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EDITORIAL

India can boast to have Asia's second largest chemical industry. However, it goes along with a human and industrial disaster of much larger proportion – the Bhopal Gas Tragedy of 1984. The 40 tonne methyl isocyanate (MIC) leak claimed 20,000 lives, rendered 500,000 chronically sick, exposed not so organised medical treatment, and led to poor compensation, endless litigations, etc.

The tragedy still continues in the form of abandoned Union Carbide factory which has a stockpile of chemicals like aldicarb, carbaryl, chemical waste tar, hydrochloric acid, mercury, phosgene, etc. The chemicals contaminate the local water and soil. For example, the five worst affected residential areas showed food, soil, water and breast milk contamination with heavy metals (nickel, chromium, mercury, and lead), volatile organic compounds (dichlorobenzene) and halo-organics (dichloromethane). Under trade secrecy, Union Carbide has not divulged the composition of chemicals released. So, it is not easy to decide the course and nature of long-term treatment. Therefore, a new ailment known as *Bhopal Gas Disease* has been identified by the Indian Council of Medical Research. It is defined as 'a condition of ill-health, due to exposure to Bhopal's toxic gases'. It has forty symptoms ranging from low backache to breathing difficulties. Rehabilitation of affected people is practically an unattended task and only 450 victims have been rehabilitated.

What lessons have we really learnt? The human face of tragedy must be the first priority – health, rehabilitation, compensation, etc. But, environmental and medical aspects should get equal attention as they will enrich human scientific knowledge as well as skill to tackle such incidents effectively in future. Our inaction should not blur the tragedy.

REGULATORY ISSUES IN THE CONSERVATION AND MANAGEMENT OF MANGROVE ECOSYSTEM

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Introduction

The need for conservation and management of mangrove ecosystem is strongly felt today primarily due to increasing human population year by year and consequent increase in pressure on mangrove ecosystem. As the population grew in the coastal areas, the pressure on the mangrove forests increased for timber, fuelwood, fodder and other non-timber forest produce (N.T.F.P). Increasing population and economic development invariably increase the demand for forest products and the forest land (Soemodihardjo *et al*., 1996). Ever-increasing population pressure had caused dramatic changes in the mangrove ecosystem throughout the world (Saenger *et al*., 1983).

From the available literature (Blasco, 1975; Untawale, 1985), it is clear that the condition of Indian mangroves is highly degraded as a result of lack of awareness, planning and pressure of resource use. Growing awareness of the protective, productive and social functions of tropical mangrove ecosystem has highlighted the need to conserve and manage them sustainably (FAO, 1994). Appropriate management of mangrove ecosystem can ensure its conservation for environmental benefits and at the same time it can ensure optimum supply of various forest and other produce to local people to meet their day to day basic requirements. With the proper planning on scientific lines, the supply of various produce from the ecosystem can not only be maintained on sustainable basis but also can be further improved. It is necessary to undertake management plans to conserve the mangroves (RSAM, 1992). Various aspects of Indian mangrove have been studied so far but no concrete attempts have been made to protect and conserve these resources. Conservation and management of mangrove genetic resource is an imperative need to prevent further deterioration (Jagtap *et al*., 1993).

Role of management is not confined only to these environmental and economic benefits. It can open many new avenues for self-employment like eco-tourism, fishing, honeybee keeping, mangrove forest produce based cottage industries etc. for the local unemployed people (FAO, 1994), which can play a very crucial role in socio- economic upliftment of the local communities. Management is also required to effectively tackle various

problems, which have originated due un-wise interference of human beings in mangrove ecosystem. Several International funding agencies viz. UNESCO, UNDP, WWF, IUCN, etc have shown much interest to conserve and protect the mangrove ecosystem (Naskar and Mandal, 1999). The paper is based on author's field work in the state of Goa, Andaman and Nicobar Islands and relevant reports from different parts of the globe.

" Mangroove conservation & development efforts have definitely reduced the degree of problems. Some specific action points can, however, further improve the situation."

Regulatory Issues

Regulatory issues pertain to variety of problems, which have cropped up in mangrove forests. These issues call for adoption of appropriate management practices immediately to conserve the unique ecosystem (Anonymous, 1989).

Indiscriminate Tree Felling and Lopping

Indiscriminate tree felling and lopping of mangroves mainly for the firewood, fodder and timber result in the degradation of mangroves (Fig.1).

Fig. 1. Indiscriminate felling of mangroves.

It was observed in Goa that local people lopped mainly *Avicennia officinalis* and *A. marina* which grew quite big in size among the mangrove trees. Tree felling and lopping were mostly seen in the areas close to human habitation. In Middle Andaman, lopping of *Bruguiera parviflora* for fodder and felling of *B. gymnorrhiza* for getting poles were noticed. Table 1 gives information on mangrove related offence cases booked in Middle Andaman in different years.

Indiscriminate and over-exploitation of mangroves has resulted in resource depletion and posed serious threats to the ecology and environment of mangrove bearing coastal areas (Untawale, 1984, 1987).

Untawale (1996) reported over-exploitation and deforestation of mangroves for fuel wood and fodder in Goa. Qureshi (1996) reported lopping of mangroves in Pakistan for fuel wood and fodder. Naskar and Mandahave shown much interest to conserve and protect the mangrove ecosystem (Naskar and Mandal, 1999). The paper is based on author's field work in the state of Goa, Andaman and Nicobar Islands and relevant reports from different parts of the globe.

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Illegal mangrove tree fellings have also been reported from abroad. In Vietnam, demand for mangrove timber, poles and firewood is far larger than the supply. People come to forests and use subtle tricks such as sawing the trees at ebb tide, with other relatives guarding outside to warn of danger and transporting the timber

away in midnight. Sometimes, the trees are tied to the sides of the boat and thrown into the river, if discovered (Cuong, 1994).

- **Indiscriminate Conversion**

Indiscriminate conversion of mangroves bearing areas for aquaculture, agriculture, human habitation and industrial purposes have wiped out mangroves from many industrial purposes have wiped out mangroves from many areas. There are examples in Goa where mangrove bearing areas were converted to other uses. Some mangrove areas have already been converted for prawn culture at Chorao (Goa). Recently, Fisheries Department of Goa government has sought permission of the Forest Department to further clear the mangroves for development of aquaculture at Chorao. Along the Mapusa estuary (Goa), mining related activities have adversely affected the mangroves. At Goa, several bunds were noticed in different parts of the state which were constructed to reclaim the mangrove areas. Conversion of mangrove areas for agriculture, brackish water fisheries, prawn and shrimp farm, salt pans, development of ports and harbours, tourist spots, cities had several adverse affects on the natural regeneration process (Clough, 1982).

In Middle Andaman, the Revenue Department has allotted mangrove-bearing land for human settlement and agriculture/ horticulture. These deforested and cleared naked lands become subject to soil erosion during tidal inundation or rain (Naskar and Mandal, 1999).

Interference with the free flow of tidal water and of fresh water from the landward side may alter the character or destroy the normal vegetation of the mangrove swamp. In Port Blair, reclamation by means of embankments has rendered large areas unfit for the growth of mangroves and marshy blanks have resulted (Sahni, 1957).

The total wetland area which has been converted for other uses is about 40 m ha in India, as compared with 10 m ha in Indonesia and about 2 m ha in Malaysia (Untawale, 1992). During the last two centuries more than 50 percent mangrove areas in the Indian part of the Sundarbans have been reclaimed and converted to agricultural fields, brackish-water fisheries and rural habitations (Naskar, 1985). Mangrove areas of the undivided Sundarbans have been reduced by more than 50 percent during the last two centuries (Chanda, 1977).

Several reports on indiscriminate conversion of mangrove areas have come from various part of the world. Mencer and Hamilton (1984) reported that during the last two centuries, vast areas of the mangrove forests of the world had been reclaimed to shrimp farms and brackish water fisheries in the South-East Asian countries. Shrimp and crab rearing is tremendously profitable when compared with forestry business (Hong, 1996) and the fact lures the people to convert mangrove areas.

In Peninsular Malaya (Malaysia), about 10,500 ha mangrove lands have been converted during 1955 to 1980 for agricultural purposes (Razani, 1982). Several hectares of these mangrove cleared lands also remain fallow or idle due to acid sulphate in these soils (Ong, 1982). Similarly, in Sarawak, about 4,000 ha mangrove lands have been reclaimed for agriculture from 1933 to 1982 (Chai, 1982). In Peninsular Malaya alone, 500 ha mangrove areas have been cleared for aquaculture. Besides these agricultural and aquacultural utilisation of mangrove areas in Malaysia, the rapid growing urbanisation, mining, over- exploitation, cross bund construction on rivers, have caused large-scale deforestation or mortality of mangroves like other world mangals (Chan, 1988).

- **Industrial Pollutants**

When industrial pollutants are discharged into the rivers without giving proper treatment, they adversely affect the mangroves and hinder its natural regeneration (Clough, 1982). This problem is not severe in Goa and Middle Andaman, but in some regions of the world, it is one of the major problems.

In Karachi and its vicinity, there is pollution resulting from the steady growth of this major industrial city of over a million people. Apart from untreated domestic sewage which flows into the rivers, streams and creeks, there are significant industrial discharges from major industries such as steel mills, refineries, power stations, tanneries and textile mills. Tanneries perhaps represent the main source of pollution, since the waste has a high metal content which is less easy to control (IUCN, 1987a).

- **Encroachments**

The entire mangrove areas have not been surveyed from the point of view of ownership. It is believed that people might have encroached upon the Government's mangrove forest lands. At some places in Goa, local people were seen cultivating paddy on government land along the banks of the estuaries after uprooting the natural and planted seedlings. In Vietnam, some households, living far from the forestry station, steadily encroach and destroy mangroves for building aquaculture ponds (Hong, 1996).

- **Ownership of Land**

A considerable mangrove area in Goa belongs to *communidade* (village community) and private people. As ownership of this land is not with the government, it is relatively difficult to conserve and develop the mangroves over such lands if the owners of these lands do not extend co-operation. Qureshi (1957) emphasised the need to transfer all mangrove forests under control of Forest Department for scientific management.

- **Traditional Method of Fishing**

In the traditional method of fishing in Goa and Middle Andaman, dragnets are used along the rivers where young mangrove seedlings may be there. At the time of dragging the net, young seedlings get entangled in the nets and are uprooted. Thus, this method of fishing hampers regeneration of mangroves. Large-scale shrimp/prawn seed collection cause tremendous detrimental effect on the aquatic environment of the mangroves of Sunderbans (Naskar and Mandal, 1999). Fishermen, women and their children usually gather edible molluscs and catch fish in the plantation area. These activities are also a threat to the seedlings (Hong, 1996).

- **Movement of Barges**

Barges are used in Goa for carrying iron ore. While sailing through the estuaries, barge movement gives rise to strong waves, which sometimes damage the young mangrove seedlings. *Rhizophora* seedlings are broken by the boats passing through the plantation (Hong, 1996).

- **Wildlife**

Rarely, wildlife was also seen destroying and damaging mangroves in Middle Andaman to little extent. Deer were seen damaging the young plants of *Avicennia* by eating its foliage. Population of spotted deer and barking deer

is substantial in Middle Andaman as evident by day to day field observations. There are no carnivorous like tiger, leopard, etc. who feed on deer but deer poaching is common in Andaman and Nicobar Islands.

In Vietnam, after the Vietnam War, the number of wild boar increased rapidly. Their habitat and food source was large clumps of *Phoenix paludosa* and *Acrostichum aureum.* In 1989, when the burnt *Phoenix* was replaced by planted *Rhizophora mucronata*, wild boars destroyed the newly planted species by digging up the propagules. After four months, 58 percent of experimental planting of *Rhizophora mucronata* on high land was destroyed (Nam, 1994).

There is no threat to mangroves from the wild boars in Middle Andaman. Wild boars are hunted by Jarwa tribe, which is their favourite food but deer are not eaten by them as they worship deer as pious animal.

In Vietnam, troops of long tailed macaques (*Macaca fascicularis*) gathered in newly planted areas to search for crabs and molluscs, trampled and damaged the *Rhizophora mucronata* seedlings (Hong, 1996). Monkeys are not found in Middle Andaman. Wildlife is not a serious threat to mangroves in Goa and Middle Andaman.

- **Cattle Pressure**

In many areas, cattle mainly goats, buffaloes and cows were seen browsing the leaves of some mangrove species. They also trampled the young mangrove seedlings. This problem was more severe in the areas close to human habitation where owners of the domestic cattle let them free for grazing. Grazing / browsing in mangrove of Central West Coast of India have been reported by Untawale (1996). Pressure from overgrazing has resulted in stunted trees in some mangrove area of Pakistan (Qureshi, 1996). Domestic animals in Vietnam are considered as hazards to replanted mangroves located near river mouths. They trample the planted seedlings and eat the foliage (Hong, 1996).

- **Natural Stress**

Mangroves are also subject to stress from cyclones, typhoon and strong wave action (Naskar and Mandal, 1999). Mangroves of Andaman and Nicobar Islands are prone to damage by these natural agencies because of its geographical location.

- **Wood Borers**

In some mangrove areas like Chorao in Goa, wood-borer attack on plants was noticed which ultimately resulted in the death of the plants. Several insects (caterpillars) and molluscs wood-borers eat away the mangrove foliage and damage the wood as well (Naskar and Mandal, 1999).

- **Infestation by Barnacles, Oysters, Crabs and Gastropods**

Barnacles are small cones shaped shellfish that attaches itself to object under water. Barnacles, in Goa, were seen attacking newly planted propagules. Barnacles attachment to young seedlings interferes with respiration and photosynthesis so delaying seedlings growth (Hong, 1996).

Damages to the young leaves and plumules of *Rhizophora* and *Ceriops* by the Oysters were noticed in Middle Andaman. Due to oyster attack, large areas of *Kandelia candel* planted in the central and north coast of Vietnam have become bushes with lot of branches (Hong, 1994).

Crabs attack on mangroves was not noticed in Goa but in Middle Andaman, it is a serious problem. Crabs generally attack young seedlings and girdle the root collars. Crabs also eat the fleshy tissues of the propagules. During the course of experiments in mangrove nursery in Middle Andaman, crabs were seen eating seeds of *Sonneratia* and young leaves of *Avicennia* seedlings.

Sesarma crab attacks propagules and saplings of *Rhizophora* and *Ceriops*. The damage is inflicted on young seedlings by nibbling into the young propagules until they are completely girdled or even bitten through. Attacks occur just above or below the mud surface (Chan, 1994).

Gastropods are also a big problem in Middle Andaman. They were seen eating young leaves and flowers of mangroves. Eating of leaf surface and young propagules by gastropods have been reported by Untawale (1996).

- **Marine Algae**

Presence of marine algae hampers establishment and growth of young mangrove seedlings, however, it is not a serious problem in Goa and Middle Andaman. In dry season, marine algae such as *Sargassum, syzigium* and some other *Rhodophyta* species are washed ashore. Mangrove plantations at Can Gio in particular and along the coast line of Vietnam in general have suffered a high mortality or retarded growth due to these algae. They choke the seedlings to death or cling to the hypocotyl, giving additional weight, which results in bending or breakage of the stem of the seedlings (Cabahug *et al.,* 1986)

- **Pests**

The larvae of *Parasa* species (Limacodidae- Lepidoptera) is a common pest on *Rhizophora***.** It is a leaf-eating caterpillar, which damage the foliage very badly (Fig. 2).

Fig .2. Pest attack on Rhizophora.

In Middle Andaman, large numbers of buds were noticed in the genus *Sonneratia* but hardly 1 percent of them bloomed into flowers (personal observation). Fig. 3 shows flowers and buds in *Sonneratia alba*. This was probably due to some pest attack. Propagules of *Rhizophora* are often attacked by *Poecilips fallax* (Scolytidae-Coleoptera) which are rarely inundated by tide (Agaloos, 1994). The pest appears at the beginning of the dry

season (Nov. – Feb.) in mangrove areas. Therefore, if propagules are collected during this time, the death rate of the seedlings will be high. In the 1980s when *Rhizophora apiculata* was transported in great amounts from Minh Hai Province to Can Gio, which take many days by boat, these beetle (*Poecilips fallax*) destroyed a large number of propagules (Hong, 1994). From December to April, in a pure population of *Avicennia*, *P. fallax* caused epidemic defoliation and new leaves formed in the next rainy season (Hong, 1996).

Fig . 3. Flowers and buds in Sonneratia alba

At some places in Can Gio, *Rhizophora apiculata*, *R. mucronata* and *Ceriops tagal* were planted and the growth of the seedlings was inhibited by competition from *Acrostichum aureum* and *Phoenix paludosa* for living space and light (Nam, 1994).

Deforested mangrove areas are usually occupied by *Acrostichum aureum*, which is difficult to eradicate subsequently. Sometimes the dense growth of *Acrostichum aureum* and *Acanthus* species act like pest and do not allow the regrowth of the economic mangrove tree species, in the mangrove felled areas (Teas, 1979).

- **Grass Cutting**

Over a considerable area along the banks of the estuaries, thick and tall grass occurs naturally both in Goa and Middle Andaman. Local people use this grass for thatching purposes. This grass protects young mangrove seedlings from the strong wave action and help in the establishment of the young seedlings. But, unfortunately at the time of cutting and removing the grass, young mangrove seedlings are also damaged.

- **Mortality of Mangrove Trees**

Although unusual mortality of mangroves was not noticed in Goa but mortality of big patches of mangroves were noticed at Baludera near Baratang (Middle Andaman Island). At Shoal Bay No. 18 (South Andaman Forest Division), *Bruguiera* trees in approximately 1 ha area have become dry. At Tarmugli Island, *Avicennia* trees in about 50 ha area have dried.

Obstruction and diversion of water flow at Shyamkund, (Middle Andaman) for culvert construction, resulted in death of mangroves in about 0.5 ha area (personal observation). Diversion of estuary/ creek flow is very common in Sundarbans, which makes the waterways in unwanted situation for the tidal flow (Naskar and Mandal, 1999).

The climax species in the Sundarbans of Bangladesh, is *Heritiera fomes*, which constitutes almost 73% of the growing stock (Das and Siddiqi, 1985). Large-scale mortality of *Heritiera fomes* has been reported in mangroves of Bangladesh, which may be due to inadequate supply of upstream freshwater and for the age of the plants (Naskar and Mandal, 1999).

Root Causes of the Problems Involving Regulatory Issues

It is always advisable to examine root causes of the problems so as to adapt appropriate strategies to eliminate or minimise those factors itself, which give birth to the problems. This will minimise the incidences of re-occurrence

of the problems. It has been rightly said that prevention is better than cure. Following are the root causes of the various problems as learnt during the field study in Goa and Middle Andaman:

- poor financial condition of the local inhabitants force them to depend on mangroves for their fuelwood, timber and fodder requirement. Whether it is legal or illegal, they collect their requirement from mangrove forests without paying any cost;
- increasing population results in more biotic pressure on mangroves;
- lack of education and awareness among masses regarding importance of mangroves;
- improper planning of developmental activities likes aquaculture, agriculture, human habitation, mining, industrialization, etc.;
- short supply of fuelwood, timber and fodder at low or reasonable price;
- release of untreated pollutants in the form of industrial waste into the rivers;
- greed of some people to earn easy money may inspire them for felling of mangroves;
- ignorance about the rules and regulation regarding conservation of mangroves;
- so far, no systematic survey of mangroves has been done in the state to ascertain their area and ownership and land on which they grow. Taking advantage of the situation, some people might have encroached upon the areas under mangroves. The first step in the management of mangroves forests should be survey and demarcation to bring them under scientific management (Qureshi, 1957);
- mangroves also occur on the private and *communidade* (village community) land. The ownership of this land is not with the Government. This may, sometimes, give rise to conflict with the land-owner over the mangrove conservation issue;
- geographically mangroves are widely distributed. Due to their scattered occurrence, protection of mangroves becomes difficult;
- there is acute shortage of staff and other infrastructural facilities with the government for protection of mangroves.

Action Points to Overcome Problems Involving Regulatory Issues

Mangrove conservation and development efforts taken by the Government of India, Government of Goa and Andaman-Nicobar Administration so far have been successful up to a significant extent. The efforts have definitely reduced the degree of problems but problems are still there. There is a scope for further improvement in the situation by eliminating or minimizing the problems. Following action points may be helpful in the conservation and management of mangroves:

- **Patrolling**

At present, Forest Departments in states/union territories do not have sufficient staff and infra-structural facilities like motor boats, communication network etc to take up patrolling work effectively. Procurement of speedboats, wireless sets and posting of additional staff may improve the situation. Strengthening of intelligence network may further facilitate management by providing information about the offenders. Severe punishment to the offenders under the law may act as deterrent for the others. Regular patrolling in the creeks is necessary to check possible destruction of mangrove habitat (Andaman and Nicobar Islands, 1997). In Vietnam, the facilities, means of transportation and communication system of the guard of the forest network are poor (Hong, 1996). During the course of study in Middle Andaman, illegal collection of fruits of *Xylocarpus granatum, X. moluecensis*, *Nypa fruticans*, and *Heritiera littoralis* was noticed. Local agents engage the people for illegal collection of mangrove fruits. These fruits are ultimately exported to mainland through the main agents at Port Blair. Probably, these mangrove fruits are used for making some medicine. Indiscriminate collection of mangrove fruits on large scale hampers their natural regeneration. Vigil in the field, jetties and harbours during the fruiting period may control the illegal collection of mangrove fruits. Information gathered on fruiting periods can help us in planning out strategy for safeguarding mangroves (personal observations and experience).

- **Legislative Needs**

Drag net fishing has done great harm to young mangrove seedlings. Ban on fishing by using dragnets, in the areas having seedlings of less than five years of age, is the need of the hour. Govt. of Goa has already banned felling of 15 species of mangroves for a period of 10 years under Goa, Daman and Diu Preservation of Tree Act, 1984 (Notification No. 8/ 10/ 83- FOR dated 11.09.90.). This protection is desirable for all the mangrove species but the need for total ban on mangrove felling/ lopping may be periodically reviewed. For Andaman and Nicobar Islands, a suitable enactment is necessary to stop felling of mangroves in Revenue and Private areas (Anonymous, 1997). Speed limit for the barges may be prescribed in the areas having young mangrove seedlings so that these seedlings are least damaged by wave action. Strict implementation of anti-pollution laws may put a control on the industrial and other wastes being discharged into the creeks, estuaries and rivers. There should be ban on the removal of the grasses along the banks of the estuaries so that young mangrove seedlings are not damaged while cutting grasses. Mangrove forests may also be notified as Reserve or Protected forests as per requirement of the specific area in order to provide effective protection to them. Suitable mangrove forests areas can also be brought under the cover of Sanctuary or National Park for bio-diversity conservation.

Indian Forest Act, 1927 and Wildlife (Protection) Act, 1972 provide protection to flora and fauna (without mentioning anything specific to mangroves). These acts can also be used to conserve flora and fauna of

mangrove ecosystem, prevent mangrove ecosystem related offences and to deal with the offenders who violates provision of these acts. Since 1927, Indian Forest Act was applied to mangrove forest of Sundarbans and these were declared as 'reserved' (Naskar and Mandal, 1999).

Forest (Conservation) Act, 1980 was enforced by the Government of India which says that no forest area shall be diverted for any non-forestry purpose without prior approval of the Government of India. This act has proved very effective in preventing diversion of mangrove forest areas for non-forestry purposes.

Environment (Protection) Act, 1986 is a very- important act, which has played a crucial role in conservation and management of mangrove ecosystem. Under Rule 5 (3) (d) of the Environment (protection) Act, 1986; the Government of India has declared the Coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 from meters from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and HTL as Coastal Regulation Zone. The Government of India has put several restrictions on industrial and other activities in this zone in order to protect the environment in coastal areas. For the purpose of this notification High Tide Line means the line on the land up to which the highest water line reaches during the spring tide.

The distance from the High Tide Line (HTL) applies to both sides in the case of rivers, creeks and backwaters and may be modified on a case to case basis while preparing Coastal Zone Management Plans. However, this distance shall not be less than 50 meters or the width of the creek, river or backwaters whichever is less. Under the Coastal Regulation Zone, prohibited activities include-

[a] discharge untreated water and effluents from industries, cities or towns and other human settlements;

[b] dumping of city or town water for the purpose of land filling or otherwise;

[c] land reclamation, bunding or disturbing the natural course of sea water with similar obstructions except those required for control of coastal erosion and maintenance or clearing of water ways, channels, ports and for the prevention of the sandbars and also except for tidal regulators, storm water drains and structures for prevention of salinity ingress and for sweet water recharge.

For regulating development activities, the coastal stretches within 500 meters of High Tide Line on the landward side are classified into four categories viz CRZ-I,II,III and IV. CRZ-I includes those areas, which are ecologically sensitive and important, which also includes mangroves. Areas between the Low Tide Line and High Tide Line also falls within CRZ-I. In this Zone no new construction is permitted within 500 meters of the High Tide Line. Between Low Tide Line and High Tide Line also no construction activity is permitted except those pertaining to facilities for carrying treated water discharge into the sea, facilities for carrying sea-water for cooling purposes, oil, gas etc. CRZ-II includes those areas, which have already been developed upto or close to the shoreline. CRZ-III includes those areas, which are relatively undisturbed and those, which do not belong to either CRZ-I or II. CRZ-IV includes coastal stretches in Andaman and Nicobar, Lakshadweep and small islands except those designated as CRZ-I, CRZ-II or CRZ-III. Enforcement of the legislative mandates is a prime need (Untawale, 1992)

- **Afforestation**

Mangrove afforestation is required for quick restoration of degraded mangrove areas and also to increase mangrove cover. Restoration of mangrove areas is the key aspect of mangrove management (Field, 1996). Large-scale mangrove afforestation schemes have been taken up in Goa along Mandovi, Zuari, Chapora

estuaries and Cumbarjua canal. However, in Andaman and Nicobar Islands, no large-scale mangrove afforestation works have been taken up in last three years. Plate-4 shows plantation of *Bruguiera gymnorrhiza* in Middle Andaman. Nursery is an important component of mangrove afforestation programme. Mangrove afforestation in Florida (USA) is conducted in a legal context for ecological reasons relating to fisheries and wildlife. Horticultural practices such as pruning and trimming are also prohibited in mangrove areas irrespective of ownership. Although permits for mangroves destruction are approved when they in the public interest (Gilmore & Snedaker, 1993).

As a result of mangrove conservation as well as reforestation programme along the central West Coast of India, the following impacts have been observed:

Public awareness regarding importance of mangroves has increased, intertidal mudbanks and their establishment have been controlled, new avenues for forestry and social forestry activities have opened, biomass along the estuaries has increased, which has resulted in additional organic matter which has further influenced the biological productivity, bird and other animal life has increased (Untawale, 1996).

- **Awareness Programme**

People's awareness regarding importance of mangroves is most essential for getting their willing support for effective conservation and management of mangroves. Awareness can be spared through film shows; exhibition; newspapers; magazines; distribution of posters, stickers and brochures; display of banners, organisation of seminars, nature camps, bird watching etc (Anonymous, 1997). 'Mangrove Conservation Day' may also be celebrated to spread the awareness. On this day essay competition, debate, drawing competition etc. may be organised. School teachers may also be requested to conduct study tours in the mangrove forests to spread awareness among students. Establishment of mangrove parks in the mangrove areas close to towns may be a very powerful and effective medium to educate people very powerful and effective medium to educate people especially children. The park may have facilities like Nature Education and Interpretation Centre, small library, boats for movement in the creeks, watch-towers, walk-ways, etc.

Once the people realise the importance of mangrove ecosystem, they themselves come forward to protect and develop the ecosystem for their own benefit.

Tanzania mangals are in a stressed condition and degrading day by day, likewise the other mangals of the SE Asian countries. These need well-planned policy making along with strict conservation measures, awareness programmes and people's participation (Naskar and Mandal, 1999).

- **People's Involvement**

As far as possible local people should be involved in the mangrove conservation and development works. Local people's participation may involve information sharing, consultation, decision making and implementation of plans (FAO, 1994).

People residing close to mangrove forests, may prove very effective in the protection of the forests. They may be made responsible for protection and in return government may offer them fuelwood, small timber and other non- timber forest produce, for their own use, derived from the mangrove forests. They may also be engaged as casual labourers for raising mangrove nurseries, plantations and other works in order to give them employment and earn their goodwill. During the period of their employment, motivational efforts may bring active co-operation

of the people in mangrove forest protection, spreading awareness and other miscellaneous works even after discontinuance of their employment with the government.

The mangrove forests at Can Gio (Vietnam) are divided into 24 sectors with clear natural borders (Cuong, 1994) and presents a classic example of people's involvement in management of mangrove forest. The main guard force includes workers from the Management Board of the City's Environmentally Protected Forests (MBCEPE), workers from the agro-forestry enterprises, employee of the Forester Agency, and household allotted forests to protect. Local households have signed 30- year contract with MBCEPE. To date, a total area of 10,850 ha has been allotted to 208 household forests. The guards are given monthly salaries, 35 percent of the forest produce from thinning, an allocation of 3 to 5 ha per household for aquaculture or salt-pans and reward for good protection of forests. Other benefits that the households have obtained are: money to build houses on allotted land, boats for forest protection, loans for fisheries production in accordance with the common plan and schedule of the city, and technical help through short training courses on thinning, reforestation and shrimp forming. These measures have successfully educated the local people about the role of the mangrove ecosystem in providing direct and indirect benefits (Hong, 1996). In India, if the people are to be involved in mangrove management, similar type of measures will have to be taken, otherwise active participation of people may not be achieved.

- **Survey of Mangroves**

So far no systematic ground survey of mangrove has been done in Goa to find out precise area under mangroves and to ascertain their ownership. This survey is very necessary for proper planning and management of mangroves. The first step for preparation of management plan for any mangrove area is a fact-finding survey. Unless the state of mangroves is completely known, no plan for mangrove area can be prepared (Anonymous, 1989).

Management of Mangroves Occurring on the Private and Village Community Land

Mangroves on such type of lands may be conserved and developed with active co-operation of the owner of the land. Government may offer some benefits/ concessions to the owners of the land if they agree to conserve mangroves occurring on their lands. This requires detailed study and wide discussions on the subject matter before taking any action. The Government may also acquire some important mangroves bearing areas.

- **Planned Development**

All the developmental activities in the State should be planned in such a way so as to be in harmony with mangroves conservation and development works. Matang Mangroves have been often reported to be one of the best-managed mangroves in the world (Chan, 1996). The forest plantations through planned development are able to sustain ecological balance, forestry activities and also a wealth of fishing industries.

Ong (1978) estimated that the Matang forest industries involving extraction and processing of timber provide employment for a direct work-force of about 1400 and an indirect work-force of another 1000. The total annual revenue from forestry is about a million US dollar (Haron, 1981). The fishing industries, on the other hand, provide direct employment for about 2600 workers and indirect employment for about 7500 workers. Annual revenue derived from fisheries has been estimated to be about 33 million US dollars (Tang *et al.,* 1984). Thus, the 40,000 ha Matang Mangrove provides employment for a work-force of about 12,500 and annual revenue of about 42 million US dollars. On an area basis, this works out to a monitory return of just over 1000 US dollar per hectare. The coastal waters, estuaries and waterways of Matang support flourishing fishing industries while the extensive mudflats serve as feeding and stop over for both resident and migratory shore birds (Chan, 1996). Recently, efforts have been made to promote eco-tourism. Facilities available include a museum, boat cruising and boardwalks. The success of management is reflected in the extent of quality forest stands which accounts for about 85% of total mangrove area in Matang (Chan, 1996).

- **Infestation by Barnacles, Oysters, Crabs and Gastropods**

Nursery grown tall seedlings should be used for planting to reduce the infestations by barnacles as the leading shoot of tall seedlings remains above the water level. Taller seedlings are less vulnerable to attack by oysters, crabs and gastropods.

Intensity of insect infestation is higher in mono-specific crop, which can be controlled by raising mixed plantations (Siddiqi *et al.,* 1992). In Vietnam, planters apply sap of *Excoecaria agallocha* to the mangrove stem,

which force the barnacles to leave the mangrove seedlings or die. Some people place chemical pesticides on a wet cloth and tap the bundle gently on the stems or roots of mangrove plants where oysters are clinging at ebb tide. After 10-20 min., the oysters leave the stand. However, these methods when applied can cause water pollution (Hong, 1994).

- **Marine Algae_**

To restrict the harm caused by algae, removal from the mud flat and from the seedlings is done manually at neap tide. Bent seedlings are strengthened and held up with the earth (Hong, 1996).

- **Research Activities**

To solve various problems, research work is necessary to find out their solution. Research is also needed to collect basic information required for appropriate management of mangrove ecosystem.

The Government of India, through the Ministry of Environment and Forests has set up a National Mangrove Committee to plan research and development programmes for Indian mangroves. At the state level, there are State Level Steering Committees, which look into mangrove programmes. Although during the last 5 years much activity has taken place in the field of mangrove management, there is an urgent need to determine priorities under this programme. Conservation, afforestation, and thorough ecological studies of denuded mangrove areas are of the utmost importance (Untawale, 1992). Research activities should be scientifically designed. In Thailand, initially research programmes were not based on scientific designs and as a result during the last 20 years about 30% of the total mangroves have been destroyed (Aksornkoae, 1987).

In Malaysia, during 1978, an *ad hoc* Mangrove Research Co-coordinating Committee with the leadership of the Malaysian Forest Research Institute was formed with the objectives to co-ordinate the different research activities of the Malaysian mangroves and to avoid duplication of works. Various institutes in Malaysia have taken up activities and studies in connection with the development, management and conservation of Malaysian mangroves. Some of the important studies are on the topics like natural regeneration of important mangrove species, effect of thinning on mangrove stands, phenological studies of economic mangrove tree species, impact of bunding on mangroves, mangrove restoration along eroding mangroves shores, natural succession following clear felling, planting trials of *Rhizophora* in *Avicennia* forests and *Acrostichum* infested areas, natural regeneration in exploited areas, growth of mangrove trees in natural and exploited forests, etc. (Chan, 1987).

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National Workshop on Conservation and Sustainable Utilisation of Lesser-Known Tree Species

March 8-10, 2004

Forest Research Institute Dehradun

Traditionally the Indian society has depended on a large number of plant species for its subsistence and sustenance. However, with the advent of the so-called 'scientific forestry' the emphasis shifted mainly to a few timber species which were required by the British Government for industrial development. Therefore, large number of traditionally important species are gradually disappearing from the forests although they have a good potential for commercial exploitation.

To enable adequate attention towards the lesser known tree species (LKTS), a National Workshop on 'Conservation and Sustainable Utilisation of Lesser-Known Tree Species' is being organised by Forest Research Institute (Indian Council of Forestry Research & Education), Dehradun from March 8 to 10, 2004. The main objectives of the Workshop are to prepare an inventory of LKTS and document their uses, traditional knowledge and silviculture practices so that the age-old traditions could be revived and people are encouraged to plant these tree species.

WORKSHOP THEMES

THEME I – Status of LKTS and their silviculture

i. Inventorisation of species diversity and genetic resources.
ii. Silviculture and planting stock improvement.
iii. Role in eco-restoration and afforestation programmes.
iv. Silvicultural options for natural forests.

THEME II – Preservation of indigenous knowledge

i. Involving indigenous groups in management and conservation.
ii. Intellectual Property Rights and transferring benefits to indigenous communities.
iii. Participatory forest management with emphasis on LKTS.

THEME III – Utilisation and value addition

i. Sustainable use of forest products – food, fodder, oil, gums & resins and medicine.
ii. Wood-based products.
iii. Neutraceuticles and other non-traditional products.
iv. Valuation and market strategies.

THEME IV – LKTS and poverty alleviation

i. Alleviation of poverty and food insecurity
ii. High nutrition fodder from LKTS.
iii. Capacity building and employment generation.

THEME V – Conservation and sustainable management of LKTS

i. Policy formulation.
ii. Demonstrating sustainable management through technology transfer and training.
iii. Greater involvement of stakeholders.

SUBMISSION OF ABSTRACTS / PAPERS

One page abstract (300 words) including the title, authors, affiliation and key words formatted in MS Word in " Times New Roman" font should be submitted to the organising secretary by January 31, 2004. Full papers (as per format of the journal Forest Ecology & Management) should be submitted by February 20, 2004. The

abstracts/full papers can be e-mail at: mgera@icfre.org; pandeyr@icfre.org; singhyp@icfre.org. The delegates may also submit posters, which will be displayed at the venue of the Workshop.

IMPORTANT DATES

Submission of Abstract - January 31, 2004
Submission of Full Papers - February 20, 2004
Submission of Posters - March 8, 2004

REGISTRATION FEE: Nil

For further information contact

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ENVIRONMENTAL

UPS & DOWNS

ENVIRONMENTAL UPS

- Total annual resin production in Uttaranchal has almost doubled in the last six years due to the adoption of rill method of resin tapping.
- Ministry of Environment and Forests (MoEF) has formulated and notified Forest Conservation Act, 2003 that will plug the holes in Forest Conservation Act, 1981. Deadlines have been fixed for state governments to send the forest land transfer and lease renewal proposals to MoEF. Proposals have to be

sent compulsorily. Proposals for above 40 ha land need to be sent to MoEF and those upto 40 ha to the zonal offices of MoEF.

- Due to the persistent efforts of Dehradun Forest Division under the guidance of Forest Research Institute, Dehradun, the population of *Hoplo* insect (sal borer) in sal forests has reduced to merely 10% of the population that existed five year back.
- To protect the reserve forest in district Dindori, Madhya Pradesh and stop illegal felling of trees by naxalites, Madhya Pradesh high court has directed the state government to constitute a permanent task force.
- To help the medicinal plant growers, the Government of Uttaranchal has decided to set up a 'mandi' on medicinal plants at Hardwar. This will help the growers of not only Uttaranchal but also other states.
- The Supreme Court has directed Himachal Pradesh government to withdraw its notification dated Aug. 24, 1998 through which it had diverted hundreds of hectares of forest land for non-forestry use in contravention of Forest Conservation Act. The land used to be classified as "gair mumkin" and "charagah bila darakhtan" before the infamous move of the government.
- An annual award of Rs. 10,000 has been instituted for the best forest guard of Corbett Tiger Reserve.
- A worldwide survey has recently adjudged Islamabad as the greenest national capital in the world with a record of 325 trees per hectare. Gandhinagar in India has, however, recorded 425 trees per hectare i.e. 100 trees per hectare more than Islamabad.
- A Rs. 442 crore forestry and biodiversity project has started in Rajasthan to conserve the gene pool in the desert state and restore the ecological status of the Aravalli range. The project is being funded by the Japanese Bank for International Cooperation on a soft loan package at a very low interest rate of 0.75 per cent.
- The West Bengal government has submitted draft Act — the West Bengal trees (Protection and Conservation in Non-Forest Areas) Act — for checking felling of trees and promoting tree planting in areas outside the forest. The draft Act was submitted before the Green Bench of the Calcutta High Court in April, 2003.
- Astounding even veterans of the fight against animal extinction, cloning technology has produced two endangered bantengs in Iowa, USA. Bantengs are white stockinged animals. Less than 8000 bantengs exist in the world, mostly in the Java islands of Indonesia.
- Two trained elephants have been deployed in Similipal National Park in Mayurbhanj, Orissa to catch poachers.
- Thanks to the participation of villagers in Joint Forest Management programme, lush green forest has been established in Dhantura and nearby villagers in Gujarat. Hundreds of other villages are now trying to follow the example of those villages.
- An award has been instituted in the memory of Amrita Devi Bishnoi who had sacrificed her life along with 363 others for the protection of 'khejri' tree in Khejrali village near Jodhpur, Rajasthan 273 year ago. The first Amrita Devi Bishnoi National Award for Wildlife Conservation has been posthumously conferred upon Ganga Ram Bishnoi of Jodhpur district for heroic deed in protecting chinkara even at cost of his life.
- The centre has drawn up a Rs.1430 crore plan to make use of oil of the seeds of *Jatropha curcas* shrub as a bio-alternative to diesel. It is expected to produce 6 lakh tonne diesel-quality oil valued at Rs.1,020 crore per annum at the end of a gestation period of 4 years. Plantations will be established in an area of 4

lakh hectares. NOVOD Board will implement the programme. The project will generate 1200 lakh mandays of employment every year.

- Indian Railways has successfully conducted trial run on environment friendly biodiesel from non-edible oilseed in diesel locomotives hauling Shatabdi Express between New Delhi and Amritsar. The railways has decided to allocate 500 hectare land to Indian Oil Corporation for plantation of *Jatropha curcas* which is expected to yield 500 to 800 metric tonne biodiesel in 2 to 3 years time.
- Reports of celebration of 'Van Mahotsava', the festival of planting trees, have come in from different parts of the country.

ENVIRONMENTAL DOWNS

- Although Himachal Pradesh has recorded on increase of 561 sq. km in its forest cover during 1997-1999, yet dense forests over 1001 sq km of area have degenerated into open forests during the same period. The degeneration has been attributed to the policy of granting trees to the right-holders under the timber distribution (TD) rules. Every year 1.25 lakh cubic metre wood is allotted to villagers. The right-holders select the best trees for felling to get maximum timber.
- Oak trees in Uttaranchal, especially in Nainital region have been reported to be under an epidemic attack of Bana (*Taxillus loranthus vestitus*), a stem parasite.
- National Forestry Action Programme (NFAP), a comprehensive strategic plan for augmenting tree cover in India is plagued by resource crunch. The plan requires an estimated Rs.13,000 crores annually while the available resources are in the range of Rs.1,600 crore. The objective of NFAP is to bring 25 percent of land area under tree cover by the year 2005 and 33 percent by 2012 through afforestation, farm forestry, urban forestry and by arresting deforestation.
- Reports of death of sal, shisham, deodar, salix, blue pine, etc. have been received.
- Gujarat Forest Department has unearthed a Rs.2,000 crore land scam in the state which involved regularisation of 60,000 acre land of sanctuaries, reserved forests and protected forests, presently held by encroachers. The scam operating since 1980 involved issuing of challans to encroachers for 10 years. After 10 years, the encroachers used to stake claim over the land saying that they had been holding it for over 10 years. The scam came to light in Vadodara, Bharuch and Panchmahals districts. It is believed to be the tip of the iceberg, as much larger forest areas in other parts of the state have also been encroached upon.
- Innumerable reports of forest fires have been reported throughout India, particularly in the hills of north India.
- Poaching of wild animals continued unabated; incidents of illicit felling of trees have also come to light in some parts of India.
- More than 100 people have been killed by leopards and double the number injured during the past three years in Uttaranchal. Killings of human beings by wild animals in other parts of India have also been reported. Reports of damage to crops by wild animals have also been received.

FACTS FOR YOU

Ministry of Environment and Forests, Govt of India, has directed the states to survey non-wood forest product resources and develop a database to regulate their judicious use avoiding both under-utilisation and over exploitation. The centre is trying to promote Madhya Pradesh model which, over the years has evolved into 1066 cooperative societies that give four such products viz. tendu leaves, sal seeds, gum and myrobalan or herra to an apex body called M.P. State Minor Forest Produce (Trading and Development) Cooperative Federation for marketing. About 15 lakh families are involved in this Rs. 200 crore business.

The Times of India **May 31, 2003**

Soybean cultivation is dramatically expanding in Brazil, thereby eating up larger and larger chunks of land in the Amazon. There was 40 percent jump last year and 10,000 square mile of Amazon jungle was deforested.

The Hindu**, Sept. 20, 2003**

Poplar cultivation has no more remained popular among farmers in north India. The prices of poplar wood have crashed from Rs. 300 - Rs. 400 per quintal last year to Rs. 125 - Rs. 200 per quintal this year.

The Tribune**, Sept. 20, 2003**

The world market for herbal drugs is now worth $100 billion. It is dominated by the Northern bloc, comprising Germany, U.K., Sweden, Switzerland and the USA which account for $47 billion. Of the balance $ 53 billion, China commands 57
per cent of the market while India remains on the fringe with only a 2.3 per cent share. China has focused on the development of evidence-based medicine acceptable to the global market while India lacks behind because of the failure to absorb technology for scientific validation of traditional knowledge.

The Hindu**, Sept. 14,**

2003

ECONOMIC VALUATION OF RESEARCH AND DEVELOPMENT INSTITUTIONS - A CASE STUDY OF FOREST RESEARCH INSTITUTE

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Introduction

Faced with tightening budgets and growing needs for environmental actions, government must make difficult decisions about how to allocate public investments to protect and restore natural environment. Unfortunately, the use of natural resources such as forests, water bodies and other ecosystems has not always been optimal. Efficient use of natural resources requires knowledge of the value of these resources in various uses (Prato, 1998). Market price does not always reflect the full social cost of resource use. Many uses cannot be thus valued in the market place because of incomplete or non-existent markets. Thus valuation of natural resources is needed to justify and decide how to allocate public spending on conservation, preservation or restoration initiatives. This also helps in considering people's values and encourages public participation and support for such initiatives.

Economic valuation can be defined as an attempt to assign quantitative values to the goods and services that are provided by environmental resources, whether or not market price are available for them. The economic value of something is measured by the summation of many individuals' willingness to pay for it. So, economic valuation in the environment context is about measuring the preferences of the people for an environmental good or against an environmental bad. Preservation, sustainable use or total development are the usual options according to which a resource may be utilised or conserved. Economic valuation is actually concerned with the proper allocation of environmental resources in order to improve human welfare. It thus serves as a very important tool in the hands of the decision/ policy makers (Verma *et al.*, 2001).

A variety of economic techniques and models have been developed for assigning monetary values to gains or losses associated with changes in the availability or character of natural resources. The aim of these techniques is to obtain an estimate of the value that would be revealed if there were competitive markets for such a resource. The values could be obtained either through direct valuation methods or through indirect valuation and thus could be expressed in monetary terms.

The contingent valuation method (CVM) involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. It is called ‘contingent’ valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service (Brookshire and Eubanks, 1978). The CVM uses survey questions to elicit people's preferences for environmental services by finding out what they would be willing to pay for specified improvements in them. The method is thus aimed at eliciting their ‘willingness to pay’ (WTP) in monetary terms. The idea is to compensate for the absence of markets for the goods and services being valued by presenting the consumers with hypothetical market in which they can buy the good in question.

The CVM is thus actually a public survey in which the respondents are presented with material, in the form of a personal interview usually, which consists of three parts as given below (Mitchell and Carson, 1989):

a. A detailed description of the goods or services being valued and the hypothetical circumstance under which it is made available to the respondent;

b. Questions which elicit the respondent's willingness to pay for the goods or services being valued;
c. Questions about respondent's characteristics (e.g. age, income), their preferences relevant to the good(s) being valued, and their use of the good(s).

In case of a well-designed and carefully pre-tested study, the respondents' answers to the valuation questions should represent valid WTP responses. From these, a benefit estimate is developed. The results are then generalised with a known margin of error to the population from which the respondents were sampled. It has been found by many people that the respondents' value statements are highly dependent on the information contained in a CVM questionnaire (Fischoff and Furby, 1988).

Scope of the Study

Forest Research Institute (FRI) was established to organise and lead forestry research activities in the country. Its history is synonymous with the evolution and development of scientific forestry not only in India but also in entire subcontinent. Society has drawn a number of benefits from FRI such as over all output of forestry research, education and extension. Some of these outputs are improved quality of life, income generation, employment and quality forest products. Forests are key to global life support and forestry research helps in conservation of biodiversity. FRI estate not only has immense heritage value, it is also a centre of excellence in forestry research in the country.

Despite in existence for almost a century, no attempt till date has been made to place a monetary value on the services that the society derives from FRI Estate. The present study is first of its kind in which attempt has been made to place a monetary value on an Institution mainly responsible for research and development.

Following services being provided by FRI Estate have been valued in the present study:

(1) Use values

A. Non-consumptive direct values:
- Forestry research, education and extension
- Human and wildlife habitat

B. Evolutionary Processes:
- Global life support
- Biodiversity conservation

(2) Non-use values:
- Existent value (heritage value)
- Bequest value

Since neither these services are traded in the market nor any market value can be assigned using surrogate markets, Contingent Valuation Method was applied to elicit the value of these services from the people.

Study Area

FRI Estate, spread over an area of around 1,200 acres and established in the year 1906, is the premier Institution of the country in the Field of the Forestry Research and is acclaimed World over. The Estate is situated between

30^0 19' 55" and 30^0 21' 16" N latitudes and 77^0 58' 40" and 78^0 01' E longitudes and is about 5 km away from the heart of the city of Dehradun. The area comes under the Western sub-Division of the Dehradun district. The Institute caters, in particular, to the research needs of the states of Delhi, Punjab, Haryana, Uttaranchal, Uttar Pradesh and the Union Territory of Chandigarh. However, technical knowledge and know-how is being provided not only to India, but to other countries as well. The research perspective of the Institute focus on enhancement in forest productivity; improvement of planting stock; rehabilitation of wastelands; efficient utilisation of wood and non-wood forest products and development of eco-friendly products and processes.

FRI earned the status of Deemed University in 1991, with the objectives to impart education in different aspects of forestry and environment, provide for research advancement, dissemination of knowledge and to create consciousness about forests and environment among the people.

Methodology

The city of Dehradun was considered to be the Universe for this study. A total of 1% household were aimed to be surveyed during the study. For the purpose ward wise latest census data (2001) of the city was collected. The city has been divided into 60 wards. For estimation of number of households in a ward total population of each ward was divided by average number of family size, i.e., considered as six, and 1 per cent sample selected at random was identified making strata band on three income classes, i.e., lower, middle and high.

A detailed draft questionnaire to elicit people's willingness to pay for the services that the society derives from FRI, was developed after an exhaustive literature review. It was discussed among the peers in this field and changes were made accordingly. The modified questionnaire was also sent to a few experts for comments and finally, a pre-test of the same was carried out. On the basis of the results of the pre-test the draft questionnaire was modified to obtain the final version of the questionnaire. The questionnaire was divided into five sections, viz., attitudinal questions, scenario building and valuation, socio-economic details, respondent's evaluation and enumerator's evaluation.

The average WTP obtained was then extrapolated to total number of households in Dehradun city. This value represents the total amount that the people of city of Dehradun are willing to pay for the services that the society derives from FRI.

Results and Discussion

A total of 812 filled questionnaires were obtained at the end of the survey. The questionnaires were screened to eliminate the ones in which evaluation of the respondent by the enumerator was not good or where they showed a lack of conviction in improvements that were mentioned as part of the scenario and also where the enumerators mentioned lack of understanding or seriousness on part of the respondents. In the process, 80 questionnaires were rejected and the number was reduced to 732, which included responses with zero willingness to pay. Therefore a total of 732 questionnaires were utilized for statistical analysis.

The data obtained from the questionnaires was utilized for stepwise regression analysis treating WTP as dependent variable and rest of the quantitative and qualitative parameters as independent variables. Several models were obtained and following model was selected:

WTP =	95.92	Edulvl +	124.75	Income -	88.78	Envimp +	116.15	Sex -	31.93	Visit no. +	57.62	Forestre		
	(13.91)*		(13.75)*		(25.02)*		(31.10)*		(8.05)*		(27.77)		(R2 = 0.63)	

Where:

WTP	-	Willingness to pay (Rupees per household per year)
Edulvl	-	Education level of the respondent (1: up to middle; 2: intermediate; 3: graduation; 4: post-graduation; 5: professional qualifications)
Income	-	Income of respondent's household (Rupees per annum)
Envimp	-	Importance attached to environmental issues by the respondent (1: most important; 2: very important; 3: important; 4: somewhat important; 5: least important
Sex	-	Sex of the respondent (1: male; 2: female)
Visit No.	-	Frequency of visits to FRI (Varies from daily to once a while)
Forestre	-	Requirement of forestry research for welfare of society (1: strongly agree; 2: agree; 3: neutral; 4: disagree; 5: strongly disagree)

The above model explained maximum variation in WTP. Six variables, viz., Edulvl, Income, Envimp, Sex, Visit no. and Forestre have significantly contributed towards the variation in WTP and nearly 63 per cent of the variation is explained by these variables.

The mean WTP was calculated as Rs. 475.51, and the maximum WTP was observed to be Rs. 3500, however 74 respondents were not willing to pay anything at all. The mean value for WTP is taken for extrapolation of result to the whole Dehradun city. Altogether there are 71,050 households estimated in the city. Considering that the mean WTP to be taken is Rs. 475.51 the estimated WTP for the entire city was calculated as Rs 3,37,84,986 (appx. 33.78 million rupees). This is the amount the people of Dehradun city are willing to pay collectively on annual basis in order to derive the selected services that the institute provides to the society.

The flexibility of the CVM permits its application to a wide range of non-market valuation problems. Past CVM studies carried out in India have focused on resource problems ranging from valuation of forest resources to valuation of benefits from water quality improvements. Hadker *et al.* (1997), reported an average value of Rs. 7.50 per month for next five years that the residents of city of Mumbai were willing to pay for the maintenance and preservation of Borivili National Park. In another study Chopra *et al.* (1999) reported an average WTP of Rs. 519.87 per year per household from the inhabitants of Terai region, spreading over five northern states, for different services derived from forests.

The present study, however, focused on the contribution of a key R&D institution towards management, conservation and preservation of country's forests. The average value obtained per household per annum is also composed of a significant portion of existence value, i.e., 'heritage value' since the residents of Dehradun city feel attached to the FRI campus particularly the main building.

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BIOFUEL: SLIP BETWEEN CUP AND LIP ?

The recent experiences of Petroleum Ministry are going to dampen the spirits of bio-diesel enthusiasts in India. The Petroleum Ministry has admitted that the bio-diesel is costing around Rs. 70 per litre in comparison with the cost of Rs. 20.73 per litre for diesel. Unless the cost of producing bio-diesel comes down drastically, the commercial use of bio-diesel will only remain a dream. A pilot project on bio-diesel to be started in Rewari, Haryana has also failed to get good response; only two companies filled the tender forms and offered to supply diesel at Rs. 70 per litre. Oil companies have now been directed to go slow on bio-diesel plans and focus more on ethanol-blended petrol. The oil of Jatropha, Karanj, etc. is planned to be used to produce bio-diesel.

***Dainik Jaagran*, Dec. 21, 2003**

WEBSITES

Forest Biometry, Modeling and Information Sciences (FBMIS)
http://www.fbmis.info
A new free-access e-journal has been launched. This journal is concerned with the main methodological disciplines that support and contribute to research and management into forests, forestry and the forest environment. The journal is peer-reviewed and archival.

The Journal of Urban Forestry and Urban Greening
http://www.urbanfischer.de/journals/ufug
This journal was founded in August 2002 under the Danish Forest and Landscape Research Institute in Denmark. The journal publishes fundamental and applied research on all aspects of green resources in and around urban areas.

Water Information Network
http://www.nwp.nl
The network provides information on water subjects and knowledge from third parties in a particular field. It has a vast database with news facts, project descriptions, events information and contact addresses.

Community Forestry Network in China
http://www.cfnetwork.com.cn
The nationwide Community Forestry Network in China was established in 1992. This network collects, disseminates and exchange information on experiences and methods of community forestry.

The Sustainable Tree Crops Program (STCP)
http://www.treecrops.org/htm
The STCP was created to achieve a shared vision for sustainable tree crop development. It is a public-private partnership between industry, producers, researchers, government agencies, public sector institutions and conservation groups. The STCP program framework allows a unique cooperation and coordination of field activities among all the partners. Its mission is to improve the economic and social wellbeing of smallholders and their communities, and ensure the environmental sustainability of tree crop systems. The Canadian experience on certification and commercial extraction of non-tree forest products (NTFP) is also accessible at this site.

Centre for International Forestry Research (CIFOR)

http://www.cifor.cgiar.org
The CIFOR is an international research and global knowledge institution committed to conserving forests and improving the livelihoods of people in the tropics. CIFOR's research helps local communities and small farmers gain their rightful share of forest resources while increasing the production and value of forest products.

University Grants Commission (UGC)
http://www.ugc.ac.in
The UGC, established in 1956, is a statutory body of the Govt. of India for coordination, determination and maintenance of standards of university education in India. In pursuit of the above mandate, it also provides funds to universities and colleges and offers awards for excellence in the area of research and education.

Forestry Research Partnership
http://forestresearch.canadianecology.ca
The Forest Research Partnership is a joint undertaking between the Canadian Ecology Centre, the Canadian Forest service, the Ontario Ministry of Natural Resources, and Tembec Inc. These four partners are working together to create a strategic alliance with benefits to both environment and forestry. It has applied cooperative programmes on fibre production, sustainability, forest management, operational implementation, spatial analysis, knowledge transfer, etc.

WASTELAND DEVELOPMENT THROUGH AGROFORESTRY

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Introduction

Soil is nature's gift to mankind and in a country like India with high population pressure on the land, rational utilization of the soil resources assumes great importance for optimum and sustained production with minimum hazards. Soils are one of the most valuable natural resources of a nation as it takes almost 1,000 years to produce an inch of soil. They are essential for our existence. It is, therefore, imperative that we manage and conserve them to meet the growing need for feed, fodder, timber, fibre and fuel. However, prevalent problems like water logging, salinity, alkalinity, acidity, sand shifting, soil erosion, floods and other degradation processes bring about imbalance in rural economy. Agroforestry is a sustainable land management system which aims at growing of woody perennials alongwith agriculture crops and animals simultaneously or sequentially on the same unit of land either in some form of spatial mixture or temporal sequence. One of the ways to increase forest cover is through afforestation of wastelands. Other techniques for arresting wastelands involve considerable civil work, huge quantity of amendments and are, therefore, expensive. They also pollute rivers and require regular

maintenance. On the other hand, agroforestry is least expensive, environment friendly and also assures sustainability of croplands.

Wasteland can be defined as degraded land which can be brought under vegetative cover with reasonable efforts and which is currently under-utilised land and is deteriorating for lack of appropriate water and soil management or on account of natural causes. The data show that an area of about 187 m ha, representing about 57 percent of the total geographical area of the country has been affected by various land degradation problems (Table 1)

Degradation type	**Total degradation**	
(m ha)		(%)
Water erosion	148.9	45.3
Wind erosion	13.5	4.1
Chemical deterioration (loss of nutrients, salinisation)	13.8	4.2
Physical deterioration (waterlogging)	11.6	3.5
Total affected area	187.1	57.1

Table 1. Soil Degradation In India.

Development of appropriate technologies for marginal and wastelands in India will largely determine the future prospects of increasing food, fibre, fuel wood and timber production. The concept of agroforestry has undergone radical changes and fine tuning in recent years. It is technically feasible to grow trees in wastelands of different categories. Some of the tree species have wide adaptability and are emerging as commercial viable ventures. If all the direct, indirect, present and future benefits are included, the afforestation of wastelands might pass the test of profitability and economic viability. Major areas of wastelands in different states are shown in Fig.1.

Fig .1. States with major degraded area.

Land Degradation Due to Water and Wind Erosion

Water erosion is the most serious degradation problem. Soil erosion by water takes place at an average rate of 16.35 tonnes/ha/year totalling 5,334 M tonnes /year. Nearly 29 per cent of the total eroded soil is permanently lost to the sea and nearly 10 per cent is deposited in reservoirs resulting in the reduction of their storage capacity by 1 to 2 per cent annually. Wind erosion is a serious problem in the arid and semi-arid regions including the states of Rajasthan, Haryana, Punjab and Gujarat. In India wind erosion is moderate to severe covering an area of 28,600 km^2 of which 68 per cent is covered by sand dunes and sandy plains. For controlling water erosion from denuded and eroded hill slopes *Acacia modesta, Acacia catechu, Prosopis juliflora, Eucalyptus tereticornis, Cassia siamea, Albizia lebbek* and *Anacardium occidentale* should be planted. *Dalbergia sissoo, Acacia nilotica* var. *cupressiformis, Acacia aneura, Acacia salicina, Acacia tortilis, Azadirachta indica, Parkinsonia aculeata, Prosopis juliflora, Albizia lebbeck, Casuarina equisetifolia* and *Eucalyptus camaldulensis*, etc. can be used as windbreak or shelterbelt. *Salix* is a potential tree species for soil conservation. *Acacia senegal*, *Acacia tortilis*, *Calligonum polygonoides*, *Colophospermum mopane*, *Dichrostachys glomerata, Prosopis cineraria, Prosopis juliflora*, etc. are the tree species for sand dune stabilization whereas *Tecomella undulate*, *Holoptelea integrifolia, Albizia lebbek, Azadirachta indica, Cassia siamea, Eucalyptus camaldulensis, Hardwickia binata*, etc. can be planted on semi-established sand-dunes or established dunes.

Land Degradation Due to Chemical Deterioration

It can take place through the loss of nutrients/or organic matter and accumulation of salts and/or pollutants. It is reported that annual average loss of nutrients from land is worth 5.37 to 8.4 m tonnes. Amongst the soil groups, Alfisols, Ultisols and Oxisols are prone to chemical deterioration due to nutrient depletion. The net irrigated area in India has increased from about 22 m ha in 1950 to 51 m ha at present. A large portion of the irrigation has been achieved through expansion of canal irrigated areas. Nearly 50 per cent of the canal irrigated areas are suffering from salinisation or alkalisation due to inadequate drainage, inefficient use of available water resources and socio-political reasons. Typical examples of salinisation caused by the rise in ground water can be observed in Uttar Pradesh, Haryana, Maharashtra, Karnatka and Rajasthan. In almost all cases, water table which was several metres deep prior to the introduction of irrigation has been rising following the introduction of irrigation. Soils with pollutants from industries containing heavy metals can be reclaimed by planting suitable tree species. *Salix viminalis* is such a potential tree species which is used for soil filtering. Tree species which can be planted on soils with different pH values are given in Table 2.

Land Degradation Due to Physical Deterioration

It generally relates to decrease in soils organic matter making them more prone to crusting and increased runoff etc. Subsoil compaction has also been reported from intensively cultivated areas. However, by far the most serious physical degradation problem is of excessive wetness due to waterlogging which is the main cause of wetlands. Wetlands are lands transitional between terrestrial and aquatic systems where the water table is

Table 2. Relative tolerance of tree species to pH

Average pH	Soil type	Fuel wood/Timber species
> 10.0	Alkali	*Prosopis juliflora, Acacia nilotica, Casuarina equisetifolia*
9.0-10.0		*Tamarix articulata, Terminalia arjuna, Albizzia lebbek, Pongamia pinnata, Sesbania sesban, Eucalyptus tereticornis*
8.5-9.0		*Dalbergia sissoo, Morus alba, Grevillia robusta, Azadirachta indica,Tectona grandis, Ailanthus excelsa*
< 8.2	Saline	*Prosopis juliflora, Tamarix articulata, Casuarina equsetifolia, Salvadora persica, Leucaena leucocephala, Eucalyptus camaldulensis*
< 7.0	Acidic	*Albizia* spp*., Alnus nepalensis, Erythrina spp., Casuarina, Gmelina arborea, Dalbergia, Gliricidia, Inga, Parkia, Sesbania, Cassia*

Table 3. Promising tree species for special sites

Wetlands	Canal banks	Biodrainage
Eucalyptus robusta, Trewia nudiflora, Syzygium cumini, Salix spp, *Populus nigra, Terminalia arjuna, Acacia nilotica, Bombax malabaricum, Barringtonia* spp., *Bischofia javanica, Casaurina*	*Salix* spp., *Acacia nilotica*, *Syzygium cumini, Terminalia arjuna, Dalbergia sissoo*, *Trewia nudiflora, Bombax malabaricum*	*Salix* spp., *Terminalia arjuna, Syzygium cuminimi, Eucalyptus tereticornis, Albizia lebbeck*

Table 4. Some promising tree species in different states/regions for agri-silviculture in degraded lands

State/region	Tree species
Uttar Pradesh (Western)	*Eucalyptus tereticornis*, *Dalbergia sissoo, Acacia nilotica*
Uttar Pradesh (Central)	*Dalbergia sissoo, Albizia lebbek, Azadirachta indica, Acacia nilotica, Prosopis juliflora, Eucalyptus* spp.*,Acacia catechu, Bamboo* spp*., Madhuca latifolia*
Uttar Pradesh and Uttaranchal (tarai)	*Eucalyptus* spp., *Dalbergia sissoo*
Punjab (Kandi)	*Dalbergia sissoo, Acacia catechu, Acacia nilotica, Zizyphus* spp*., Grewia optiva*
Punjab (Alluvial)	*Eucalyptus* spp*., Dalbergia sissoo*
Haryana	*Eucalyptus tereticornis, Populus deltoids, Acacia nilotica, Dalbergia sissoo*
Rajasthan	*Prosopis cineraria*
Bihar (NW districts)	*Dalbergia sissoo, Wendanadia exerta, Dendrocalamus strictus, Bombax malabaricum, Tectona grandis*
Tropical plain region	*Acacia nilotica, Ailanthus excelsa, Azadirachta indica, Casuarina* spp.
Coastal Region	*Casuarina* spp, *Prosopis juliflora, Eucalyptus tereticornis*,

at or near the surface or the land is covered by shallow waters. Some of the important characters of a wetland are:

- water should be present for at least seven successive days in the season;
- it should support aquatic macrophytes in water and soil at least in some part of the year;
- soil should be flooded for a long time and become anaerobic in the upper layers.

Excessive waterlogging along canal banks and forthcoming secondary salinity is rendering large area unproductive. It results in restriction of the normal circulation of air. The optimum depth of water table may vary from surface for rice and *Salix* spp. to about 1.5 m for poplar and field crops. The major rivers in India have extensive floodplains. The flat land close to the large rivers remains covered with flood waters due to natural floods during some seasons of the year. These areas remains completely inundated even after the flood waters recede. The flood plains are more diverse along the lower reaches of the rivers. Biodrainage is a biological option for controlling waterlogging and salinity which have become hazards for irrigated agriculture. Trees are planted in the waterlogged areas to reclaim the lands. On the other hand, sub-surface drainage system involves perforated pipes buried in trenches through which percolating sub-surface water can flow out of the area into the rivers etc. It is expensive, pollutes rivers and requires regular maintenance. Biodrainage is least expensive, environment friendly and is a step towards reforestation. Tree species which can be planted depending on plantation sites are listed in Table 3.

Most of the tree species recommended for improving different types of wastelands are already adopted in agroforestry in India (Table 4). Other tree species can also be tested under agroforestry with main emphasis on checking land degradation.

Poplar is widely planted on irrigated fertile lands in Punjab, Haryana, Western U.P. and tarai region of Uttaranchal; but it does not thrive well in wastelands. *Eucalyptus* is planted on field boundaries as well as in block plantations.

On the basis of isolated work done on the preliminary aspects (e.g. rotation, heavy metals uptake , soil conservation on the hills, suitability in rice-wheat rotation under tarai conditions, etc.) of *Salix*, this tree species has been recommended for testing in different categories of wastelands (National Workshop on Reorientation of Diversified Agroforestry Systems for Profitable Rural Industries, 2001).

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THE ‘OTHER SIDE’ OF CLIMATE CHANGE

Neeta Hooda

There is enough evidence to suggest that the global warming is not a myth but a reality. Satellite reports confirm that Arctic ice has shrunk by 40 per cent and global sea levels have risen by 4 to 8 inches. Enough has been said and heard at the national and international forums about climate change. It is interesting to note, however, that the term 'global warming' was rejected at the international forums in the initial years as the concept was misleading and negative in connotation. Subsequently a unanimous decision was taken to adopt a more acceptable and mild terminology and the phrase 'climate change' was adopted. As intricate as the subject is, one does wonder whether all is wrong and negative with climate change or could there be some positive outcomes too.

Well, some outcomes that can be perceived as positive even with the lack of huge formal endeavours by our country are as follows:

- An acceptance has emerged that developed countries have contributed to the problem more than developing countries. The negative consequences, whether slow or catastrophic, will have to be borne by all because nature is supreme and does not discriminate between human beings on the basis of artificial/international boundaries separating them. In other words the brunt of collective responsibility for past actions will have to borne by all, the degree may, however, vary.
- The second side is that collective corrective action can help us overcome the problem i.e. values of cooperation, unity and mutual understanding between nations will have a prominent say in determining whether we survive the adverse effects and change the trend of global warming to that of 'global communal harmony'.
- Climate change issues have forced mankind to think on a global level as never before as the very survival of living beings is at stake.
- On the scientific level we have admitted that nature's bounties (fossil fuel, forests, etc.) have been used indiscriminately and the abuse of nature cannot continue infinitely.
- All formal endeavours by the international climate change regime (Flexibility Mechanisms, Clean Development Mechanisms, Joint Implementation within the Kyoto Protocol, etc.) present an opportunity to 'clean' the environment and reduce disparities between rich and poor nations through a 'flexible' approach aiming at equitable flow of resources. In my view it could be a giant step towards making this planet a better place to live in for the present and future generations, provided words are turned into action.
- Economic flow of benefits could be available to weaker sections of society through carbon trading and that is what we as a nation should aim for. We must ensure that the financial burden of cleaning up environment does not fall on the smallest contributors to the problem of global warming and climate change. All the same, global carbon trading should not become the dominant agenda. The foremost objective of reducing GHG concentrations must not be forgotten in the race for drawing out the details on carbon trade. This unfortunately seems to be the trend at present.
- We suddenly have changed our focus from 'advanced' technology to 'clean' technology and have become advocates of use of green wood and green energy. Even the USA is advocating use of

liquid hydrogen as an alternative source of energy. These are positive and conscious changes in ways of thinking that should benefit all.

- Climate change should be viewed in our minds not purely as a threat but as a worldwide campaign to clean up the mess we inadvertently created in the name of development and modern life style.
- In a nutshell the spirit with which the UNFCCC was convened needs to be maintained. Currently, however, this seems far from reality. The divide between interests of developed and developing nations seems to be widening with the USA not ratifying the Kyoto Protocol. How can we achieve what we set out to if the global negotiations are ridden with nations trying to watch their own interests and loss of magnanimity to consider others' interests? May be it is time to revisit the basics of initiating the global climate change mitigation process a few decades.

DID YOU KNOW ?

India's forest cover has increased marginally from 19.39 per cent of the total land area in 1999 to 20.55 per cent according to the State of Forest Report, 2001 released by Forest Survey of India (FSI), Dehradun on March 22, 2003. FSI has remarked that the increase might not necessarily be due to actual afforestation. Instead this might be the result of the methodology adopted in the survey. Earlier surveys used visual methods after collecting photographs taken by satellites. But this time digital image processing method has been used which can map even one hectare clusters of trees. Earlier methods could measure forest cover only in clusters over 25 hectares.

The Supreme Court has allowed Himachal Pradesh government to do green felling on the condition that it will be carried out in accordance with forest working plans approved by the centre and a minimum 20 per cent of the revenue thus raised will be ploughed back for reforestation of the felled area.

Madhya Pradesh government has notified the Lok Vaniki Rules 2002 for scientific exploitation of private forests. It simplifies the cumbersome process of obtaining permission from the collector for felling of trees. The exploitation and management plans under the Lok Vaniki project will require to be endorsed by the State Forest Department prior to felling. The applications will be disposed of within 30 days. The exploitation and management will be done by gram panchayat or gramsabha.

Himachal Pradesh government has pleaded a case for compensation before Planning Commission of India as it is losing a revenue of Rs. 250 crore each year accruable from selective felling due to ban imposed by the Supreme Court. The loss so far amounts Rs. 2,000 crore; but the Commission was unmoved.

Calendar of Meetings

- **6-7 February 2004**

  Annual Seminar on Environmental Management and Technologies in Pulp and Paper Mills, Kolkata.
  Contact: Dr. M. Patel, Executive Secretary, C.P.P.R.I. Campus, PO Box No. 47, Saharanpur – 247001, Uttar Pradesh Fax: +91 80 5244592; e-mail: ippta@ippta.org

- **14-16 February 2004**

  International Workshop on Recent Trends in Environmental Sciences, New Delhi.
  Contact: Director, Workshop-RTES, National Environmental Science Academy, 206, Raj Tower-1, Alaknanda Community Centre, New Delhi – 110019 e-mail: nesaindia@nesaindia.com

- **25-27 February 2004**

  National Seminar on Remote Sensing and its Applications in Environmental Management, Bangalore University, Bangalore.
  Contact: Prof. R.K. Somashekar, Deptt. of Environmental Sciences, Janan Bharthi, Bangalore University, Bangalore – 5600056 Fax: +91-80-3219295; Email: rksmadhu@rediffmail.com

- **14-17 March 2004**

  Seventeenth North American Mushroom Conference and Sixteenth International Congress on the Science and Cultivation of Edible and Medicinal Fungi, Miami Beach, Florida, USA.
  Contact: American Mushroom Institute, 1 Massachusetts Ave., NW, Suite 800, Washington, DC 20001, USA Fax: 202/408-7763

- **22-26 March 2004**

  International Conference on Innovative Techniques in Soil Survey, Cha-am, Thailand.
  Contact: Dr. Taweesak Vearasilp, Department of Land Development, Phaholythin Road, Chatuchak, Bangkok – 10900, Thailand Fax: +66-2-579 1560; e-mail: vearasilp@access.inet.co.th

- **29 March - 1 April 2004**

  International IUFRO Symposium on Human Dimensions of Family and Farm Forestry, Washington State University, Pullman, WA.
  Contact: David M. Baumgartner, Washington State University, P.O. Box 646410, Pullman WA 99164 – 6410, USA. e-mail: baumgartner@wsu.edu Fax: +1-509-335-2878; Website: www.familyforestry symposium.wsu.edu

- **12-14 April 2004**

International Symposium on Management of Tropical Dry Forest, Woodlands and Savannas: Assessment, Silviculture and Scenarios, Brasilia, Brazil.
Contact: Jose Imana Encinas, University of Brasilia, Forestry Department, Caixa Postal: 04357 70919 – 970, Brasili a, DF – Brazil Fax: +55-61-3470631; e-mail: iufro@unb.br Website: www.unb.br/ft/etl/iufro

- **21-23 April 2004**

Third International Symposium on Sustainable Management of Forest Resources, Pinar del Rio, Cuba.
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- **6-11 June 2004**

Twelfth International Peat Conference, Tampere, Finland.
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TEAK IN MADHYA PRADESH

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Introduction

Teak (*Tectona grandis* L.F., family Verbenaceae) has world wide reputation as a paragon among timber trees and is truly an Indian species. Madhya Pradesh is one of the states with extensive teak forests and is famous for its high quality teak timber. The most important teak forests are located in Hoshangabad, Betul, Chhindwara, Seoni and Mandla. A distinct variety of teak known as 'teli', based mainly on leaf characters and resistance to its leaf skeletoniser, [*Eutectona machaeralis* (Walker) (Lepidoptera : Pyralidae)] is found in the forests of Madhya Pradesh.

Distribution

Teak, a species of world wide reputation among timber trees, is distributed predominantly in tropical or sub-tropical region. Indian region is considered to be the centre of maximum genetic diversity and variability of teak (Hedegart, 1975) with distribution over 8.9 million hectare (Seth and Kaul, 1978). The natural teak forests of India are confined to Peninsular India below 24°N latitude with a total area of about 1.4 million hectare (Pande, 1983). The most important teak forests are found in Madhya Pradesh, Maharashtra, Tamil Nadu, Karnataka and Kerala (Kumaravelu, 1992) besides Uttar Pradesh, Gujarat, Orissa and Rajasthan. Madhya Pradesh is one of the states with extensive teak forests. The total forest cover of Madhya Pradesh (including Chhattisgarh) is 95221.14 sq. km. (i.e. 31% of total area), and teak forests occupy 17.88 per cent of total forest area (Anonymous, 2001). In Madhya Pradesh, the most important teak forests are in Hoshangabad, Betul, Chhindwara, Seoni and Mandla (Tewari, 1992). The detailed profile of teak forests of Madhya Pradesh is presented in Table 1 (Bebarata, 1999).

Morphology

Teak varies greatly from locality to locality to locality in timber characteristics such as colour, grain, texture and figure. In Seoni and Kanker in Madhya Pradesh, the timber is golden yellow (Tiwari *et al*., 1998a). Morphological studies based on shape, size, colour and texture of leaves and petiole determine variation within the species (Bor, 1939). Morphological variation in the form of a distinct variety known as 'teli' (meaning 'only') based mainly

on leaf characters and resistance to its leaf skeletoniser [*Eutectona machaeralis* (Walker) (Lepidoptera : Pyralidae)], is found in the forests of east Kalibhit range of north Khandwa Division, Damoh and Sagar. It differs from the normal teak both morphologically as well as phenologically with early leafing by a little over a month and early flowering at the end of April. The leaves are smooth, shining, hairless and dark in colour. The bole is more cylindrical with very little fluting. Variation in seedling morphology such as rosette formation and 3 cotyledons instead of usually 2 have also been recorded in this variety (Kaushik, 1956; Bedell, 1989). Taxonomically, the teli variety does not differ from the species proper except at intra-specific level, and can be considered an altogether different genotype having superior qualities. Dogra (1981a, b) has discussed variation in Indian teak (including Madhya Pradesh) explaining the great diversity in the species and potential to make substantial gain through tree breeding activities.

Table 1. Profile of teak forests in Madhya Pradesh*

Attribute	Extent/Unit
Total geographical area	4,43,446 sq. km
Total forest cover	1,35,164 sq. km
Per capita forest	0.002 sq. km
Teak forest area	23,973 sq. km
Percentage of teak forest	17.70%
Teak forest : crown density class	
D1 157 sq. km	
D2	16,032 sq. km
D3	7,784 sq. km
Total	23,973 sq. km
Total growing stock	1,226.44 lakh cu. m
Volume of growing stock of teak forest ha	51.16 cu. m/ha
Annual increment of teak forest	30.66 lakh cu. m
Annual increment/ha of teak forest	1.28 cu. m/ha

*including Chhattisgarh

Site Conditions

The most suitable soil for teak is deep, well-drained alluvium with an optimum pH range of 6.5-8.0 (Kulkarni, 1951; Puri, 1951), and relatively high content of calcium and phosphorus (Bhatia, 1954). Most teak soils in Madhya Pradesh contain more than 3% exchangeable calcium that appears to be the critical minimum. Good regeneration occurs on soils with phosphorus content of 5-7 mg/100g soil. On lateritic soils teak growth deteriorates. Other factors that inhibit teak regeneration are water logging and low lime content (Kumaravelue, 1992).

Table 2. Classification of teak forests of Madhya Pradesh

Type	Ecotype	Forest type	Rainfall (mm)	Division
I	3 B/C 1(b)	Moist teak forests	1600-2500	Hoshangabad (P)
II	3 B/C 1(c)	Slightly moist teak forests	1200-1600	South Seoni, south Mandla, south Balaghat, north Balaghat, Kanker, Hoshangabad
III	5 A/C 1(b)	Dry teak forests	900-1200	Harda, north Khandwa, Indore, Dewas, Dhar, Guna (P) north Seoni, Damoh, Jabalpur, Narsingpur, east Bhopal, west Bhopal, Sagar, south Chhindwara, east Chhindwara, south Betul, east and west Sidhi, Umaria
IV	5 A/C 1(a)	Very dry teak forests	<900	East Khargone, Jhabua (P), south Khandwa, Shivpuri, Guna (P), Tikamgarh

Climate

Teak grows under a variety of edaphic and climatic conditions from sea level to an altitude of 1200 m and in the precipitation range of 800 to 2500 mm (Seth and Khan, 1958; Khanna, 1984; Bhatia 1959; Sagreiya, 1959, Sharma, 1959). As recommended in the proceedings of All India Teak Symposium, 1957-58, as well as in the classification adopted by Champion and Seth (1968), the teak forests of Madhya Pradesh are classified on the basis of rainfall and temperature variations. The areas falling in similar ranges of annual rainfall and temperature are grouped together to form one ecotype (Table 2). The distribution of natural teak forests in Madhya Pradesh is given in Table 3 (Tewari *et al*., 1998b).

Table 3. Natural teak forests in Madhya Pradesh

District	Teak forest (sq. km.)	Type of forest	Rainfall (mm)
Balaghat	92.27	Slightly moist teak	1400-1450
Betul	1606.85	Dry teak	950-1000
Bhopal	16.19	Dry teak	1150-1200
Chhatarpur	1127.53	Dry teak	1000-1050
Datiya	58.31	Very dry teak	700-750
Dhar	1065.31	Very dry teak	700-800
Dewas	724.81	Dry teak	900-1000
Damoh	866.37	Dry teak	1050-1100
Guna	425.41	Dry teak	950-1000
Hoshangabad	2641.43	Slightly moist teak	1200-1250
Indore	444.81	Very dry teak	800-900
Jabalpur	210.71	Dry teak	1150-1200
Jhabua	535.63	Very dry teak	700-750

Khargon	1003.49	Very dry teak	750-800
Khandwa	1401.25	Very dry teak	750-800
Mandla	740.60	Slightly moist teak	1300-1350
Mandsour	645.27	Very dry teak	700-750
Narsingpur	644.21	Dry teak	1100-1150
Panna	941.26	Dry teak	1050-1100
Raisen	273.30	Dry teak	1100-1150
Rewa	54.78	Dry teak	1050-1100
Rajgarh	62.12	Dry teak	900-950
Ratlam	25.37	Very dry teak	800-850
Sajapur	10.97	Dry teak	950-1000
Sagar	671.15	Dry teak	1100-1150
Sidhi	11.62	Dry teak	1150-1200
Sheopur	1.88	Very dry teak	800-850
Sheopuri	12.28	Very dry teak	750-800
Seoni	1826.11	Slightly moist teak	1200-1250
Sehore	625.25	Dry teak	1100-1150
Satna	312.43	Dry teak	950-1000
Shahdol	26.55	Dry teak	1150-1200
Tikamgarh	249.68	Very dry teak	800-850
Vidisa	28.20	Dry teak	950-1000

Phenology

Teak is a large deciduous tree. In Madhya Pradesh, teak sheds leaves from December to February and remains leafless during the month of March to April. The new leaves appear normally during May to June, according to locality. The inflorescence appears in the rainy season from August to October. The fruit setting occurs from August to November. The fruits ripen from December to February and fall during March to April. Ansari *et al.* (2001) conducted a systematic phonological study on teak of Madhya Pradesh, which revealed that teak grows actively, producing new flush of leaves during the period from April-June (Table 4).

Table 4. Phenological behaviour of teak in Madhya Pradesh*

Month	Leaf flushing	Foliage	Flowering	Fruit Setting
January		+++++		+++++
February		+++++		++
March				
April				
May	++			
June	+++++	+		
July	+++++			
August		+++++	+++	++++
September		+++++	+++++	+++++

October	+++++	++++	+++++
November	+++++		+++++
December	+++++		+++++

+ indicates intensity of occurrence of the parameter.
*observations based on 5 donor trees selected randomly from plantation of teak of 40 years old at Moeanala, Jabalpur.

Yield Tables

Looking into long felt need, recently Tiwari *et al.* (1998b) have prepared yield table of teak in Madhya Pradesh on the basis of growth data of 35 sample plots established by State Forest Research Institute in artificially regenerated forest area situated in different zones such as Seoni (20), Betul (5), Hoshangabad (4) and Indore (2). The authors have drawn following conclusions from yield tables:

- Various crop parameters differ from one zone to another. Variations in height, diameter and basal area ranged from 20 to 30 percent while yield and mean annual increment varied from 40 to 48 percent.
- Effect of locality was more pronounced on yield and mean annual increment rather than on growth parameters.
- The maximum growth and yield of teak was recorded in Hoshangabad zone followed by Seoni, and minimum was observed in Indore zone (Table 5).

Table 5. Growth and yield of teak in Madhya Pradesh in respect of different zones

Parameter	**Zone**
Crop height	Hoshangabad > Seoni > Sagar > Betul >Indore
Top height	Hoshangabad > Seoni > Sagar > Betul > Indore
Crop diametrer	Hoshangabad > Seoni > Sagar > Betul > Indore
Total yield/ha	Hoshangabad > Seoni > Sagar > Betul > Indore

Table 6. Teak plantations raised by Forest Development Corporation of Madhya Pradesh up to 1993

Name of district	**project**	**Area of plantation (ha)**

Hoshangabad and Chhindwara	7,804
Seoni – Barghat Project	10,433
Balaghat – Lamta Project	11,723
Mandla – Mohgaon Project	12,150
Betul – Kesla Project	8,202
Jabalpur – Kundam Project	11,087
Mandla – Nainpur Project	8,565
Shadol – Umariya Project	9,839
Total	**79,803**

Teak Plantation

In the post-independence period, formation of Forest Department Corporation heralded an era of teak plantation in the state of Madhya Pradesh by improving the planting technology and managing teak plantation scientifically (Bebarta, 1999). The extent of plantations made by Forest Development Corporation in the state of Madhya Pradesh is presented in Table 6.

In spite of centuries of heavy and usually dysgenic exploitation, the natural teak forests of Madhya Pradesh still offer valuable gene resources. Although, large-scale teak plantations are being established in many places of Madhya Pradesh, in most cases these represent only a fraction of the species genetic variability. It is, therefore, necessary that major teak plantation programmes should cover a wide range of seed source. Since, teak is one of the dominant species of Madhya Pradesh, more emphasis should be given on systematic research, both basic and applied, that may lead to substantial economic gain in tree improvement programme due to high value of timber and the large area of Madhya Pradesh under teak.

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12.	Development of Green Belts	Dr. Veena Chandra	Botany	23-27 Aug., 2004
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14.	Classification and Grading of Timber	Sh. V.K. Jain	Forest Products	04-08 Oct., 2004

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GLOBAL CLIMATE CHANGE AND ROLE OF FORESTS AS CARBON SINKS

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Introduction

The climate of the earth is affected by changes in radiation balance of the atmosphere due to various sources. These include atmospheric concentrations of several greenhouse gases (GHGs), which have been increasing due to human activities. An increase in concentrations of green house gases is expected to raise the global temperature. The atmospheric concentration of GHGs has risen from 280 ppm in the year 1750 to 368 ppm in 2000, which is likely to be between 540 and 970 ppm by the year 2100 (Ravindranath, 2002). The so-called global warming effect has attracted worldwide attention on climate change issues.

It has been widely accepted now that the most important cause for global climate change is human interference in the natural cycle of GHGs. Emissions resulting from human activities primarily the burning of fossil fuels such as oil, coal and natural gas and changes in the land use and land cover, etc. are substantially increasing the atmospheric concentration of GHGs i.e. carbon dioxide, methane, chlorofluorocarbons and nitrous oxide. The increase in GHGs concentration is gradually changing the global climate resulting in an additional warming of the earth's surface. Forests play a beneficial role in global climate change. They are vulnerable to projected climate change and provide large mitigation opportunities to stabilise GHGs concentration in the atmosphere.

Green House Gases (GHGs) and their Effect on Climate Change: IPCC Report – I

According to Intergovernmental Panel on Climate Change (IPCC) the important greenhouse (GHGs) causing global climate change are carbon dioxide (Co_2), methane (CH_4), chlorofluorocarbons (CFCs), nitrous oxide (N_2O), tropospheric ozone (O_3) and stratospheric water vapour (H_2O).

The major contributor to increased concentrations of GHGs since pre-industrial times is CO_2 (61%) with substantial contributions from CH_4 (17%), N_2O (4%) and CFCs (12%), stratospheric H_2O (6%). The recent

decadal increase in radiatively active (greenhouse) gases is CO_2 (56%), CH_4 (11%), N_2O (6%), CFCs (24%), stratospheric H_2O (4%).

Ozone is an effective greenhouse gas and its concentration in the troposphere is highly variable because of its short lifetime. It is photo-chemically produced *in-situ* through a series of complex reactions involving carbon monoxide (CO), CH_4, non methane hydrocarbons (NMHC) and nitrogen oxide radicals (NO_x). Hence, the concentration of O_3 largely depends upon its precursor gases. There is evidence that concentration of O_3 has decreased by a few percent globally within the last decade. The causes identified for enhancement of GHGs are:

Table . 1. Characteristics of Green house Gases.

Gas	Major contributor?	Long lifetime?	Sources known?
Carbon dioxide	Yes	Yes	Yes
Methane	Yes	No	Semi-quantitatively
Nitrous oxide	Not at present	Yes	Qualitatively
CFCs	Yes	Yes	Yes
HCFCs, etc	Not at present	Mainly no	Yes
Ozone	Possibly	No	Qualitatively

- burning of fossil fuels such as oil, coal and natural gas;
- land use change, particularly deforestation.

The cited emissions can be brought down by reducing use of fossil fuels and using more and more bio-energy. Some gases are potentially more effective than others at changing climate and their relative effectiveness can be estimated.

Carbon dioxide, methane and nitrous oxide, all have significant natural and human sources, while the chlorofluorocarbons are only produced industrially. Two important green house gases are water vapour and ozone. Water vapour has the largest green house effect, but its concentration on global scale is not affected by human sources and sinks. Water vapour will increase in response to global warming. The concentration of ozone is changing in the atmosphere due to human activities.

Carbon dioxide, as per the Ministry of Environment and Forests, Govt. of India, accounts for the maximum greenhouse gas emissions from developed countries. Fuel combustion is the biggest contributor. Other areas of concern for global warming include industry, agriculture and the burning of coal and wood.

Impacts of Climate Change: IPCC Report – II

The Intergovernmental Panel on Climate Change (IPCC) was set up jointly by the World Meteorological Organization and the United Nations Environment Programme to provide scientific opinion on climate change.

The assessment by IPCC reveals that human health, ecological systems and socio-economic sectors are vulnerable to changes in climate including the magnitude and rate of climate change as well as to changes in climate variability.

Human activities, primarily the burning of fossil fuels and changes in land use and land cover, are increasing the atmospheric concentrations of greenhouse gases, which alter radioactive balances and tend to warm the atmosphere, and in some regions, aerosols which have an opposite effect on radioactive balances and tend to cool the atmosphere, are also affected.

Since aerosols do not remain in the atmosphere for long period and global emissions of their precursors are not projected to increase substantially, aerosols will not offset the global long-term effects of greenhouse gases, which are long-lived.

These changes in greenhouse gases and aerosols, taken together are projected to lead to regional and global changes in temperature, precipitation, and other climate variables resulting in global changes in soil moisture, an increase in global mean sea level and prospects for more severe extreme high temperature events, floods and droughts in some places. Climate models project that the mean annual global surface temperature will increase by 1 to 3.5^{o}C by 2100, that global mean sea level will rise by 15 to 95 cm, and that changes in the spatial and temporal patterns of precipitation would occur. The average rate of warming probably would be greater than any seen in the past 10,000 years (IPCC Report – II, 1998).

Scientific studies show that human health, ecological systems, and socio-economic sectors e.g. hydrology and water resources, food and fibre production, coastal systems, and human settlements, all of which are vital to sustainable development, are sensitive to changes in climate including the magnitude and rate of climate change as well as to changes in climate variability.

Kyoto Protocol

In December 1997, during a Conference of Parties 3 (COP3), a protocol known as the Kyoto Protocol was adopted. The Protocol legally binds industrialised countries to reduce their collective emissions of the greenhouse gases by 5.2 percent by the first commitment period (2008 – 2012). GHGs by 59 protocols have been developed (WRI, 2001) and GHGs Registry (Environmental Resources Trust, 2000) are functioning for carbon credits.

In addition to domestic reductions, the Protocol has included three Flexible Mechanisms i.e. Emissions Trading, Joint Implementation and Clean Development Mechanism, with the prime aim to reduce the collective global carbon. These mechanisms will help the countries indicated in Table 2 to achieve their obligations cost effectively (Samsudin, 2001). Kyoto Protocol further makes provision to take into account afforestation,

reforestation and deforestation and other agreed land use, land use change and forestry (LULUCF) in meeting their commitments 2000 (Vine *et al*., 2001).

The main difference between the first two mechanisms with the third is that the Clean Development Mechanism (CDM) allows gaining of credits in countries that do not have emission targets. There were concerns, especially amongst the European Union (EU) countries, that any CDM Project would allow greater emissions from industrialised nations. In particular, forestry or 'carbon sink' projects will only temporarily offset those additional emissions because the carbon stores in the vegetation is released when the forests are harvested or burnt, trees decay or the forest lands are converted to other uses.

Role of Forests in Climate Change Mitigation

Developing countries recognise the role and importance of the forests as 'sinks and reservoirs' of carbon. As such, planting or protecting trees and issues of forest management are drawing global attention. Forests play a critical role in global carbon cycle. They contribute about 20 percent of global CO_2 emissions and are vulnerable to projected climate change.

Sustainable management of forests and raising plantation of trees can combat deforestation and minimise carbon emissions, thereby, acting as carbon sinks. Plants capture CO_2 from the atmosphere and release oxygen through photosynthesis. Some of the CO_2 is lost through respiration, but a major part is sequestered in living organisms, and dead organic matter, for instance in wood, wood products and soils. While burning fossil fuels releases CO_2 that has been locked up for millions of years; whereas burning biomass implies return to the atmosphere of the CO_2 that was absorbed as the plants grew. Under suitable management, this CO_2 is again recaptured by the growing forest and there is not net release of CO_2.

Harvested wood from forests is converted into wood products, which also act as a sink until the decay or destruction of old products. Forests and their products have a finite capacity to store CO_2 from the atmosphere, hence, they act as a perpetual carbon store only when managed sustainably and otherwise release the carbon previously fixed.

If biomass, including wood, is substituted for fossil fuels, land used for sustainable biomass and bio-energy production can continue to provide emission reduction indefinitely with the greater bio-energy production achieved from the newly created forests or adapted agricultural systems. It is estimated that bio-energy may reduce global CO_2 emissions in the year 2050 by up to 25 percent of projected fossil fuel emissions (Matthews and Robertson, 2002).

Table 2. Countries using emission control mechanism

Sl. no	Country	Sl.no	Country
1.	Australia	22.	Liechtenstein
2.	Austria	23.	Lithuania
3.	Belarus	24.	Luxembourg
4.	Belgium	25.	Monaco

5. Bulgaria
6. Canada
7. Croatia
8. Czech Republic
9. Denmark
10. European Economic Community
11. Estonia
12. Finland
13. France
14. Germany
15. Greece
16. Hungary
17. Iceland
18. Ireland
19. Italy
20. Japan
21. Latvia
26. Netherlands
27. New Zealand
28. Norway
29. Poland
30. Portugal
31. Romania
32. Russian Federation
33. Slovakia
34. Slovenia
35. Spain
36. Sweden
37. Switzerland
38. Turkey
39. Ukraine
40. Great Britain & Northern Ireland
41. United States of America

The United Nation's Framework Convention on Climate Change (UNFCCC) as well as the Protocol acknowledged the role and importance of the forests as 'sinks and reservoirs' of carbon. Article 4 of the Convention requests countries to protect sinks such as the forests while Article 2 of the Protocol requires that they should be managed on a sustainable basis. Forest related activities have been linked to the Flexible Mechanism and some parties notably the US, wanted to gain emission credits by planting or protecting trees and by sustainably managing forest resources (Samsudin, 2001).

Future Strategies to Reduce Climate Change Effect

There are many uncertainties in our predictions particularly with regard to the timing, magnitude and regional patterns of climate change and due to our incomplete understanding of:

- sources and sinks of greenhouse gases, which affect predictions of future concentration;
- clouds, which strongly influence the magnitude of climate change;
- oceans, which influence the timing and patterns of climate change, and
- polar ice sheets which affect predictions of sea level rise.

There is a need to provide a scientific assessment of:

- the factors which may affect climate change during the next century, especially those which are due to human activity;

- the responses of the atmosphere-ocean-land-ice system;
- current capabilities of modelling global and regional climate changes and their predictability;
- the past climate record and presently observed climate anomalies.

Studies and assessment of climate change issues will be conducted by Indian Council of Forestry Research and Education (ICFRE), Dehradun and Indian Institute of Science (IISc), Bangalore with the Ministry of Environment and Forests, Govt. of India being the nodal agency in India and USEPA in U.S.A. (Singh, 2002).

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International Conference on Multipurpose Trees in the Tropics: Assessment, Growth and Management is being organised by Arid Forest Research Institute, Jodhpur — a constituent institute of Indian Council of Forestry Research and Education, Dehradun and sponsored by International Union of Forestry Research Organisations (IUFRO).

Objective:

To bring together scientists, foresters and all other stakeholders to evaluate the status of assessment techniques, genetic improvement, modelling and management of multipurpose trees.

Topics:

1. Management of multipurpose tree species (MPTS) including trees of medicinal value;
2. Assessment of trees outside forests;
3. Modelling growth and production data needs, techniques;
4. Improvement strategies for MPTS with special emphasis on tree genetics.

Call for Papers:

One page abstract, not exceeding 500 words, including the title , authors, affiliation and keywords should be submitted to the conference secretariat by 28th February 2004. Authors of papers for oral or poster presentations will be notified by the end of March 2004.

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Forestry and Agriculture Face Similar Challenges

Today, agriculture and the forest sector are more inextricably linked than ever before as they face similar challen coping with poverty and food insecurity. While these problems contribute to forest destruction and degradation, the solut alleviating them and for minimizing the negative impacts of agriculture on the environment involves a complex set of fact using the best of old and new technologies, innovating ideas and modern institutional arrangement. The sustainable management of forests and trees, including the use of agroforestry and watershed management, is an integral part of th

effort to reduce food insecurity, alleviate poverty and improve environmental quality for the rural poor. Technological innovations and new management methods that increase agricultural and forest yields per hectare can also have a sign positive impact on the world's forest.

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FOREST TYPES, VOLUME AND BIOMASS IN THE WORLD

A. Continent – Wise

Area	Forest types (% of country's forest area)				Wood volume in forest		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total (million m^3)	(tonnes/ ha)	Total (million tonnes)
Africa	98	1	0	0	72	46,472	109	70,917
Asia	61	23	14	2	63	34,506	82	45,062
Europe	0	5	22	73	112	116,448	59	61,070
North and Central America	15	16	29	40	123	67,329	95	52,357
Oceania	62	30	8	0	55	10,771	64	12,640
South America	96	2	1	0	125	110,826	203	180,210
World	**52**	**9**	**13**	**25**	**100**	**386,352**	**109**	**422, 256**

B. Important Countries

Country	Forest types (% of country's forest area)				Wood volume in forest		Wood biomass in forests	
	Tropical	Subtropical	Temperate	Boreal/polar	(m^3/ha)	Total	(tonnes/ ha)	Total

						(million m^3)		(million tonnes)
Argentina	91	5	4	0	25	866	68	2,356
Australia	54	38	8	0	55	8,506	57	8,840
Brazil	98	2	0	0	131	71,252	209	113,676
Canada	0	0	26	74	120	29364	83	20,240
China	3	59	29	8	52	8,437	61	10,038
France	0	0	100	0	191	2,927	92	1,418
Germany	0	0	100	0	268	2,880	134	1,440
India	95	5	0	0	43	2,730	73	4,706
Japan	0	54	46	0	145	3,485	88	2,128
Mexico	70	30	0	0	52	2,871	54	2,981
Nigeria	100	0	0	0	82	1,115	184	2,493
Pakistan	2	98	0	0	22	53	27	64
South Africa	68	32	0	0	49	437	81	720
United Kingdom	0	0	87	13	128	359	76	213
United States	0	37	48	15	136	30,838	108	24,428

KAREEM'S THIRTY-TWO ACRES WATER SPONGE

Deep inside every one of us is a call to the wild. Much of the impatience, discontent or violence around us is due to a lack of opportunity to reconnect with where we came from. For sanity and generosity of spirit we should be able to witness nature at its unceasing, rejuvenating work. That is what Abdul Kareem felt about a mission in which a patch of about 32 acre lateritic land on a hill slope was converted into a wild with an untiring effort of 25 years.

Abdul Kareem was born in 1947 at Nileswar, a small town on the NH 7 between Kasargod and Payyanur in Kerala. His father Abdullah was a small-time businessman. After passing his high school and a year in college, Kareem decided to venture out to Bombay. He worked in a private dockyard as a labourer to learn the ropes. In 1969 just when he thought that he had found a vocation, he was shaken by parochial riots. Back in Nileswar, he taught himself book keeping and typewriting to become an accountant. Marriage followed and also some good fortune. The Persian Gulf boom began in the early 1970s and Abdul Kareem sensed an opportunity. He began a travel and placement service for the thousands of Keralites eager to flood the Gulf. His wife came from the

village of Puliyamkulam, about 20 km from Nileswar. He would often visit there with her and spend some weekends. And that's how he came by his hill.

The pathetic situation of the hill slope, forced him to think about Kaavu - the Sacred Grove that every village had upon a time. In a spur of moment, he bought five acres of land with a dried well. He was a man haunted by his desire fo Kaavu. After about a year of helplessly watching his property, he began to plant mature saplings of wild trees in spaces between laterite rocks. During the summer he would fetch water in cans lashed to his motorbike from a source a kilomet away. For decades his rocky spreads had produced nothing. As his family watched in panic, Abdul Kareem bought 32 a a rocky slope. For three summers, he nursed his plants with water ferried from afar. And then nature sent him a feedbac the third year, when my plantation was but of young adult trees, the water level in the well rose!" he says. That itself see an end for him and he began to plant the whole extent in frenzy. He chose a variety of plants plucked from the wild and nature do the rest. He learnt that one can enable nature, not direct it. Birds on his young plantations started helping him discharging variety of seeds of weeds, herbs and medicinal plants; hare, fowl and other small game have colonised the forests. Beehives, the size of a sack, are emerging. There was a dry inherited tank on the land. Water levels in Kaliyana Varranjnyur and other villages within a 10 km radius rose. The once barren hill was now a water sponge, he can pump 100,000 litres out of it at a go and the level will bounce back in a few minutes. The forest is actually producing water. He believes that he got nature's reward in the form of highly mineralised and herbalised water, the fragrant air, the daily wal through the woods, a healthy life and enormous peace. It is the time when Abdul Kareem has to strike a balance betwee preserving his growing dream and his growing responsibilities as he had already put all his money into this forest. Optio marketing of water, forest as eco-destination, eco-school, etc. are many but resource is none. A helping hand is really n

(As long as the earth is full of hills and forests,
it will keep fostering generations of mankind)

- Durga Saptashati