 600 had more vessels per unit area (56.16/mm) while RRIM 605 recorded the least (44.44/mm). This indicated that response

The plant contains two new quinones - zeylanone & isozeylanone, plumbagin, plumbagic acid, vanillic acid and β-sitosterol. The enzymes protease and invertase, free glucose and fructose alongwith plumbagin were also obtained from root bark.

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ANATOMICAL STUDIES ON REGENERATED BARK OF HAIL DAMAGED *HEVEA BRASILIENSIS* TREES – A CASE STUDY

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Hailstorms are a regular phenomenon in the North East India during the pre-monsooon period. Though their intensity used to be mild, occurrence of strong hailstorms causing severe damage is not unusual in this region. *Hevea brasiliensis* Muell Arg., the Para rubber tree is reported to suffer extensively under hailstorm damage. An incidence of such a devastating hailstorm was reported from rubber plantations at Agartala, Tripura in 1986 (RRII, 1987). A detailed description of this damage and its consequences were reported by Meenattoor *et.al.*, (1995), which described a yield reduction on regenerated bark, the production being about 36% less than that of the virgin bark. The present study was aimed at investigating the anatomical differences in hail damaged and virgin bark as a possibility of explaining the yield reduction experienced and other anatomical consequences of wound healing process.

A severely damaged clone evaluation trial, planted during 1980 at the Research Farm of the Rubber Research Institute of India at Taranagar, Agartala (91°15'E; 23°53'N; 30m MSL) constituting five clones *viz.*, RRII 105, RRII 118, RRII 203, RRIM 600 and RRIM 605 were selected for the study. The trial was planted in randomised blocks with three replications. Five trees were selected randomly from each clone and bark samples were collected at three different loci both at damaged and normal sides. The bark samples were fixed in Formaldehyde-Acetic acid-Alcohol (FAA) mixture. Sledge microtome sections of 25 µm thick were taken and stained with combination of Safranin-O and Fast green FCF for general histology, tannic acid-ferric chloride for tannins (Johansen, 1940) and Sudan III for latex vessels (Premakumari *et. al.*, 1996). Sections were examined through a projection light microscope for anatomical investigations. Data were analysed statistically.

Analysis of variance revealed that highly significant variation existed between normal and regenerated bark for all characters (table 1). Except for density of tannin filled cells, all other characters showed significant reduction in regenerated bark than normal bark, whereas tannin accumulation was high in regenerated bark. The clone × side affected interaction showed non-significant variation for all clones indicating that they suffered equally of hail damage.

The mean data on number of latex vessel rows (NLVR), density and diameter of latex vessels and density of tannin filled cells are given in table 2. Data on NLVR and density of latex vessels showed no significant variation among clones in virgin bark. However, on regeneration these two traits showed significant variation among clones. In renewed bark, RRIM 605 had the highest average number of 7.93 rows of latex vessels while RRIM 600 recorded the lowest of 6.07 rows. On the contrary, RRIM 600 had more vessels per unit area (56.16/mm) while RRIM 605 recorded the least (44.44/mm). This indicated that response to regeneration varied among clones conforming to the earlier study by Meenattoor *et al.*, (1995). Though diameter of latex vessels was found reduced significantly in regenerated bark than virgin bark, no acceptable clonal variation could be observed in either case. Of the three traits, NLVR, density and diameter of latex vessels, NLVR was reported to be the most important parameter in yield determination (Gomez, 1982). Lowest yield recorded for RRIM 600 in the same experimental area by Meenattoor *et al.*, (1995) could be due to low NLVR values recorded by this clone in both virgin and regenerated bark even though it had higher density of latex vessels. Webster and Paardekooper (1989) had reported that density and diameter of latex vessels had little contribution towards yield. In the present case, it was observed that the hailstorm chipped off almost 75% of bark on one side of the tree upto a height of 4-5 m from base leaving intermittent areas of intact virgin bark. This resulted in development of islands of regenerated and virgin bark on the entire affected side. A tapping cut made in this area would cut through virgin and regenerated barks throughout its length. This unusual situation could explain the yield depression observed on affected side.

Tannins are known to be the most important defensive secondary metabolite produced as a result of wounding (Swain, 1965). In the present study, unlike other traits, density of tannin-filled cells had wide variation among clones in virgin and renewed bark. Regenerated bark had more density of tannin-rich cells than virgin bark for all the clones. The abundance observed in renewed bark indicated that wound-healing process could have stimulated tannin production. Similar response on wound healing during normal tapping was reported by Thomas *et al.*, (1995 *b*). Two clones, RRII 105 and RRIM 605 showed relatively higher density for tannin cells both in virgin and renewed bark when compared to other clones indicating their inherent ability of tannin production.

Major difference between hailstorm damage and tapping is the extent of wounding. In tapping, a controlled wound is made leaving a thin inner bark external to cambium (shallow wounding). This residual inner bark is instrumental in healing and completes regeneration process (Thomas *et.al.*, 1995 *b*). Moreover, a distinct time gap between two successive tapping facilities healing process. During hail damage a large area was affected with wounds ranging from shallow to deep (either involving cambium or not), in a single instance (Thomas *et al.*, 1995 a). Deeper wounds often remain partially close exposing wood, due to lack of complete cambial activity. It was also established that speed of recovery is often regulated by the extent of injury (Kramer and Kozlowski, 1979). This was because wounding would damage vascular tissues and thereby interrupting translocation of hormones, which may be necessary for production of new vascular tissues (Aloni, 1995). Therefore wider the damaged area, slower would be the recovery. This was evident from the fact that, even

Table 1. Variation component mean squares for the characters by pooled analysis of variance

Source of Variation	No. of latex vessel rows (per mm)	Density of latex vessels (μm)	Diameter of latex vessels (per mm)	Density of tannin cells
Clone (C)	1.204*	221.335*	5.357	1287.716*
Side (S)	5.368*	1047.134*	218.700*	19423.95*
C x S	o.417	73.414	3.716	222.462
Residual	0.495	36.535	4.953	129.348
Residual df = 18	* Significant at 5% level			

Table 2. Mean values of anatomical traits in virgin and regenerated bark of five clones

Clone	No. of latex vessel rows	Density of latex vessels (per mm)	Diameter of latex vessels (µm)	Density of tannin cells (per mm)
a) Virgin bark				
RRII 105	7.73	56.73	21.34	23.55 a
RRII 203	8.16	55.33	21.80	1.33 b
RRII 118	7.87	69.60	19.68	12.88 b
RRIM 600	7.60	60.27	21.70	32.89 a
RRIM 605	8.20	57.16	19.86	37.33 a
Variance ratio	0.212	1.435	0.543	4.304
SE(d)	ns	ns	ns	10.028
b) Regenerated bark				
RRII 105	7.00 b	35.95 d	15.92	88.89 a
RRII 203	6.93 b	49.73 bc	17.46	59.12 b
RRII 118	7.40 ab	53.73 ab	15.46	54.65 b
RRIM 600	6.07 c	56.16 a	13.62	68.21 b
RRIM 605	7.93 a	44.44 c	14.92	91.56 a
Variance ratio	12.045**	19.373**	1.687	7.212**
SE(d)	0.280	2.593	ns	8.921

** significant at 5% level ns=non-significant

Means followed by same letters are not significantly different at 5% level by LSD test.

though the present study was taken up after eight years of hailstorm damage, affected trees were found not to regain complete anatomical features as far as the lacticiferous system is concerned.

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PURPLE ROOT DISEASE OF *HEVEA*: A REPORT FROM MEGHALAYA

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The para rubber, *Hevea brasiliensis* Muell. Arg. is the most important commercial source of natural rubber. It was the native of Amazon river basin of South America. In India it has been grown traditionally in Kerala and its adjoining states. Although the N.E. region of India lies far outside the traditional rubber growing belt, the agroclimatic conditions prevailing there permits cultivation of rubber. One of the constraints for rubber cultivation in this area is the non-availability of planting materials. For obtaining better quality planting materials as well as for the development of rubber plantations in this region, a seedling nursery has been established at District Development Centre, Jenggitchakgre, Tura, Meghalaya.

Though the crop losses due to various diseases in rubber plantations are considerable, timely adoption of plant protection measures may ensure healthy growth and satisfactory yield. The purple root disease caused by *Helicobasidium compactum* Boedijin has been considered as an important plant disease and was reported from many parts of the world. The fungus is having a wide range of host plants and was reported for the first time on rubber by Snowden (1921). In India, Rajalakshmy and Joseph (1994) first reported the incidence of purple root disease on rubbr from Kerala. As no scientific reports on the incidence of purple root disease on rubber is available from the northeastern India, a survey has been conducted in different rubber growing areas under West Garo Hills district of Meghalaya and the results are reported here.

Fig.1. Infected seedlings in the nursery: dead leaves still attached to the plants

Symptoms

The occurrence of purple root disease was first noted during November and December, 1998 in one and two year old seedling nursery at District Development Centre, Jenggitchakgre, which is located about 13 km away from Tura (Lat. 25°-26° N; Long. 90°-91°E Altitude 400 m MSL). The pathogen infected the seedlings and the symptoms appeared when the lower portion of the stem started to become brown. Interestingly, no sign of infection was noticed in still younger seedlings when the stump was green and immature. The infection led to yellowing of leaves which gradually dried off; but the dried leaves did not fall off from the plant (Fig 1). The tap root of the infected seedlings decayed and the bark at the distal end of the roots peeled off easily when the seedling were pulled out (Fig 2). With the advancement of the infection, a purple coloured fruiting body was formed encircling the collar region of the infected seedlings and finally the whole plant died off. The fruiting bodies were generally very soft, spongy and 2-8 mm in thickness. Rajalakshmy and Joseph (1994) reported that under severe conditions the whole root system was prone to the attack of the pathogen, finally causing the death of the plant. The extent of infection in the nursery based on actual count of the infected plants and the total plants raised in the nursery are given in table 1. It was observed that during 1998, the infection recorded was 7.8%, while in the succeeding year it was 5.6% only. To check the disease, an experiment was conducted at the nursery site where disease intensity was very high. Two fungicides namely carbendezim (Bavistin) and mancozeb (Indofil M-45) were sprayed, separately and in combination, to evaluate the effectiveness of the fungicides. Five treatment combinations have been tested with five replications each. The treatments were: T1=Control; T2= Bavistin @0.1%; T3=Indofil M45@0.75%; T4=Bavistin

Table 1. Incidence of purple root disease in the seedling nursery

Year	Total no. of seedlings	Total no. of plants infected	Percentage of infection
1998	1,27,000	9,906	7.8
1999	1,07,000	6,000	5.6

Fig.2. (A) Infected seedlings with fruiting body and peeling off bark of roots (B) Healthy seedlings

@0.1% alternate with Indofil M45@ 0.75% and T5= Bavistin 0.05% + Indofil M45@ 0.37%. Four rounds of spraying had been done at weekly interval in the nursery beds before sowing the seeds. It was observed that Bavistin (T2) was found better and more effective as compared to Indofil M-45.

The causal organism was isolated from the infected root samples and maintained on potato dextrose agar medium. Based on the morphological and culture characters, the fungus was identified as *Helicobasidium compactum*.

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FORM IV

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VERMICOMPOST FROM RUBBER LEAF LITTER AND WOOD SAW DUST: A NEW AREA OF IMPORTANCE

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Generally, the vermicompost is prepared from waste materials like green waste, vegetable waste, leaf litter, saw dust, sugarcane trash, processed food waste, municipality waste, rice, wheat and millet straws etc. Accumulation of these wastes causes pollution and poses a threat to the environment. Vermicomposting is one of the biotechnologies to accomplish the conversion of waste into valuable manure which can supply adequate quantity of nutrients to the plant kingdom and simultaneously can reduce enviromental pollution. Earthworms involved in the vermicomposting decompose complex waste matter into simpler form. The value of original waste is upgraded to a reusable material. Vermicompost is a renewable source to supplement chemical fertilizers and is prepared by a low-cost technology.

A rubber tree is an eco-friendly tree and the biomass of *Hevea* tree is comparable to any fast growing tropical perennial tree (Corley, 1983). The tree is deciduous in nature and a sizeable quantity of leaf litter is accumulated every year in each plantation. Now-a-days, the rubber wood is used as a source of timber which has decreased the logging pressure on natural forests. A good quantity of saw dust is also generated in wood processing units and a part of the saw dust is being used as a fuel and the rest is accumulated around the saw mills. Both these wastes—rubber leaf litter and wood saw dust are good substrates for vermiculture and vermicompost can effectively be prepared from these sources by suitable earthworm species.

Vermicompost, in general, is rich in different macro & micro nutrients, growth regulator substances, some vitamins and other useful substances which are responsible for plant growth. Different ingredients locked up in the organic matter were mobilized into nutrient forms available to plants, the casts, during passage of the plant material through the gut of the earthworms (Chaudhury *et al.*, 2001). Indian farmers get excellent results in the production of different crops on application of vermicompost. Addition of vermicompost/presence of earthworms in soil improves its physical properties like water-holding capacity, porosity, infiltration, soil aggregation etc. and chemical properties like available nutrient content, organic carbon content, pH etc. and consequently the plant growth on such soil is accelerated. Certain metabolites produced by earthworms are responsible for stimulating plant growth. Growth promoters like cytokinins and auxins may be present in the cast. Earthworm, a friend of the farmer, improves the physical, chemical and biological properties of the soil by their general activities like burrowing, feeding, digesting and acts like the microorganisms in decomposing. The egg masses of the earthworms in the vermicompost increase the earthworm population. The earthworm enhances the microbial decomposition activity too. On addition of vermicompost, it was noticed the grain and straw yields of rice increased and also the soil properties like bulk density, organic carbon content, CEC and soil fertility status improved (Kumaraswamy, 2000). In general, the nutrient status of a waste is improved during vermicomposting and the values of different nutrients of the vermicompost are available in literature. The nutrient level of vermicompost depends on the nature of the organic waste, the food source for earthworm (Chaudhury *et al.*, 2000). The vermiculture substrate and earthworm species are the contributing factors for the physical and chemical characteristics of a vermicompost. Earthworms involved in vermiculture should be disease tolerant and an efficient converter of organic material and should have faster growth & high fecundity rate, easy adaptability to environmental factors, high consumption, digestion & assimilation rate, least vermistabilisation time and more effective cultural techniques. It is also a vital point to select the suitable earthworm species for vermiculture. *Eudrilus engeniae, Eisenia fetida* and *Perionyx excavatus* are generally used for this purpose. Any degradable waste may be suitable as vermiculture substrate for a specific earthworm species.

A rubber plantation is a sustainable, renewable agroforestry system, economically high yielding and compatible with nature (Pal & Dey, 2000). The soil and microclimate under rubber plantation is favourable for growth of different types of plant species and the rubber plantation does not change the organic nature of the area (Chakraborty *et al.*, 2001). The plantation soils contain a large number of earthworms, actinomycetes, bacteria and fungi and there are no root exudates from rubber tree or any by-product of the leaf litter decomposition which are not friendly to the soil macro and micro fauna (Jacob, 2000). In the context of vermicomposting of rubber leaf litter, it is necessary to mention that the leaves of the rubber tree are trifoliate with long stalks and the petioles with extrafloral nectaries in the region of insertion of the leaflets. The rubber tree exhibits normal leaf fall known as wintering. The defoliation is followed by refoliation and the wintering pattern is varied in different rubber clones. The wintering in traditional regions in India is reported to start during December and continue up to January. However, defoliation is little delayed in non-traditional regions. The annual litter addition in rubber plantaion is about 7 tons/hectare (Jacob, 2000). A huge quantity of leaf litter is accumulated in each plantation every year. The rate of decomposition of rubber leaf litter is faster because the rate of litter accumulation on the floor of a rubber plantation is less than many native ecosystems and monoculture plantations such as teak etc. although there is a comparable or even higher standing biomass in a mature rubber plantation (Jacbob, 2000). Vermicomposting of rubber leaf litter shows that this litter is a good vermiculture substrate in which earthworm can perform their activity efficiently. A laboratory experiment was conducted with earthworms on rubber leaf litter. The study revealed that the rate of biomass increase in rubber leaves was more in *Eudrilus eugeniae* than in *Eisenia fetida* and this in turn, was more than that in *Perionyx excavatus* and the suitability of the species on the vermiculture substrate of rubber leaf litter was in the order *Eudrilus eugeniae*> *Eisenia fetida*>*Perionyx excavatus* (Chaudhury *et al.*, 2001). They also reported the following nutrient status along with pH and ash content of rubber leaf litter as shown in Table 1.

Several research workers reported chemical changes during vermicomposting of different wastes. As rubber leaf litter is a good vermiculture substrate, suitable chemical changes during vermicomposting of leaf litter can be expected.

Generally, after the expiry of economic life period, the rubber tree is cut down and replanted to generate more profit. Rubber plantation is a good source of timber of commercial value now-a-days. The finishing adaptability and working quality of rubber wood is comparable even with teak wood. The processed rubber wood is being utilized in making furniture, panelling, flooring, household articles etc. and the present production of rubber wood per ha is 150 and 180 m^3 in small holdings and estates respectively (Rubber Board, 2001). So it is expected that large quantity saw dust is being generated in wood processing units. Rubber wood industry can produce about 70,000 t saw dust (Mathew *et al*, 2000). The accumulated rubber wood saw dust can be utilized for production of vermicompost. Scientists of Rubber Research Institute of India have been working in the field of vermicomposting for utilization of rubber wood saw dust by using the detritivorous earthworms. The vermicompost obtained from this source is as good as vermicompost from leaf litter.

Table 1: Nutrient status of rubber leaf litter

Parameter	Value
pH	7.51 ± 0.04
Carbon (%)	52.68 ± 0.38
Total nitrogen (%)	2.31 ± 0.013
C/N ratio	22.75 ± 0.057
Total phosphorus (mg/100 gm)	114.51± 4.82
Total potassium (mg/100 gm)	835.6 ± 28.79
Ash content (%)	9.92 ± 0.907

Nowadays, people are aware that the large use of inorganic fertilizers has detrimental effects on the quality of agricultural or farm produces and also the same is responsible for declining soil health. Moreover, it is more costly. Vermicompost is cost effective and is free of chemical or biological pollutants. In this context, the utilization of vermicompost deserves more attention since organic farming is gaining importance.

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Distribution of Rubber Goods Manufacturers According to their Total Consumption of Rubber During 2004-2005

Consumption Group	No.of Manufacturers	Consumption (Tonnes)			
		Natural Rubber	Synthetic Rubber	Reclaimed Rubber	Total
A	1,868	12,603	3,501	713	16817
B	1,822	67,846	16,542	4,363	88,751
C	621	43,496	11,421	4,929	59,846
D	381	95,318	40,949	21,433	1,57,700
E	46	25,267	5,059	2,500	32,826
F	62	5,10,875	1,47,178	39,122	6,97,175
Total	**4,800**	**7,55,405**	**2,24,650**	**73,060**	**10,53,115**

(Rubber Statistical News - February 2006)

WIND DAMAGE IN RUBBER PLANTATIONS AND A FEW SUGGESTIONS FOR RISK REDUCTION

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Wind is an essential part of environment and has useful and harmful effects on plants. Air movement increases transpiration by decreasing the boundary layer resistance of leaves and increases the CO_2 supply for photosynthesis and helps in lowering the temperature simultaneously. The response to wind was also particular to different species in the photosynthetic performance (Clark *et al*, 2000). Wind is an important factor having tremendous influence on the performance of rubber plantations. Sometimes wind increases transpiration too much so that it causes water deficit and this decreases turgor pressure, which is a crucial factor for latex flow of *Hevea*.

Strong wind causes damage to almost all kinds of plantations, but such damages are of exceptional severity in case of *Hevea* plantations. Frequent gales can cause considerable damage to plantations by way of branch snap, trunk snap, uprooting etc. Morphological and anatomical deformations are usually associated with high wind velocities. High wind often causes severe damage to *Hevea* plants. The damage varies with age of the tree and nature of the wind. In general, the young plants in seasonal wind lashed area become very much stunt, leaning or shows stem bending or even sometimes twisting. Such plants require corrective pruning and propping, failing which the infected trunk or the branch becomes susceptible to wind damage. Crack develops on the trunk due to twisting of the tree or branch and tapping panel dryness develops later. Besides, the morphological and anatomical deformations due to high wind velocity, excessive cold and dry winds affect physiological processes. Plantations developed in windy locations show deformation in their canopies and show asymmetric structures in which the branches appear to be swept to the leeward side (Grace, 1977). In valleys where the wind direction is often upslope in the day and down slope in the night due to cold air drainage, flagging can be seen in the direction of the night wind (Vijaykumar *et al*, 2000).

In mature *Hevea* plantations, the damage may be uprooting, trunk snap or branch break etc. Uprooting is particularly prevalent on shallow soils mostly near vacant places or when the soil has been softened by rain prior to high wind. Wind damage is also high in elevated areas. Tall trees with unbalanced branches, heavy canopy and extra weight due to water carried on the leaves after raining coupled with poorer girth becomes more susceptible to wind damage.

Generally young plants with heavy canopy show more tendencies towards stem bending and hence require corrective pruning and propping. Susceptibility to

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Distribution of Rubber Goods Manufacturers According to their Total Consumption of Rubber During 2004-2005

Consumption Group	No.of Manufacturers	Consumption (Tonnes)			
		Natural Rubber	Synthetic Rubber	Reclaimed Rubber	Total
A	1,868	12,603	3,501	713	16817
B	1,822	67,846	16,542	4,363	88,751
C	621	43,496	11,421	4,929	59,846
D	381	95,318	40,949	21,433	1,57,700
E	46	25,267	5,059	2,500	32,826
F	62	5,10,875	1,47,178	39,122	6,97,175
Total	**4,800**	**7,55,405**	**2,24,650**	**73,060**	**10,53,115**

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WIND DAMAGE IN RUBBER PLANTATIONS AND A FEW SUGGESTIONS FOR RISK REDUCTION

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Wind is an essential part of environment and has useful and harmful effects on plants. Air movement increases transpiration by decreasing the boundary layer resistance of leaves and increases the CO_2 supply for photosynthesis and helps in lowering the temperature simultaneously. The response to wind was also particular to different species in the photosynthetic performance (Clark *et al*, 2000). Wind is an important factor having tremendous influence on the performance of rubber plantations. Sometimes wind increases transpiration too much so that it causes water deficit and this decreases turgor pressure, which is a crucial factor for latex flow of *Hevea*.

Strong wind causes damage to almost all kinds of plantations, but such damages are of exceptional severity in case of *Hevea* plantations. Frequent gales can cause considerable damage to plantations by way of branch snap, trunk snap, uprooting etc. Morphological and anatomical deformations are usually associated with high wind velocities. High wind often causes severe damage to *Hevea* plants. The damage varies with age of the tree and nature of the wind. In general, the young plants in seasonal wind lashed area become very much stunt, leaning or shows stem bending or even sometimes twisting. Such plants require corrective pruning and propping, failing which the infected trunk or the branch becomes susceptible to wind damage. Crack develops on the trunk due to twisting of the tree or branch and tapping panel dryness develops later. Besides, the morphological and anatomical deformations due to high wind velocity, excessive cold and dry winds affect physiological processes. Plantations developed in windy locations show deformation in their canopies and show asymmetric structures in which the branches appear to be swept to the leeward side (Grace, 1977). In valleys where the wind direction is often upslope in the day and down slope in the night due to cold air drainage, flagging can be seen in the direction of the night wind (Vijaykumar *et al*, 2000).

In mature *Hevea* plantations, the damage may be uprooting, trunk snap or branch break etc. Uprooting is particularly prevalent on shallow soils mostly near vacant places or when the soil has been softened by rain prior to high wind. Wind damage is also high in elevated areas. Tall trees with unbalanced branches, heavy canopy and extra weight due to water carried on the leaves after raining coupled with poorer girth becomes more susceptible to wind damage.

Generally young plants with heavy canopy show more tendencies towards stem bending and hence require corrective pruning and propping. Susceptibility to wind damage is greatest at the time of maximum girthing and canopy development. Trees with narrow crotches are more prone to wind damage (Dijkman, 1951). A report from China reveals that an annual mean wind velocity below 1 m per second has a healthy effect on the growth of rubber tree. A velocity range of 1.0 to 1.9 m per second has no effect on growth, but with the increase in wind velocity from 2.0 to 2.9 m per second, both growth and latex flow are affected. At a velocity of above 3 m per second, growth and latex flow are severely inhibited. Crinkling and laceration of young leaves occur when there is a strong wind having a velocity of 8 to 14 m per second. The damage is further aggravated when the strong wind gets associated with cold wave. At a wind velocity beyond 17 m per second, trunks and branches of wind susceptible clones snap. When the wind speed goes beyond 24 m per second, most of the rubber trees are uprooted. However, the susceptibility to wind damage varies from clone to clone (Huang Zongdao and Zheng Xueqin, 1983).

Tree losses in the early year of tapping

The rubber trees, which have been opened for tapping, have reduced rate of girthing, which sometimes is not compensated by proportionate reduction in crown growth. This condition is more pronounced in some clones like RRIM 501 making the tree more susceptible to wind damage (Rajalakshmy & Jayarathnam, 2000). Some clones like PB 86, PR 107, PB 5/51 & GT 1 are reported to be wind fast (Rubber Board, 2001). Wind damage is observed in rubber plants of all age groups. Young plants in exposed and wind lashed areas become very much stunted in growth. The leaves of plants in such areas are found to be lacerated and crinkled and the crown becomes sparse and open. Branch snap is a phenomenon common in clone like PB 5/63, RRIM 605, RRIM 607 & Tjir 1. Trunk snap is the most serious form of wind damage in rubber plantations. Such breakage can happen in any part of the tree and in case of such breakage in the tapping panel, the damage is irreparable. Clones susceptible to wind damage are RRIM 501, RRIM 605, Tjir 1 and RRIM 623 (Rajalakshmy & Jayarathnam, 2000).

Effect of tree structure and wind strength on wind damage

The effect of tree structure and wind damage have been mostly studied on conifer species. But this type of species's are characterized by tall and a dominant straight trunk. But the tree structure of rubber tree (*Hevea brasiliensis*) is not the same and as such the inferences drawn from the aforesaid studies cannot be compared with that of rubber plantations. The latter is markedly different as the trunk gives way mostly very early in life to different competing branches and hence the tree behaviour gets modified due to the swaying of these side branches. (Clement Demange *et al*, 1995). Researches in Ivory Coast found no relation between torsion couples (resistance to twist) and wood density (Institute de Resherches Sarle Caoutehouc en Afrigue, 1976). The wood density was a clonal character related to the age of the tree and to wind damage (Watson, 1989). Faulty crown development in some wind susceptible clones leaves the tree at the disposal of wind and in such cases the trees are damaged by strong wind. However corrective pruning at the early age may be advised as this can lessen the extent of damage. (Rubber Research Institute of Malaya, 1967).

Types of damage in rubber plantations

Usually tall trees with heavy crowns are affected by wind. The intensity is more pronounced near vacant patches within a stand and is severe during the rainy days. The initiation of tapping of rubber trees causes a reduction in the rate of girthing. But this reduction in girthing is sometimes not compensated by the proportionate reduction of the crown growth. Such a condition, as has been observed in case of clones like RRIM 501, makes the tree more susceptible to wind damage (Rajalakshmy & Jayarathnam, 2000). Trees with a heavy main branch and with branches arising at narrow angles from the main stem becomes more susceptible to wind damage.

i) Complete uprooting of plants: Complete uprooting of plants occurs due to the improper development of the tap root. The effect of soil type and before planting tillage are important with regard to the susceptibility to uprooting. On water logged soils or soils with a lateritic pan close to the surface of the typical tap root of *Hevea*, uprooting is generally prominent from about 8 to 9 years onwards. This particularly happens once the aerial part of trees has acquired certain mass while the tap root typical of *Hevea* becomes unable to anchor itself to a sufficient extent (Hegden, 1998).

ii) Breaking of main trunk/ trunk snap: This happens due to weak points arising out of insect attack, holes, inherent wood characteristics of the clone and defects developed due to belated and improper pruning. Besides the above, trunk bending in the direction of the prevailing wind is common in rubber plantations. This is compensated by the development of the `windward' branches which acts as a counter weight. In case of clones like Avros 2037, it is highly susceptible to trunk bending but it has also gained reputation of being snap resistant. (Clement Demange *et al*, 1995). But in case of clones like PB 311, where the breakage occurs in the tapping panel region, the damage is irreparable (Hegden, 1998). Other clones like RRIM 501, RRIM 603, RRIM 605, RRIM 614 and RRIM 623 are reported to be susceptible to trunk snap (Hegden, 1998).

iii) Branch breakage/snap: This phenomenon is particularly observed in case of clones like RRIM 600, where the breakage occurs at the fork in between the trunk and a branch or between two branches (Clement Demange et al., 1995). However, this is rare in plantations having plants with well balanced canopy and phyllotaxy of branches in a spiral form. In case where the main trunk is straight, and have more vigour and dominance than the side branches, the occurrence of branch snap is less. Probably due to some morphological reasons, the occurrence of forked branching between two elements of similar size as that of branch and trunk or branch and branch at an angle of 30° to 60° is most clearly related to wind damage (Clement Demange *et al*, 1995).

iv) Slanting of trees: Slanting of trees due to wind are of common occurrence. This causes damage to the root system and results in loss of yield. The plantations suffer major losses due to unbalanced canopy and improper root anchorage.

Prevention of risks in rubber plantations:

The following preventive measures can be taken to reduce the wind damage in rubber plantations in wind prone areas.

a) Use of shelter belts to prevent wind damage: The shelter belt is a porous tree barrier that decreases the wind velocity on the leeward side of the barrier by deflecting or by shifting it through. The principal effect of the shelter is to alter the pattern of mean wind velocity and turbulence. Shelter can also change the radiation and energy balance of crops both in lee and for a short distance to wind ward. Air, soil temperature, humidity and CO_2 concentrations can all be altered by a shelter. Planting of fast-growing trees on the borders to form a windbreak is one of the measures to mitigate the adverse effect of wind on young plants. Wind speed decreases to a minimum at some distance behind a shelter belt depending on species and height of the shelter belt. Usually a shelter belt that is moderately permeable to wind provides the best shelter. The species considered must be able to grow under the given site conditions and grow quickly, have nitrogen fixing ability and firm crowns to be able to break the wind or reduce wind speed. The main trees in the wind belt should be fast growing and wind-resistant like *Eucalyptus* species. Secondary tree should be with good shape tolerance at juvenile stage such as *Acacia confusa*, *Homelium hainanensis* and *Michelia macclurei* (Huang and Zheng, 1983). For undergrowth trees, oil producing woody plants should be used e.g. *Camellina oleifera*.

b) Planting of wind fast clones: Clones like PB 86, PR 107, PB 5/51 and GT 1 are reported to be wind fast (Rubber Board, 2002).

c) Higher girth opening: Opening for tapping at a higher girth than standard girth may be wind fast.

d) Pruning: Unbalanced branches, heavy canopy and extra weight due to water carried on leaves after rain add to the tree being top heavy and having high turning movement around the trunk (Rajalakshmy and Jayarathnam, 2000). Early selective pruning of heavy lateral branches to reduce crown weight also help in preventing wind damage.

e) High density planting: Higher density of plants may be maintained for less wind susceptible canopies. Crown contact with neighbouring trees makes a contribution to resistance to wind forces and this can be particularly observed in trees grown close together. In China, the tree densities are increased from 375 to 630 tree/ha to provide mutual shelter and thinner and less wind susceptible canopies (Watson,1989).

f) Inter cropping: Growing of an inter crop like banana also reduces the damage to young plants to strong wind (Rajalakshmy and Jayarathnam, 2000).

g) Application of balanced fertilizer: Excess fertilizer application should be avoided. Some clones respond positively by vegetative growth due to nitrogenous fertilizers. Such plants even though show a greater biomass are very much prone to suffer wind damage in rainy season. Hence, to avoid application of excessive fertilizer, soil and leaf should be tested to find the optimal value of fertilizer to be added.

h) Better rooting: Sowing seeds and budding the seedlings in the field in order to obtain a tap root as deep as possible is advisable in some areas. When budded stumps are planted, plants with a healthy and straight tap root should be selected for planting. In case of polybag plants, the tap root is to be examined carefully, removing the bent/coils if any, with least disturbance to the soil core, and planted in the pit only thereafter. In case a hard lateritic stoney layer is noticed at the recommended depth of 75 cm, the depth of the pit may be increased, and in such a case the bottom of the pit should be made tapering like that of a bucket, so as to provide a congenial soil condition for the proper downward growth of the tap root (Hegden, 1988). Generally no plant is uprooted which has a well developed, strong and deep penetrated tap root with properly developed laterals.

In Malaysia, it is reported that when the trees are opened at a girth higher than the standard girth, they seemed to be wind fast (Watson, 1989). After reaching five years of age, tapping increases vulnerability (i.e. decreases threshold wind speed) upto an age of 9-10 years and then vulnerability decreases slowly as the height increment changes relatively more than the breast height girth increment. Some vulnerability related parameters would have to be observed in rubber plantations along with the intensity of tapping as monitoring of such parameters could become a useful tool in selection criteria for breeding. But while recommending such measures to estate managements, the economic impact of modified management, for example, a lower tapping intensity, the profit factor should be kept in mind. In spite of the adoption of sev-

Table: 1 - The mean wind velocity (km hr^{-1}) of different rubber growing areas of West Coast of India

Month	Dapchari Latit 20°04'N Long 72°04' E Altitude 48 m (4)	Nettana Latit 12°45'N Long 75°32' E Altitude 110 m (1)	Padiyoor Latit 11°58' N Long 75°40' E Altitude 20 m (1)	Kottayam Latit 09°32' N Long 76°36' E Altitude 73 m (4)	Chethackal Latit 09°22' N Long 76°50' E Altitude 80 m (3)
January	3.50	1.70	2.00	1.40	2.00
February	1.02	1.10	2.40	1.72	1.60
March	1.37	1.35	2.90	1.97	1.10
April	1.33	1.20	2.40	1.70	0.86
May	2.35	0.50	2.20	1.52	0.90
June	2.30	1.50	1.35	1.30	1.35
July	1.97	2.40	1.90	1.42	1.85
August	1.50	0.90	0.70	1.52	1.30
September	0.71	0.33	1.30	1.47	1.10
October	0.42	0.90	1.40	1.22	0.95
November	0.59	NA	1.40	0.97	2.36
December	0.71	NA	1.60	0.95	1.06

NA - Not Available

Figure in parenthesis is the average of number of years.

eral techniques, there can occur instances of wind damage which are beyond human control. If a super cyclone blows on, as in the case of Orissa in some years, there are few techniques left to save the plantations. It is suggested to refrain from *Hevea* cultivation in extreme cyclone prone areas. The crucial factors affecting tree behaviour are the tree mass, the effective canopy drag areas, the height of the center of pressure, stem stiffness and anchorage of the root in soil. Mean wind velocity or frequent gales in windiness has a tendency to increase near the coast and at higher elevations. (Vijaykumar *et al.*, 2000). Calculating the mean wind speed at which a tree will break or be uprooted gives a probable assessment of the risk at a particular station. The mean wind velocity of different rubber cultivation areas in the West Coast and East & North East locations are presented in the Table 1 & 2. It is observed that the wind velocity is not a major factor in West Coast. However, high winds were prevalent in a few locations of East & North East in different seasons. A general survey of the plantation areas with the probable magnitude of effect and risk in particular zone needs to be conducted for assessment, prior to planting. For this, a study on wind magnitude and frequencies, soil characteristics, topography, cultural techniques, clones as well as the riskier time and evaluation of tree vulnerability is essential. By adopting a single method, the wind damage cannot be prevented. However, multiple methods may be adopted to reduce the wind

Table: 2 - The wind velocity (km h^{-1}) of different rubber growing areas of East & North East India

Month	Location					
	Dhenkanal Latit 20°49′ N Long 85°30′ E Altitude 100 m (1)	Agartala Latit 23°53′N Long 91°15′ E Altitude 20 m (3)	Kolasib Latit 24°13′ N Long 92°41′ E Altitude 150 m (1)	Tura Latit 25°31′ N Long 90°14′ E Altitude 600 m (3)	Guwahati Latit 26°35′ N Long 90°52′ E Altitude 105 m (3)	Nagrakatta Latit 28°54′ N Long 88°25′ E Altitude 229 m (3)
January	NA	1.46	6.50	1.30	3.95	3.05
February	0.60	1.73	7.10	2.00	3.20	1.60
March	0.50	3.60	7.20	2.80	3.35	1.30
April	0.80	5.16	7.50	3.13	2.90	0.70
May	1.00	4.53	4.00	2.53	2.16	0.96
June	1.20	6.00	2.30	2.50	1.56	1.60
July	2.20	5.06	3.20	1.86	1.33	0.83
August	1.55	4.63	2.15	1.60	1.36	1.75
September	1.10	2.86	3.00	1.33	1.30	1.36
October	0.40	1.63	1.80	1.70	1.73	0.90
November	0.10	1.00	3.30	1.13	1.93	0.76
December	0.10	0.86	3.15	1.43	1.93	1.10

NA - Not Available

Figure in parenthesis is the average of number of years.

damage risk and the economic loss.

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MULCHING - A BENEFICIAL CULTURAL PRACTICE IN *HEVEA* CULTIVATION

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Introduction

Rubber is a versatile raw material obtained from the rubber tree (*Hevea brasiliensis*). In India, more than 35,000 different industrial, agricultural and household articles are made out of rubber. Rubber is traditionally cultivated in humid tropics, 10° North and South of the equator, where the total rainfall, its distribution and the atmospheric temperature are suited for its growth. In India, Kerala produces about 90 percent of rubber. Kerala and adjoining districts of Tamil Nadu and Karnataka are the traditional rubber growing areas, which extend upto 13° north latitude (ie. South West coast of India). Availability of land is a limiting factor for further expansion of rubber cultivation in the traditional rubber growing tracts of India. Hence, now rubber cultivation has been extended to many potential regions such as North eastern region, Orissa, Andhra Pradesh, Konkan in Maharashtra, Andamans, Bastar District in Chattishgarh regions, and parts of West Bengal, which are marginally suited for rubber growing (Sethuraj *et al.*, 1991).

In Orissa, rubber can be successfully cultivated in Dhenkanal, Mayurbhanj, Balasore, Cuttack, Phulbani, Puri, Khurda, Nayagarh, Ganjam and Gajapati districts etc, provided that life saving irrigation is given to young rubber plants during the summer months (March to June) in the initial 4 to 5 years. These non-traditional regions receive 1300-3000 mm rainfall (Sethuraj *et al.*, 1991) concentrated during the southwest monsoon period (June-September) followed by a dry period of five to seven months (Gupta *et al.*, 1998). Besides, these regions are prone to high temperature and low relative humidity during summer months leading to soil moisture stress, which adversely affect the growth and productivity of *Hevea* (Rao *et al.*, 1993; Chandrasekhar *et al.*, 1996, Meenattoor *et al.*, 2000; Vijaykumar *et al.*, 2000; Gupta and Edathil, 2001).

Adoptions of agronomic practices to offset the deleterious effects of various biotic and abiotic stress factors are essential for successful cultivation of *Hevea* in these regions. These include improving the soil moisture regime, application of mulches, growing cover crops and following soil and water conservation measures. Among them, mulching is an important agro-management practice and has wide potential to conserve the moisture efficiently and increase growth of rubber. This can be followed during the immaturity period and can play a major role in good establishment of rubber plantation. It also lowers the soil temperature, checks weed growth, minimize evaporative losses and adds organic matter to the soil.

Definition of mulch

Mulch is any material at the soil surface that is grown and maintained in place, any material grown but modified before placement and any material processed or manufactured and transported before placement. In otherwords, mulch is the material applied on the soil surface to check evaporation, improve soil water and reduce the weed growth. Some of the mulch materials may be organic mulches (eg. straw, crop residues, cover crop cuttings, tree lopping, dry leaves, weed cuttings), chemical mulches (polyethylene mulch—it may be redeemed/used polybags, containers of black, opaque, semi transparent, white and plastic films etc.), and cultural or soil dust mulches (pulverized top 5 cm soil).

Benefits of mulch application

1. Improvement of the water and plant nutrient holding capacity of the soil through run-off control, increased infiltration, decreased evaporation and addition of organic matter.
2. Maintenance of the soil around young rubber plants in a cool and moist condition during the months of March-June through radiation shielding, heat conduction and trapping and also evaporative cooling.
3. Multiplication of the microbial population of soil, ensuring better plant nutrient availability.
4. Protection of the soil from splash erosion resulting from heavy rainfall.
5. Control of weeds around the plant bases.

Probably the greatest benefit from mulch application for rubber plantation is soil moisture conservation, soil temperature regulation and weed control.

Time and method of mulching

The efficiency of mulching depends on the time and method of application. Mulching should be undertaken in nurseries as well as in young plantations after fertilizer application and before the onset of the regular summer. The month of November is the ideal time for mulching, to protect the plants and adverse effect of drought (Potty, 1980). Field experiments on mulching indicated that one round of mulching prior to hot weather in December was adequate. Organic mulches applied at 5 to 10 cm thickness are ideal for mulching. Clear polythene sheets of 40 to 100 gauge, used rain guard polythene sheets of 250 gauge, polythene bags (used plant containers) of 450 gauge were also used. Sufficient number of holes were punched on these polythene materials are spread in strips in the interrow areas/plant bases. Placement of a thin layer of soil (0.5 cm thickness) over the plastic film also prevents drifting away of the plastic by wind, in addition to preventing loss of soil moisture through the punched holes (Lakshmanan *et. al*, 1995).

Beneficial effects of mulches on rubber

1. Effect on growth

Mulch application at nursery stage significantly influenced the growth parameters, plant diameter, height, plant biomass, leaf area and root weight, and number of roots at the collar region over non-mulched seedlings (Lakshmanan *et. al.*, 1995). The growth of *Hevea* seedlings was found to be better under black polyethylene mulch followed by organic mulch (Gupta *et. al*, 2001). At immature phase, girthing of plants under mulched plots was found to be more vigorous over legume cover or natural cover grown plants (Samarappuli, 1992). In an experiment in Thailand, mulches of saw dust, rice husks or dry grass increased the girthing rate of plants even in months with adequate rainfall and mulched plants could be bulgrafted earlier than in the unmulched, with consequent savings in weeding and fertilizer cost (Webster, 1989).

At Konkan region, addition of mulch at 4 tonnes/ha with irrigation showed better growth due to reduced evaporation, increased infiltration and reduced transpiration by weeds of a combination of these factors (RRII, 1992). The net benefit of proper mulching is improved growth of plants and reduced immaturity period (Samarappuli, 1992; Samarappuli and Yogaratnam, 1995).

2. Effect on soil moisture

Mulching is a supplementary technique for marginal areas. In areas of marginal rainfalls and on steep-sloping terrain susceptible to erosion, mulching can be helpful to young nurseries of rubber by protecting the soil, maintaining cool and moist surface condition and by suppressing weeds immediately

Young rubber plants with heavy mulch in Orissa.

on the seedling nursery beds. In young rubber plantations, care should be taken to conserve water during the rainy season through proper soil water conservation measures in order to reduce the intensity of moisture stress, well in advance of onset of dry period by adding heavy mulch (Fig) as much as possible around the plant base (Punnoose *et al.*, 2000).

Added mulch acts as vapour movement barrier and minimizes the evaporation. It also reduces the intensity of radiation and wind thereby reducing the rapid upward movement of soil moisture and reduces evaporation losses from soil surface. This results in modification of soil microclimatic conditions and is beneficial for the plant growth (Lal, 1974; Bond and Willes, 1970). Gupta *et al.* (2001) reported that mulching alongwith once in five days irrigation in seedling nursery of *Hevea* was found to be superior to no mulch condition. In seedling nursery, the soil moisture content in the surface soil (0-15 cm) with the polyethylene mulch was 87-113 percent more than in no mulch plots during extreme dry weather conditions, while with plant/organic mulch it was only 50 percent (Lakshmanan *et al.*, 1995). Samarappuli (1992) reported that plants applied with 4.5 tonnes/ha of straw mulch at 6 months gap have recorded highest soil moisture profile storage capacity of 27.6 cm for a 90 cm profile depth compared to legume growing cover or natural covers. The leaf water potential, relative water content and leaf water deficit indicated that the water status of the plants was improved thus enhancing nutrient uptake and thereby increasing growth and yield. Mulching very significantly increases the soil moisture content throughout the dry season in mango orchards (Gregoriou and Rajkumar; 1984). The unmulched and unirrigated soil suffered severe moisture loss as the dry season progressed, reaching 11 per cent, almost wilting point during the months of May (Gregoriou and Rajkumar, 1984). Mulching indirectly influences the moisture holding capacity and moisture release characteristics of the soil (Lal, 1974).

Under paddy straw mulch, an increase in soil and leaf K content was observed (Hsiao and Lauchli, 1985). They further reported that adequate K nutrition tends to increase the water use efficiency of plants. With the increase in soil moisture stress, decrease in stomatal conductance and transpiration rate were observed, which seems to suggest that K sufficient rubber plants appear to close stomata and reduce transpiration more readily than the K deficient ones. It is possible that water stress develops due to the sluggish opening and closing of stomata in plants low in K and also due to their low capacity to respond to rapidly changing weather conditions.

3. Effect on soil temperature

Mulching generally tends to maintain lower soil temperature and helps the soil to maintain its moisture status for relatively longer periods as in the case of covers with a large organic matter turnover (Saseendran *et al.*, 1992). *Hevea* seedlings suffer from sun scorch as summer advances, due to heating up of soil around the collar region. The bark later dries up resulting in girdling effect leading to saprophytic fungal attack (*Botryodiplodia* sp.) and drying of seedlings. This can be prevented by mulch application. It helps in reducing the sudden variations in surface soil temperature resulting in greater soil water content by radiation interception and evaporative cooling. Seedlings raised under mulch recorded lower soil temperature at 1430 IST compared to those with no mulch. Mulched soil surface helps in reducing the sudden variations in surface soil temperature (Gupta *et al.*, 2001). Modification of soil thermal regime influenced the formation of surface feeder roots, soil microbial activity and nutrient availability (Lakshmanan *et. al.*, 1995). The effect of mulch depends upon its type, the amount applied and its rate of decay (Othieno, 1982).

In seedling nursery during summer months maximum soil temperature fluctuations were in the range of 7.4 to 14.1°C at 5 cm soil depth in non-mulched plots and 5 to 7.4°C in mulched plots. But at 20 cm soil depth no marked soil temperature fluctuations were found (Lakshmanan *et. al.*, 1995). In experiments at NERC, Guwahati (Assam), Gupta *et. al.*, (2001) reported that under no mulch condition, the soil temperature under *Hevea* seedlings increased to as high as 39.6°C at 5 cm soil depth and decreased very rapidly to as low as 29.8°C between 25th and 26th weeks (2nd fortnight of June), when the soil moisture reaches saturation due to the rains of the post monsoon. The sudden drop in soil temperature under no mulch condition may cause physiological disturbances in plants and this may also be true for *Hevea* seedlings. Lowering of soil temperature and dampening of its diurnal wave was observed due to organic and white polyethylene mulches, whereas increase in temperature was noticed due to black polyethylene mulches. Application of mulch helped to reduce the soil temperature during the summer and to increase during the winter months (Gupta *et. al.*, 2001).

On farm trials conducted near Cuttack with pointed gourd, it was found that application of 15 tonnes straw mulch maintained surface soil temperature at round 33 to 38°C under mulch, while, temperatures soared up to 55°C at 2-3 pm under no mulch condition. Straw/organic mulch application delayed irrigation frequency and total irrigation requirement over non-mulched plots in pointed gourd (Nanda *et. al.*, 2000) and in rubber seedlings (Gupta *et. al.*, 2001). The temperature gradient in soil decreases with depth during the dry periods, whereas it is reversed during wet periods. The lower soil temperature observed during the week 22nd (June) at the surface soil layers could be due to the loss of heat through wetting of the dry soil. Mulching and frequent surface wetting changes the thermal capacity of the surface layer to avoid extreme heating or cooling (Kakde, 1985). Mulching can also reduce the water requirement of rubber at Konkan region (RRII, 1992).

4. Effect on weeding

In the establishment of rubber nursery and young rubber plantation, weeds pose a serious problem, as they compete with rubber for soil moisture, nutrients and space. The minimum of 4-5 rounds or more of hand weeding are required a year during the initial stage (first two years) of establishment. Prolonged manual weeding is not economically feasible and may also cause undue disturbance of the soil surface leading to soil erosion during the wet seasons.

Mulching was found to help in the control of weeds and aid in soil water conservation. Mulched seedling plots recorded a weed control efficiency of 66 percent with polythene mulch and 33 percent with plant mulch over unmulched control (Lakshmanan and Punnoose, 2000). Experiments have shown that *Salvinia* spp., 'African payal' a noxious and menacing weed in the waterways could also be used as mulch material in seedling nursery of *Hevea* (Abdul Kalam and Punnoose, 1975).

Stapleton *et. al.*, (1989) observed around 82 percent reduction in ground coverage by weeds as a result of polythene mulching. Similarly use of conventional plant mulches and polythene mulches reduced weed growth to the extent of 57 percent and 84-90 percent respectively, over unmulched control, irrespective of type of weed (Lakshmanan *et. al.*, 1995). Black polythene sheet used as a mulch material to control weeds in young rubber has been shown to be promising in preventing weed growth because of its imperviousness to light. Seedlings are found to grow better and the cost of weed control is also reduced by mulching plant basin in summer (Gupta *et. al.*, 2001).

5. Effect on soil physico-chemical properties

Some important soil physical parameters such as bulk density, soil porosity and soil resistance were improved under mulching in the clean weeding circle around the rubber plants. Beneficial effect of surface mulches on soil structure results primarily from the mulches absorbing the energy of falling rain drops, thus reducing dispersion and surface sealing. Mulching reduces water runoff and provides the soil more time to absorb water. Infiltration rates are maintained and the formation of hard crust of soil in the plant basin is prevented (George, 1962). Addition of materials like legume cover, crop cuttings having a narrow carbon to nitrogen ratio has greater effect in improving soil fertility (Punnoose *et. al.*, 2000). If mulching is done after the fertilizer application, soil erosion and leaching loss of fertilizer are reduced during the rainy season (Samarappuli and Yogaratnam, 1984).

Addition of paddy straw as mulch material with wide carbon to nitrogen ratio improves the leaf nutrient contents and physical condition of soil. Under paddy straw mulch, an increase in soil and leaf K content was observed (Hsiao and Lauchli, 1985). Mulching also favoured increase in soil nutrients, soil pH, CEC and eliminated competition for nutrients unlike that in legume cover and natural cover. It also increased the available P, exchangeable K and Mg levels. Besides, straw mulch also improved the CEC and pH of the soil and the highest soil aggregation of 20% under mulch were reported compared to natural or legume covers. This may be due to higher organic matter content. Under increasing organic matter content, microbial gums and filamentous fungi thrive well and this probably contributed to increase in the percentage of aggregation (Samarappuli *et al.*, 1999). This helps in increase of microbial population in soils insuring better availability of plant nutrients with special reference to phosphate. When the land was clean weeded or bare, about 62-tonnes/ha of topsoil was found to be lost during initial three years. It was possible to reduce this loss to 1.3 tonnes/ha by mulching or growing leguminous cover crops (Yogaratnam, 1985).

Economics of mulching

Polythene mulching was less costly compared to plant mulching. Used rainguard polythene sheets (250 gauge) showed a cost saving of 44.6 percent over that of plant mulches. The percentage of saving was less with 250 gauge used rain guard polythene, the material can be reused for 2-3 seasons compared to that of 40 and 100 gauge polythene sheets (Lakshmanan *et al.*, 1995). The total cost of mulching with used rain guard sheets/ polythene bags (redeemed plant containers) will work out to be much lower than that with plant/organic mulches. The total labour required in the first eight months of *Hevea* seedling nursery was slightly less for polythene mulch than that for no mulch plots. Also the cost of weed control was reduced (Gupta *et. al.*, 2001). Reduction in labour utilization for weed control operation to the extent of 60 percent was reported with black polythene mulching (Lakshmanan *et. al.*, 1995).

Conclusion

There are many advantages in using mulches in *Hevea* cultivation. Addition of mulches in rubber at nursery and during immature stage improves the growth and yield of rubber by improved soil water and temperature regimes, improved soil structure, soil erosion control and various other soil and plant environmental factors associated with mulches. Recently polythene mulches are also used as an alternative to organic mulch without any adverse effect on the plant growth and could be used for a longer period. These advantages would contribute a lower cost of cultivation in terms of weeding and reduced the gestation period for maturity. The only draw back in the plastic/ polythene mulch is the absence of nutrient addition, unlike that with organic/ plant mulches.

Thus it indicates the possibility of re-utilizing the discarded polyethylene plastic bags, organic waste and plant mulches as a mulching material. This could be a beneficial cultural practice in rubber (*Hevea*) cultivation.

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CONTENTS

MINISTER MEETS
STAKEHOLDERS OF RUBBER INDUSTRY

Sri. Jairam Ramesh, Minister of State for Commerce, interacts with the stakeholders of NR industry

* Meets Chairman, Officers and Scientists

* Interacts with the Stakeholders

* Addresses the Media

Sri. Jairam Ramesh, Union Minister of State for Commerce, held discussions with the stakeholders of the rubber industry on his visit to Kottayam on 7 June 2006. Having arrived at the Rubber Research Institute of India, the research wing of the Rubber Board, at 9 am, he had a busy schedule – holding discussions with Sajen Peter IAS, Chairman, attending the meeting of the Heads of Departments of the Board and the scientists of RRII, interacting with the stakeholders of the industry and addressing the media.

After hearing the stakeholders in a meeting held in the Silver Jubilee Hall of RRII, he assured the growers that there was no proposal to ban export of NR from India. He asked them to take up replanting of senile plantations to ensure high productivity.

Later, addressing the media persons, the

Addressing the media with Sri. Sajen Peter, Chairman, Rubber Board

Inaugurating the new guest house building at RRII

minister reiterated that there would not be any ban on rubber exports, as long as there was no economic justification for such a ban. The minister expressed his appreciation over the fact that Indian natural rubber exports exceeded 70,000 tonnes for the first time, without any subsidy, during the fiscal ended March 2006. He opined that a brand and logo should be developed for Indian natural rubber, which could make it identifiable and acceptable the world over. The minister promised that attractive schemes for encouraging replanting and strengthening of RPSswould be implemented in the next FiveYearPlan. S S.JacobThomas, A.Jacob, EttumanoorRadhakrishnan, P.R.Muraleedharan,Prof.K.K.Abraham, Thomaskutty,Adv.M.S.Karunakaran,(Rubber Board members),Sri. Mathew C Kunnumkal, AgriculturalProductionCommissioner of Kerala, representatives of Automotive Tyre Manufactures Association, Rubber Dealers Federation, Rubber Producers Societies, National Federation of RPSs, Block rubber Processors, Latex Processors and UPASI attended the stakeholders' meeting. Earlier, the minister was received at RRII by Sri.Sajen Peter, Chariman, Dr. N.M Mathew, Dr. K. R. Vijayakumar, M. K. Balagopalan Nair, Viju Chacko, K. J. Joseph, (Directors), G. Mohana Chandran, (Jt. Director) and other senior officials of the Board.

K.D. Sebastian
Asst. Director (Publicity)

A REVIEW ON POPULATION DYNAMICS AND BROOD DEVELOPMENT OF INDIAN HONEYBEE *APIS CERANA INDICA* F.

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Apis cerana indica is the common honey bee found throughout the tropical, sub tropical and temperate zones of Asia including the Indian subcontinent and Srilanka, Indonesia and the Philippines in the east. Further north, it is found in southern USSR, China, Korean Peninsula and Japan. There are wide differences in morphology of worker bees, nest size, colony population, swarming and absconding behaviour among the tropical and temperate races of Indian honey bees.

Population dynamics

A normal bee colony consists of one queen, a number of workers from 60,000–80,000 in a major honey flow season (October to May) to as low as 10,000 or less in the nectar and pollen dearth period (mid May to mid August). The number of drones range from a few hundreds to two to three thousand (FAO, 1986). The maximum population of *Apis mellifera* and *Apis cerana indica* colonies in Punjab plane is recorded in the month of May and minimum in August (Goyal, 1978). Chand and Singh (2005) reported that there was a steep increase in colony strength from November to March which declined in the month of April.

The population of worker bees in a colony ranges from about 35,000 bees in the South Indian plains type to about 70,000 in the Kashmir species. But usually the colonies have smaller population of 18,000-22,000 and rarely some are strong colonies having 80,000 bees (Goyal, 1978). A colony comprises one queen, 20000-25000 workers and 700-1000 drones. The queen lays about 800 eggs per day (Nehru, 1999). Reproductive swarming is a regular feature of *A. cerana* and it starts when colony strength is around 2000 bees (Atwal, 2000).

The peak number of drones is attained four weeks before swarming of a colony, mostly in spring and autumn (Atwal, 2000). In a newly settled swarm at first the worker cells are constructed and after 22 days of establishing a colony the drone cells are also constructed. When the colonies are large more drone cells are constructed. Though there are only a few hundred drones usually present in a colony, the number may go upto 1000 or more as it has been recorded. Since they feed on the food resource, they are tolerated only during honey flow season or when there are plenty of food sources (Atwal, 2000).

The architectural design of the comb of all honey bee species is essentially similar. It consists of adjoining hexagonal cells made of wax secreted from wax gland of the worker bees. The bees use these cells to rear their brood and to store their food. The general utilization of comb space is also similar among the species. Honey is stored in the upper part of the comb; beneath this, row of pollen storage cells, worker brood cells and drone brood cells are arraged in order. The ground nut shaped queen cells are normally built at the lower edge of the comb (FAO, 1986).

Brood development

The brood development of *Apis cerana indica* is not uniform throughout the year. There may be several reasons for this. One of the reasons for irregular egg laying by the queen is inbreeding depression resulting in loss of diploid drone brood. During this period the worker bees may not rear the brood up to the adult stage. The number of eggs laid and the larval development may be more than what bees could rear. During the main nectar flow 95 percent of larvae are raised to sealed brood stage but during moderate flow of nectar and pollen only 50 percent of the larvae are reared to that stage. During a forage dearth the queen continues to lay eggs but the worker bees kill them and no brood is reared. Efficient brood rearing is determined mainly by the interaction between pollen availability and some unknown internal colony factors (Woyke, 1976).

The brood rearing activity is generally low in winter but is resumed with the onset of spring, reaching a peak before the honey flow. The normal life of a queen is for three years. In general the number of eggs laid by the queen during its first year of life is higher than that in the second year (Rehman and Singh 1940). Atwal (2000) reported that a queen lays eggs ranging from 300 to 500 in South India and 700 to 800 in North India. An average number of nine queen cells is observed in a swarming season for *A. cerana indica*. The queen walks over a comb and examines the cells with the head and forelegs. If the cell is clean and is of the required type she turns around, lowers her abdomen, directs the egg to the bottom of the cell and glues it there in a vertical position, the thinner end being the lower side. As the egg develops it leans over and at the end of third day it lies flat on the floor of the cell. The larva inside is ready to emerge and the worker bee places royal jelly around it. The young larvae are pearly white and remain curled up along the basal wall of the cell either on left or on right side till it is fully-grown. The total development period from egg to adult is 21 days for worker, 16 days for queen and 24 days for drones.

The highest brood activity as indicated by the average brood area was 408.00 sq.inch in yellow strain during February there was progressive decline in the activity during May, June and August. Lowest brood rearing activity was recorded during September as 16 sq.inch (Hiremath et al; (2002). Chowdegowda and Reddy (2003) reported that the maximum brood and pollen area is in April. The absconding was found to take place when the area under honey, pollen, egg, larvae, sealed brood and total brood was less than 710, 20, 50, 1, 10 and 60 sq.cm. respectively (Sharma, 1943) Nectar and pollen has a direct effect on brood rearing (Ramachandran and Mahadevan 1950). The proportion of bees in a colony that foraged for pollen, the pollen store in the hive and the amount of brood reared followed a similar seasonal pattern (Reddy and Raj, 1979). Atwal (1999) observed that egg laying by the queen and the brood rearing by the worker depends upon the availability of nectar and pollen from flowers. Sensing the floral conditions in the field, the workers stimulate or restrict the queen from laying eggs. When pollen stock diminishes brood rearing slows down or may entirely stop. If colonies possess reserve of pollen but run short of honey stores then also brood rearing is slowed down. The ideal weather condition for good brood rearing activity in the plane type bees was found to be a mean maximum day temperature of 34.4°C, long daily hours of sunshine and comparatively calm weather (Subhiah, 1956). Naim (1983) reported that the most active period of egg laying was during summer months (April to June) when temperature ranges from 37°C-42°C.

The queen may suspend egg laying for a short period owing to adverse climatic conditions but returns to normal as soon as conditions are favourable and during summer, spring and autumn season more brood is reared (Verma, 1988). The relative humidity of air surrounding the hive has an effect on brood rearing. In dry period the bees stop brood rearing. Eggs may even dry up and fail to emerge (Muttoo, 1986). The number of eggs laid by the queen is influenced by the environmental conditions such as temperature and the kind and the amount of food it receives from the nurse bees. The nurse bees provide food to the queen and control its egg laying in accordance with the floral and weather conditions (Mishra, 1997). Kumar (2003) observed that the size and shape of the combs showed variation among the different species. The variation in morphology and comb growth within a species is related to their habitat and floral conditions.

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CONTROLLED UPWARD TAPPING

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History of upward tapping dates back to the early 20th century (Wright, 1912) and the practice of tapping a half spiral or full spiral cut on high panel has since then been followed. This method became widely popular during the second world war period because of the immediate large increase in yield from bi-directional tapping (Ashplant, 1942), but the high yield was not sustainable. The absence of a proper knife was one of the major reasons for the poor standard of tapping resulting in severe wounding, profuse spillage, high rate of bark consumption, variable angles of slope and lengths of cut among trees within a task. These defects led to high incidence of Tapping Panel Dryness (TPD), rapid yield decline and early exhausting of high panels. Moreover, lack of proper technique and wrong posture of tapper caused body ache and fatigue, ultimately leading to the tappers' resistance to this and hence this method was abandoned.

Subsequently, for long-term exploitation of high panel, downward tapping of 1/2 V-cut above the basal panel (from 1 m or more above the opening height of basal panel) was introduced. Since wooden or metallic ladders were used to reach the cut, this method is known as ladder tapping. The tapping knife used was the ordinary 'Mitchie-Golledge' type. However, in this method, yield declined drastically as the cut approaches the renewed bark of basal panel. Since ladder tapping is more strenuous and time consuming, reduced tapping tasks, generally half of normal, are usually given resulting in increased tapping cost. Moreover, accidents like falling from ladders are also common.

The drawbacks of the earlier high panel exploitation methods were solved to a larger extent by the introduction of controlled upward tapping (CUT) of stimulated short cuts using a long-handled modified gouge knife. This system was introduced in Malaysia in the mid-1970s. In India, adaptive research on CUT was started in late 1980's. Recommendation of CUT using long handled modified gouge knife, and with necessary modifications to suit the agroclimatic conditions in India was made in 1991 (Vijayakumar and Thomas, 1993). Since then, CUT has been accepted as a very innovative and useful system for sustainable increase in productivity in the later half of the economic life. It has also helped in increasing tapping task for high panel exploitation. The use of the modified gouge knife for upward tapping minimizes spillage, bark consumption and cambial injury and maintains the angle of the cut. Tapper can tap the cuts from ground without using a ladder. Physical strain on body caused by raising of hands above shoulder while tapping with ordinary knife is not there with the gouge knife as the left hand is not raised above the shoulder and right hand not above its elbow.

The productivity of renewed bark is usually affected by various factors. CUT can be practiced for longer exploitation of the virgin bark, above the basal panel and can be adopted under situations like poor regeneration, uneven surface due to injurious tapping, tapping panel dryness, early completion of virgin bark etc. Moreover, it is useful for prolonged exploitation of high panels.

The modified gouge knife specially made for controlled upward tapping, can be used from the ground. The V-shaped knife blade produces an inverted groove (with an acute angle) on cut surface, which helps in better adhesion of the latex along the groove, whereby spillage is minimized. The knife is fixed on the long handle at an angle of 30° which allows the tapper to stand near the tree while tapping, without having to raise his hands above the shoulder level. This ensures less strain on the arms and body during tapping. Thus, better control of tapping, uniform rate of bark consumption without injury to cambium and proper maintenance of the slope can be achieved with a task comparable to that of basal panel tapping. Since the end of the blade is made at a 60° inclination to the keel of the gouge, consistent length of tapping cut is ensured *i.e.* there will be no panel encroachment. A well-sharpened knife ensures easier and faster tapping. The modified gouge knife can be sharpened from the inner face out or from the outer face. The knife can be fitted on a 1.2m long metallic or wooden handle. When the tapping cut reaches higher levels, the length of the handle may be increased further. The knife can be light weight (750 g) or heavy (900 g).

Controlled Upward Tapping should commence on the virgin bark of the high panel, just above the renewed bark of the basal panel,

Table.1: Dry rubber yield (kg) under Controlled Upward Tapping with periodic panel change at Neria estate, Ujire, South Karnataka during 1997-98 to 2004-05

Year	1971 RRIM 600	1973 RRIM 600
	4982 trees	1165 trees
1997-98	24259	5329
1998-99	21909	4449
1999-00	28089	5934
2000-01	33588	5540
2001-02	25804	5244
2002-03	26325	6158
2003-04	23799	5068
2004-05	23461	5275
Cumulative yield (kg)	207232	42997
Average/year	25904	5375
Mean kg/tree/yr	5.19	4.61

Table. 2: TPD status for 1973 and 1971 RRIM 600 under periodic panel change (1/2S→1/4S ↑ d/3 6d/7) during 7th year (2004-05) in Neria estate, South Karnataka.**

Field	Blocks	Trees/ block	Basal Panel			High panel (CUT)		
			Yielding trees	TPD trees	TPD %	Yielding trees	TPD trees	TPD %
1973 RRIM 600	82	296	249	47	16	294	2	1
	83	290	263	27	9	286	4	1
	84	282	261	21	7	280	2	1
	85	297	259	38	13	285	12	4
Total	4	1165	1032	133	11	1145	20	2
1971 RRIM 600	96	305	259	45	15	302	3	1
	97	307	278	29	9	305	2	1
	98	288	229	59	20	268	20	7
	99	293	242	51	17	290	3	1
	95	304	263	41	13	298	6	2
	100	295	239	56	19	287	8	3
	101	314	286	28	9	311	3	1
	102	277	237	40	14	275	2	1
	103	290	258	33	11	288	2	1
	104	279	233	46	16	277	2	1
	73	291	239	52	18	285	6	2
	87	299	255	44	15	294	5	2
	89	274	207	67	24	272	2	1
	91	284	241	43	15	282	2	1
	92	290	248	42	14	286	4	1
	93	292	244	48	16	287	5	2
	94	300	271	29	10	296	4	1
Total	17	4982	4229	753	15	4903	79	2

** *Adapted from Vijayakumar et al, 2005*

preferably on the opposite side of the basal panel under tapping. From the front end of the previous base panel half spiral cut, a vertical line is drawn on the trunk upwards (front guide line). Another vertical line (back guide line) is drawn on the left side of the front guide line, passing through the quarter circumference point of the tree. Between these two lines, a tapping cut with a slope of 45° (high left to low right) from the horizontal is made. The first few tappings should be done downwards with a regular knife to make available a space equivalent to the width of the modified gouge knife blade (1.5 cm). This will serve as a supporting cut as well. In CUT the direction of tapping is from the front end of the tapping cut towards the back (low right to high left). The quarter spiral cut at 45° slope ensure better control, minimum injury of cambium, lower bark consumption and minimum spillage of latex along the panel.

In CUT, good tapping standards should be stressed. Wounding the trees, which could also cause spillage of latex, has to be avoided and a depth within the range of 0.5 to 1.0 mm from the cambium may be ensured. The amount of bark to be consumed for a fixed period has to be marked on every tree. In CUT, the rate of bark consumption varies according to the height of the panel, age of the bark and the tapping frequency. At the commencement of CUT, since tapping of the high panel is within reach and the tree lace can be removed by hand before tapping, the rate of bark consumption should be maintained at 2.5 cm per month. However, at higher level, bark consumption will be slightly higher.

For successful implementation of CUT, the tapper's body movement is very important. Since the tapping is from the front end of the tapping cut towards the back, the tapper has to stand facing the front channel with legs abducted at about 60 cm apart.. During tapping, the handle of the knife should be held close to the body and the left arm should never be lifted above the shoulder. The tapping knife should be held in the right hand and the left hand used for guiding the knife along the tapping cut. Even when the tapping cut is at a higher level, for easy tapping, the left and right hands should gradually and progressively glide down over the handle. If all the operations are carried out in a proper and systematic way by trained tappers, CUT will be the easiest exploitation technique for high level tapping. Special training for about a week is required to use the modified gouge knife, and to tap without raising the hands above the shoulder level.

With effective yield stimulants like ethephon, there is no need to resort to longer cut than 1/4S-. Moreover in the short cut, the time required for tapping is more or less the same as that for conventional downward tapping. For a quarter cut, effective exploitation is possible only with stimulation. Generally, ethephon at 5 per cent concentration is applied on lace at monthly intervals for 1/4S d/3 . Stimulation during extreme drought may be avoided. Positions of the first and subsequent panels would depend on the positions of the basal panels and the tapping cut in the basal panel. Subsequent high panels need to be taken towards the right side of the earlier panel.

The length of the tapping cut depends on the duration for which CUT is to be followed. . Tapping frequency for CUT is the same as that for base panel. The best system suitable for CUT in South India is periodic panel changing, i.e. base panel tapping with rainguarding during rainy season and CUT on high panel during non-rainy seasons. Following this system , CUT on 1/4S can be practiced for minimum 12 years, each 1/4 panel being exploited for 24 months. Under periodic panel changing , overall production will be higher since both cuts receive rest for half of the year.

In the estate (medium and large) sector in India, CUT became very popular with a short period. It replaced ladder tapping of 1/2V cut completely. Though there was initial resistance, long handled modified gouge knife was widely accepted. A case study is presented here.

M/s Neria estate is located 25 km away from Ujire in D.K.Dist, Karnataka. The annual rainfall of the estate is more than 3000 mm (in 4-5 months). For almost 7-8 months in a year, there is no rain. This estate after imparting proper training for their tappers on the use of modified gouge knife, initiated CUT in very large area. Data on dry rubber yield (kg) and TPD from two fields, viz. 1973 and 1971 RRIM 600 are presented in tables 1 & 2. Mean annual dry rubber yield per tree from 1997-98 to 2004-05 was 4.6 and 5.2 kg, respectively. In these fields, TPD on basal panel was 11 and 15 percent respectively.

In addition to good and sustainable yield over long term, controlled Upward Tapping (1/4S ↑d/3) with periodic panel change is very useful in managing Tapping Panel Dryness. In the 1973 RRIM 600 field, total number of trees in four blocks was 1165. Among these, basal panels of 133 trees were non-productive due to TPD. When CUT was introduced with ¼ spiral upward cut during 1997-98, high panels of the 133 TPD trees were also opened. The tapping system followed was periodic panel change, i.e, basal panels were tapped with rainguard during rainy season, whereas CUT panels were tapped during non rainy months. All these years there was no tapping on basal panel for the TPD trees. i.e. every year these 133 trees were tapped roughly for six months only under 1/4S ? d/3 as their basal panels are non-productive. By 2004-05, from the 133 TPD trees, reoccurrence of TPD on high panel was noticed only on 20 trees, i.e. only 15% of TPD affected trees.

Similarly, in the 1971 RRIM 600 field, total number of trees in 17 blocks was 4982. Among this, basal panels of 753 trees were non-productive due to TPD. When CUT was introduced with ¼ spiral upward cut during 1997-98, high panels of the 753 TPD trees were also opened. The tapping system followed was periodic panel change, i.e, basal panels were tapped with rainguard during rainy season, whereas CUT panels were tapped during non rainy months. All these years there was no tapping on basal panel for the TPD trees. i.e. every year these 753 trees were tapped roughly for six months only under 1/4S ? d/3 as their basal panels are non-productive. By 2004-05, from the 753 TPD trees, reoccurrence of TPD on high panel was noticed only on 79 trees, i.e. only 11% of TPD affected trees (Vijayakumar et al, 2005).

When CUT is implemented properly, in addition to ensuring sustainable high yield for long term, it is very efficient in managing TPD affected trees.

The authors are extremely thankful to M/s Neria estates for the inco-operation.

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CHANGES IN SOIL PROPERTIES DUE TO INTERCROPPING: A CASE STUDY

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Abstract

A survey was conducted in the rubber holdings coming under the operational area of the Rubber Board Regional Office, Kottayam during 1999-2000 to study the changes in physico-chemical properties of the soil due to intercropping. Organic carbon content in all the selected fields was in the medium to high range and no appreciable difference was found in the fields with intercrops. Available phosphorus showed wide variation from field to field and was higher near the intercrop irrespective of the crop, compard to near rubber or in uncultivated area. Available potassium content was in the medium range in almost all the situations. Bulk density was less near intercrops compared to near rubber possibly due to the tillage operations carried out for intercrops.

Introduction

In Kerala, rubber is cultivated in about 4.78 lakh hectares, which account for 16 per cent of the total cultivated area of the state. About 92 per cent of total production of natural rubber in India is from Kerala. Small holdings with an average holding size less than one hectare account for more than 90 per cent of the area under rubber. Rubber is usually grown as a monocrop at a spacing of 6.7 x 3.4 m on slopes and 4.9 x 4.9 m on flat lands. The wider spacing is provided to meet the resource requirment of trees during the mature stage, but results in an inefficient use of land and other resources during the immature period.

Rubber has an immaturity period of around seven years, during which period, no income is obtained from the plantation. Intercropping with annuals and short duration crops can generate some income during the first few years of planting. However, the management practices adopted for each intercrop will affect the physical and chemical properties of soil and these should be looked into for the long term sustainability of the rubber growing soils.

A survey was conducted in Kottayam region (Kottayam and Vaikom Taluks) during 1999-2000 to identify smallholdings with and without intercrops and to study the changes in physico-chemical properties of the soils due to intercropping.

Materials and methods

Fifty one small holdingscoming under the operational area of Rubber Board Regional Office, Kottayam, Kerala were selected for the study. Twenty one farmers having a holding size of 0.20 ha and above and with rubber planted in 1997 and 1998with clone RRII 105 were identified.Soil physicochemical properties were studied from four cropping situations viz (1) rubber intercropped with banana – 3 fields each in 1997 and 1998, (2) rubber intercropped with pineapple – 3 fields each in 1997 and 1998, (3) rubber with cover crops – 3 fields in 1997 and 1 field in 1998 and (4) rubber alone – 3 fields in 1997 and 2 fields in 1998.

Soil samples (0-30 cm) were collected from 30 cm away from the base of rubber, base of intercrops and nearby uncultivated area. Organic carbon (OC), available phosphorus (P), available potassium (K) and pH were determined using standard methods (Jackson, 1973).

For determining bulk density, soil samples were taken from 30 cm away from the base of rubber and intercrops using a core sampler with 5.2 cm diameter and 8.2 cm height.

Rusults and discussion

The mean values of OC, available P, K and pH of soil samples collected from various fields are presented in Table 1 and 2.

Among the 21 fields studied, 18 fields received farmyard manure @ 4 kg per plant at the time of planting, others received bone meal @ 150 to 500 g per plant at the time of planting. In the case of banana, 5 fields received farmyard manure @ 4 - 6 kg per plant and one field received 4 kg bone meal per plant. All the farmers applied green manure to banana. Organic manures were not applied for pineapple and cover crop. The Organic carbon content in all the fields were in the medium to high range, 1.06 to 1.87 in 1997 and 1.10 to 1.62 in 1998 (medium level - 0.75 to 1.5%). Even though farm yard manure and green manure were applied to banana, there was no appreciable difference in the organic carbon content near banana compared to the uncultivated area. In 1998 planted fields, the organic carbon content was slightly higher near banana. After first crop of banana, farmers chop the crop residues and put them back to the field. This practice also did not increase the organic carbon content of the soil immediately as indicated by the organic carbon content of the 1997 planted fields intercropped with banana. In the case of cover crop, it is too early to notice an improvement in the organic carbon content due to the addition of cover crop biomass.

The mean available P content of soil samples collected from different fields showed wide variation and ranged from 0.77 to 2.98 mg/100g soil in 1997 planted

Table 1. Soil chemical properties (1997 planting)

Situation	Sampling Site	Org C %	Available Nutrients (mg/100g)		pH
			P	K	
Rubber + banana	Near Rubber	1.32	1.35	4.4	4.7
	Near banana	1.41	2.98	5.8	4.5
	Uncultivated area	1.44	1.98	7.9	4.5
Rubber + pineapple	Near rubber	1.35	0.77	8.7	5.6
	Near pineapple	1.32	0.99	4.6	4.7
	Uncultivated area	1.87	0.88	14.9	4.7
Rubber + cover crop	Near rubber	1.22	1.50	5.0	4.6
	Under covercrops	1.17	1.13	5.5	4.6
Rubber alone	Near rubber	1.06	1.43	4.4	4.6
	Uncultivated area	1.13	1.45	5.1	5.0

fields and 0.15 to 1.89 mg/100g soil in 1998 planted fields (Table 1&2). All the farmers applied fertilizer separately to rubber and intercrop. The available P content of the soil was always higher near intercrop, irrespective of the type of crop compared to near rubber or uncultivated area. Intercropping has been reported to increase the available P status of soils by Zainol et al., (1993) and Jessy et al. (1996). Application of rock phosphate to intercrops might have increased the P content of soil near intercrops. In the case of rubber, though fertilizers were applied, the P content was lower near rubber compared to the uncultivated area in most cases. Higher quantity of fertilizers applied to intercrops might be the reason for the higher P content near intercrops compared to rubber.

The mean available K content of soil collected from the uncultivated area was in the medium range in majority of the fields (Table 1&2). The available K content near banana plants in both years was maintained in the medium range. The K requirement of banana is comparatively high and it was found that the quantity of K fertilizer applied was also high. Compared to the uncultivated area, a slight reduction in available K content was noticed near rubber. This might be due to the lower quantity of K supplied through fertilizer to rubber and uptake by the plants. In the case of pineapple also a slight reduction in the available K was noticed near one year and two year old plants which might be due to the locking up of K in the pineapple plant.

The pH of the soils of different fields ranged from 4.1 to 5.6 and did not vary appreciably between fields (Table 1&2). Cultivation of banana as intercrop with rubber did not influence the soil pH, in the first or second year of banana cultivation. But in the case of pineapple, soil collected from near one year old pineapple plants (1998 planting) had a lower pH compared to the nearby uncultivated area. The farmers were found to apply fertilizers in excess of the recommended does during the first year of planting of pineapple and this might be the reason for the lower pH observed. The pH of the soil collected from near the two year old pineapple plant was comparable to that of uncultivated area. The information collected from

Table 2. Soil chemical properties (1998 planting)

Situation	Sampling Site	Org C %	Available Nutrients (mg/100g)		pH
			P	K	
Rubber + banana	Near rubber	1.44	1.67	6.7	4.8
	Near banana	1.49	1.72	9.9	4.5
	Uncultivated area	1.23	1.40	7.8	4.7
Rubber + pineapple	Near rubber	1.15	0.33	5.8	5.6
	Near pineapple	1.62	1.89	4.7	4.1
	Uncultivated area	1.59	0.93	6.5	4.6
Rubber + cover crop	Near rubber	1.42	0.75	13.6	4.2
	Under covercrops	1.10	0.15	5.4	4.2
Rubber alone	Near rubber	1.25	0.80	5.6	4.4
	Uncultivated area	1.40	0.82	6.3	4.5

the farmers indicated that they apply fertilizers in excess of the recommended dose during the first year (150 to 200 % higher than the dose recommended by Kerala Agricultural University). In the second year, the quantity is less compared to the first year but still in excess of the recommended dose. The pH of the soil near rubber was slightly higher than that of soil in the uncultivated area in the majority of the fields studied irrespective of the year of planting.

Bulk density of the soil collected from the fields ranged from 1.13 to 1.37 g/cm^3 in 1997 and 1.27 to 1.44 g/cm^3 in 1998 (Table 3). In general, bulk density near intercrops was less, compared to that near rubber. This might be due to the tillage operations needed for intercrop. In the rubber alone fields also, bulk density was higher in the uncultivated area, compared to near rubber.

Table 3. Bulk density (g/cm^3)

Situation	Year of Planting	
	1997	1998
Rubber + banana (near rubber)	1.37	1.44
do(near banana)	1.26	1.39
Rubber + pineapple (near rubber)	1.35	1.37
do(near pineapple)	1.29	1.27
Rubber + cover crop (near rubber)	1.13	1.29
do(under covercrop)	1.15	1.37
Rubber alone (near rubber)	1.27	1.29
do (uncultivated)	1.32	1.41

Conclusion

Organic carbon content in all the fields selected for the study was in the medium range and no oppreciable change was found in fields with intercrops. Available P showed wide variation from field to field, and was higher near the intercrop irrespective of the type of crop compard to near rubber or uncultivated area. Available K was maintained in the medium range near banana and near rubber in almost all cases. Bulk density was less near intercrops compared to near rubber due to the tillage operations.

Acknowledgement

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Table 2. Soil chemical properties (1998 planting)

Situation	Sampling Site	Org C %	Available Nutrients (mg/100g)		pH
			P	K	
Rubber + banana	Near rubber	1.44	1.67	6.7	4.8
	Near banana	1.49	1.72	9.9	4.5
	Uncultivated area	1.23	1.40	7.8	4.7
Rubber + pineapple	Near rubber	1.15	0.33	5.8	5.6
	Near pineapple	1.62	1.89	4.7	4.1
	Uncultivated area	1.59	0.93	6.5	4.6
Rubber + cover crop	Near rubber	1.42	0.75	13.6	4.2
	Under covercrops	1.10	0.15	5.4	4.2
Rubber alone	Near rubber	1.25	0.80	5.6	4.4
	Uncultivated area	1.40	0.82	6.3	4.5

the farmers indicated that they apply fertilizers in excess of the recommended dose during the first year (150 to 200 % higher than the dose recommended by Kerala Agricultural University). In the second year, the quantity is less compared to the first year but still in excess of the recommended dose. The pH of the soil near rubber was slightly higher than that of soil in the uncultivated area in the majority of the fields studied irrespective of the year of planting.

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Table 3. Bulk density (g/cm^3)

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do(under covercrop)	1.15	1.37
Rubber alone (near rubber)	1.27	1.29
do (uncultivated)	1.32	1.41

Conclusion

Organic carbon content in all the fields selected for the study was in the medium range and no oppreciable change was found in fields with intercrops. Available P showed wide variation from field to field, and was higher near the intercrop irrespective of the type of crop compard to near rubber or uncultivated area. Available K was maintained in the medium range near banana and near rubber in almost all cases. Bulk density was less near intercrops compared to near rubber due to the tillage operations.

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10TH PLAN SCHEMES FOR RUBBER PLANTATION DEVELOPMENT

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Rubber Board, Kottayam -686 002.

Development schemes of the Rubber Board have played a crucial role in the expansion and modernization of rubber plantations in India. The schemes are designed so as to provide financial as well as technical assistance to growers based on the changing needs of the natural rubber industry.

An analysis of the production and consumption pattern of natural rubber (NR) in the country from 1980-81 to 2001-02 (terminal year of the 9th plan) reveals that consumption of NR had always been more than the production, excepting for two years ie. 1997-98 and 98-99 when there was a general recession in the industrial sector leading to lower rubber consumption. With industrial growth rate picking up from 1999-2000 onwards, consumption again surpassed production and at the end of the terminal year of the IX plan period the production was less by 7000 MT than the consumption. The relevant figures are given in the table1.

Production of NR both domestic and global, is estimated to be less than the demand during the next two decades. The widening gap between production and consumption points to the need for increasing production in order to :-

i) meet the internal demand for the commodity,
ii) save foreign exchange that would be otherwise required to import the required quantity of NR and
iii) earn foreign exchange through export of NR.

During X plan period (2002-03 to 2006-07), apart from replanting of old and uneconomic plantations, with high yielding varieties, and expansion of rubber area through new planting, especially in the non-traditionalregion, productivity enhancement of the existing plantations is given focus. Thrust is also given for increasing the economic viability of rubber plantations through promotion ofancillary income generation activities leading to large scale adoption of these activities.

NR production sector in the country in general has been inward oriented and was mostly catering to the demand of the domestic industry. In an era of liberalized economy and an emerging global market, the NR production sector should also aim at exporting NR to the major consuming countries, in addition to meeting the internal demand. Productivity of plantations has to be increased

Table 1. Consumption and production of NR in India (99-02)

Year	Consumption (MT)	Growth rate (%)	Production (MT)	Growth rate (%)	Deficit of production over consumption (MT)
1999-2000	6,28,000	6.2	6,22,000	2.8	60000
2000-01	6,31,000	0.5	6,30,000	1.3	1000
2001-02	6,38,000	1.1	6,31,000	0.2	7000

considerably besides bringing in significant improvement in quality in order to make the small holding sector globally competitive.

It was in this background the Government of India approved various schemes for development of rubber plantations during the X plan period. The rubber growing areas of the country have been divided into 3 zones for the purpose of implementation of these schemes and separate programmes have been drawn up taking into account the distinctive features and requirements of these zones. The 3 zones are:-

1. Traditional Area comprising of Kerala and Kanyakumari district of Tamil Nadu,
2. Non Traditional Area (NTA) including all states other than traditional area and North Eastern region.
3. North Eastern Region (NE) including the North Eastern states and part of West Bengal.

The development schemes implemented in these zones are summarized below.

SCHEMES FOR TRADITIONAL AREA

1. Replanting/ new planting

The component envisages replanting an extent of 33850 hectares and new planting 2500 ha. in the traditional area during the plan period.

For replanting, the financial assistance is a planting grant at the rate of Rs. 20000 per ha. to growers having an area up to 5.00 ha., with financial assistance limited to 2.00ha. The rate of planting grant for new planting is Rs.12000 per ha. for growers having an area up to 5.00 ha., with financial assistance limited to 2.00ha. The planting grant is released in six annual instalments as shown in table 2.

Apart from this, additional assistance at the rate of Rs.3.00, Rs.2.00, Rs.1.00 per plant is granted for planting in the years 2002-03, 2003-04 and 2004-05 respectively as reimbursement of cost of advanced planting materials , limited to a maximum of 500 plants per ha. All categories of growers are eligible to avail of this assistance. This additional assistance has been discontinued from 2005-06 onwards in traditional area.

The minimum extent to be replanted/ new planted in any one year by one participant , under the component, is 0.10 ha. of contiguous land. Replanting in less than 0.10 ha. also will become eligible if it is the only part of an area remaining to be replanted in an estate. The land selected for planting should be suitable, in all respects, for rubber cultivation. Lands situated 450metres above MSL will not be considered for grant of assistance unless such lands are found fit for the purpose after technical scrutiny by Rubber Board.

The Board will extend necessary advisory and extension support to growers who avail assistance under the programme. The technical officers of the Board visit the holdings at least once a year. Growers also may request for any additional technical assistance required. Board's service in this respect will be rendered free of charges.

Table 2. Assistance for Replanting/ New planting - Traditional Area

Year	Assistance Re-planting (Rs./ha.)	Assistance for New planting (Rs./ha.)
1	5000	3000
2	2500	1500
3	2500	1500
4	2500	1500
5	3000	1800
6	4500	2700
Total	20000	12000

2. Rubber plantation for tribal settlement

This is a project for rubber development in the land of tribal people with financial collaboration of the concerned state governments. The Rubber Board undertakes planting of rubber in the tribal land and maintains it. On attaining maturity the plantations are handed over to the beneficiaries. The beneficiaries themselves work in the plantations raised under the project and a part of their wages is contributed as their share in the project. An amount of Rs. 621 lakhs is sanctioned for this purpose during the plan period.

3. Maintenance of mature tribal plantations

The plantations raised earlier under the rubber plantation project for tribal settlement have now become ready for tapping. In order to prevent alienation of these plantations from the real tribals a programme is drawn up to provide training to the beneficiaries in scientific rubber tapping and processing of latex. It also provides for setting up common facilities for community processing of latex, effluent treatment, marketing etc. This programme also is to be operated jointly by the Board and the concerned state Government. The Board's involvement during the plan period will be Rs.125 lakhs.

4. Productivity enhancement.

In spite of having reached a high productivity level among major NR producers, even now there is ample scope for improving productivity. Productivity enhancement measures are essential to increase production at competitive cost. Similarly quality of raw rubber processed in the smallholding sector also needs improvement to be globally competitive. Improvement in quality can be brought in through intensive extension activities ensuring adoption of technology and timely use of appropriate inputs leading to productivity enhancement,besides building up of infrastructure for primary processing and marketing. The various programmes implemented towards achieving these objectives are enumerated below.

a) Procurement of plantation inputs – revolving fund

The programme involves purchase of plantation inputs utilizing a revolving fund of Rs.1000 lakhs and distribution of the materials through Rubber Producers' Societies (RPSs)/ companies jointly promoted by Rubber Board and RPSs, after collecting the price. The fund thus returned to the Board will be utilized to continue the procurement and distribution in the subsequent years. This programme is applicable only to mature rubber holdings. The inputs being distributed and the maximum quantity eligible per hectare of mature area are given in table 3.

b) Input concession

Every year a price concession on all input items is proposed to be given to the growers as an encouragement and incentive for adopting the scientific agro-management practices. Besides, a service charge also is being paid to the participating RPSs and/ or companies to meet the handling charges involved. The incentive to growers is 9% and the service charge to RPSs/companies is 10% of the cost of inputs.

c) Quality planting material generation

The Rubber Board is

Table 3. Estate Inputs for Productivity Enhancement

Sl.No.	Item	Quantity per ha
1	Rainguarding plastic	12kg.
2	Rainguarding adhesive	38kg.
3	Copper sulphate	25kg.
4	Copper oxychloride	8kg.
5	Spray oil	40litre

maintaining 8 nurseries in the traditional and non traditional area. These nurseries produce good quality budded plants of high yielding clones and are the source of genuine budwood material. It is also very essential to maintain these nurseries to ensure quality control and check unscrupulous practices by the private nurseries.

The outlay for implementing this component in the traditional area during the plan period is Rs.450 lakhs.

d) Farmer group formation and strengthening

From the mid 1980 onwards Rubber Board has been promoting formation of grassroots level organization of smallholders viz. Rubber Producers' Societies (RPS) with the major objective of strengthening the sector and to provide better services at close quarters. Already around 2100 RPSs have been formed. The Board has been implementing various programmes for strengthening these RPSs like arranging trainings, facilitating inter agency linkage and financial and technical assistance for setting up infrastructure.

During X plan period it is proposed to form new RPSs in areas where they do not exist now. The Board is also promoting formation of Self Help Groups (SHG) under the RPSs to increase farmer participation and to implement specific programmes for women development. The areas identified for supporting the RPSs/SHGs are the following

i) Financial assistance for purchase of latex collection equipments to set up latex/sheet/ scrap collection center.

ii) Financial assistance to arrange training programmes related to rubber sector such as bee keeping, nursery management, processing/preservation of latex, capacity building, accounts maintenance etc.

iii) Financial assistance for apiculture

iv) Providing planting material at concessional rates to raise rubber nursery.

The financial provision for these activities is Rs.50 lakhs

(Apart from these the RPSs will be supported for setting up group processing facilities, with pollution control and biogas generation, women empowerment programmes etc. These activities are included in the schemes / projects of the Board for 'Processing ,quality upgradation and product diversification' and 'Human Resource Development').

e) Support to Model RPS

This programme is to support Model RPSs and RPSs with Group Processing Centres for conducting training programmes for growers as well as office bearers of the RPS in the fields of latest agro-technology, group activities, group management etc.. Under this programme financial assistance is provided for purchase of computers and necessary peripherals, software and furniture. It also provides for training RPS personnel in the use of computer.

The assistance is proposed to be extended to 92 RPSs.

f) Educational campaign programmes and farmers' meetings

Dissemination of information regarding the latest trends in the industry is vital for the sustainability of the smallholdings, especially during this era of globalized economy. The Rubber Board in association with RPSs is arranging massive campaigns, seminars, group meetings, exhibitions etc. for this purpose. Through these interactions the Board also gets feedback information directly from the growers.

The expenditure proposed for these activities is Rs.100 lakhs.

g) Consultancy

Consultancy studies by reputed national/ international agencies are proposed to be carried out in order to assess the impact of various schemes , scientific need assessment etc.. Certain field surveys regarding trend in rubber production and productivity, replantable plantations etc. are also proposed to be carried out.

A provision of Rs.25 lakhs is made for this item during the X plan period.

5. Extra income generation from rubber plantations-Apiculture

Rubber plantations are good sources of honey and bee keeping in rubber estates will add to the financial viability of the plantations. In fact this potential of rubber plantations is only sparingly utilized now. A component for promoting extra income generation from rubber plantations through bee keeping is being implemented.

The proposal is to provide financial support to 5000 growers at the rate of Rs.2000 per grower for establishing bee keeping units in rubber plantations. The assistance is envisaged to be given to growers who undertake the venture on a group basis through RPSs or SHGs approved by Rubber Board. One bee keeping unit, as per the programme, is comprised of 4 beehives with colonies and a set of essential accessories like honey extractor, smoker etc.. The sponsoring RPS/SHG will be purchasing the units in bulk and distributing them to intending members. The eligible financial assistance will be released to the RPS/SHG after the units are established in the members' rubber holdings.

SCHEMES FOR NON-TRADITIONAL AREA

1. Replanting / new planting

During X plan period it is proposed to carry out new planting in 2500 ha. and replanting in 1000 ha. in the non-traditional area other than North Eastern region

For replanting, the component provides for a planting grant of Rs.20000 per ha. to growers having an area up to 5.00 ha. and Rs.16000 per ha. for those having an area between 5.01 ha. and 20.00ha. For new planting the planting grant is Rs.16000 per ha. to growers having an area up to 5.00ha. and Rs.12000 per ha. for those having an area between 5.01 ha. and 20.00ha.

The planting grant is given in 6 annual instalments as shown in table 4.

Apart from the above, all categories of growers are eligible for reimbursement of cost of polybagged plants of advanced growth at the rate of Rs.8.00 per plant limited to 500 plants per ha.

Table 4. Assistance for Replanting/New planting – NT Area.

Year	Replanting – up to 5 ha. (Rs. Per ha.)	Replanting - 5.01 to 20ha./ New planting up to 5 ha. (Rs. Per ha.)	New planting 5.01 to 20ha. (Rs. Per ha.)
1	5000	4000	3000
2	2500	2000	1500
3	2500	2000	1500
4	2500	2000	1500
5	3000	2500	1800
6	4500	3500	2700
Total	20000	16000	12000

2. Integrated Village Level Rubber Development

During the X plan it is proposed to have an integrated approach to rubber development on a village basis wherein it is proposed to have programmes for revitalization of sick plantations, established after 1997, replanting of poor plantations, implementation of productivity enhancement measures for mature plantations and creating processing and marketing facilities on a group basis. The various programmes of the component are given below.

a) Revitalization of sick rubber plantations.

The programme is to provide assistance to small growers to revitalize sick plantations for bringing these into normal standards of growth and stand per hectare. Plantations with a stand of less than 400/ha.but above 250/ha. will be considered for grant of assistance under this programme. The financial assistance will beRs.10000 per ha. given in 3 instalments over a period of 3 years starting from the first year at the rate of Rs.7000, Rs.2000 and Rs.1000 respectively.

b) Restocking of poor rubber plantations.

The programme is intended to provide assistance to small growers for restocking their poor plantations wherein the stand per hectare is far below the stand of 250/ha. Assistance in the form of grant will be at the rate of Rs.20000 per ha., limited to a maximum area of 2.00 ha. It will be given in 3 annual instalments. The instalments will be at the rate of Rs.10000, Rs.6000 and Rs.4000 respectively for first, second and third year.

c) Productivity Enhancement

Taking into consideration the socio economic importance and also the need for producing NR, the small holding sector needs to be supported with programmes ensuring higher returns to the farmer, which in turn will ensure sustainability. There is scope for increase in productivity, which requires transfer of technology and use of inputs at the appropriate time. Rain guarding materials, plant protection chemicals and spray oil are being supplied in the NT area, with price concession to growers and handling charge to RPSs/ companies as in the traditional area.

d) Financial assistance for smoke house

Small growers owning rubber plantations not exceeding 5.00ha. are eligible to receive financial assistance for construction of smoke house, provided that the plantation comprises mature rubber trees or rubber trees that would, in the opinion of Rubber Board, attain maturity within one year from the date of application for assistance. The construction of smoke house should be undertaken as per the design and specification laid down by the Board during the plan period.

The financial assistance from the Board is Rs.7500 or 50% of the cost of construction whichever is less. Smoke houses of larger capacities constructed by growers at higher cost also will be eligible for assistance limited to a maximum of Rs.7500 per smoke house. Financial assistance will be extended also for other models of smoke houses/ driers approved by Rubber Board.

3. Irrigation

The component provides capital assistance for promoting irrigation in the immature rubber plantations in non-traditional rubber growing areas. Rubber growers having immature rubber areas planted under the Rubber Plantation Development scheme only will be eligible to receive this assistance. Rate of assistance will be Rs.5000 per hectare or 50% of the actual cost whichever is less subject to a ceiling of Rs.50000 per grower. All categories of growers including large growers are eligible.

4. Boundary protection

The component is for granting assistance to small and marginal growers for boundary protection of their plantations. Immature rubber plantations raised under the RPD scheme only will be eligible for assistance.

The following types of boundary protection will be eligible for assistance under the component.

a) Five strand barbed wire fence supported on reinforced cement concrete poles
b) Five strand barbed wire fence supported on jungle hard wood post
c) 1.5metre wall stone hedge
d) Bamboo fencing, provided the fencing is strong enough to protect the plantation from possible loss due to grazing of cattle and other animals.
e) Trenches (1.5 metre wide at top, 1.5 metre deep and

Table 5. Financial assistance for fencing – NT Area.

Classification of holdings	Assistance offered (Rs. per hectare)*		
	For SC/ST growers		For others
	Item a, b and c	Item d	Item a,b,c and d
Rubber holdings up to 1.ha	4000	2500	1500
Rubber holdings above 1ha and up to2 ha	3000	2000	1200
Rubber holdings above 2 ha and up to 5ha	2200	1750	1000
For community plantings of smallholdings	Rs.1000 per 100 running metre length of protection structure		

* In the case of providing trenches and bunds as stipulated vide item `e', the rate of assistance will be limited to 50% of the assistance shown in the table

with suitably sloping sides) with dug out soil formed into firm bund inside the plot

The financial assistance will be given as cash reimbursement of the expenses incurred by the growers and will be limited as shown in table 5.

SCHEMES FOR THE NORTH EASTERN REGION

Rubber development in an organized manner started in the North East in 1967 when Rubber Board opened a Field Office in Tripura. This office was upgraded to a Regional Office in 1979 and in the same year a Regional Research Station also was established in Tripura for undertaking location specific research. Though smallholder development programmes were initiated during late 1970s, significant progress was achieved during the VII five year plan when Government of India sanctioned a scheme for the accelerated development of rubber plantations in North East.

As the land available for expansion of area in the traditional rubber growing region is limited, to ensure production of rubber to meet the domestic demand, development of rubber plantations in the non-traditional areas had to be taken up. North Eastern region is the most potential of the NT areas for rubber plantations because of the agro-climatic factors and socio economic and ecological considerations. An assessment made by the Rubber Board indicates that rubber plantations can be raised in about 450,000 hectares in the North East.

Taking into account the socio economic impact and also the need for producing more NR in the country, the sector needs to be supported with programmes ensuring better returns to the grower which in turn will guarantee a higher economic stability and sustainability.

The scheme for Rubber Plantation Development approved for the NE region during X plan aims at achieving a faster and sustainable rubber development in the region. The scheme has five components namely Rubber Plantation Development, Research, Processing, Quality upgradation and Product Diversification, Market Development and Human Resource Development. A brief description of the components is given below.

Rubber plantation development

This is the major component in the scheme implemented by the Board in North East. The scheme is aimed at promotion of rubber planting in a scientific manner, adopting the recommended package of practices.

A. New planting / replanting

The area proposed for new planting in NE region during the X plan period is 10,000hectares; of this 6375 ha. is for Group planting and 750 ha. for Block Planting. Area proposed for replanting is 150 ha., mostly in Tripura.

An amount of Rs. 20,000/- per hectare is paid in 6 annual instalments for holdings up to 5 ha. and Rs. 16,000/- per ha in 6 annual instalments for holdings above 5 ha. and up to 20 ha. Cost of planting materials of advance growth will be reimbursed @ Rs.8/- per plant, subject to a maximum of Rs. 4,000/- per ha. An interest subsidy of 3% on loans availed from banks participating in the scheme as per the norms fixed by NABARD, will be allowed to growers who do not avail planting and replanting grants. It will be limited to 50% of the subsidy payable to small growers.

B. Integrated Village Level Rubber Development.

An integrated approach to rubber based development on a village basis is adopted in the North Eastern Region during X Plan period. It is estimated that about 2000ha.would require additional support for bringing into normal standards of growth and stand per hectare. Apart from this, an area of about 1000 hectare has to be completely restocked since the present stand per hectare is far below the accepted norms. It is also proposed to identify potential areas for expansion, adopting block plantation as well as group plantation approach.

Block Planting

The Board has been implementing special programmes for economic rehabilitation of the tribal people in the NE Region . The Board in collaboration with the Tribal Welfare Department of the Government of Tripura is implementing the Block Planting project in which large blocks of tribal are as are planted with rubber initially engaging beneficiaries as wage earners. The plantations on attaining maturity will be parcelled out and handed over to the beneficiaries and they will be collectively helped to produce and market the rubber from their individual holdings. The programme is proved to be highly successful and popular for socio-economic upliftment of tribal families in NE Region. It is proposed to plant 750 hectares under block planting in NE Region during the X Plan period.

Group planting

As the involvement of the Board in the Block Plantation is much intense, the scheme could be provided only to a limited number of farmers. The Board, therefore, shifted its focus from individual farmers to groups. The group approach with greater involvement of community in the various areas adopted has achieved great success.The financial assistance provided is almost similar to that provided under the Rubber Plantation Development to individual growers.The concept will help to set up group processing centres and marketing channels, thus helping the growers not only to get better prices but also to ensure quality.

The financial assistance extended under the component are the following.

(1) Revitalization of sick rubber plantations :

The component is intended to provide assistance to small growers in NE Region to revitalize their sick plantations, having a stand of plants between 250 to 400 per hectare, for bringing these into normal standard of growth and stand per hectare. Assistance is in the form of grant @ Rs.10,000/- per hectare in three annual instalments @ Rs.7,000/- , Rs. 2,000/- and Rs. 1,000/- per hectare limited to a maximum of 2 hectare of rubber area owned by the applicant.

(2) Restocking of poor rubber plantations:

The component is intended to provide assistance to small growers for restocking their poor plantations having a stand of plants below 250 per hectare. Assistance is in the form of grant @ Rs.14,000/- per hectare in three annual instalments @ Rs.8,000/-, Rs. 3,500/- and Rs.2,500/- per hectare.

(3) Block Planting:

The project will be implemented in collaboration with the state government. In Tripura, 50% of the cost for the development of plantations will be met by state government. The Board will contribute 40% and beneficiaries' share will be 10%.In other states, where state governments' contribution is not available at present, the project would be implemented on a selective basis confining Board's involvement to a maximum of 50%.

(4) Additional assistance to Beneficiaries under Group Planting:

The component is aimed at providing additional assistance to all categories under Group Planting in NE Region during X Plan period. The scale of additional assistance for SC/ST beneficiaries is Rs.20,000/- per hectare and Rs.15,000/- per hectare for general category under group planting scheme, over and above the subsidy under Rubber Plantation Development Scheme.

(5) Supply of fertilizers and rain guarding materials at subsidized rates to small growers through RPSs:

The objective of the component is to provide critical inputs which are not generally available in the North-East to small growers through the groups (RPSs) established on a village basis to enhance the productivity level of the rubber small holding sector. The component envisages supply of fertilizers and rainguarding materials at 50% concessional rate to general category growers and 75% concessional rate to SC/ST growers.

C. Demonstration of Agro-management practices.

Rubber being a relatively new crop in the North Eastern Region, strong extension support is required to make the farmers adopt scientific agro-management practices in their plantations. The main components now under implementation are the following.

(1) Setting up of demonstration plots in farmers' fields for soil and moisture conservation methods (SMC): Under the component 2000 demonstration plots would be set up in NE Region during 10th Plan period under the assistance for demonstration of Agro-Management Practices.

(2) Setting up of demonstration plots in farmers' fields for controlled upward tapping. (CUT): Under the component, 1000 demonstration plots will be set up in NE Region under 'Assistancefor demonstration of Agro-Management Practices during 10th Plan period.

D. Educational campaign programmes and farmers' meetings.

The Board is also conducting meetings to keep the farming community informed about the latest trends in the industry especially during this era of global competition. The components now under implementation in NE Region for the benefit of Women Self Help Groups attached to Rubber Producers' Societies/ Rubber Growers' Societies are Training on Tapping, Crop Processing, Apiculture, Health and Hygiene Programme and Economic Activity. Technical support and expenditure within the schedule will be provided by the Board.

E. Irrigation.

Individual small rubber growers who have established irrigation system in their rubber holdings for irrigating the young plants will be eligible for a financial assistance of Rs.5,000/- per hectare limited to a maximum of Rs.50,000/- per grower.

F. Fencing.

Individual small rubber growers who provide fencing for protecting the young plantations during the year of planting only will be eligible for financial assistance as shown in table 6.

G. Quality planting material generation.

The Rubber Board is maintaining its own rubber nurseries in different parts of the NE Region. These nurseries scientifically produce good quality planting materials, to ensure quality control and to check unscrupulous trading practices adopted by the private nursery owners.

II. Research

Research activities in the NE region focus on location specific issues. Regional Research Stations were established for research on agro-management practices and crop improvement aspects of rubber. Trials on rubber based farming system with rubber as the major component are also laid in the various Regional Research Stations. Facilities are also established for providing fertilizer recommendation to the growers.

III. Processing, Quality upgradation and Product Diversification.

Scientific post harvest processing of latex into marketable forms of rubber is currently one of the thrust areas of the Board's activities in the North-East. Encouragement is given more for setting up community/group processing facilities than individual processing units. Effluent treatment in processing plants is given adequate emphasis and financial assistance is given to set up biogas plants attached to processing units. The estimated expenditure for setting up group processing facilities in one RPS will be Rs. 10 lakhs. Of this, 10% of the expenditure will be met by the beneficiary growers by way of land/ labour. Another 40% of the expenditure will be met by the concerned State Governments from their funds for tribal/social welfare programmes. So the Board's share of expenditure will be limited to 50% of the cost ie, Rs. 5 lakhs per RPS. This includes assistance for construction of smoke houses, biogas plants, training facilities, electrification and water

Table 6. Financial assistance for fencing - NE Region.

Category of holding	Scale of assistance for SC/ST (Rs/ha)		Scale of assistance for general category (Rs/ha)	
	Barbed wire fencing	Bamboo fencing	Barbed wire fencing	Bamboo fencing
Up to 1 hectare	4000	2500	1500	1500
1 to 2 hectares	3000	2000	1200	1200
2 to 5 hectares	2200	1750	1000	1000
Up to 1 hectare	10000*	-	-	-

**If the fencing is done with concrete poles with seven strands of barbed wire and two diagonal strands.*

connection, purchase of processing equipments etc.

Individuals are also financially supported for purchase of rubber sheeting rollers, construction of smoke house and setting up of biogas plants attached to their rubber processing sheds, in a limited way as noted below.

(1) Rubber Sheeting Roller:

Individual small rubber growers who have purchased and installed hand operated rubber sheeting rollers in their own land for improving the quality of Ribbed Smoked Sheets will be considered for financial assistance at a rate of 25% of the cost of the roller limited to a maximum of Rs. 5,000/- per set. The Board will also supply hand operated rubber sheeting rollers, free of cost to NGOs/RPSs/RGSs for the benefit of poor small growers in NE region, on need basis, subject to viable proposals and approval thereof by the Board.

(2) Smoke house:

Individual small rubber growers who have constructed smoke houses in their own land for improving the quality of Ribbed Smoked Sheets produced by them will be considered for financial assistance at a rate of 50% of the cost of construction limited to a maximum of Rs.10,000/- per smoke house.

(3) Biogas plants:

Individual small rubber growers who have constructed Biogas plants of suitable size in their own land for treating the effluent generated in their processing centres and control environmental problems, will be considered for financial assistance at a rate of 50% of the cost of construction limited to a maximum of Rs.5,000/- per unit

IV. Market Development

To provide marketing support to growers in the NE region, purchase depots were opened in the region. These outlets not only purchase sheet rubber produced by the small growers but also arrange distribution of agro-inputs. Export of NR to neighbouring countries is also promoted under this component.

V. Human Resource Development

To facilitate skill development for tapping as well as other aspects of rubber cultivation, infrastructure has already been developed including Tappers' Training Schools and Regional Training Centre with facilities for on-campus training on all aspects of rubber cultivation, processing and product development for all categories namely growers, managers, entrepreneurs etc.In addition to this, the Board has established a Rubber Research and Training Centre in Assam. There is also provision for intensive Short Duration Tappers'Training in selected plantations.

As part of an orientation programme, a study tour of growers('Sastradarsan') from the NE Region to the traditional belt is also being arranged at Board's expenses, in order to give first hand knowledge about rubber plantation industry.

The Rubber Board is implementing the programmes with its operational capability and infrastructure in toto with the involvement of rubber growers and there has been remarkable increase in the area new/replanted with rubber . Successful implementation of the projects has attracted appreciation and good comments not only from the groups who have benefitted from them, but also from outside agencies and experts. Considering the performance of the Rubber Board in the past, it is expected that the targets of the various schemes would be achieved during the X plan period also.

A BIBLIOGRAPHY OF INDIAN BIBLIOGRAPHIES ON NATURAL RUBBER

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Abstract

Contributions of the Rubber Research Institute of India (RRII) towards the bibliographic control of published literature through bibliography on natural rubber (NR) from India and abroad are assessed and documented. The institute has compiled 10 bibliographies of which three are systematic listing of publications of the RRII and the Rubber Board published since 1955. This list also includes five annotated bibliographies with abstracts of specific subjects including rubberized bitumen, rubber seed, exploitation technology, tapping panel dryness and rubber based farming systems. The institute also compiled an annotated bibliography on its own publications on soils and agronomic studies and an enumerative bibliography of international research contributions on Corynespora leaf disease.

Keywords: RRII; Information dissemination; Bibliographies; Bibliographic control; Natural Rubber Research.

Introduction

Access to information is key in the present day society for its smooth functioning and growth. New information generated at an exponential rate in each discipline through systematic R&D calls for proper documentation so that much time of the researcher can be saved and duplication avoided. This is true in the case of natural rubber (NR) also where remarkable progress has taken place in the recent past in the production, processing and industrial as well as engineering applications. On par with the developments in R&D activities, the information on NR is also increasing and it is available in a variety of sources including periodicals, presentations in scientific forum, dissertations, patents, books and monographs. Systematic listing of documents facilitates easy access to the right information to growers, researchers, information scientists and other clientele of NR information by providing bibliographic control of published literature.

The Rubber Research Institute of India (RRII), since its inception in 1955 as the Research Department of the Rubber Board, has contributed substantially towards the generation of NR information and also for the bibliographic control of published literature. In addition to providing the traditional library services and other bibliographic and information dissemination tools, the institute compiled a series of bibliographies not only of its own publications but also of outside publications related to specific disciplines of NR research. This paper apprises the contributions of RRII towards bibliographic control of published literature on NR from India and abroad.

The RRII has compiled 10 bibliographies which are classified mainly into two broad categories, namely enumerative and annotated subject bibliographies (Fig. 1). The first group comprises of three enumerative bibliographies on NR literature published by officers and scientists of Rubber Board and RRII. The bibliography of connection, purchase of processing equipments etc.

Individuals are also financially supported for purchase of rubber sheeting rollers, construction of smoke house and setting up of biogas plants attached to their rubber processing sheds, in a limited way as noted below.

(1) Rubber Sheeting Roller:

Individual small rubber growers who have purchased and installed hand operated rubber sheeting rollers in their own land for improving the quality of Ribbed Smoked Sheets will be considered for financial assistance at a rate of 25% of the cost of the roller limited to a maximum of Rs. 5,000/- per set. The Board will also supply hand operated rubber sheeting rollers, free of cost to NGOs/RPSs/RGSs for the benefit of poor small growers in NE region, on need basis, subject to viable proposals and approval thereof by the Board.

(2) Smoke house:

Individual small rubber growers who have constructed smoke houses in their own land for improving the quality of Ribbed Smoked Sheets produced by them will be considered for financial assistance at a rate of 50% of the cost of construction limited to a maximum of Rs.10,000/- per smoke house.

(3) Biogas plants:

Individual small rubber growers who have constructed Biogas plants of suitable size in their own land for treating the effluent generated in their processing centres and control environmental problems, will be considered for financial assistance at a rate of 50% of the cost of construction limited to a maximum of Rs.5,000/- per unit

IV. Market Development

To provide marketing support to growers in the NE region, purchase depots were opened in the region. These outlets not only purchase sheet rubber produced by the small growers but also arrange distribution of agro-inputs. Export of NR to neighbouring countries is also promoted under this component.

V. Human Resource Development

To facilitate skill development for tapping as well as other aspects of rubber cultivation, infrastructure has already been developed including Tappers' Training Schools and Regional Training Centre with facilities for on-campus training on all aspects of rubber cultivation, processing and product development for all categories namely growers, managers, entrepreneurs etc.In addition to this, the Board has established a Rubber Research and Training Centre in Assam. There is also provision for intensive Short Duration Tappers'Training in selected plantations.

As part of an orientation programme, a study tour of growers('Sastradarsan') from the NE Region to the traditional belt is also being arranged at Board's expenses, in order to give first hand knowledge about rubber plantation industry.

The Rubber Board is implementing the programmes with its operational capability and infrastructure in toto with the involvement of rubber growers and there has been remarkable increase in the area new/replanted with rubber . Successful implementation of the projects has attracted appreciation and good comments not only from the groups who have benefitted from them, but also from outside agencies and experts. Considering the performance of the Rubber Board in the past, it is expected that the targets of the various schemes would be achieved during the X plan period also.

A BIBLIOGRAPHY OF INDIAN BIBLIOGRAPHIES ON NATURAL RUBBER

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Abstract

Contributions of the Rubber Research Institute of India (RRII) towards the bibliographic control of published literature through bibliography on natural rubber (NR) from India and abroad are assessed and documented. The institute has compiled 10 bibliographies of which three are systematic listing of publications of the RRII and the Rubber Board published since 1955. This list also includes five annotated bibliographies with abstracts of specific subjects including rubberized bitumen, rubber seed, exploitation technology, tapping panel dryness and rubber based farming systems. The institute also compiled an annotated bibliography on its own publications on soils and agronomic studies and an enumerative bibliography of international research contributions on Corynespora leaf disease.

Keywords: RRII; Information dissemination; Bibliographies; Bibliographic control; Natural Rubber Research.

Introduction

Access to information is key in the present day society for its smooth functioning and growth. New information generated at an exponential rate in each discipline through systematic R&D calls for proper documentation so that much time of the researcher can be saved and duplication avoided. This is true in the case of natural rubber (NR) also where remarkable progress has taken place in the recent past in the production, processing and industrial as well as engineering applications. On par with the developments in R&D activities, the information on NR is also increasing and it is available in a variety of sources including periodicals, presentations in scientific forum, dissertations, patents, books and monographs. Systematic listing of documents facilitates easy access to the right information to growers, researchers, information scientists and other clientele of NR information by providing bibliographic control of published literature.

The Rubber Research Institute of India (RRII), since its inception in 1955 as the Research Department of the Rubber Board, has contributed substantially towards the generation of NR information and also for the bibliographic control of published literature. In addition to providing the traditional library services and other bibliographic and information dissemination tools, the institute compiled a series of bibliographies not only of its own publications but also of outside publications related to specific disciplines of NR research. This paper apprises the contributions of RRII towards bibliographic control of published literature on NR from India and abroad.

The RRII has compiled 10 bibliographies which are classified mainly into two broad categories, namely enumerative and annotated subject bibliographies (Fig. 1). The first group comprises of three enumerative bibliographies on NR literature published by officers and scientists of Rubber Board and RRII. The bibliography of

Corynespora leaf disease of *Hevea* is also grouped under this category. The five annotated bibliographies with systematic listing of bibliographic details of publications with abstracts on specific disciplines published all over the world are included in the second group. The annotated bibliography of RRII publications on agronomic and soil studies is also included here. The NR literature covered in these bibliographies includes books, conference papers, monographs, theses and other publications of relevance, besides research articles in periodicals.

ENUMERATIVE BIBLIOGRAPHIES

The RRII published the first bibliography in 1983 with the objective of better exposure and utilization of the scientific contribution of Rubber Board and the RRII in its full depth and breadth before the national and international scientific community (Nair, 1983). This volume provides full bibliographic details of 490 selected scientific and technical contributions of RRII and Rubber Board since 1955 till August 1983. The bibliography has four sections with its main classified part listing all contributions alphabetically by the names of the first author under major subjects. The second part is the list of all publications by each author with the listing of authors alphabetically. The third part provides particulars such as qualification, designation and period of service of the authors. Abbreviations and a short index of major subject group constitute the final section.

The 1994 compilation (Jose and Korah, 1994) consists of four sections and covers bibliographic details of publications by scientists and officials of RRII and the Rubber Board published during 1984-94. In the bibliographic section, papers are arranged alphabetically under the surnames of each author. The keywords index comprises of relevant key words selected from the titles and the theme of the paper. Author index includes names of authors arranged alphabetically with their entry number suffixed. In the last section, the full names and addresses of authors are included.

The book by Korah and Jose (2005) is a comprehensive list of 2368 scientific and technical contributions from the RRII/Rubber Board published from 1955 to 2005.This volume with its format and style similar to that of the previous volumes incorporates the publications already covered in the earlier two volumes and also consists of four sections. In the bibliographic part, the papers are arranged alphabetically under authors' names. Section two is the key word index comprising of all relevant key words selected from the title and content of papers. The author index and affiliation and address of authors are given in sections three and four respectively.

The bibliography compiled by Jose and Latha (2006) lists 166 references on leaf diseases of rubber caused by *Corynespora cassicola* published during 1917-2005. Indonesia with 39 citations leads the list in terms of maximum number of papers, followed by Sri Lanka (32), India (30), Malaysia, Thailand (25 each), France (7), Nigeria, Brazil (6), China (2), Bangladesh and Ivory coast (1 each). The country of publication of six citations is not known.

ANNOTATED SUBJECT BIBLIOGRAPHIES

The RRII is very active in compiling annotated bibliographies of contextual and thematic relevance. Annotated bibliographies include a brief descriptive paragraph and/or an evaluative summary of the papers in addition to citations of books, articles and other documents. The RRII has compiled six subject bibliographies (Fig. 1) one of which (Karthikakyttyamma and Sathisha, 2004) lists publications of RRII on soils and agronomic studies of *Hevea*.

RUBBERIZED BITUMEN

This bibliography (Latha

et al., 2002) lists 82 publications on rubberized bitumen and related fields published since 1931. The book has two sections. In the bibliography section entries are arranged alphabetically by the title followed by the authors, citation and abstract. The keywords index lists the relevant keywords alphabetically suffixed with the respective entry numbers in the bibliography section.

RUBBER SEED

This compilation on rubber seed (Sujatha et al., 2003) covers literature on various aspects of rubber seed including collection, rubber seed oil, rubber seed cake and commercial as well as industrial applications. The bibliography section is arranged alphabetically by the title followed by authors, citation, abstract and key words. The key word index alphabetically lists all the key words from the articles with the respective entry numbers in the bibliography section.

EXPLOITATION TECHNOLOGY

The bibliography on exploitation technology (Latha and Jose, 2003) contains 200 records on various aspects of exploitation technology and related areas including tapping systems, stimulation, rainguarding, labour productivity and tapping panel dryness published during 1990-2003. The bibliography has three sections, bibliography, key word and author index.

TAPPING PANEL DRYNESS

The annotated bibliography on TPD (Latha and Jose, 2005) provides details of TPD or brown bast research in India and abroad since 1917. The compilation consists of three sections. In the first section, the references are arranged in the chronological order under the surname of each author. The keyword index and author index are suffixed with their entry numbers.

RUBBER BASED FARMING SYSTEMS

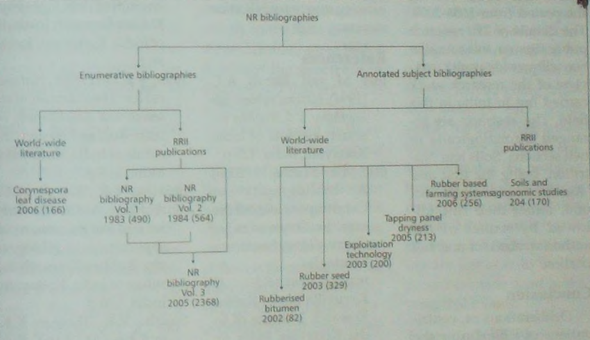

Fig. 1. Indian bibliographies on natural rubber: A subject-wise classification

Figures in parenthesis indicate total number of publications

The compilation on rubber based farming systems (Sujatha et al., 2006) lists bibliographic details of 256 research articles published all over the world during 1941 to 2005 on rubber based farming and related aspects. This bibliographic tool provides the international trends on different aspects of intercropping in various rubber producing countries.

SOILS AND AGRONOMIC STUDIES IN *HEVEA*

The compilation by Karthikakuttyamma and Sathisha (2004) is a collection of abstracts with full bibliographic details of RRII publications in the field of agronomy and soils covering the period from 1956-2004. The details of 170 research publications in this compilation will provide a quick overview of the research work carried out in India in this field. The abstracts are arranged chronologically in two sections `Soils and Nutrition' being the first and `Agromanagement' the second, under their title followed by names of the author(s), abstract and full citation.

Conclusion

Deliberations on contributions of RRII during the past 50 years would be incomplete without documenting its efforts towards generation, processing and transfer of information on NR. The RRII Library through its specialized tools and services, strive for the vital bibliographic control essential for the proper dissemination of NR information.

The systematic bibliographies so far published by the RRII facilitate bibliographic control of publications from RRII and Rubber Board whereas the subject bibliographies, in addition to the above, purvey information on specific subjects during specific periods. The NR bibliographies, as systematic listing of documents with full bibliographic details, assist researchers, information scientists and other clientele as effective and potential bibliographic tool for handling the existing sources of NR information.

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SOLAR RADIATION AND ITS EFFECTS ON HEATING

Shammi Raj
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Every organism at the surface of earth is immersed in an environment of radiation consisting of short-wave radiation from heavenly bodies and long-wave radiation from nearby surfaces including earth. The variation of total radiant flux from one site to another on the surface of the earth is enormous and the distribution of plants and animals respond to this variation. The ultimate source of all the energy for physical and biological processess occuring on the earth is radiation received from the sun.

At the average distance of the earth from the sun, the mean intensity or strength of the solar beam has been estimated to be about 2.0 calories per minute per square centimeter. It is the intensity of radiation flux received on a plane surface held at right angles to the beam of the sun vertically overhead in the absence of the earth's atmosphere. This is called the Solar Constant. Heating is correspondingly weaker for the slant rays of the sun over the earth's surface, but it covers a larger area. Hence solar radiation depends upon latitude and the time of the year. The 24 hr total amount of solar energy depends on the length of the day between sunrise and sunset which is a function of latitude only. Incoming solar radiation is mainly in the form of short-wave radiation, about half of it within the spectrum of wavelengths that are visible to the eye as light (0.4 to 0.7μ). After absorption of the short-wave radiation, the outgoing radiation from the surface of the earth is in the longer wavelength (3 to 100μ). The oxygen, ozone, water vapour, clouds and carbon dioxide present in the atmosphere are most effective in absorbing energy in the long wavelengths of the outgoing terrestrial radiation (radiation emanating from the earth). This energy warms the air at the levels where it is absorbed and the air reradiates the energy in all directions, so that some of it returns to earth and much of it is involved in further radiation exchanges within the atmosphere. As a result the average temperature near the earth is kept at a level about 15°C which is found to be 40°C higher than that when the atmosphere is absent. A 10% increase in the amount of carbon dioxide will increase the temperature by 0.3°C. The grand totals of incoming and outgoing radiation balance each other within the margin of uncertainty of the global all seasons estimates. It is probable however, that the budget is not perfectly balanced every year and that some accumulations or deficiencies of heating are left over to be dispersed or made good in the years that follow.

Temperature variation with height

There are two levels where the atmosphere is heated, namely at the earth's surface and the top of the ozone layer which is about 50 km above (in the stratosphere or the second thermal layer). These levels generally show a net gain in the radiation balance. Prevailing temperatures tend to decrease with distance from these heating surfaces. The world's average lapse rate of temperature (change in temperature with altitude) in the lower atmosphere is 6 to 7°C for every vertical kilometer away from the ground. Lower temperatures prevail with increasing height above sea level because of the less favourable radiation balance in the free air and because rising air undergoes a reduction of temperature associated with its expansion due to the decline in the presence of the overlying atmosphere. The rising air (being lighter) can be treated as a parcel of air which does not exchange heat with the surrounding atmosphere, the process being termed as adiabatic. Therefore, this is the adiabatic lapse rate of temperature which equals about 10°C reduction in temperature for every one km for dry air and 5°C per km for saturated air in which condensation (with liberation of latent heat) is produced by the adiabatic cooling. The difference between these rates of change of temperature (and therefore density) of rising air currents and the state of the surrounding air determines whether the upward currents are accelerated or retarded. In simpler terms, the difference between rates determines whether the air is unstable so that vertical convection with its characteristically attendant tall cumulus cloud and shower development is encouraged, or whether it is stable and convection activity is damped down. For these reasons, the air temperatures observed on hills and mountain heights are generally lower than those on low ground except in the case of extreme plateaus, which present a raised heating surface. That is why on still sunny days, a mountain peak is able to warm the air that remains in contact with it making it clearly visible to the eye from a long distance.

Absorption of radiation by surrounding air in depressed landforms are more effective than that of the projected land masses because of the spread of radiation over wider angles in projected lands. That is why valleys experience higher temperatures compared to peaks in a land mass.

Solar radiation is the main source of heat energy to the biosphere. The intensity aspect of thermal energy, i.e. temperature, is of paramount importance for organic life. It controls the physico-chemical processes, diffusion rates of gases, solubility of substances, rate of reactions, equilibrium of systems and compounds and stability of the enzyme system. Nevertheless, the vertical distribution of flora and fauna on the earth's surface primarily relates to the temperature distribution, apart from other climatic factors. ●

RB Bulletin to include more Extension Literature...

Rubber Board Bulletin, though predominantly technical in content, can publish a few lighter popular material as well. As the publication is mainly intended to planters, a few pages are set apart for authoritative extension literature also. Comprehensive articles about ongoing schemes and projects, news, reports and photographs of events of national and international importance, reviews, extracts and other popular articles will also find a rightful place in the Bulletin.

– Editor

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Dr. James Jacob
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CONTENTS

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CATCHING UP WITH THE MONSOON AT AGUMBE, THE CHERRAPUNJI OF THE SOUTH

James Jacob

Joint Director (Crop Physiology), Rubber Research Institute of India, Kottayam-686 009, Kerala.

*The author, along with his colleague *Dr. Badre Alam, Environmental Physiologist, recently visited a few rubber holdings under Kundapura Regional Office of the Rubber Board, covering Uduppi and Kundapura Taluks of Uduppi District and Thirthahalli, Sagar and Soraba Taluks of Shimoga District in Karnataka. In this article he describes his impressions about rubber cultivation in this non-traditional region based on the visit made at the height of the monsoon.*

Although Parasuram Express was late by more than half an hour when it left Kottayam in the morning, it pulled into Mangalore station right on time. It was after a long time I was traveling along this route by a day train during peak monsoon time. It was raining throughout the journey and the monsoon was in its fullest fury. God's own country appeared all the more beautiful in the rains. I saw the Periyar, the Bharathapuzha, the Kallayi puzha, the Mayyazhy puzha and numerous other less known rivers flowing in full. Monsoon is the only time when you find full water in the Periyar and the Bharathapuzha, the two most important and romantic rivers of Kerala. We got out of the Mangalore Railway Station into a cold and wet night. After a quick supper we immediately retired for the day.

I woke up at 5.30 the next morning and torrential rains greeted me. I spent some time quietly watching the rains. By 7 o' clock we were on the road heading towards the Agumbe Ghats in a North Easterly direction from Mangalore. On the way, we had a refreshing breakfast of idli-vada-sambar. Mr. Pradeep and Mr. Reghunadh, our officers from the Kundapura Regional Office, were waiting for us at Hebri where rubber cultivation is fast picking up. Hebri lies in the foothills on the Western Ghats and the region has an altitude of less than 100 m. above MSL. The topography is plain to gentle slope and the vegetation is luxuriant and green. Soon we were in Muniyal to check out the rubber plantation of Mr. Sebastian who along with his son Mr. Siju arrived at Muniyal in January 2005 from Angamaly in Kerala. The father-son duo did not waste any time. They cleared the land and planted 2850 polybag plants of RRII 105 in June 2005 itself and another 2000 plants during 2006 - just a couple of weeks before our visit. We spent some time talking with them inside their newly made farmhouse, which was modest, but quite spacious. We spent more time walking with them through their young plantation. The one and two year old rubber plants looked healthy and happy. With the rain still drizzling, the young rubber leaves were wet and they appeared so beautiful and exuberant.

Mr. Sebastian also has another 870 trees of RRII 105, which are in the seventh year of taping. He brought this estate some time last year. Between the end of October 2005 and middle of

* Dr. Badre Alam, is presently a Senior Scientist with the National Research Centre for Agroforestry, Jhansi.

BOOK ON TPD RELEASED

Seen in the photograph along with our Chairman and the editors are Dr. Wan Abdul Rahman Wan Yaacob (Malysia), Chairman, IRRDB Dr. Chen Quiubo (China) and Mr. Hubert Omont (France), both Vice-Chairmen, IRRDB, Dr. Abdul Aziz S.A. Kadir (Malysia), Secretary-General, IRRDB and Mr. Mai Van Son (Vietnam), Director, Rubber Research Institute of Vietnam.

Shri Sajen Peter IAS, Chairman, Rubber Board, released the book entitled "Tapping Panel Dryness of Rubber Trees" published by the Rubber Research Institute of India during the IRRDB Annual Meeting at Ho Chi Minh City, Vietnam on 16 November 2006. This book, which is the first of its kind dealing with TPD was edited by Dr. James Jacob, Joint Director (Crop Physiology), Dr. R. Krishnakumar, Senior Scientist (Crop Physiology) and Dr. N.M. Mathew, Director of Research (Retd.), Rubber Research Institute of India.

This book has 33 chapters contributed by scientists working in the NR sector in eight different countries and discusses topics ranging from the extent and prevalence of TPD, Physiology, Biochemistry and Molecular Biology of TPD, Pathology of TPD and its Economics and Management. This is an excellent reference manual for planters and scientists.

January 2006, he got 36 tapping days (in the d/2 system) and got roughly 1.9 tonnes dry rubber, which is about 60 g/tree/tap. Not a bad yield at all.

Fig. 1. Mr Siju Sebastian in his one year old plantation near Muniyal (Karkala taluk).

The Revenue Department in Karnataka has been completely computerized. It takes only a few minutes and a small fee to get copies of revenue documents such as Record of Tenancy Certificate (RTC). This must have been a pleasant surprise to Keralites who are increasingly migrating to this region for rubber cultivation. Many people in this region, both natives and new migrants from Kerala are taking up rubber cultivation in a large way. You can buy and cultivate a property only if it has an RTC issued from the revenue office.

Next we visited the holdings of Messrs Balakrishna Shetty (Manamakki village), Madanamohana Ulloor (Shedimane village) and Venkitramana Nakshtri (Shedimane village); all in Kundapura Taluk. All these holdings lie at an altitude of 70-90 m above MSL and the topography is plain. Messrs Ulloor and Nakshtri are pioneers in rubber cultivation in their villages. The first planting was in 1985 and there were only three other growers to take up rubber cultivation with them at the beginning. The pioneers derived inspiration to grow rubber in this region from a seminar organized by the Ujire Rubber Growers and Producers Marketing Society with the help of the Rubber Board in the early 80s.

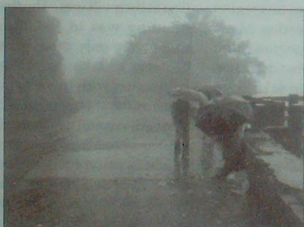
Fig. 2. Scenes of mature and young rubber plantations from Someswara where rubber is fast replacing coconut (Karkala taluk).

Several growers whom we met during this trip mentioned about the Rubber Board and this particular 1980 seminar. Evidently we earned many "converts" from this seminar and people still talk about it. How effective our extension efforts must have been! Now, many farmers in this region believe that rubber is the best crop for them. This traditional coconut and arecanut-growing tract is fast changing to rubber cultivation.

Diseases such as abnormal leaf fall and bark diseases are common, but according to the growers, incidence of pink disease is relatively less. Unavailability of micron sprayer is a major constraint. From what the growers said one would get the impression that TPD is not as severe as in the traditional areas, at least for now.

Rubber cultivation in this region faces serious threats from wild animals like bison, deer and monkey as rubber holdings are interspersed with forestlands, which are abundant. Many growers resort to electric fencing. Lack of well trained tappers is yet another serious concern. Widely scattered holdings and lack of market access are also a problems.

The total rainfall received in this region is quite high (ranging from 3500 – 4800 mm). The closer you travel to the Ghats, the more the rainfall. Rainy season is from the first week of June to middle of September, when more than 90% of the annual rainfall is received. Given



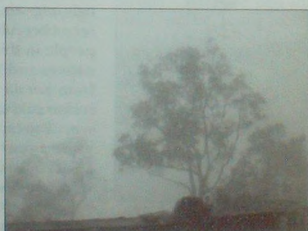


Fig. 3. Monsoon in Agumbe Ghats. Drifting clouds and mist occasionally revealed majestic trees.

this skewed distribution of rainfall, conserving rain water in the soil should be the focus of all agronomic operations. Cover crop will aid in improving the soil condition and conserving soil moisture, but this is not popular in this region. According to the growers, cover crop seeds are not available. In general, the soil appeared quite healthy and growth of the rubber trees was satisfactory, but there were patches and localities where the surface soil was hard and crusty with hard laterite rock. Growth of rubber and other trees was relatively poor in such places. October to June can be fully dry and North East monsoon is almost absent. A few summer showers are possible, but not assured. Summer is more hot and less humid than in the traditional region. Although summer can be very hot, few young rubber plants actually dry up. The growers practise good dry farming techniques such as mulching the plant basin, but they do not irrigate.

Most of the smallholders tap rubber trees on alternate days (d/2) and a very few of them tap once in three days (d/3). Tapping rest during peak summer is common. Rainguarding was not popular until this year. Owing to the current price boom growers are now doing rainguarding. The general trend has been to tap on alternate days with full rest during monsoon (about 3 months), peak summer (about 1-2 months) and wintering time (about 1 month). Thus tapping is normally done for only 6-7 months in d/2 frequency and 100 tapping days/year is the best bet. From what the growers said we got the definite impression that an average yield of 2 – 2.5 tonnes of dry rubber/ ha/year is possible in this region.

By 3 pm we had a sumptuous vegetarian lunch from Someshwara (approximately 100 m above MSL) lying at the foot of the Agumbe Ghats and started climbing the hill. It was cold, windy and raining relentlessly.

Agumbe Ghat ride was a relatively short one - less than 30 minutes to climb an altitude of 500-600 m. If you want to experience the wild fury of the monsoon, just go to Agumbe during July as we did. The Ghat was thickly vegetated. In the torrential downpour and the prevailing thick fog, visibility was so bad that we could hardly see anything beyond a few meters. Clouds of fog drifted in the breeze occasionally, revealing glimpses of dark vegetation and tree tops. At the top of the Ghat is the sleepy village of Agumbe. Once you reach the top of the Ghat, topography suddenly changes and you realize that you have reached the edge of the Deccan plateau.

Mr. Suresh, Field Officer from the Sagar office of the Rubber Board who was accompanying us told about the SVS High School at Agumbe where there was a weather station. Looking at the intensity of the rainfall that was falling around us, the weatherman inside me woke up. We stopped our car near the school gate and the three of us ran across the ground to the school verandah. We were fully drenched when we entered the school. The students and teachers looked at us with some amusement. Sri. Ramappa, the Head Master was a very kind man and talked to us about Agumbe weather when he understood our intention. He was pleased that we were interested in rains and visited Agumbe, known as the Chirapunchi of the South during the height of the monsoon and that we were actually enjoying the monsoon experience. We were drenched to our skin and feeling very cold - yet we really enjoyed the experience.

The school was started in the 1960s and since then they have been having a weather station. Today, the school has an Experimental Model Observatory (EMO) installed by the Indian Meteorological Department (IMD) and they religiously collect data on temperature, atmospheric pressure, wind velocity, relative humidity and rainfall and send the data to the IMD office in Bangalore four times a day round the year. Since the information is strictly confidential, we could not look at the actual data. But we were told that the average rainfall in Agumbe could be anywhere between an astounding 7000 – 7500 mm/year and certain years in the past this has gone beyond 10000 mm/year. Almost 90% of the annual rainfall happens in just two and a half months commencing from the middle of June. What is most striking is that this heavy cloudburst occurs every year in a tiny area that has a radius of hardly 5 km. What a closely guarded secret of nature!

About an hour's ride from Agumbe was the rubber holding of Mr. H.K. Mr. Raveendra in Theerthahally Taluk. Raveendra is a very interesting person and a hard working farmer who had about 800 rubber trees (RRII 105) planted in 1988-89. He has about a dozen head of cattle and he was a qualified veterinary technician who attends three to four calls per day. This interesting and hard working farmer does not apply any chemical fertilizers to his mature rubber trees, but in the first couple of years after planting he did give chemical fertilizers. He incorporates all the cattle manure into his rubber plantation. It was interesting to note that he taps only for five months/year on alternate days. He rests the trees during rainy season (June – September), wintering time (December – January) and peak summer (May). No wonder his yield is only about 3.5 kg dry rubber/tree/year. He says that his philosophy is to give enough "leisure" to the trees, which is perfectly in tune with the philosophy of sustainable productivity and traditional farm wisdom. The tree certainly appeared quite healthy, but I was convinced that he was giving a little too much leisure to the trees and that he could easily harvest another 1 to 1.5 kg dry rubber/tree/year without any problem.

Fig. 4. Mr. Raveendra in his holding damaged by severe storm (Thirthahally taluk).

Recently he lost about 60 rubber trees to severe windstorm and I could see the anguish on his face. He is trying to stake some insurance claim for the damage through Rubber Board.

Many of the 60 trees lost to the wind were uprooted or their branches and main trunk fully destroyed. People of Shimoga have been traditional areca farmers and I could see Mr. Raveendra's areca sentiments; he had already planted some areca saplings where the rubber canopy was now open due to the wind damage. But I told him that there was absolutely no chance of his areca seedlings growing well and giving him any bunch inside the rubber plantation.

It was still raining and we were feeling very cold walking through Mr. Raveendra's plantation. He took us inside his home and served us some excellent hot coffee with all the warmth of a rural farmer. Of course, the milk in the coffee was not the pasteurized white stuff that comes in polythene bags; it was his own cattle's fresh milk.

Another one and half hour's ride in the rain and we would find ourselves in the comfort of the hotel room in Sagar. Suresh had told a few enterprising rubber

Fig. 5. Mr. Bapat's holding in Sagar.

growers in Sagar about our visit and I was surprised that a couple of them were waiting to talk to us when we arrived at the hotel at eight in the night. They shared their "rubber experience" with us in detail. At about 10 o'clock, fearing that no supper would be available if we went on discussing any further, we promised them to see their holdings next morning and called it a day. Badre and I rushed to a nearby restaurant to grab some food.

Next day as early as seven in the morning the growers were waiting for us in the hotel lobby. We had a nice breakfast of idly-vada-sambar, the standard breakfast menu and straight went to the holding of Mr. Bapat, which was not very far from Sagar town.

Mr. Bapat is an excellent rubber grower in addition to being a highly enterprising businessman. Mr. G.N. Bhide, the founder president of the Ujire Rubber Growers and Producers Marketing Society has been the inspiration behind Mr. Bapat and many other pioneers in rubber cultivation in Shim-oga and South and North Canaras. He planted 2100 polybag plants of RRII 105 during 1990. He believes that a small percent of RRIM 600 and GT 1 was also planted along with RRII 105. He started with 5000 stumps and eventually selected 2100 polybag plants for field planting. He had banana as an intercrop for the first three years for which drip irrigation was provided. According to him, banana cultivation gave him not only attractive revenues from banana, but also gave better growth of rubber. Apart form the irrigation water given to banana, it is highly likely that the shade provided by banana to young rubber plants would have helped the latter to tide over the severe summer stress in this region – something that the Physiologists of RRII have already proved.

According to Mr. Bapat, 95% of his trees reached tapable girth by the sixth year. A quick inspection of the holding revealed that almost 20% of the original number of trees planted were lost due to wind damage, diseases, TPD or simply they were not there (vacant) or have not attained tapable girth. The holding was losing trees at an average rate of 1.25% every year. Even in the traditional region, roughly 1% of the trees are lost every year. Thus, the older the estate, the less the effective stand/ha. As with any other living organism, as age catches up, rubber trees also

Fig. 6 Mr. Thomas's holding (Sagar taluk).

succumb to pests, diseases and natural calamities. Therefore, one should very critically evaluate how long the holding should be kept before replanting. We have several practices such as low frequency tapping that prolong the lifespan of the holding, but this has also a flip side to it.

The rainy season in Sagar extents from middle of June to the beginning of September. The mean average rainfall is in the range of 2500-3000 mm and 90% of the rain occurs during the above period.

It is said that rainfall used to be as high as in the range of 3500-4000 mm or even more until recently, but of late, this has gone down significantly. Winter (December-January) can be very cold when the minimum temperature is often well below 15°C. From October/November until April/ May, there is practically no rainfall. One or two summer showers may occur during April-May. Summer can be very hot and stressful. During monsoon sunshine is very limited, but not so during the rest of the year.

Mr. G. Chandra, basically a Keralite but born and brought up in Sagar, was another enterprising grower whom we met at Sagar. He had about 50 acres of mature rubber (1996 planting, RRII 105). He taps on alternate days with rainguarding during monsoon and gives two-weeks rest each during winter and peak summer. He gets about 130-140 taping days per year. The general impression has been that the growth was quite satisfactory and yield was close to 2 tonnes dry rubber /ha/ year.

We also visited the holding of Mr. Thomas Pallipurathusseri, a native of Kuttanadu in Kerala now residing at Thyaharthy in Sagar Taluk since 1990. During 1992 he planted 2000 plants of RRII 105.

He has been an absentee planter for some time in the beginning and it took about 8-10 years for the trees to come to tapping. In the beginning he followed d/2 tapping system, but recently he shifted to once in three days tapping with rain-guaridng during the rainy season.

Fig. 7. Scenes of young plantations of Mr. Manjunath (Soraba taluk).

The general impression has been that TPD and other diseases are generally less severe in this region than in the traditional areas. It, however needs to be watched as to how the diseases and TPD intensity increased as years go by and more area is brought under rubber cultivation.

Next we visited the holdings of Mr. B.T. Manjunath and his brother Mr. V.K. Satheeshchandra in Soraba Taluk. Both are novices to rubber cultivation. Between them they planted 2000 plants in 2003, 2200 plants in 2004 and 1750 plants during 2005. The clone is RRII 105. The plants looked healthy and beautiful and the growth was extremely uniform. The brothers have planted pineapple as an intercrop for which they give irrigation. Mr. Manjunath came to Palai, the cradle of rubber nurseries to buy budded stumps in the beginning. He raised his own polybag nursery and selected only the best ones for field planting.

The brothers were of the opinion that planting should be completed between June and August and late planting should be avoided in Shimoga. Because, both winter (commencing from November/December)

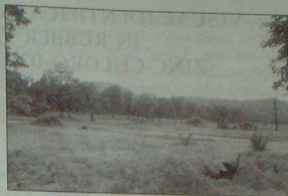
 

Fig. 8. Views of the general topography and vegetation in Sagar and Soraba taluks.

and summer that follows can be quite stressful to young rubber plants.

Travelling through the region, we could get an impression about the people, the local vegetation and terrain and the prevailing general agricultural practices. Most peasants do subsistence farming of maize, paddy, groundnut or tobacco in low lying wet land. The upland (dry land) is usually left as pastures or agroforestry land. We got the impression that uplands are suitable for rubber cultivation and such large areas are available.

We concluded our field visit and left Sagar by1 pm and arrived at Mangalore railway station just before 6 pm, right in time to catch the Malabar Express back to Kottayam. When we boarded the train, the monsoon was still pounding. Images of the two-day visit came to my mind – images of rubber plants and rains. I tried to place them in some perspective. Rains weighed heavily on my mind. They gave the young rubber plants strength to tide over the harsh summer ahead. The rains rejuvenate nature, and every thing that dwells in it - plants, animals and human beings.

Monsoon is not just about rains and romance, or about ayurveda and scholarly contemplation as Alexander Frater wrote; it's our very life, and we cannot complain about the miseries of the rainy season. We cannot imagine a life without the monsoons. They have been visiting us like an annual ritual for several millennia with great punctuality. Without the monsoons, the Western Ghats would not have been what they are today. The English would not find the Nilgiris and the Kodai hills charming and pristine. Our rivers would not have existed. *Neelakurinji* would not bloom in the Munnar hills and the lion-tailed macaque would not roam in the Silent Valley. Tea gardens would not carpet the rolling hills and the fragrance of the coffee blossom would not have been known to us. Imagine the Western Ghats with no spices and condiments; the history of the India sub-continent itself would have taken a different course! Not to say the least, rubber plantations would not have come up here. As I was lost in my monsoon musings, the train slowly left the station. I looked out of the window into the darkness and it was still raining relentlessly. Having travelled in the rains for a few days, I tried to fathom Frater's thoughts and feelings when he was "Chasing the Monsoon" from Trivandrum to Cherrapunji by all means of transport. When I left Kottayam three days ago, I knew that the monsoon had already advanced into the North Malabar and the Konkan, but I was glad that I could catch up with it at Agumbe, the Cherrapunji of the South. ●

VISUAL IDENTIFICATION OF TENSION WOOD IN RUBBER TIMBER USING ZINC-CHLORO-IODIDE FORMULATION

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Abstract

The occurrence of tension wood is a serious natural defect in rubber wood (*Hevea brasiliensis*) which causes more than 40% recovery loss in rubber wood processing industries. Tension wood zones can not be distinguished clearly for elimination of such zones during sawing operations. The present study deals with the development of a macroscopic staining technique for the visual identification of tension wood zones in rubber wood which helps to eliminate compact tension wood zones in rubber timber during sawing operations. The staining formulation using zinc chloride, iodine and potassium iodide was tried which gave distinct colour differentiation between normal and tension wood zones in green sawn wood, whereas in partially dried and fungus infected wood it did not give such colour variation.

Introduction

Tension wood formation is considered a major natural defect in various hardwood species. Structurally tension wood differs from normal wood in a number of ways and most of these differences are mainly associated with the structure and cell wall composition of wood fibers. Certain layers of the secondary wall of tension wood fibers are unlignified or partially lignified and composed of crystalline cellulosic microfibrils which gives the characteristic 'gelatinous' or sticky nature. It has already been proved that lignin content is reduced in tension wood fibers (Wardrop and Dadswell, 1948; 1955a; 1955b; Schwerin, 1958; Norberg and Meir, 1966; Timell, 1969; Furuya *et al.*, 1970; Scurfield, 1972 and Cote, 1977 : Reghu, 2002).

Tension wood is generally weaker than normal wood and its occurrence is associated with various wood working and seasoning problems in wood based industries (Panshin *et al.*, 1964; Hughes, 1965). The presence of unlignified or partially lignified cellulosic secondary G-layer of tension wood fibers makes the wood surface lustrous, wooly and rough (Lim and Sulaiman, 1994; Hughes, 1965). Some of the practical disadvantages of tension wood during primary wood processing, machining and finishing of end products are (i) the saws and cutters get blunted and sawing and peeling of green wood often produce rough and wooly surface (ii) the unlignified G-layer of tension wood fibers tend to be pulled out during cutting and stick to the saw blade preventing the further free movement of the saw (iii) as the G-layer is rich in moisture content and lacks lignin, longitudinal shrinkage of tension wood is very severe during seasoning resulting in uncontrollable distortion and warping in the form of twisting, spring, bow and cup etc. (Anonymous, 1972).

Rubber wood, a byproduct of rubber plantations has become an important raw material for various wood based industries. Currently the wood is being used widely for making furniture, door frames, window frames, shutters, panels etc. Even though rubber wood has many desirable features conducive to its wide application, it also displays certain inherent demerits. Susceptibility to biological deterioration is the major demerit of rubber wood and this can be effectively controlled by adopting advanced preservative treatments and controlled seasoning.

The formation of tension wood in *Hevea* is unavoidable / uncontrollable and hence the elimination of tension wood zones in rubber wood during primary processing (cutting and sawing) will enhance the quality of end products. However, tension wood zones can not be distinguished during cutting and sawing and hence ascertaining the proportion of tension wood for adopting differential sawing is not possible. In this context the present study was undertaken to develop an economically viable and eco-friendly staining technique for the visual identification and demarcation of tension wood zones in rubber timber which helps to eliminate compact zones of tension wood during sawing operations.

Materials and methods

Ten year old trees of the clone RRII 105 were used for the present study. Fifteen wood discs were collected from the tree trunk after clear felling. The cut ends of ten wood discs were sprayed with 0.5% aqueous Sodium Penta-Chloro-Phenate (NaPCP) to protect from sap stain fungus infection, of which five discs were exposed to air for drying and the other five discs were kept in green state. The remaining five unsprayed wood discs were kept in open air for 2 – 3 days for allowing sap stain fungus infection.

Preparation of staining solution

The following reagents were used for the preparation of 100 ml staining solution as per Mathew and Reghu (2005).

1. Zine Chloride ($ZnCl_2$)	87. 5 g
2. Potassium iodide (KI)	21. 0 g
3. Iodine	1. 0 g
4. Distilled water	100 ml

Zinc Chloride (87.5g) was dissolved in 50 ml distilled water in a glass or plastic container (solution A). Potassium iodide (21g) and Iodine (1.0g) were also dissolved in 50 ml distilled water in another container (solution B). Both these stock solutions were stored at 20°C. These solutions were mixed together only during stain application.

The staining formulation was applied on the surface of the green and partially dried wood discs treated with NaPCP and also the fungus infected unsprayed wood discs. Wood sections at 15 m m thickness were also taken at cross sectional plane from the tension wood and normal wood zones and stained with toludine blue'O'(O'Brien *et al.*, 1964) to confirm the stainability of tension wood fibers through microscopic observations.

Results and discussion

Researchers so far concentrated on the identification of tension wood fibers only at microscopic level through various staining procedures. The identification and demarcation of tension wood zones at macroscopic level would help to avoid such weakest zones during sawing operations. The normal wood zone retained its original colour, devoid of any stainability similar to that of the unstained control samples (Fig. 1a) whereas the compact bands of tension wood in the green-sawn wood disc sprayed with NaPCP showed brownish pink stainablility with zinc – chloro – iodide reagent (Fig. 1b). Microscopic observations of the sections stained with toludine blue 'O' also confirmed the brownish pink colouration of the tension wood zones (Fig. 2 a & b-*colour pictures on inside cover pages*).

It was also revealed that the mixing of zinc chloride and iodine-potassium iodide solutions at the time of staining gives good results instead of mixing them together in advance. While mixing, zinc iodide is formed and this will bind the hydrogen bonds located between the chains of cellulose in gelatinous cellulosic wall of tension wood fibers. Iodine is responsible for colour reaction in the presence of zinc iodide and it will accumulate in between the cellulosic microfibrils of the secondary fiber wall. The application of this reagent on the cut ends or the surface of the green sawn planks was found to be suitable for demarcating tension wood zones as brownish pink clouration in contrast to the yellow colouration in normal wood zones.

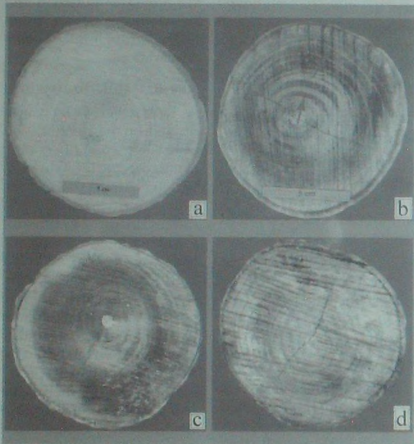

Fig. 1 a-d . Macroscopic staining of rubber wood using Zinc chloro-iodine reagent

a : Wood disc prior to the application of stain

b : Wood disc after the application of stain showing compact tension wood (brownish pink colour) and normal wood zone (pale yellow colour)

c : NaPCP treated partially dried wood disc after the application of stain

d : Fungus infected wood disc after the application of stain

The compact bands of tension wood in partially dried wood discs treated with NaPCP also stained pale brownish pink and the normal wood zone showed a pale black colouration (Fig. 1c). The development of black colouration in partially dried wood discs by the application of the reagent may be due to the precipitation of zinc iodide on the wood surface. The moisture loss in partially dried wood discs prevents the penetration of the reagent to the interior of wood tissues, resulting in pale brownish pink and pale black colouration of the tension and normal wood zones, respectively.

The zinc-chloro-iodide reagent did not give any distinguishable colour differentiation between normal and tension wood zones in unsprayed and fungus infected wood discs. However, in certain portions, feeble pink and black colouration was noticed (Fig. 1d). It has already been reported that the fungi such as *Aspergillus, Curvularia, Fusarium, Gliocladium, Trichoderma, Sphaeronaema and Penicillium* are the main surface colonizers in rubber wood (Ali Sujan *et al.*, 1980; Hong, 1981; Tsunoda *et al.*, 1983; Hong *et al.*, 1987). These fungi easily thrive on the readily available carbohydrates occurring in abundance in the parenchymatous tissues without affecting the ligno-cellulosic components of the wood.

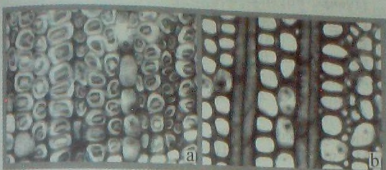

Fig 2 a & b. Cross section of tension wood and normal wood zone stained with toludine blue 'O'

a : Tension wood fibers showing unlignified gelatinous layer (pink colour)

b : Normal wood fibers with lignified walls (blue colour)

Botryodiplodia theobromae Pat. has been reported as the common fungus responsible for the sap stain (blue stain) infection on rubber wood (Hong, 1976; Kaarik, 1980; Tsunoda *et al.*, 1983). The application of zinc-chloro-iodide reagent on fungus infected wood disc did not give colour differentiation and this may be due to the occurrence of fungal mycelia on the wood surface which prevents the penetration and reaction of the reagent to the interior of the wood.

The present investigation revealed that zinc-chloro-iodide reagent can be used effectively as a macroscopic stain for the identification and demarcation of compact-tension wood zones in rubber wood particularly in green condition. Studies on the economic feasibility of this staining procedure and its extensive usage in the primary rubber wood processing sectors like selective/differential sawing patte-rns would help to avoid tension wood zones to a considerable extent, as this reagent is very cheap, non-toxic and eco-friendly.

Acknowledgements

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IMPACT OF GROUP PROCESSING CENTRES ON MARKETING WITH A FOCUS ON SOCIO - ECONOMIC DEVELOPMENT

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Introduction

The Indian rubber plantation industry is largely dominated by small growers. At present the smallholding sector accounts for 89 per cent of area and 91 per cent of production of natural rubber (NR) in the country.Presently there are about one million small growers in the country with an average holding size of 0.50 ha.

The rubber plantation industry in India has been evolved with the active intervention of the Government since independence, at different levels of cultivation, processing and marketing. Rubber Board, a statutory body formed under the Rubber Act 1947 and functioning under the Ministry of Commerce and Industry of the Government of India, is the nodal agency for the development of the NR industry. The Board has a strong research and extension network in the country.

Though the Rubber Board was concentrating its activities mainly in the production and primary processing of NR, the problem of marketing the produce was not neglected. During 1960s itself the Board started promoting group approach in marketing through the formation of rubber marketing cooperatives. However, the cooperatives, soon became large, politicized and with more Government controls could not focus on the growers' needs to the extent desired. By 1985, the number of smallholdings increased to 412211 from 75374 in 1960. By this time the vast majority of small and marginal growers were left to the local arrangements available for marketing, leading to exploitation by the middlemen. This led to the need for organizing the small growers at the grass root level and the Rubber Board took the initiative to form the Rubber Producers' Societies (RPSs).

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Rubber Producers' Societies are voluntary self help associations of small growers, registered under the Charitable Societies Act. The RPSs are envisaged as non profit making institutions imparting technical and scientific know how to the members for the general improvement of their plantations and thereby achieving economic and social welfare.

For sustaining and strengthening the performance of the RPSs, private limited companies were formed as joint ventures of the RPS and Rubber Board for setting up processing factories and taking up trading of latex, sheet rubber, field coagulum and agro inputs. These companies form regional level apex bodies of RPSs.

In 1999, a new scheme for setting up 'Model RPS' was implemented under the World Bank Aided Rubber Project. A few selected RPSs were given financial and technical assistance to construct their own office, sheet processing facilities with a 1000 kg smoke house, processing shed and a training hall. Two biogas plants, with a total capacity of 25 cubic meter were also constructed for gainfully treating the waste water from the processing shed. A total of 35 Model RPSs were set up, 30 in the traditional and 5 in the non traditional region. These model RPSs were set up to function as models in providing all support to small growers in producing high quality rubber, undertaking profitable marketing, providing all agroinputs and services at reasonable cost and arranging training in all aspects of scientific rubber cultivation, crop harvesting, primary processing and marketing.

Since the NR processing in the country has been evolved to cater to the requirements of a captive domestic market, it is dominated by the sheet grades accounting for more than 70 percent of the total productiom. In the emerging scenario, with the removal of quantitative restrictions since 1 April 2001, the processing sector has increasingly come under serious compulsions to face the challenges posed by the potential cheap imports. Imports may create glut leading to lowering of price in the domestic market. In this circumstance, dependence on internal market alone will not sustain the rubber plantation industry and it is imperative to get established in the international market for which one has to ensure a regular supply line of reasonable quantity of good quality rubber. The situation also calls for empowering the smallholder to face the challenges of the WTO mandated regime. Infrastructure will have to be developed in the rural areas for cost effective and quality processing, for imparting required training to the needy and for ensuring access to essential inform-ation.

A preliminary study on the impact of marketing of NR through RPSs, conducted in five selected RPSs in

Thiruvananthapuram District of Kerala found that marketing of NR through RPS has resulted in quality upgradation, controlling exploitation and assured market with guaranteed price throughout the year (Usha Rani, 2002). It was also found that formation of village level associations functioning in the style of self help groups is a rational approach to socio economic upliftment. Another study on the impact of processing and marketing of NR through RPSs has found that the challenges faced by the rubber planters particularly the small growers, can be addressed through group approach. The consortium of RPS and marketing companies in the cooperative sector, now under operation in some regions of the traditional rubber growing tract of Kerala, has proved its worth in this context. The study on the success story of Janatha Model RPS, Aimcombu, (Kerala) shows that this Model RPS has been instrumental in the overall development of the farming community it has been serving (Dhanakumar, 1999).

Following the success of the Model RPSs, Rubber Board decided to provide the infrastructural facilities to larger number of RPSs during the 10th plan period (2002-03 to 2006-07). Accordingly, the scheme for 'Setting up of Eco-friendly Group Processing Centers' in RPSs was implemented with the main objective of improving the quality of sheet rubber and achieving global competitiveness. The scheme provides for 50 per cent grant for construction of an office, 1000 kg smoke house, a processing shed and a training hall. Besides this, construction of biogas plants for treatment of effluents and distribution of equipments for DRC estimation and audio visual aids are also included in the scheme. The total cost for setting up the infrastructure is estimated at Rs.12.00 lakhs.

As on date, 147 RPSs have availed assistance under the scheme. Construction of the Group Processing Center was completed in 106 RPSs and the rest are under various stages of progress. During 2004-05, Group Processing Centers (GPC) were commissioned in 59 RPSs. This study is an attempt to assess the impact of these Centres on the marketing of NR by the smallholders. The study also explores the socio economic development of the members of the RPS, achieved through these centers.

Methodology

The study is exploratory and analytical combining both qualitative and quantitative methods. Three regions in Kerala viz., Adoor, Pala and Nilambur in the south, central and northern zones respectively were chosen. Three Group Processing Centers (GPC) each in all the three regions were selected for the study. Three RPSs, which do not undertake any group acti-

Rubber Producers' Societies are voluntary self help associations of small growers, registered under the Charitable Societies Act. The RPSs are envisaged as non profit making institutions imparting technical and scientific know how to the members for the general improvement of their plantations and thereby achieving economic and social welfare.

For sustaining and strengthening the performance of the RPSs, private limited companies were formed as joint ventures of the RPS and Rubber Board for setting up processing factories and taking up trading of latex, sheet rubber, field coagulum and agro inputs. These companies form regional level apex bodies of RPSs.

In 1999, a new scheme for setting up 'Model RPS' was implemented under the World Bank Aided Rubber Project. A few selected RPSs were given financial and technical assistance to construct their own office, sheet processing facilities with a 1000 kg smoke house, processing shed and a training hall. Two biogas plants, with a total capacity of 25 cubic meter were also constructed for gainfully treating the waste water from the processing shed. A total of 35 Model RPSs were set up, 30 in the traditional and 5 in the non traditional region. These model RPSs were set up to function as models in providing all support to small growers in producing high quality rubber, undertaking profitable marketing, providing all agroinputs and services at reasonable cost and arranging training in all aspects of scientific rubber cultivation, crop harvesting, primary processing and marketing.

Since the NR processing in the country has been evolved to cater to the requirements of a captive domestic market, it is dominated by the sheet grades accounting for more than 70 percent of the total productiom. In the emerging scenario, with the removal of quantitative restrictions since 1 April 2001, the processing sector has increasingly come under serious compulsions to face the challenges posed by the potential cheap imports. Imports may create glut leading to lowering of price in the domestic market. In this circumstance, dependence on internal market alone will not sustain the rubber plantation industry and it is imperative to get established in the international market for which one has to ensure a regular supply line of reasonable quantity of good quality rubber. The situation also calls for empowering the smallholder to face the challenges of the WTO mandated regime. Infrastructure will have to be developed in the rural areas for cost effective and quality processing, for imparting required training to the needy and for ensuring access to essential inform-ation.

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Results and discussion

Improvement in quality

The shift from homestead processing to group processing has brought about remarkable improvement in the quality of the sheets produced. A considerable quantity of the sheets produced in the GPCs is RSS 1. The quantity of the different grades produced in the GPCs is given in Table 1. The percentage of the different grades produced is shown in Figure 1. It is also noteworthy that the production of RSS 5, the lowest grade among the graded sheets is almost nil or brought to a minimum in all the three regions. The GPCs ensured that not a single sheet that came out of their smoke house is ungraded. Bulk of the production in Adoor and Nilambur regions was of grade 5. In Pala more than 80 per cent was RSS 1. Adoor produced 18 per cent and Nilambur 42 per cent as RSS 1.

The improvement in quality is conspicuous as the small growers were not able to produce and market the superior grade without the group approach. The percentage of the different grades produced by the selected members of the GPCs during 2003-04, *ie.*, the year before opting for group processing, is shown in Figure 2. It can be seen that the share of RSS 1 in the quantity of sheet processed by the members of GPCs during the year was nil and the major share was of ungraded sheets in Adoor and RSS 5 in Pala and Nilambur. It is also clear that the smallholders with homestead processing are not producing RSS 1 as evidenced by the percentage of different grades produced by the members of the RPSs, which do not undertake group processing activities as shown in Figure 3.

There has however been wide variation among GPCs of the three regions in the percentage of RSS 1 produced. The probable reason behind it is that most of the GPCs selected for the study had started functioning only in 2004-05 and different GPCs took different time in up grading the quality. Defects in the construction of the smoke house also caused delay in production of RSS 1 grade.

Price realization

The members of the GPCs whose latex is processed in the center received better price than that received by the members of the RPSs who processed sheets in the homestead. The improvement in quality coupled with their bargaining capacity has enabled the GPCs to obtain a better price than the ordinary sheets produced by the individuals of the locality. The centers could thus give their members a better price than what was obtained by the individual processors, after meeting the processing cost. The average price realized by the members of the GPCs and the RPSs without GPCs during 2004-05 and the difference between the two are shown in Table 2.

It can be seen that the highest average price of Rs. 53.70 per kg was disbursed in Pala region because of the higher share of RSS 1 in the total rubber produced. This reasoning however does not hold good in a comparison between Adoor and Nilambur region as GPCs of Adoor could pay slightly more, in spite of the lower share of RSS 1 in the total quantity. This might be due to some gainful bargain achieved by the Adoor region or due to failure in the part of Nilambur region to obtain a right deal for their better quality sheets.

Production of export quality sheets

An analysis of the quality of sheets produced by the individual processors indicated a very high degree of variation in the grades of sheets produced in the homesteads. The GPCs, guided by the Rubber Board's extension officers are adopting almost the same procedure for processing which results in uniformity in shape, colour etc., which is essential for acceptance in the international market. The GPCs in fact played a crucial role in India's exceeding the export targets in 2004-05.

Strengthening of RPSs

The group processing ensures round the year activity, which is vital for the sustenance of any RPS. It has brought about increased involvement of the growers in the RPS.

Table 1. **Production of different grades of sheet (kg) in the GPCs during 2004-05**

Region	*RSS 1*	*RSS 4*	*RSS 5*	*Total*
Adoor	7618	36363	780	44761
Pala	51063	9792	1678	62533
Nilambur	44150	52280	0	96430
Total	102831	98435	2458	203724

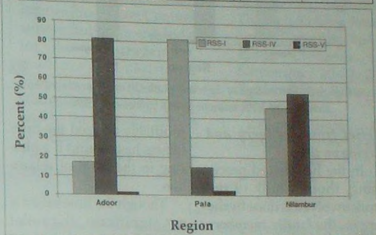

Figure 1. Percentage of different grades of sheet produced in GPCs during 2004-05

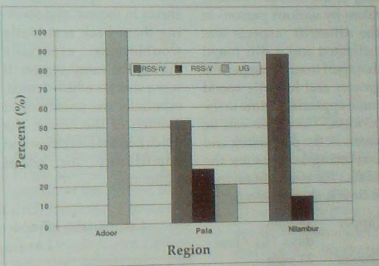

Figure 2. Percentage of different grades of sheet produced by growers before group processing (2003 -04)

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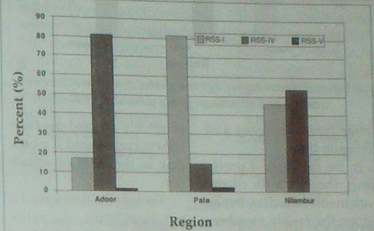

Figure 1. Percentage of different grades of sheet produced in GPCs during 2004-05

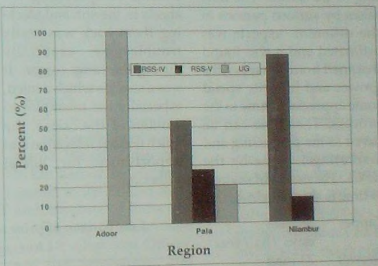

Figure 2. Percentage of different grades of sheet produced by growers before group processing (2003 -04)

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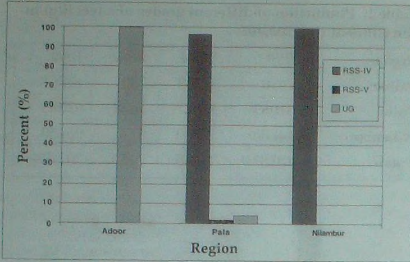

Figure 3. Percentage of different grades of sheet produced by members of RPS without group processing(2004-05)

Relief from drudgery and saving on time

In the homestead processing, though bulk of the work involved is done by the tapper, the family members also involve in the drying, smoking, storing and marketing of the sheets. The time taken by various persons in the different aspects was estimated and it was found that apart from the tapper, the grower and his wife spend some appreciable time in the process. That time can be saved as the processing and marketing is done by the GPCs. The extent of savings in time is shown below.

Tapper	38 man days /ha./year
Grower	23 man days/ha./year
Wife	10 man days/ha./year

Regarding utilization of the time saved, in general, the tappers are found to have profitably utilized the time. Others have found it a blessing in the form of relaxation.

Though the time saved is not significant, the relief from the drudgery involved is remarkable. The daily routine of spreading the sheets in the sun and stacking them back was really troublesome, especially during the rainy season. It was a shackle which denied, especially the unemployed women of the house, the much needed relaxation and opportunity for social gathering.

Cleaner environment

A remarkable benefit resulting from the group processing is a cleaner environment. Almost all the informants agreed that processing in the homestead created effluent stagnation leading to foul smell and breeding of mosquitoes. Those who opted for group processing got rid of those hazards. Interestingly, majority of the growers had no complaint about the smell of sheets in the house as they were accustomed to it. However, the next generation may not like to stock it in their newly built modern houses.

Employment generation

The GPCs have excellent potential for employment generation especially to the economically backward rural women. The monthly average of employment generated in the GPCs is shown in Table 3.

GPCs in the three regions, on an average, have generated employment worth 118.50 mandays. Employment generated was the highest in Nilambur region

Table 2.

Comparison of price realized during 2004-05 (Average-Rs./kg)

Region	*GPC (Rs./Kg)*	*RPS without GPC (Rs./Kg)*	*Difference (Rs./Kg)*
Adoor	51.00	49.40	1.60
Pala	53.70	52.20	1.50
Nilambur	50.80	50.10	0.70

(171.51 mandays) and lowest in Adoor region (76.82 mandays)

In spite of the labour intensive processing, the GPCs were able to deliver a profitable price to the growers through improved quality. Therefore the employment potential of the GPCs is not only sustainable but also likely to increase as evidenced by successful Model RPSs where additional smoke houses were necessitated to contain the increased inflow of latex.

Conclusions

The GPCs have achieved remarkable improvement in the quality of the sheets. The production and marketing of the higher grades of sheet like RSS I has been made possible among the rubber smallholders with the setting up of GPCs. Following the set scientific practices, the GPCs are able to maintain uniformity of the sheets produced which is critical for acceptance in the international market. Improvement in quality has resulted in better price for the smallholders. RPSs which have set up GPCs are further strengthened due to continuous activity, increased involvement of the members and increased turn over. The latex being processed and marketed by the GPCs, their members are relieved of the drudgery involved in the process. It has further improved the quality of their life by way of useful leisure time and a cleaner environment. The GPCs hold excellent potential for employment generation especially for the rural women.

Acknowledgements

The authors are thankful to Dr. A.K. Krishnakumar, Rubber Production Commissioner, Rubber Board, India for the encouragement, guidance and assistance given for carrying out the study. The assistance rendered by the extension officers of Regional offices, Adoor, Pala and Nilambur in conducting the field survey is acknowledged with thanks. We are also grateful to the staff of the computer section of the Rubber Research Institute of India and Mr. K.G.Unnikrishnan Nair, Asst.Development Officer, for the tabulation and analysis of the data.

Table 3.
Employment generated in GPCs (monthly average in man days)

Region	*Men*	*Women*	*Total*
Adoor	31	46	77
Pala	27	104	131
Nilambur	35	137	172
Average	32	87	119

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DISSEMINATION OF INFORMATION ON NATURAL RUBBER BY THE RUBBER RESEARCH INSTITUTE OF INDIA: SCIENTIFIC BOOKS

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Abstract

The paper evaluates the contributions of Rubber Research Institute of India (RRII) towards the dissemination of information through scientific books. Ever since the publication of the first book in 1977, RRII has released 20 books of which six are proceedings of conferences organized or hosted by the Institute. Publication of Handbook of Natural Rubber Production in India in 1980 and Natural Rubber: Agromanagement and Crop Processing in 2000 is a landmark in the annals of NR in India. Two books of the Institute were published by overseas publishers, five by Indian publishers and the remaining 13 were brought out by the Institute itself. RRII published 11 books since 2001 of which seven were released in 2005-2006 in commemoration of the Golden Jubilee of the Institute.

Key words: Books; India; Information dissemination; Natural rubber; Publications; RRII.

Introduction

In research, books play only very limited role as an initial medium for reporting original results or observations. In the highly specialized era of science reporting scientific journals, presentations in conferences and other primary publications proved to be more efficient for wider and speedy dissemination of information than books. Economic considerations also favour dissemination of information through means other than books.

But scientific books present a synthesis or consolidation of existing knowledge on a given topic. The primary research elements in this synthesis include consolidation of results that are scattered in the numerous scientific journals, conference papers, books and other publications. Hence books also play an undisputed prominent role in modern science communication systems by distilling the works of journals into more manageable monographic format. Books, even today, form a fairly constant figure in modern citation practices, not only in humanities, arts and social science but in science, technology and agriculture also.

Since its inception in 1955, the Rubber Research Institute of India (RRII) has been effectively utilizing these channels for the dissemination of scientific information generated by it to its clientele and books and monographs have a prominent role in this communication system. In addition to the articles contributed by scientists in periodicals and conferences, the Institute published books and monographs. The bibliography of the 50 years of research contributions of RRII lists 14 scientific books along with other publications (Korah and Jose, 2005). Thomas *et al.* (2006) also list 20 books among other means of information dissemination. This paper attempts to asses the contributions of RRII towards the dissemination of scientific information through scientific books till date. An analysis of the evolutionary sequence of scientific books, subject domain, yearwise publication productivity and publisher details are also included.

Books and other publications of RRII

The publication productivity of RRII during the past 50 years is given in Table 1. The Institute has so far published 2379 publications of which 1171 are periodical articles, 784 are presentations in scientific seminars and 97 are theses/dissertations. In addition, 20 books and 36 monographs, 179 chapters in various books and lecture notes and 36 articles in souvenirs are the other publications of the Institute (Thomas *et al.*, 2006). RRII has compiled 13 bibliographies and directories for better bibliographic control of published literature on NR. The Institute has registered 42 genotypes with GeneBank of National Centre for Biotechnology Information (NCBI), USA and the Institute holds the US patent for deproteinization of NR latex.

Scientific books: A chronological review

The RRII published its first book, *Plant and Soil Analysis: Laboratory Manual* in 1977, (Karthikakuttyamma, 1977). This book, a compilation of the standard and analytical procedures on the subject, is useful in routine analytical work and various other investigations in soil and plant nutrition. The second edition of the book was brought out in 1989.

Table 2. Year wise publication of books (1971-2005)

Period	*Number*
1971-1980	1
1981-1990	3
1991-2000	5
2001-2006	11
Total	**20**

The release of the book, *Natural Rubber Production in India*, on 24 November 1980 by Dr. M.S. Swaminathan in commemoration of the Silver Jubilee of the RRII is a major event as there was no other single volume available anywhere which covered all aspects of NR production and processing (Pillay, 1980). The book had 30 chapters beginning with the history of rubber plantation industry in India and concluding with rubber statistics. In the intervening chapters botanical and agronomical aspects of

Table 1. RRII publications by form (1955-2005)

Type of publication	*Number*
Journal articles	1171
Papers presented in conferences	784
Chapters in books, lecture notes etc	179
Dissertations	97
Souviner articles	36
Monographs	36
Books	20
Bibliographies & Directories	13
Others	43
Total	2379

rubber cultivation, latex biosynthesis, exploitation techniques, diseases and pests and their control, processing of the crops into different marketable forms etc are discussed. Details of farm management, byproducts and ancillary activities in rubber plantations legislations covering plantations labour and activities of the Rubber Board were also included. The book, unique in its content and coverage, was well accepted by its target clientele - growers, students, manufacturers etc.

The *Proceedings of Sixth Plantation Crops Symposium* (PLACROSYM VI) was published in 1987 incorporating 51 papers presented in the symposium held at RRII during 16-20 December 1984 (Sethuraj, 1987). The subject of presentation was arranged under botany, plant protection, agronomy and economics and marketing and the proceedings included seven papers from RRII. The book, *Tree Crop Physiology* (Sethuraj and Raghavenrda, 1987) was published in 1987 on the recommendations of the international symposium, *Treephysindia* 82, held at RRII. Having 15 chapters organized in two parts, the book presents information on various methodologies for physiological investigation on tree crops. The contributed articles in the first part provide an insight into different approaches to in the study of the physiology of tree crops where as chapters in the second part offer specific studies of physiological investigations on economically important tree crops.

RRII published the book, *Rubberwood: Production and Utilization*, prepared by A.C. Sekhar (1987), former Director, Forest Products Research, Forest Research Institute, Dehradun in 1997. It is the first attempt to compile the information on rubber wood processing and utilization from available published literature from countries where rubber is cultivated and rubber wood is utilized commercially. Another book, *Rubberwood Processing and Utilization in India* (Gnanaharan *et al.*, 2002) was published in 2002. The book contains 16 chapters of which three were contributed by scientists of RRII.

The book, *Natural Rubber: Biology, Cultivation and Technology*, (Sethuraj and Mathew, 1992), dealing with all aspects of NR from its history, production and processing was published in 1992. The book has 25 chapters authored mostly by scientists and deals with a broad spectrum of subjects related to NR. The book contains one chapter each on rubber wood and ancillary products and the chapter on guayule (*Parthenium argentatum*) has been included as a possible alternative source of NR. The book, *Management of Plantations* (Haridasan,

Information dissemination by scientific books

1992) published in 1992 contains a comparison of management of practices followed in rubber estates belonging to Indian and foreign based plantation companies. The book has nine chapters in addition to a bibliography on the subject.

The book, *Indian Rubber Economy* (Unni *et al.*, 1995) published in 1995, is the result of a joint project of the Economic and Social Institute of the Free University in Amsterdam and the Rubber Board. Arranged in 10 chapters under four sessions, this book describes the major factors that determine the future of Indian rubber industry.

In 1998, Allied Publishers, New Delhi published the book, *Developments in Plantation Crops* containing 72 papers presented in 12th Plantation Crop Symposium (PLACROSYM XII) held at RRII, Kottayam during 27-29 November 1996 (Mathew and Jacob, 1998). The proceedings contain 30 papers on crop improvement, 22 papers on crop management and 10 each on crop protection and crop processing. In addition, the key-note address given by Dr. M.R. Sethuraj, the General Chairman of the PLACROSYM XII on Biotechnology in Plantation Crops Research hass also been included.

There have been tremendous advances in scientific research and allied activities of rubber cultivation and primary processing during the two decades since the publication of the Handbook in 1980. The Institute released the book, *Natural Rubber: Agromanagement and Crop Processing* in 2000, incorporating all aspects of NR cultivation and primary processing with all available information (George and Jacob, 2000). The book is organized in 34 chapters covering history, botany, crop management and harvesting, crop protection, processing and marketing. Adequate attention is given to byproducts and ancillary income, waste management, plantation management and labour legislation. The book concludes with a positive note presenting NR as a green polymer, alternative and complement to synthetic rubber in future. Each chapter begins with a brief presentation of the contents to facilitate easy access to information and to stamp a uniform style upon many chapters.

The book, *Global Competitiveness of Indian Rubber Plantation Industry* (Jacob, 2003) contains 53 papers presented in the Rubber Planters' Conference India 2002 organized by the Rubber Board to mark the centenary celebrations of the rubber plantation industry in India. The range of subjects covered in this book is wide from nursery techniques to rubber processing, storage and marketing. As the authors of this paper include policy makers, scientists, large and small growers, the style of presentation varies widely from reviews, research articles and short communications to simple narrations. Among the 53 articles 22 were contributed by scientists of RRII and officers of Rubber Board.

The book, *Identification of Hevea Clones* (Mercykutty *et al.*, 2002) is an attempt to document various identification characteristics of different *Hevea* clones based on distinguishable morphological features. Explaining the specific features of various clones in a lucid manner and unveiling the unnoticeable differences to the extent possible, this publication proved to be an ideal practical guide to help even a layman to identify the clones correctly.

During 2005 and the first half of 2006, the RRII published a series of books on specific aspects of NR for the benefit of the rubber sector during its Golden

Jubilee. The first book, *Harmonised System Nomenclature: A Reference Manual on Rubber and Rubber Products*, is a reference manual on Harmonised Commodity Description and Coding System, popularly known as the HS and contains salient features and usage of the HS with special reference to rubber and rubber products (George and Joseph, 2005). The details contained in the four chapters of the manual include the structure and evolution as well as the composition of the HS, the six digit level classification and product description, India's tariff policy as on the year 2005-06 and eight digit level information on India's foreign trade in rubber and rubber products for the year 2003-04.

The book on crop improvement methods entitled, *A Manual on Breeding of Hevea* is a step-by-step guide to the techniques of rubber breeding (Mydin and Saraswathyamma, 2005). The book elaborates upon the time-tested conventional breeding procedures in rubber with the aid of line drawings, flow charts and colour illustrations. Modern breeding techniques and intellectual property rights (IPR) have been explained in a lucid manner along with the support data and various formats necessary for successful implementation of crop improvement programmes.

The book, *Proceedings of the International Workshop on Exploitation Technology* by Vijayakumar *et al.*, 2005 contains 21 papers on exploitation technology, plant breeding, socioeconomics, tapping panel dryness and latex diagnosis presented in the workshop held on 15-18 December 2003. Recommendations of the workshop include steps towards transfer of latest technologies to smallholders, exchange of the know-how of various new methods among member countries and seeking international funding for multicountry projects.

The book entitled *Descriptors for Rubber* (Rao, *et al.*, 2005) is an authentic guide for the management of *Hevea* germplasm containing a comprehensive description of the different growth stages of various germplasm materials. This will be a reference book related to the collection, documentation, characterisation and evaluation of wild germplasm accessions and cultivated clones of *Hevea* for its effective utilization.

The *Preprints of Papers: International Natural Rubber Conference 2005* contains 111 papers presented in the conference held at Cochin, Kerala as part of the Golden Jubilee of the Institute. The papers are arranged under eight disciplines besides the key-note address and the eight papers presented in the two plenary sessions (Mathew *et al.*, 2005).

The book, *Corynespora Leaf Disease of Hevea brasiliensis*, is a compilation of reviews on the current status of the management of one of the most serious leaf diseases of rubber (Jacob, 2006). All aspects of the disease including its occurrence, symptoms, pathogen, toxin, clonal resistance and different control measures are covered in the 17 chapters of the book. The experiences of disease control measures in Sri Lanka since its first detection in 1985 is also included and the detailed bibliography in the end facilitates further reference.

The release of the high yielding clone RRII 105 in 1980 was a significant breakthrough in the crop improvement research in RRII. Moving with time RRII has evolved and recommended five clones in the RRII 400 series for limited planting. In 2005, RRII 414 and RRII 430 were released for commercial cultivation. The book, *RRII 400 Series*

Clones of Rubber (Saraswathyamma *et al.*, 2006) is a comprehensive account of yield and other secondary attributes of these clones and their parents RRII 105 and RRIC 100. The book, organized in eight chapters, covers history of evolution of the clones, characteristics of mature and five year old trees, as well as six months old plants, leaf characteristics, genetic variation of the clones etc.

Yearwise publication productivity

The yearwise publication productivity of RRII through books is given in Table 2. Since the publication of the first book in 1977, gradual increase can be observed in the number of scientific books released during 1980s and 1990s. Nine books were published during the first five years of the present decade and in the Golden Jubilee year 2005 the Institute published five books.

Subjectwise publication of books

The subjectwise classification of the 18 books was given in Table 3. Three books (Pillay, 1980; Sethuraj and Mathew, 1997 and George and Jacob, 2000) have been accepted internationally as comprehensive basic reference books on NR cultivation and primary processing.

Table 3. Subjectwise classification of books

Subject	*Books*	*Reference*
Reference books	3	Pillay, 1980; Sethuraj and Mathew, 1992; George and Jacob, 2000
Crop improvement	4	Mercykutty et al., 2002; Mydin and Saraswathyamma, 2005; Rao et al, 2005, Saraswathyamma et al, 2006
Plantation crops	3	Sethuraj, 1987; Haridasan, 1992; Mathew and Jacob, 1998
General books	2	Jacob, 2003; Mathew et al., 2005
Rubberwood	2	Sekhar, 1989; Gnanaharan etal., 2002
Marketing and Foreign trade	2	Unni et al., 1995; George and Jacob, 2005
Crop physiology	1	Sethuraj and Raghavendra, 1987
Soil and leaf analysis	1	Karthikakuttyamma, 1977
Exploitation technology	1	Vijayakumar et al., 2005
Disease	1	Jacob, 2006

Table 4. Proceedings of Conferences organized by RRII and published as books

Year of publication	*Details of conference*	*Reference*
1987	PLACROSYM VI, 16-24 December 1984, Kottayam, India	Sethuraj, 1987
1998	PLACROSYM XII, 27-29 November 1996, Kottayam, India	Mathew and Jacob, 1998
2003	Rubber Planters Conference, 27-29 November 1996, Kottayam, India	Jacob, 2003
2005	International Workshop on Exploitation Technology, 15-18 December 2003, Kottayam, India	Vijayakumar et al., 2005
2005	INRC India 2005, 6-8 November 2005, Cochin, India	Mathew et al., 2005

The three books on crop improvement will be useful to all those who are associated with breeding, clone identification and plant genetic resource management. There are three books on plantation crops, two on marketing and foreign trade. Two general books cover compilation of articles on various aspects of rubber research. The subject covered in other books include crop physiology, soil and leaf analysis and exploitation technology.

Proceedings of conferences published as book

During the past 25 years, RRII organized 18 conferences and associated with the publication activities of the proceedings of five of these conferences (Table 4). RRII hosted the Sixth and 12th Plantation Crop Symposia and headed the editorial team for the publication of proceedings. The Institute published the proceedings of PLACROSYM XII under the title *Developments in Plantation Crop Research*. The book, *Global Competitiveness of Indian Rubber Plantation Industry* incorporates papers presented in the Rubber Planters' Conference 2002. The other two books are the proceedings of the two international conferences organized by RRII.

Table 5
Publishers of books brought out by the RRII

Publishers	*Number of publications*
Overseas publishers	2
Other Indian	5
RRII	13
Total	**20**

Publishers of books

The details of the publishers of book brought out by RRII are presented in Table 5. Two books were published by Elsevier Publishers, Amsterdam (Sethuraj and Raghavendra, 1987; Sethuraj and Mathew, 1992). Leading Indian book publishers like Oxford and IBH, New Delhi (Sethuraj, 1987), Allied Publishers, New Delhi (Mathew and Jacob, 1998), Manohar Publishers, New Delhi (Unni *et al*., 1995) and Ganesh Publications, Bangalore (Gnanaharan *et al*., 2002) were also associated in bringing out with RRII's publications. One book was published by an agency in Kerala (Haridasan, 1992) and the remaining 11 books were published by the Institute itself.

Bibliographies and monographs

During the past 50 years, RRII published 10 bibliographies (Thomas, 2006) and 38 other monographs (Thomas, 2006). Rubber Board and RRII published a few directories also. Though published as books, these are not included in this evaluation of scientific books which consolidated information on a given subject.

Conclusion

R & D efforts become meaningful only when inferences from scientific investigations reach the field. It is practically impossible for farmers, extension workers and other stakeholders of rubber sector to gather their relevant scattered information from various sources. On realisation of this fact, RRII ultimately ventured into the publication of the book, *Handbook of Natural Rubber Production in India* in 1980. Efforts to incorporate the tremendous developments in various aspects of rubber cultivation and primary processing emanated in the publication of *Natural Rubber: Agromanagement and Crop Processing* in 2000. These books along with *Natural Rubber: Biology,* *Cultivation and Processing* are rated as the basic reference texts on the subject. The book, *Tree Crop Physiology* proved to be a source of basic knowledge and it has stimulated further research in the challenging field of tree physiology.

During the past 50 years, RRII published over 2300 publications of which 20 are scientific books. Two books edited by the scientists of RRII were published by M/s. Elseviers, Amsterdam, five by other leading Indian publishers and the remaining 13 books were published by the Institute itself. Out of the 20 books, 11 were published during the last five years.

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Application for assistance under RPDS—Date extended

The Rubber Board has extended the time for receiving applications for financial assistance under Rubber Plantation Development Scheme till 29 December 2006. Those who replanted/new planted rubber in 2006 can submit the application for assistance to the corresponding regional office of the Board. The application form and relevant information can be had from Board's regional/field offices.

NATURAL RUBBER vis-a-vis SYNTHETIC RUBBER

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Introduction

Rubber is an important industrial material and more than 50,000 different products are made from rubber. Depending on origin, there are two groups of rubber, viz. natural rubber (NR) and synthetic rubber (SR). However, both are polymers and their physical properties are similar though not identical. Natural rubber which is the gift of nature, is isolated from natural latex and it is marketed in different forms after processing. The sources of latex are found in over 2000 plant species belonging to 311 genera of 79 families in different parts of the world. It can be extracted from various parts of the plant like bark, roots, leaves, stems and even tubers and fruits. Commercially, the major part of NR is obtained from the rubber tree (*Hevea Brasiliensis*) originated from Amazon basin of south America. The latex is extracted from bark of the tree by tapping. Chemically, NR is cis-polyisoprene in which isoprene molecules are linked together in symmetrical linear chain. The symmetry of the molecular chain determines its strength and other characteristics that give us opportunities to use it to make innumerable products. SRs are man made synthetic materials which are a group of high molecular weight polymers. SRs are obtained from petroleum derived chemical intermediaries. Different categories of SR are available in the market. Hi-tech products are feasible from SR for different applications.

Different forms of natural rubber

Latex collected from rubber tree is processed to suitable forms of industrial raw materials to produce a large variety of products. Different forms of NR, viz. sheet rubber, preserved latex concentrate, technically specified rubber, crepe rubber and modified forms of rubber, are available in the market (Pal an Dey, 2004).

Among these, sheet rubber has predominant share in the market. It is produced from field latex by processing. Three types of sheet rubbers are available and these are ribbed smoked sheet (RSS), air-dried sheet (ADS) and sun dried sheet. RSS is availabe in six different grades viz. RSS 1X, RSS 1, RSS 2, RSS 3, RSS 4 and RSS 5.

Latex concentrate is prepared from field latex by methods like evaporation, electrodecantation, creaming and centrifuging. Creaming and centrifuging are the most widely accepted methods which increase the dry rubber content of the latex to 50-55% and 60% respectively. The widely used centrifugation process produces preserved latex concentrate of low ammonia (LA), medium ammonia (MA) and high ammonia (HA) types. In case of LA - concentrated latex LATZ latex (latex containing 0.2% ammonia, 0.0125% TMTD, 0.0125% zinc oxide and 0.5% lauric acid) is popular in India (Mathew *et al*, 2000).

The technically specified rubber (TSR) is produced from latex, field coagulum and all forms of scrap rubber. In India, TSR is available in six grades viz. ISNR 3L, ISNR 3CV, ISNR 5, ISNR 10, ISNR 20 and ISNR 50.

The crepe rubber is produced from fresh latex coagulum, field coagulum (such as earth scrap, shell scrap, tree lace etc.) or cuttings of RSS. Two types of crepes are known and these are i) latex viz. pale latex crepe and sole crepe and ii) field coagulum crepe viz. estate brown crepe, thin brown crepe, thick blanket crepe, flat bark crepe and pure smoked blanket crepe.

Modified froms of NR fall into two groups. They are physically modified forms and chemically modified forms. The former type includes oil-extended natural rubber (OENR), superior processing natural rubber (SP), thermoplastic natural rubber (TPNR), deproteinised natural rubber (DPNR) etc. The latter type includes epoxidised natural rubber (ENR), cyclized natural rubber, constant viscosity (CV) and low viscosity (LV) rubber, graft co-polymers of NR, liquid natural rubber etc.

The structure of natural rubber is presented below in Table - 1.

Different types of synthetic rubber

At present, more than 200 varieties of synthetic rubber are produced in the world (Rubber Asia, 2003). SRs may be classified as i) General purposes synthetic rubber and ii) Special purpose synthetic rubber which have technical superiority over NR. There are different general purpose synthetic rubbers viz. Styrene-butadiene rubber (SBR: a co-polymer of butadiene and styrene), Butyl rubber (co-polymer of isobutylene and isoprene), Neoprene rubber (polychloroprene), Nitrile rubber (co-polymer of butadiene and acrylonitrile), Cis-polybutadiene rubber (BR), Cis-polyisoprene (IR), Ethylene propylene (co-polymer of ethylene and propylene) etc.

There are 22 categories of special purpose synthetic rubbers and these are polyester/polyether elastomers, acrylic rubbers and lattices, halogenated isobutylene based polymers, urethane and butane rubbers, polyolefin thermoplastic polymer, epichlorohydrin polymers, copolymer propylene oxide, cyclopentene rubbers, fluorinated elastomers, vinyl co-polymers etc. (Rubber Asia, 2003). The structure of some synthetic rubbers are presented in Table. 2.

Table-1. Structure of natural rubber

Name of natural rubber	*Structure*
Cis-1, 4-polyisoprene	$(\text{—}CH_2\text{—}C = CH\text{—}CH_2\text{—})n$ $\vert$ CH_3

Products of natural and synthetic rubbers

There are innumerable products that are made from both NR and SR industrial raw materials, which are available in both latex and dry rubber forms. The latex, an industrial raw material, includes both preserved latex concentrate of NR and synthetic latex polymers and it is used in various manufacturing processes to produce different goods. The dipping process generates goods like balloons, bladders, gloves (viz. examination, surgical, household and industrial gloves), finger stalls, condoms, rubber bands, nipples etc. The extrusion process creates elastic threads and these may be used in elastic strapping, clothing and hosiery. The foaming and moulding processes produce foam mattress, pillows, cushions etc. The casting process results in the production of toys etc.

The dry industrial raw materials are used to make mostly tyre and related products and non-tyre products. The former category products include solid

Table-2. Structures of different synthetic rubbers

Name of synthetic rubber	*Structure*
Styrene-butadiene rubebr i.e. Poly (butadience-co-styrene)	$((-CH_2-CH=CH-CH_2-)_5(-CH_2-CH(C_6H_5)-))_n$
Butyl rubber i.e. Poly (isobutylene-co-isoprene)	$((-CH_2-C(CH_3)(CH_3)-)_{50}(-CH_2-C(CH_3)=CH-CH_2-))_n$
Neoprene rubber i.e. Polychloroprene	$(-CH_2-CCl=CH-CH_2-)_n$
Nitrile rubber i.e. Poly (butadiene-co-acrylonitrile)	$((-CH_2-CH=CH-CH_2-)_3(-CH_2-CH(CN)-))_n$
Poly butadiene	$(CH_2-CH=CH-CH_2-)_n$
Silicone rubber i.e. Poly dimethylsiloxane	$(-Si(CH_3)(CH_3)-O-)_n$
Styrene acrylic	$(-CH_2-CH(C_6H_5)-)_m-(CH_2-CH(COOR)-)_n$
Vinyl acrylic	$-(CH_2-CH(OCOCH_3)-)_m-(CH_2-CH(COOR)-)-$
Urethane i.e. Poly ester or Poly ether urethanes	$HO-(-P-OCONHRNHCOO-)_n-P-OH$
Thiokol A	$(-CH_2-CH_2-S(=S)-S(=S)-)_n$

tyres, pneumatic tyres & tubes, retread materials, tyre flaps etc. The rubber tyres are shown in figure. The non - tyre products are conveyor belting and rollers, transmission belting, hoses & tubings, electrical products, packaging, boots, containers & life-saving devices, shoes & chappals, repair materials, household & stationery goods, sports items, hot water bottles, medicinal stoppers, hospital sheets, rebreathing bags, oxygen masks, anti-static tubing & flooring, adhesives, coated

fabrics, door & bath mats, rubber grating used at the entrance of buildings, rubber rollers used in typewriters, printers etc.

NR has been replaced by SR in many applications partially or fully. Synthetic rubbers have different characteristics. Styrene-butadiene rubber among the general purpose synthetic rubbers, is well known for its wide application in paper coating, adhesives and carpet binding. Ethylene propylene rubber is used for wire and cable insulation and it has superior ozone and weather ageing resistance. Butyl rubber has resistance to oxidation in air and air permeability and it can be used to produce tyre tubes, gaskets, diaphragms etc. Neoprene rubber has high tensile strength and resistance to fire, oils, solvents and ageing and it has selective application. Neoprene rubber is insoluble in petroleum and vegetable oil, especially gasoline and in liquid pentane and butane and it is used for making belts for power transmission and conveying, gaskets (washers), wire insulators etc. Nitrile rubber has wide application in the concerned products owing to its property of resistance to oil, fuel, greases etc. Acrylic polymers are used in household paint and industrial finishes and provide chemical resistance and outstanding weatherability. Ethylene-vinyl chloride copolymers (EVCL) are used as flame-retardant adhesives. Polybutadiene is used to make low-temperature flexible tape. The superiority of special purpose synthetic rubbers are due to their superior properties like resistances to chemicals including oils, sunlight, ozone, temperature etc. It has special application in atomotive industry. Such SRs are used to produce adhesives, coatings, wire insulators, packings, gaskets, seals, mouldings, footwear etc.

Comparison between natural and synthetic rubber

Characteristics

The characteristic properties of various elastomers including NR are compared in Table 2 (Stern, 1980).

The table shows that NR is excellent in certain properties like tensile strength, abrasion resistance etc. while it shows poor oil resistance, air impermeability etc. SR like butyl rubber has excellent air impermeability and therefore is widely used in inner tubes of the automobile tyres. Similarly, the excellent oil resistance of nitrile rubber, flame resistance of neoprene etc. are utilized in various applications. It is evident that the choice of selection of a rubber for a particular application is determined by the characteristic property of the rubber.

Energy requirement

The energy requirement for production of NR is much lower than that of SR. To produce one tonne rubber, NR needs about 13 to 16 GJ energy due to requirements in various components like:

fertilizers & chemicals	: 5 GJ energy
primary processing	: 3 GJ energy
transport	: 5-8GJ energy

On the other hand SR requires about 108 to 174 GJ

Table 2. Comparison of characteristic properties of various elastomers with NR

Properties	Rubber							
	Natural rubber	Butyl rubber	Neoprene rubber	Nitrile rubber	Poly butadience	Poly sulphide	Silicon rubber	Ethylene propylene
Tensile strength	Excellent							
Oxidation resistance	Reasonably well					Excellent	Excellent	Excellent
Tear resistance	Reasonably well				Excellent			
Heat resistance	Reasonably well						Excellent	
Abrasion resistance	Excellent							
Resistance to atmospheric ageing	Poor		Excellent			Excellent	Excellent	
Flame resistance	Poor		Excellent					
Compression set	Reasonably well						Excellent	
Air impermeability	Poor	Excellent				Excellent		
Acid resistance	Reasonably well	Excellent						
Low temp. flexibility	Excellent							
Animal & vegetable oil resistance	Poor			Excellent		Excellent		
Aromatic hydrocarbon solvent resistance	Poor					Excellent		
Aliphatic hydrocarbon solvent resistance	Poor			Excellent		Excellent		

energy for different types as:

butadiene rubber : 108 GJ energy
chloroprene rubber : 120 GJ energy
styrene butadiene rubber : 130 GJ energy
butyl rubber : 174 GJ energy
etc. (Mathew, 1996).

The free solar energy is utilized to produce NR through photosynthesis during the biosynthesis of rubber.

Environmental and social impact

NR is produced with low cost technology and its production requires less investment and more man power. Thousands of people are employed in latex harvesting and processing, product manufacturing, value addition, marketing and other NR related industries. It needs suitable cultivable land and favourable environment for proper growth of tree and satisfactory rubber yield. On the other hand, SR is produced with high cost advanced technology and its production needs chemical compounds derived from petroleum and requires more investment. It is synthesized in a factory with suitable infrastructure. The photosynthesis process involved in the production of NR in the tree purifies the atmosphere by absorbing carbon dioxide and liberating oxygen. During processing of natural rubber the effluent produced in the processing centre can be effectively used for generating bio-gas. The rubber plantations are a renewable, sustainable, non-polluting and environment friendly source of rubber. Rubber plantations have a green image and are inherently environment friendly. The ecology of the plantation site is not disturbed. On the other hand, SR production pollutes the surroundings. The ecology of the production site may be disturbed. NR production needs more encouragement than SR as the benefits can be shared by more people and the rural people including the poor can enjoy substantial portion of the income. On the other hand, only manufacturing units are enjoying the monetary benefit of SR production and the predominant share goes to urban people. It is also true that the production of SR requires more factories that increase the atmospheric pollution. It also encourages urbanization causing flow of people from rural areas to urban areas. One advantage in SR side is that a huge quantity of different grades of SR can be produced from factories situated in small areas within a short period.

Conclusion

Both natural and synthetic rubbers are essential industrial raw materials to manufacture a large variety of goods to cater to the increasing demand. The suitability of any type of rubber as raw material lies in its properties. Synthetic rubber is suitable in tyre side walls, treads for builder, tractor etc. and applications requiring oil resistance and thermal degradation. Natural rubber is suitable for the products with characteristics of low heat build up, high resilence etc. This valuable raw material is made with easy processing and less investment and provides opportunities to share the income widely. It is more acceptable to the environment and society. Despite the few advantages of SR, NR continues to hold an important place in the rubber undustry. Its resistance to heat build up makes this industrial raw material valuable for tyres on racing cars, trucks, buses and aeroplanes.

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GOLDEN JUBILEE OF THE RUBBER RESEARCH INSTITUTE OF INDIA

The year 2005 marked the Golden Jubilee of the Rubber Research Institute of India. A series of programmes was organized during this memorable occasion for projecting the conspicuous contributions of the Institute before the scientific community and the public.

On Friday the 29 July 2005, His Excellency the President of India, Dr. A. P. J Abdul Kalam inaugurated the year long celebrations at the headquarters of the Institute, near Kottayam, Kerala. The President, in his inaugural address, said that though there was a phenomenal increase in the area under rubber and per hectare production over the past 50 years there still exists scope for raising the national production. Hailing the RRII for its remarkable research contributions, Dr. Kalam also suggested a six-point mission for the Institute for the sustained growth of the rubber sector. On the occasion, the President also dedicated to the nation, two new rubber clones, RRII 414 and RRII 430, developed by the Institute by handing over plants of the new clones to the Chief Minister of Kerala, Mr. Oommen Chandy. The Chief Minister also unveiled the foundation stone of the Golden Jubilee Laboratory complex. The Minister of State for Commerce and Industry, Mr. EVKS Elangovan inaugurated the planting in the proposed rubber clone museum.

On 12 August 2005, the Institute organized the *National Workshop on Clean Development Mechanism (CDM)* under the Kyoto Protocol with reference to the Indian rubber sector. The Workshop held at Kottayam focused on carbon trading and the potential financial benefits the various players in the rubber sector can gain through CDM. Mr. Sajen Peter IAS, Chairman, Rubber Board, inaugurated the workshop. Ms. Ulka Kelkar, Convener, Centre for Global Environment Research, New Delhi delivered the keynote address. Experts from various research institutes, scientists of RRII and officers of the Rubber Board presented papers. A couple of CDM project developers participated in the Workshop and shared their experience. About 150 participants representing various stakeholders including planters, processors, manufacturers, foresters, academics and scientists attended the Workshop.

New clones being released by His Excellency the President of India

The *International Natural Rubber Conference*, INRC, India 2005, organized by the Institute at Cochin on 6-8 November 2005 provided a forum for more than 400 researchers from all over the world to interact, evaluating the trends in natural rubber research during the last decade and to set an agenda for the future. Technical sessions on various themes were held in parallel sessions. Plenary sessions were also held on the last two days of the conference. A poster session was organized in which over 50 papers were presented. The response to INRC 2005 was overwhelming as most of the international agencies and major rubber producing countries participated. A number of delegates from ANRPC member countries and IRRDB member institutes participated in the conference.

The RRII hosted the *International Workshop on Tapping Panel Dryness (TPD) of Rubber*, organized by the IRRDB Specialist Group on Physiology at Kottayam on 10 November. The Workshop underscored the need to address the problem in a comprehensive and holistic manner and evolve research based strategies to contain it. In his opening address Dr. Wan Abdul Rahaman, Chairman, IRRDB said that the Board has identified TPD as one of the most important problems to be addressed by scientists. The focus should be on assessing the gravity of TPD incidence in various rubber growing countries. There were 28 oral presentations and a brain storming session.

The 15 day *National Training Programme on Application of Molecular Markers in Plant Genetic Resource Management in Plantation Crops* was organized from 28 November to 14 December 2005. The 15 day programme provided hands on training to the participants on a wide range of topics. Fifteen scientists from various national institutes and universities participated in the programme.

Twelve scientists from 10 different rubber producing countries participated in the *International Training on Strategies for the Management of Corynespora Leaf Disease* funded by the Common Fund for Commodities (CFC), and held from 18 to 29 April 2006. The programme consisted of classroom lectures, practicals and field demonstrations. The trainees were prompted to develop and present a country plan for Corynespora leaf disease management to be taken up on their return. RRII also organized an orientation programme during August 2006 for the extension officers of the Rubber Board on identification of the newly released RRII 400 series clones.

The Institute conducted farmer – scientist interaction programmes at seven different centres in the traditional rubber growing region of Kerala and one in the non-traditional region of North-East India. Around forty innovative growers who have developed useful technologies in areas such as agromanagement practices, crop harvesting, crop processing, pollution control, bee keeping etc. interacted with the scientists representing various disciplines of RRII in each of this programme. Many innovative ideas of farmers could be noted which will be studied in depth by the RRII.

Six scientific books, three bibliographies, two training manuals and a directory as listed below were published by RRII during 2005 as golden gifts of the Institute to the rubber sector.

Details of the books

1. *Harmonised System Nomenclature: A Reference Manual on Rubber and Rubber Products*. Tharian George K and Joby Joseph, 76p. Price. Rs. 400
2. *A Manual on Breeding of Hevea brasiliensis*. Kavitha K. Mydin and C.K. Saraswathyamma, 100p. Price. Rs. 500
3. *Proceedings: International Workshop on Exploitation Technology*. Eds. K.R. Vijayakumar et al., 290p. (For limited circulation only)
4. *Descriptors for Rubber (Hevea brasiliensis Willd. ex Adr. de Juss.) Meull. Arg.* G. Prabhakara Rao et al., 72p. Price Rs. 400.
5. *RRII 400 series clones of rubber (Hevea brasiliensis)*. Saraswathyamma, C.K., et al, 54 p. (For limited circulation only)
6. *Corynespora leaf disease of Hevea brasiliensis: Strategies for management*. Ed. Jacob, C.K, 188 p.
7. *Training programme on application of molecular markers in plant genetic resource management in plantation crops: A Labo-*

DR. N.M. MATHEW RETIRED AS DIRECTOR OF RESEARCH

Dr. N.M. Mathew, Director, Rubber Research Institute of India who was instrumental in popularising rubber research in the country, retired from service on 31, October 2006 after a stint of nine years as Director.

Mathew is retiring at a time when the institute is standing proud with the release of five premium productivity rubber clones recently, in its golden jubilee year. Among them, RRII 414 and 430 were released for extensive cultivation this year.

Apart from a series of research-oriented programmes, the Institute organised Scientists-Growers meets in seven centres in the golden jubilee year of RRII. They were meant to integrate native knowledge on rubber cultivation with research findings, thereby enhancing productivity and bringing down production cost through innovative methods. An advanced research centre for technology with modern laboratory complex was established at the RRII during the tenure of Dr. Mathew.

It was Dr. Mathew who co-ordinated the successfull efforts of the Rubber Board to control the *Corynespora* leaf disease when the fungus attacked the plantation in northern Kerala and Karnataka. During his tenure as Director of RRII, the Institute conducted studies on the impact of the provisions of WTO on the Rubber industry in the country. Surveys and Studies were conducted in the fields of quality upgradation, development of transgenic plants and cost effective tapping systems too.

Dr. Mathew who had joined the RRII in 1972 secured his doctorate from IIT, Kharagpur. Prior to joining the services of the Board, he was a lecturer at Mar Ivanios College, Thiruvananthapuram. He had also worked as a chemist in Andhra Pradesh Paper Mills.

A native of Changanassery, he was the chief editor of Natural Rubber Research Journal and member of the governing board of Indian Rubber Manufacturers Research Association and Indian Society for Plantation Crops.

Dr. Mathew has more than 100 research papers to his credit. Six research scholars took doctorate from different universities under his guidance.

Dr. Mathew's colleagues gave him a befitting sendoff.

ratory manual. Abraham, S.T et al. 104p.

8. *Identification of RRII 400 Series Clones of Hevea in the early growth phase: A manual.* Vinoth Thomas, et al. (For limited circulation only)
9. *50 Years of Natural Rubber Research in India: A Bibliography (1955-2005).* Eds. Accamma C. Korah and Mercy Jose, 374p. (For limited circulation only)
10. *Tapping Panel Dryness: An Annotated Bibliography.* Eds. N. Latha and Mercy Jose, 96p. (For limited circulation only)
11. *Rubber Based Farming Systems: An annotated bibliography.* Eds. V. R. Sujatha et al. (For limited circulation only)
12. *RRII Library Holdings: Serials (1922-2005).* Eds. A.S Ajitha et al., 100p. (For limited circulation only)

The Golden Jubilee celebrations of RRII evoked immense enthusiasm among all those who are involved in the NR Industry in general, the Rubber Board of India and the RRII in particular.

Kurian K Thomas
Jr. Publication Officer,
RRII, Kottayam 686 009.

INTERACTION BETWEEN GROWERS AND SCIENTISTS ESSENTIAL – SAJEN PETER

The Indian Rubber Board Chairman Mr. Sajen Peter IAS said that interaction between rubber growers and scientists working in rubber sector is very much needed and should be a regular exercise. Even though Kerala, which accounts for 90 per cent of rubber production in India, lies outside the ideal rubber belt, it has achieved a very high level of productivity and rubber cultivation has successfully been extended even to North Eastern areas which are far beyond the traditional rubber growing area. This is because of the strong research and developmental activities carried out in Indian rubber sector, and the high level adoption of technologies by the rubber growers.

Mr. Sajen Peter was delivering the inaugural address in the Rubber Growers' Conference 2006 organized by the Rubber Research Institute of India. He also said that the series of grower-scientist interactions conducted earlier, throughout the traditional rubber growing area, were immensely successful and provided the scientists which numerous new ideas, indigenous knowledge and also results of several field level research activities conducted by growers. Based on the success of these interactions, the Board moots an idea to make it a regular exercise.

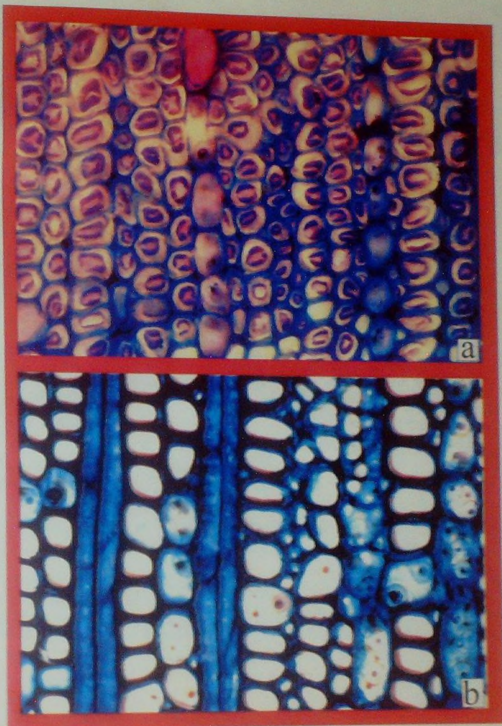
The inaugural meeting of the Conference was presided over by Dr. N.M. Mathew, Director, RRII.

Rubber Growers' conference being inagurated by the Chairman

About 50 innovative growers from different parts of the traditional rubber growing areas presented their observations and results of research activities and agro-management practices, conducted by them in their fields. These growers were selected from among the hundreds of growers who made presentations in the zonal interaction sessions conducted over the past few months. About 500 selected growers and representatives of Rubber Producers' Societies attended the conference.

A compilation of the papers presented in the Growers' Conference and a dcocumentary film on the success story of the Rubber Board in the North East were released by Mr. Sajen Peter and the first copies were received by Dr. N.M. Mathew, Director and Mr. K.K. Raghavan, Jt. Rubber Production Commissioner. Another book, *'Karshakarkku Snehapoorvam'* (To Farmers with Love) written by Mr. Sajen Peter, was released by Dr. N.M. Mathew and the first copy was received by Mr. Augustin Mylackal, President, Aimcombu RPS. The Chairman also presented an award to Mr. Kurian K. Thomas, Jr. Publication Officer of RRII, who had been selected for the first prize in the competition for designing the Golden Jubilee commemorative stamp, first day cover and pictorial cancellation.

Mr. K.K. Raghavan, Jt. Rubber Production Commisioner (Extn.) offered felicitation. Dr. M.A. Nazeer, Jt. Director (PM), welcomed the gathering and Dr. C. Kuruvilla Jacob, Jt. Director (Crop Protection) proposed a vote of thanks. ●

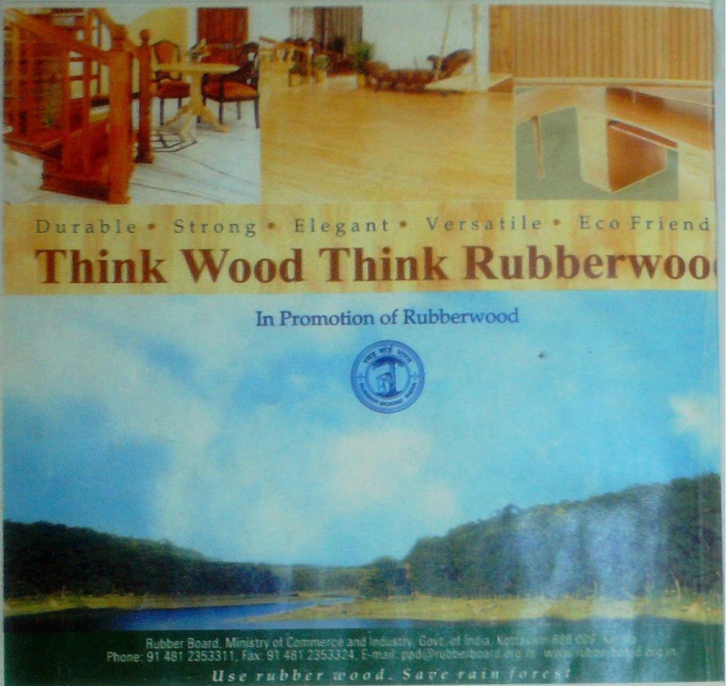


"Visual identification of tension wood in rubber timber using Zinc-chloro-iodide formulation" - Page No: 12

Fig 2 a & b. Cross section of tension wood and normal wood zone stained with toludine blue 'O'

a : Tension wood fibers showing unlignified gelatinous layer (pink colour)

b : Normal wood fibers with lignified walls (blue colour)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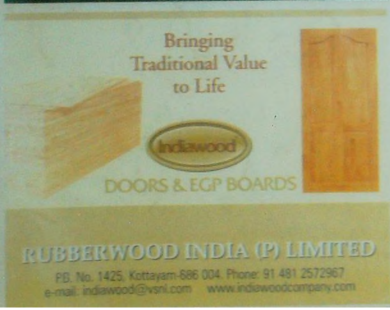
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