

# Trees: Their uses and biology

H. Y. Mohan Ram

*We are inseparable from trees probably because we had an arboreal ancestry. Reposing under a tree is like being cuddled by a mother. Comfortable and secure. As principal components of forests that form the green mantle over the earth or as individuals, trees play multiple roles in nature. They are unmatched as providers and protectors. They are the largest and the longest-lived organisms and offer an amazing diversity of form. Trees have come to symbolize benevolence, fertility and nobility.*

The crisis created by explosion in human and livestock population in the developing countries has vastly accelerated the real needs of the poor. More importantly, the avoidable over-consumption of the rich has outstripped the productive capacity of forests and trees. Rapid deforestation has led to desertification and land degradation. The gloomy prospects of the irreparable loss of trees which constitute the most valuable natural renewable assets have impelled biologists to focus their attention to evolve action plans to regreen the earth.

## Life strategies of trees

The enormous surface exposed by trees is necessary to glean substances from their surroundings present in extremely dilute concentrations. An enigma that confronts any inquisitive person who looks at a large tree like the banyan is: what makes it an individual and how is its organization controlled? A tree represents a highly decentralized system. Every branch of root and shoot has its own terminal meristem (an actively dividing tissue) which contributes to its growth and development. Correlative phenomena such as apical dominance keep in check the growth of lateral buds. The loss of a branch or two will not affect the growth of the tree; the branch closest to the lost one will take its place and carry on its functions. A tree like the pipal produces millions of tiny seeds. From each seed a large tree can develop capable of producing millions of seeds, each like the original.

A small cutting of the root or the shoot can develop into another tree. Stumps of felled trees can also put out coppice shoots to continue the growth. Propagation by root suckers is quite common. Grafting is an old useful art which is the forerunner of organ transplantation in animals. A shoot (sometimes even a bud) from

one individual (scion) can be joined to the base of another, generally more hardy individual (stock). The two parts unite and produce a compatible individual whose aerial parts yield choicest produce, be it foliage, flowers, fruits or commercial extractives like rubber. In a highly refined form of using only a selected shoot, grafting has now been perfected to augment the production of orchard trees such as citrus, mango, apple, pear, peach, guava, cashew, tamarind, sapota, amla, litchi and a large number of ornamental trees. From conventional vegetative propagation, we have moved to plant tissue culture, which has enabled rapid clonal production of selected trees such as pine, spruce, citrus, eucalyptus, sandalwood and bamboos, starting from bits and pieces of trees or even protoplasts (naked cells).

Trees have a modular type of growth. Unlike higher animals, they periodically put out new organs/structures such as branches, leaves, roots, flowers, fruits and seeds. Cellulose (also lignocellulose) is the main photosynthetic product of trees which constitutes the bulk of the plant body.

Being fixed to the ground, a tree braves the scorching days and freezing nights, floods and droughts and tolerates insults such as browsing, lopping, hacking and pollution. Trees survive stresses through physiological means. They respond to environmental cues by producing plant growth regulators (chemicals comparable to animal hormones) whose relative concentrations and combinations at specific sites control developmental phenomena.

In the temperate regions, most flowering trees (the conifers are evergreen) shed their leaves before winter sets in. Buds develop scales and lie dormant. The bark thickens to insulate the inner tissues from freezing and cambium (the lateral meristem that causes increase in girth) ceases to form new wood and bark. Growth virtually stops in winter and is resumed at the onset of spring. Every year a new ring of wood (called annual ring) is formed and the climatic conditions in which the

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## GENERAL ARTICLES

tree will be growing are imprinted in the elements that compose the wood. It is possible to interpret the climate of the past and even earthquakes, droughts and diseases of trees by careful microscopic examination of a sample of wood. This science is called dendroclimatology. Tree ring analysis also helps in determining the age of a tree and old sites of vegetation or human settlements (dendrochronology).

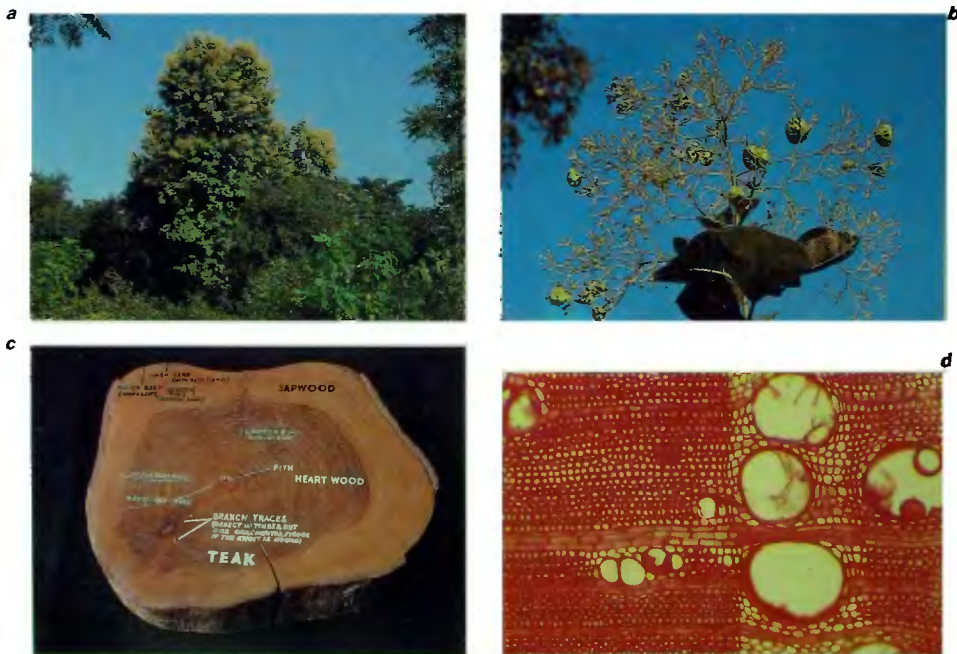
Heartwood, which occupies the centre of a tree consists of dead tissues. It provides passive support to the trees. Even if it is removed, the hollow tree can continue to live. As plants lack an excretory system, large quantities of secondary metabolites (notably phenolic compounds) are dumped into the heartwood which make it extremely durable. The deep maroon-coloured rosewood (*Dalbergia latifolia*), the dark-brown sissoo (*Dalbergia sissoo*), the scented sandalwood (*Santalum album*) and katha (*Acacia catechu*) are all derived from the heartwood. The border between the surrounding sapwood (living) and the central heartwood

where programmed cell death occurs, is a fascinating tissue for biological study.

### Protective functions of trees

Trees protect mountains against the force of torrential rains and wind and reduce erosion. They act as a 'sink' for atmospheric carbon dioxide and release large amounts of oxygen. 'The tree man', Richard Saint Barbe-Baker, called trees 'the green lungs of cities'. Trees lose huge amounts of water vapour and reduce air temperature. Large-scale felling of trees has led to land slides, erosion of top soil, flash floods and silting of rivers and reservoirs, drying up of springs and streams rendering lakhs of people hungry, homeless and landless. In the Himalayan region, collection of fuel and water have become daily drudgeries for women. It is increasingly realized that tree cover is important for ecological security and sustained agriculture.

The canopy of a tree not only manufactures food but



**Carpenter's paradise.** Teak (*Tectona grandis*), a native of India, Burma, Thailand and Indonesia, is one of the finest timbers in the world because of its durability, working properties and beauty. It is used extensively in ship-building and furniture. **a**, Flowering tree; **b**, inflorescence. Flowering is profuse but fruit and seed set is poor. Seeds are dormant, germination is problematic, **c**, Cross section of a log of teak showing different parts, **d**, Microscopic structure of portion of teak wood. Anatomical features help in identification. (**a**, **c**, **d**—M. N. B. Nair; **b**—H. Y. Mohan Ram).

stores and provides shelter to a host of other beings such as algae, fungi, lichens, liverworts, mosses, ferns and flowering plants. Insects, arachnids, birds and mammals live on trees, some of which in turn act as messengers and distribute fruits and seeds to far-off places. The root systems create an extensive network and tap water from very deep layers. This feature enables trees to survive severe drought conditions. Roots also harbour mycorrhizae, rhizobia and actinomycetes which help in the fixation and supply of nutrients. The fallen leaves, old roots and dead trees support a whole community of organisms. Thus a tree is an important component of a guild which provides

protection and support to microbes, plants and animals. Trees act as gene banks to help conserve biodiversity. Trees collect dust and other pollutants from the atmosphere. By mitigating glare, buffering noise and in alleviating the harshness of urban structures, trees have become an essential component of city planning and living.

### Silent providers

Over 300 million people in the world live in forests. Trees are an important source of food. Leaves, seeds and fruits give a rich variety of edible material. Fruits such as jack, mango, durian, coconut, babassu palm (*Orbignya* sp.), date and the starch from the stem of sago palm (*Metroxylon sagu*) are important sources of



**Bael or Bliba (*Aegle marmelos*).** Close-up of a twig. The three leaflets are considered to represent the trinity of Hindu Gods—Brahma, Vishnu and Maheshwara. Leaves are used especially for worshipping Lord Siva. Fruits pulp is made into sherbet. It is also used in traditional medicine for diarrhoea and constipation. (H. Y. Mohan Ram)



**Fruits of cacao.** A native of the upper Amazon basin, cacao is cultivated on a large-scale in Africa. Roasted and ground seeds are made into cocoa or chocolate. In India cacao is grown mostly in Kerala. (H. Y. Mohan Ram)



**The jack fruit.** An evergreen tree with shiny leaves. It is believed to be a native of the Western Ghats. Raw fruit is cooked as vegetable. Ripe fruit is aromatic and sweet. The fruit is probably the heaviest (up to 30 kg) among fruits from trees. Wood is a high class timber and source of a dye. (H. Y. Mohan Ram)



A rubber tree being tapped for latex (H. Y. Mohan Ram)



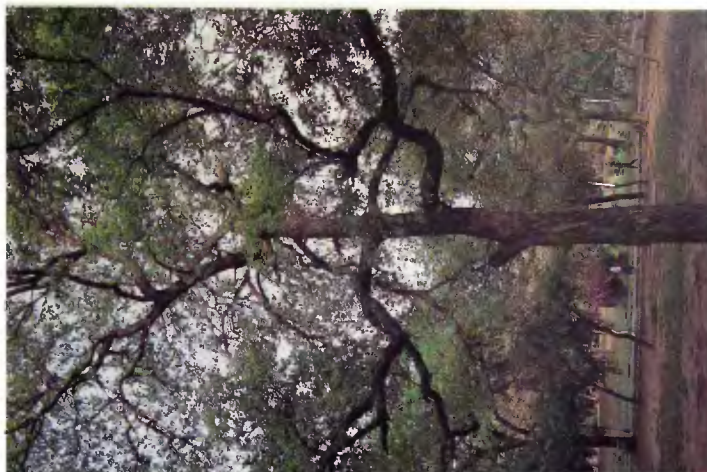
**Bael or Bliva (*Aegle marmelos*).** Tree with fruits.



**Himalayan cedar or deodar (*Cedrus deodara*).** A majestic evergreen tree that occurs in the Western Himalayan region at elevations from 1200 m to 3000 m. It often attains 60 m in height and 10 m in girth. It yields timber of excellent quality. Deodar is one of the longest-lived Indian trees. (M. N. B. Nair)



***Prosopis juliflora*.** Introduced and cultivated in India, this tree has become an important source of firewood in the semi-arid regions. (H. Y. Mohan Ram)



**Shisham tree.** Recent research has shown that it is predominantly cross-pollinated. (Courtesy Mr. Pallava Bagla)

food. Other products of trees are firewood, charcoal, fibre, timber for construction, agricultural implements, furniture, shelter, rafts, boats, vehicles and traditional medicines. In certain parts of the country, probably more animals feed on shrubs and trees than on grass or grass-legume pastures<sup>1</sup>. Industrial uses of wood include paper, rayon, cellophane, photographic film, etc. Trees synthesize thousands of useful chemical compounds at normal temperature and pressure without discharging pollutants. Barring fruit trees, plantation crops (rubber, coconut, oil palm, areca nut, cocoa, cloves, etc.) and certain ornamentals, most trees are wild or semi-wild and are not raised on fertilized soils and tended. Due to over-exploitation some of the best timbers such as teak, rosewood, padauk, deodar, toon, benteak, satin wood, marble wood and walnut are no longer in the reach of the common man and have become luxury materials. The extent of illegal felling and organized smuggling of sandalwood in Kerala, Karnataka and Tamil Nadu is well known too.

We in India are singularly fortunate that the number of species with multiple uses (multipurpose trees and shrubs or MPTS as they are presently called) is very large. The tree with the record number of uses is the coconut, aptly called Kalpataru or Kalpavriksha. White mulberry (*Morus alba*), mango (*Mangifera indica*), mahua (*Madhuca indica*), *Ficus* spp., jack tree (*Artocarpus heterophyllus*), neem (*Azadirachta indica*), babul (*Acacia nilotica*), khejari (*Prosopis cineraria*), flame of the forest (*Butea monosperma*), toddy palm (*Caryota urens*), date palm (*Phoenix dactylifera*) and wild date (*P. sylvestris*), drumstick tree (*Moringa oleifera*), jamun (*Syzygium cumini*), sal (*Shorea robusta*), tamarind (*Tamarindus indica*) are some of the native species with several uses. Bamboos (they are not trees in the strict sense but are woody grasses) such as *Dendrocalamus strictus* and *Bambusa arundinacea* can be added to this list, as they provide basic materials to support the lives of a large number of poor people, particularly the tribals.

### Trees and people

Throughout history, trees have featured in religion and folklore. They have been an integral part of Indian ethos. Sages meditated and taught under trees. Buddha attained Nirvana beneath the bodhi tree (*Ficus religiosa*). Emperor Ashoka planted avenue trees to provide shade to the traveller and to give employment for both men and animals. Valmiki and Kalidasa have extolled the virtues and beauty of our trees. Deified and worshipped through the ages as abodes of the Gods, protectors of the dead and the guardians of the living, trees have been traditionally preserved in sacred groves. Village panchayats and classes are held under trees. Swings are hung from branches in the rainy season and

women and children enjoy themselves with gay abandon. Trees have come to bear an affectionate kinship with man, not shared by many other things. Trees have a symbolic association with scholarship. Both need deep roots and room to grow. Cessation of growth means the onset of decay.

Following oriental wisdom, Gurudev Rabindranath Tagore started a tree plantation festival in Santiniketan in July 1928. This celebration is held on 22nd Shravana (7th or 8th of August) every year to commemorate his death anniversary. Vanamahotsava was popularized by the late Dr K. M. Munshi in 1949. This activity, started with the noble objective of greening India, has met with indifferent success in different regions of our country. After the political fanfare with claims of planting millions of trees is over, the protection of the saplings is ignored. The majority are eaten up by the grazing animals. Vanamahotsava has failed largely because it has not been a people's programme. In many places the programme has turned out to be a mere travesty for employment creation.

As they exhibit an extraordinary range of form, size, canopy architecture, flower colour, fruit shape and aroma, trees are used in landscaping to enhance beauty and gracefulness of homes, schools, offices, gardens, places of worship, hospitals, burial grounds, playgrounds and avenues. Each species of tree has a unique personality. Some of the most attractive native trees are Indian laburnum (*Cassia fistula*), semul or red silk cotton (*Bombax ceiba*), flame of the forest (*Butea monosperma*), coral tree (*Erythrina indica*), kachnar (*Bauhinia* spp.), champak (*Michelia champaca*), kadam (*Anthocephalus chinensis*), maulsari (*Mimusops elengi*), scholar's tree (*Alstonia scholaris*), mast tree (*Polyalthia longifolia*) and queen crape myrtle (*Lagerstroemia speciosa*). A large number of trees introduced to India, and too numerous to be listed here, have enriched our landscape. Notable among these are gulmohr (*Delonix regia*), jacaranda, African tulip tree (*Spathodea campanulata*), several species of *Cassia*, rain tree (*Samanea saman*), *Chorisia*, *Araucaria* and frangipani (*Plumeria acuminata*).

### Needs of the poor not met

In spite of the enormous diversity and potential uses of trees, the needs of the poor are not met. In rural areas trees are the main source of energy. India has augmented its grain production but there is acute shortage of energy to cook food. Unless massive tree improvement, planting and utilization programmes are taken up with a sense of urgency, involving people, firewood availability will worsen in the coming decades.

A continuous search for native and introduced trees for meeting firewood needs has been carried out. Trees

that are fast-growing, have high calorific value, fewer demands and inputs and are non-browsable have been identified. Lists of trees that can be grown on degraded lands have been widely publicized<sup>2</sup>. Studies on rates of growth and biomass production of several Indian and introduced trees are being carried out at the National Botanical Research Institute, Lucknow; Madurai Kamaraj University and a few other research centres. *Eucalyptus*, *Casuarina*, *Prosopis juliflora* are some of the exotics that have been successfully established. *Eucalyptus* has been the subject of much controversy as it has been planted in areas where food crops could be raised and it does not meet the traditional needs of the poor. Its cultivation is reported to cause deterioration of soil quality and drastic reduction in moisture availability. Importantly the wood of *Eucalyptus* has been diverted for use in paper and rayon industry.

Many farmers do not plant and protect trees because of lack of secure land tenure, free choice of species, unrestricted rights of usufruct including felling, unrestricted rights to transit to markets, competitive markets and good market information<sup>3</sup>. Tree planting by the poor farmers is done in the semi-arid regions where trees are a part of the farming system, where they increase soil fertility, yield fodder, mulch and shade<sup>3</sup>. In the high rainfall areas of Kerala, Karnataka and Assam, trees are planted in home gardens to augment family income. Trees are also raised in areas where agriculture is uncertain or land is unfit for crop production.

### Exotic trees change plantation scenario

Among the several benefits of the post-Columbian era are the introduction of four important South American trees—*Cinchona* (source of quinine, the antimalarial drug), cocoa (*Theobroma cacao*, the beverage plant), cashew (*Anacardium occidentale*, source of the most delicious nut which is one of India's foremost items of export) and para rubber (*Hevea brasiliensis*), to Asia and Africa. Latex from the rubber tree has changed the pace of civilization. We walk on rubber, sleep on rubber and use it in bicycles, carts, automobiles, aeroplanes and countless other articles. We depend on rubber for safe surgery. For the manufacture of three billion pairs of surgical gloves used annually in the world today (especially with the rapid spread of AIDS) and of condoms and diaphragms for contraception, only natural rubber is permitted. It is reported that natural rubber is superior to synthetic rubber for the production of aircraft tyres. A good deal of basic tree biological studies have gone into the improvement of natural rubber to meet the increasing global demands.

The African oil palm (*Eleaëis guineensis*) is presently the highest yielder of vegetable oil (4 metric tonnes per hectare). Planted on a large-scale in Malaysia, it has

come to prominence through concerted research and development efforts of scientists, economists, business managers and engineers. To meet the acute shortage of vegetable oil, the Department of Biotechnology has set up mini plantations in four states in India, using imported seedlings of oil palm.

### Resurgence of interest in native trees

There is a common saying that what grows in your backyard has no value. Nevertheless, there is a revival of interest in re-examining the traditional uses of native trees. Neem is a source of an antifeedant compound—azadirachtin, which can provide a safe, non-toxic, inexpensive bioinsecticide<sup>4</sup> and an antifertility compound (the formulation of which is called 'Praneem', developed by Dr G. P. Talwar and associates). A popular avenue tree which gives abundant shade, an abode for bird fauna, source of fodder, timber, firewood, oil, disposable toothbrushes, honey, etc., neem has been taken for granted. No serious attempt has been made in India to collect its germplasm and select populations containing high azadirachtin content and other valuable properties. Two international conferences have been held on 'Neem' outside India. Another world conference is scheduled to be held at Bangalore from February 24 to 28, 1993.

The drumstick tree (*Moringa oleifera*) is grown in homes in many parts of India. Its flowers, leaves and fruits are used as vegetables and the foliage is valued as fodder, green manure and for medicinal properties. The plant is in much demand in Japan for its soft wood for chopsticks. The work done at the National Botanical Research Institute, Lucknow has shown that distinct varieties of drumstick can be raised for wood, fruits and fodder.

Our country has failed in providing safe drinking water, in spite of mounting a serious mission. One of the main reasons of its failure is over-dependence on sophisticated and costly technologies unsuited for the target communities. A joint project by the University of Malawi (Africa) and Leicester in the UK has demonstrated that the crushed seeds of drumstick added to a pot containing turbid water acts as a coagulant, like alum (source: Centre for Environmental Education—Network for Information Sharing, Ahmedabad) and is significantly effective in inactivating bacteria and preventing their multiplication. Such findings are beneficial for rural people in India. This use should be popularized through mass media.

There is a common water purification practice in Kerala. Pieces of heartwood of *chappa* or *sappangam* (Malayalam name for *Caesalpinia sappan*) are boiled in water used for drinking. This procedure is reported to provide relief in mild cases of dysentery and diarrhoea.

**a**



**Semul or red silk cotton.** One of the spectacularly attractive trees of India with large, fleshy, orange or scarlet flowers. (M. N. B. Nair)

**b**



**Gulmohr or flamboyant tree.** Believed to be a native of Madagascar (Malagasy) from where it has disappeared, this gorgeous tree is planted for its bright orange-scarlet flowers throughout the tropics. Some exquisite specimens are found in Karnataka. Seeds are hard to germinate. (M. N. B. Nair)

**Sterculia urens.** A tree that occurs in Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra and Andhra Pradesh, it is the main source of gum Karaya. It exposes white branches when leafless and bears profuse clusters of yellowish-brown flowers (**a**). The gum principally collected by tribals has innumerable domestic and industrial uses and is exported from India. Tapping of gum is done by blazing or stripping the bark of the tree. Heavy tapping affects regeneration and health of tree as shown by (**b**). Safe tapping techniques are needed. (**a**, M. N. B. Nair; **b**, H. Y. Mohan Ram).



Copious production of gum arabic in response to ethephon application made in a hole of the trunk. (J. R. Bhatt)



**A Dusehri mango tree** laden with fruits. An evergreen tree that originated in the Indo-Burma region, mango has been in cultivation for more than 4000 years in India. Hundreds of varieties exist. Wild trees yield a reddish wood used in low-cost furniture. (H. Y. Mohan Ram)



**Mahua.** A large deciduous tree that occurs in several parts of India. The thick cream-coloured flowers are rich in sugars. The fallen corollas are swept from the floor, are eaten raw, cooked or fermented and distilled to obtain a liqueur by the adivasis. Oil from seed is used for cooking, soap-making and burning. Wood has several uses. Tree finds many traditional medicinal applications. (H. Y. Mohan Ram)



**Khejari.** A tree that grows on sand throughout Rajasthan. Pods are eaten as vegetable and valued as fodder. Leaves are fed to goats. Wood is a minor timber. The Vishnois venerate the tree. (H. Y. Mohan Ram)



A twig of Drumstick tree with flowers and fruits. (M. N. B. Nair)



**Pipal tree** along the banks of river Ganga in Varanasi. Considered sacred by the Hindus and Buddhists, it is planted in temples and worshipped. It is also used for shade and fodder.



**Queen crape myrtle.** A colourful avenue tree with large pink and mauve flowers with crumpled petals (M N B Nair)

The heartwood is also the source of a dye (Brazilian dye) for facial paints.

Trees have been employed for medicinal purposes since ancient times. A few examples of sources of drugs employed in Ayurveda that have lately come to prominence are guggal (*Commiphora wightii*, the petroleum ether fraction of its gumresin has hypolipaeic, anti-coagulant, anti-atherosclerotic, anti-inflammatory and anti-arthritis activities)<sup>5</sup>, *Crataeva nurvala* (for dissolving urinary tract stones and restoring bladder tone after prostatectomy) and *Saraca asoca* (oxytocic). The Central Drug Research Institute, Lucknow is screening a very large number of plants for potential medical applications.

### Points for action: role of basic sciences

Considering the productive, protective, ecological, conservational, educational and recreational roles of forests, the number of trained scientists and the extent of research and developmental activities in forestry area are dismally low. For too long forestry was excluded from the mainstream of Indian education, in contrast to the situation with agriculture.

Most forests are owned by the state governments and tree improvement programmes have not been given the necessary thrust. Agricultural revolution in India was possible through distribution of better seeds, irrigation, fertilizers, pesticides and a package of practices. Above all, demonstrations to farmers were crucially important. The land was secure, inputs were subsidized and harvesting and selling of produce was not restricted.

No genetic improvement to enhance the production of timber, firewood, fodder, fruits, gums, resins, tannins, dyes or any product from trees can be achieved unless there is basic understanding of the biology of the selected species. The number of economically useful trees in India is embarrassingly high in contrast to the situation in the temperate countries of the West. Some estimates put the number of timber species alone above 200. According to Champion and Seth<sup>6</sup> this is because the forests of India 'include a greater range of composition and appearance than can be found over a similar area in any part of the globe'. We have a fairly good knowledge about the gross structure, properties, availability, seasoning, durability and uses of these timbers owing to the excellent work done in India by foresters and forest scientists. However, our total knowledge about the genetic variability, breeding systems, phenology, pollination biology, seed production, viability, dormancy, germination, establishment<sup>7</sup>, ecology, pathology, entomology, nutrition, productivity and several other aspects of even a single useful tree is extremely meagre.

Collection of germplasm from various provenances,

selection of plus trees, raising of seed orchards, progeny testing on specific sites and making available improved seeds of superior quality in large quantity require time-bound, target-oriented programmes. We also do not have scientific studies on growth curves of major timber species, forest soils, hydrology, and biomass needs of the rural population<sup>8</sup>. There is such an acute shortage of basic information that these programmes cannot be taken up meaningfully. To cite an example Shisham, whose wood yields a valuable material for carving (especially in Saharanpur, UP) and firewood and which is moderately fast-growing, extremely tolerant of salinity and drought, was considered a self-pollinating tree. Recent research done at the Department of Botany, University of Delhi by Menon<sup>9</sup> has shown that this plant is 98.8% outcrossed (a basic requirement for heterozygosity), which underlines how important it is to have this knowledge for breeding of this tree.

**Trees should not be valued only for their economic returns. T. M. Das of Calcutta University has made a rough estimate of the total benefits in terms of money from a 50-year-old tree, weighing 50 tonnes, including oxygen production, control of soil erosion, soil fertility, recycling of water, control of air pollution, sheltering of birds, animals and insects, timber, fruits, flowers, animal protein etc. It comes to over Rs 20 lakhs!**

Coconut, which is indispensable to millions of people in India as a source of food, drink, shelter and fibre and is held in deep reverence, is suffering from a serious disease (root wilt or 'disease of unknown etiology') in several parts of Kerala. No solution has been found for it in spite of research carried out for the past 75 years! Although a mycoplasma-like organism (MLO) has been implicated as the causal organism, latest studies indicate that accumulation of serium and depletion of magnesium could be responsible for this disorder<sup>10</sup>.

Factors that trigger senescence and cell death regulate heartwood formation. It has been shown that injection of ethephon (2-chloroethylphosphonic acid), a synthetic chemical that releases ethylene in plant tissues, can accelerate these processes. This basic study is important because many standing mature rosewood trees which are auctioned may or may not have heartwood, often resulting in total loss to a purchaser. Whether or not there is a genetic basis that determines heartwood formation is not clear. Ethephon increases

flow of latex in rubber and that of gums and gumresins<sup>10,11</sup>.

Over 80 per cent of the world's supply of gum arabic comes from the Sudan. The source is the leguminous tree *Acacia senegal*, commonly found in the semi-arid regions of the Sahel. It can tolerate drought, fixes nitrogen symbiotically in its roots and is a good fertilizer for crops. Although millions of trees of this species occur in Gujarat and Rajasthan, they yield very little gum. Application of ethephon through a hole in the trunk has yielded up to 900 g per tree<sup>12</sup>.

There is need to step up the yield of the valuable Karaya gum (from *Sterculia urens*) being exported from India using modern tapping techniques. These measures can generate income to a large number of tribals in areas where agriculture is not possible<sup>13</sup>.

India is the only country in the world which has four types of silk — mulberry, tasar, eri and muga. Whereas much research has been done on both mulberry and silkworm in China, Japan, India and France to totally domesticate them and obtain high economic returns, this has not been possible with the other three kinds of silk because of lack of basic research on the food trees and the life-cycles of the insects involved.

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## NEWS

# Report on the brainstorming session in the area of tree biology

The Department of Science and Technology through its Programme Advisory Committee on Plant Sciences has evolved an innovative approach for reaching out to scientists in remote universities and young scientists who need encouragement and guidance for formulation of meaningful programmes. The National Seminar on Life Sciences organized at Lucknow in December 1988, had identified ten challenging areas under Plant Sciences. A series of brainstorming sessions in the identified areas have been organized. A brief report on three earlier brainstorming sessions has recently appeared in *Current Science*. A brainstorming session in the area of tree biology was organized at the North Eastern Hill University, Shillong during February 18–20, 1992 under the chairmanship of H. Y. Mohan Ram, Department of Botany, Delhi University, Delhi.

India has a number of tree species

uniquely suited for various applications such as timber, firewood and fodder production, social forestry, agro-forestry, watershed regulations and reclamation of degraded lands. However, there is very little indigenous information on their biology, so essential for breeding and selection. Although the study of trees falls under the purview of forestry, the PAC on Plant Sciences felt that encouraging fundamental studies on trees would provide basic scientific information to foresters, conservationists and agriculturists. The session provided a platform to bring together foresters and scientists from other disciplines to develop meaningful programmes.

In his keynote address, Mohan Ram outlined the importance of trees in Indian economy and emphasized the crucial role of forests in the livelihood of a large number of tribals, rural people, village artisans, etc. and emphasized the need for encouraging basic studies in

this area. Other experts reviewed the state-of-the-art in reproductive biology, tree architecture and foliage dynamics, dynamics of root growth, nutrient relations of trees, cambial activity and wood formation, resin/gum secreting tissues and regeneration ecology of trees.

After detailed discussions, the following recommendations were made:

1. For afforestation work, study of natural variability of trees, selection of individuals/genotypes and superior provenances will be important as production of high-quality seeds is dependent on our understanding of their reproductive characteristics.
2. In view of the renewed interest in the study of tree architecture and foliage dynamics, particularly in tropical rain forests, studies on the effect of gap size and shape on the resultant microclimate, particularly light, are important. Modelling studies on tree architecture,