

# **Forest genetic resources and management in India – status, needs, challenges and actions required**

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## ***Introduction***

Forests, the world's most valuable renewable natural resource and repositories of terrestrial biological diversity are in imminent danger due to urban expansion, infrastructural development, agriculture and global warming (Bawa and Dayanandan 1998, Brown and Pearce 1994, Stedman-Edwards 1998). Forest trees being long-lived, out-breeding, highly heterogeneous and occurring in diverse and variable environments have developed complex mechanisms to maintain high intra-specific diversity. Genetic variation is essential for species to evolve and adapt to changing environmental conditions. Thus, sustained ability of forest trees to provide goods and services depends on the maintenance and management of forest genetic resources (FGR). Critical information on the status, distribution, extent and threats to genetic diversity are prerequisite for planning effective conservation strategies. Although the basic principles of conservation of FGR are conceptually rooted in our understanding of crop genetic resources, in view of unique characteristics of forest trees evolving specific mechanism and procedures will be essential.

The term FGR is used variedly enclosing a range of components from intra- to inter-specific genetic diversity among a set of taxonomically and/or ecologically related species, to the entire range of forest species that are economically important and/or potentially useful (Young *et al.* 1999). India is one of the 12 mega-diversity countries of the world, which together possess 60 to 70% of the World's biodiversity (MoEF 2004). The country is endowed with great genetic diversity of the forests. Status of the forest resource management and conservation endeavours in the country has been discussed in the present paper.

## ***Organizational set up***

India has strong set up of government (union and states), non-governmental organizations (NGOs), and academic and research institutions, to carry out various activities in the field of forest genetic resources.

## **The Ministry of Environment and Forests**

Starting as Department of Environment in 1980 and later becoming the integrated Ministry of Environment and Forest in 1985, the ministry is the nodal agency for planning, promotion, coordination and overseeing the implementation

of various forestry programmes in India. It also provides financial support to various government and non-government institutions for conducting research in various forest related areas.

The ministry functions as the nodal agency for United Nations Environment Programme (UNEP), South Asia Cooperation Environment Programme (SACEP), International Union for Conservation of Nature and Natural Resources (IUCN) and various other international agencies. The ministry also functions as the nodal agency and participates in international agreement related to environment such as the Convention on Wetlands of International Importance, Conventions on Biological Diversity and Climate Change, and Convention to Combat Desertification.

### **Other government institutions**

In addition to the Ministry of Environment and Forest, there are other government institutions, which directly or indirectly, focus on the forest genetic resource management and research. These include:

- Department of Environment at the State and Union Territory level.
- Department of Science and Technology
- Department of Biotechnology
- National Biodiversity Authority
- Department of Non-conventional Energy Sources
- Council of Scientific and Industrial Research

### **The Indian Council of Forestry Research and Education (ICFRE)**

ICFRE is an autonomous body under the Ministry of Environment and Forests, with eight research institutes and three advanced centres in various parts of the country:

1. Forest Research Institute, Dehradun
2. Tropical Forest Research Institute, Jabalpur
3. Institute of Forest Genetics and Tree Breeding, Coimbatore
4. Institute of Wood Science and Technology, Bangalore
5. Arid Forest Research Institute, Jodhpur
6. Himalayan Forest Research Institute, Shimla
7. Rain Forest Research Institute, Jorhat
8. Institute of Forest Productivity, Ranchi
9. Centre for Social Forestry and Eco-rehabilitation, Allahabad
10. Centre for Forestry Research and Human Resource Development, Chhindwara
11. Forest Research Centre, Hyderabad

ICFRE caters to the needs of different biogeographical regions of the nation to increase the productivity through genetic and silvicultural improvement, treatment of wasteland and conservation of forest ecosystems. ICFRE has had research collaboration with DANIDA and FAO, FORTIP (UNDP/FAO Regional Forest Tree Improvement Project), UNDP and World Bank on economically

important species. ICFRE's priority areas for research include among others (NFRP 2001):

- Research on conservation, protection and sustainable development of existing forests to conserve biodiversity
- Increasing productivity of existing forests and future plantations through high quality seed production; production and multiplication of site matched planting stock; improvement of species and varieties using traditional breeding methods and biotechnology.
- Research on non-wood forest products, which provide sustenance to people and supply raw materials to forest-based industries; and socioeconomic research for motivating farmers/land owners to adopt tree farming.

### **The Forest Survey of India (FSI)**

The Forest Survey of India, an organization under the Ministry of Environment and Forests, Government of India, has been carrying out assessment of forest resources in the country since its inception as Pre-Investment Survey of Forest Resource (PISFR) in 1965. Initially, FSI assessed the forest resources in different parts of the country through ground inventory and interpretation of aerial photographs. However, since the early 1980s, it started using satellite data to assess the forest cover of the country. Under its revised mandate of 1986, FSI assesses the forest cover on two-year cycle and publishes the information in the form of a State of Forest Report (SFR). The first such report was published in 1987, using Landsat data of US satellites through visual interpretation technique on 1:1 million scale. The latest assessment is based on the scale of interpretation of 1:50000. The introduction of advanced digital image processing systems has helped in reducing the time lag between the presentation of the report and that of the underlying satellite data. The periodic assessment of forest cover provides a quantitative measure of the extent of land area under forest/tree cover, along with the density. It helps in monitoring changes in the cover. Forest cover information is the basis of national and state policy planning. Comprehensive assessment of the forest resource involves measurement of numerous parameters such as forest cover, growing stock, annual increment, species composition, bio-diversity, non-timber forest products, etc. However, the FSI is able to assess only the forest cover for the whole country, and the assessment of other parameters is done only for specific areas.

### **Botanical Survey of India (BSI)**

Botanical Survey of India (BSI) established in 1890, is responsible for survey, identification and recording status of the plant resources of the country.

### **National Bureau of Plant Genetic Resources (NBPGR)**

NBPGR is an independent national institute, which has been established to introduce, collect and conserve plant genetic resources mainly of agricultural and horticultural species in India since 1976.

### **National Bureau of Forest Genetic Resources (NBFGR)**

ICFRE has principally agreed to establish a National Bureau of Forest Genetic Resources (NBFGR) under its Genetic Resource Programme, with a wide network of regional institutes situated at various agroecological zones for germplasm collection, *ex situ* and *in situ* conservation as well as introduction and evaluation.

### **Department of Biotechnology (DBT)**

DBT is the premier national body dealing with various aspects related to biotechnology in India. In the field of forestry, it has supported a major programme on plant tissue culture with the objective of developing protocols for regeneration of economically important plant species including forest trees. Studies on genetic manipulation of important forest tree species, neem and populus; and characterization/cataloging of the important clones of forest trees by DNA fingerprinting are underway. A network of three gene banks has been set up by DBT for conservation of seeds, live plants and *in vitro* material of rare, threatened and economically important species.

### **GB Pant Institute of Himalayan Environment and Development**

The GB Pant Institute of Himalayan Environment and Development, Almora (Uttaranchal) established in 1988 is an autonomous organization of the Ministry of Environment and Forests for developing strategies, technologies and knowledge base for ecologically sound development of the Himalayan region.

### **Indian Institute of Forest Management (IIFM)**

The Indian Institute of Forest Management, Bhopal, an autonomous organization of the ministry also undertakes education, training, research and consultancy in forest management.

### **Tropical Botanic Garden and Research Institute (TBGRI)**

TBGRI has the mandate of conservation and sustainable utilization of tropical plant diversity and recognized as a National Centre of Excellence in *ex situ* conservation of tropical plants through various research and development programmes.

### **Centre for Ecological Sciences, IIS, Bangalore**

Combines basic ecological research, applied environmental problems and extension work with particular reference to the Western Ghats, the Centre has designed Western Ghat Biodiversity Information System adapting the state-of-art database technology and information.

### **State forest departments (SFDs)**

All states have individual departments for environment/forests. Many state forest departments have established institutes to conduct research in the field of forestry. For example Kerala Forest Research Institute, Peechi; State Forest Research Institute, Kanpur (UP) and Jabalpur (MP).

In addition, with the aim to improve the productivity and profitability of planting forest species and offering an attractive land use option, many SFDs have established Seed Production Areas, Clonal Seed Orchards, Seedling Seed Orchards (SSOs), Vegetative Multiplication Gardens (VMGs) and modern nurseries for production of quality planting stock material.

### **The National Afforestation and Eco-Development Board (NAEB)**

NAEB is responsible for promoting afforestation, tree planting, ecological restoration and eco-development activities in the country, with special attention to the degraded forest areas and lands adjoining the forest areas, national parks, sanctuaries and other protected areas, as well as the ecologically fragile areas like the Western Himalayas, Aravallis, Western Ghats, etc. The NAEB has seven regional centres located at different universities and national-level institutions in the country. Two major programmes, Coastal Shelterbelt Plantation Programme (CSPP) for afforesting coastal areas in the country with suitable tree species to form shelterbelts; and Bamboo and Medicinal Plantation Project, have been taken up by NAEB as thrust areas.

### **National Botanical Garden**

A National Botanical Garden at Noida, Delhi, is being set up by the Botanical Survey of India. The National Botanical Garden would *inter alia* facilitate *ex situ* conservation and propagation of threatened/endangered plants of the country, serve as a center of excellence for research and training, and thereby cater to the conservation needs of endangered species in the region.

### **Non-governmental organizations (NGOs)**

Conservation of forest genetic resources would be impossible without active participation of people. NGOs play an important role in mobilizing the people at the grassroots. Some of the NGOs working in the arena of FGR are:

- Foundation for Revitalization of Local Health Traditions (FRLHT), Bangalore
- Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore
- Environmental Resources Research Centre (ERRC), Thiruvananthapuram
- The Energy Research Institute (TERI), New Delhi
- BAIF Development Research Foundation, Pune
- Centre for Environment Education (CEE), Ahmedabad
- Centre for Science and Environment (CSE), New Delhi
- Indian Association for Environmental Management (IAEM), Nagpur
- Kalpavriksh, New Delhi
- Vanarai, Pune
- Centre for People's Forestry (CPF), Secunderabad
- The C.P. Ramaswami Aiyar Foundation, Chennai
- Society for Conservation of Forest and Wildlife, Pune

### **National FGR conservation programmes**

The Government of India has adopted several schemes under National Forestry Programmes to achieve sustainable forest management and the national goal of one-third of land area under forest/tree cover, and also to have linkages with livelihood and poverty alleviation issues of forest dependant communities. Such sustained commitments on the part of the state and Union Territory governments have also resulted in the significant participation of local people in tree planting and forest management, as well as in the conservation of biodiversity.

### **National Forestry Action Plan (NFAP)**

Recognizing the role of forests in rural livelihoods and in securing environmental security for future generations, the Government of India have formulated the National Forestry Action Plan (NFAP) which is a comprehensive work plan for the next twenty years to achieve the goal of sustainable development of forests and also to increase the forest/tree cover in the country to 33 percent of the land area as mandated in the National Forest Policy, 1988. The implementation of NFAP requires huge investment, about US\$20 billion to achieve sustainability of all types of forests in the country. International attention is needed in key areas such as finance, transfer of environmentally sound technology, legal protection of traditional forest related knowledge, etc.

### **Biosphere reserves and national parks**

Some economically important forest tree species have been conserved in gene banks, *in situ* and *ex situ* conservation sites with wide networking between the state forest departments. National parks (90), and other protected areas in the form of biosphere reserves (13) and wildlife sanctuaries (502), which have been regarded as *in situ* conservation and management of FGR at the species level have been established. In addition, a variety of field repositories of genetic resources, including nature reserves and other protected areas, private and publicly owned, managed and unmanaged, natural forests and plantations, trees outside forests managed in agroforestry systems and growing on homesteads and along rivers and roads, arboreta and botanic gardens, field trials and live collections, have also been developed within the framework of selection and tree improvement programmes to increase the productivity of forest.

Biosphere Reserves are multipurpose protected areas to preserve the genetic diversity in the representative ecosystems. The major objectives of biospheres reserves are:

- To conserve biodiversity and integrity of plants, animals and micro-organisms;
- To promote research on ecological conservation and other environmental aspects;
- To provide facilities for education, awareness and training.

So far 13 biosphere reserves have been set up: Nilgiri, Nanda Devi, Nokrek, Great Nicobar, Gulf of Mannar, Manas, Sunderbans, Simlipal, Dibru, Daikhowa, Dehong Deband, Pachmarhi, Kanchenjanga and Agasthyamalai. Out

of these, UNESCO has recognized Nilgiri, Sunderbans and Gulf of Mannar on the World Network of Biosphere Reserves.

### **Conservation of wetland and mangroves**

A programme on conservation of wetland is being implemented since 1987 covering 27 wetlands in 13 states. India is also a signatory to the Convention on Wetlands of International Importance.

Mangroves are reservoirs of a large number of species and stabilize the shoreline. India harbours some of the best mangroves in the world with an estimated area of 6000 sq km. Under the scheme of Conservation and Management of Mangroves, 35 mangrove areas have been identified for intensive conservation and management purposes.

### **Environment Impact Assessment (EIA)**

The programme of EIA was introduced in 1978. A notification issued in January 1994 makes EIA statutory for 29 categories of developmental projects under various sectors. The EIA notification was amended in 1997 to make public hearing as an integral part of the assessment procedure. Environmental clearance is granted by the Environment Assessment Agency.

### **Working plans**

The working plans are the instruments for scientific forest management for assessing the impact of past management practices and deciding about suitable management interventions for the future. However, periodical updating and revision of working plans is essential to keep pace with the trends emerging at the forest-people interface, and to address other national objectives. Forestry in India has undergone striking changes in the recent past. The focus of forest management has shifted from production to conservation. Non-timber forest products have come to the forefront of forestry management. The role of local people in protection and management of forests has grown immeasurably. The concept of Joint Forest Management has taken formal shape. Decentralized planning process for area specific forest management approach has resulted in formulation of micro plans. The “care-and-share philosophy” evolved in this process needs to blend with the scientific approach to forest management. In such situations it is essential to reshape the documents that embody forestry management prescriptions, that is the working plans. There has been some concern in the past about rigidity of the working plans and their inability to adapt to fast changing situations in the field. It is now time to strengthen the system of writing of working plans in a uniform manner throughout the country, and to dovetail micro plans with the working plans without compromising on the scientific principles of forest management. The government has formulated **National Working Plan Code** to accommodate the changed context and knowledge base for preparation of the working plans.

### **Criteria and indicators for sustainable forest management (SFM)**

The concept of forest management in India has been broadened to include economic, environmental, social, and cultural dimensions, in line with the National Forest Policy. To ensure the continued availability of goods and services that forests and forest ecosystems provide, based on the agreed principles of UNCED, countries have arrived at a common definition of SFM, and to develop and implement tools, by which the sustainability of forest management, in a broad sense, could be assessed, monitored, and reported. The worldwide initiatives to achieve SFM have been focused on criteria and indicator (C&I) system for assessing fulfillment of the objectives of managing the forests on sustainable basis. The initiative for development of C&I for SFM in India is the **Bhopal-India Process** in 1998. The process led to development of 8 criteria and 43 indicators after extensive consultations, workshops, etc. spanning over three years.

### **Programmes for conservation of medicinal plants**

India has probably the oldest, richest and most diverse cultural traditions in the use of medicinal plants. State forest departments of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Maharashtra, in consultation with the Foundation for Revitalization of Local Health Traditions (FRLHT) and with the support of DANIDA and UNDP, have established 54 forest gene bank sites called Medicinal Plant Conservation Areas (MPCA). The network of 54 MPCAs, measuring 200 ha to 500 ha each, has been established gradually since 1993 and represents all forest types with large bio-climatic and soil regime variations. These gene banks harbour 45% of the recorded populations of flowering and medicinal plants of Peninsular India, including 70% of the red-listed species.

Various states have established **Medicinal Plant Boards** to improve the status of existing medicinal plants in their respective areas either by *in situ* or *ex situ* conservation.

### **Conservation of bamboo resources**

India is the second richest country in bamboo genetic resources after China. Large areas where bamboos occur have been declared as national bamboo reserve areas, and provenances in the natural habitats are being maintained. ICFRE has perfected the macro-/micro-propagation techniques for bamboo. The Kerala Forest Research Institute (KFRI) has established a **Bamboo Information Centre (BIC)** for disseminating all relevant information on 137 species of Indian bamboo.

Since natural variation in the genetic resource base is required for selection and improvement, conservation of available genetic resource needs to be accorded the highest priority (Rao and Ramanatha Rao 2000). Efforts have been taken by the NBPGR, New Delhi and its stations in Thrissur, Shillong and Ranchi, ICFRE and ICAR (Indian Council of Agricultural Research) to collect and build up genetic diversity of bamboo for evaluation and maintenance. Considering the limitation in seed supply, vegetative methods for *ex situ* conservation and tissue culture work have been started.

### **National Bamboo Mission**

Keeping in view the potential of bamboo, its present poor market linkage and sub optimal level technology application for manufacture of value added products in the industrial and cottage sector, the **National Mission on Bamboo Technology and Trade Development** has been mooted to accord bamboo development a strategic role in rural economy, poverty alleviation and bamboo based handicrafts and industrial development. The task for coordinating the National Mission on Bamboo Technology and Trade Development has been entrusted by the Prime Minister to the Ministry of Agriculture. The Mission envisages coverage of 2 million ha under bamboo during the 10th Plan involving an investment of Rs. 26.08 billions. The Mission also envisages the integration of different ministries and departments for the holistic development of the sector. The mission envisions an integrated programme for expansion of plantations of bamboo species, its scientific management with the involvement of JFM committees, local initiatives and entrepreneurship for presenting this raw material for the industries, and assisting the industry to access and apply modern technology for producing globally competitive new generation bamboo products. The other features of the Mission include technology development for planting, technology intervention on process and products including standards and codes, handicraft development including training, trade and market development for bamboo products, and technology development for building material.

### **Joint Forest Management (JFM)**

India is committed to genuine and meaningful partnerships with the local communities and other sections of society. For this it has created a sound policy, institutional, and legal framework, which allows decentralization of management and control regimes and empowers the communities to take decisions on management issues and also for benefit sharing. The National Forest Policy 1988 envisages people's involvement in the development and protection of forests. The requirement of fuel wood, fodder, and small timber such as house building material, of the tribal and other villagers living in and around the forests are treated as first charge on forest produce. As one of the essentials of forest management, the policy envisages that the forest communities should be motivated to identify themselves with the development and protection of forests from which they derive benefits. In 1990, the government adopted the principles of "care and share", highlighting the need and procedures for the involvement of village communities and voluntary agencies in the protection and development of degraded forests, popularly called the "JFM Principles". These have become the cornerstone for people's participation in forest management. The JFM has been pursued vigorously with the result that JFM resolution has now been adopted in all 28 states. Till date, of the total 173 000 villages on the forest fringe, JFM has been implemented in 61 000 villages and around 85 000 JFM Committees have been formed covering more than 17 million ha of forests. States have started an innovative mechanism of decentralization of power not only for forest protection but also in forest development or expansion of forest cover. The social functions of forests are very important, as the forest fringe villages comprise 28% of the

total number of villages in the country. Forests are inseparably linked with the livelihoods of people living on the forest fringes, as they depend on forest produce for self-consumption and income. Forests support grazing of nearly 60% of the livestock in the country (270 million out of about 450 million), and produce firewood for sale. Considering the immense potential and genuine need for women's participation, the JFM programme guidelines state that women should constitute 50% of the general members of JFM committee. For the general meeting, the quorum of 50% women members is mandatory. At least 33% membership of the executive/management committee should be women. One of the office bearers should be a woman. The government is committed to confer ownership rights to the forest dwelling communities, including women. The role of women has been ensured in Forest Development Agencies (FDA), which is the confederation of JFM Committees in their area, to manage common forest resources, implement afforestation schemes, initiate steps for value addition and marketing of forest produce, protection against poaching of wildlife and illegal felling of timber, manage the existing captive water resources in the village, monitor the activities of local NGOs, and promote agro-forestry/farm forestry. At present, more than 8.3 million women are participating in the management of forests in different forest and forest fringe villages through JFM Programme.

#### **Integrated Forest Protection Scheme**

Integrated Forest Protection Scheme has been formulated. The components of scheme are infrastructure development which include working plan preparation, survey and demarcation, and strengthening of infrastructure for forest protection, and forest fire control and management.

#### **Assistance to Botanic Gardens**

The Ministry of Environment and Forests is providing financial assistance under scheme on Assistance to Botanic Gardens to augment *ex situ* conservation of rare endemic plant species.

#### ***National policies and legislations***

National policies and programmes related to FGR in India encompass a spectrum of activities, ranging from conservation/protection of rare and endangered species/populations to comprehensive approaches to the management of landscapes and ecosystems. Considerations related to FGR in India have been integrated within broad frameworks, such as national forest policy and other legislations.

Forest policy and planning in India is a concurrent responsibility of the central and state governments. Policy and planning are linked to authorizations contained in basic national legislation, including forestry legislations. In turn, policy shapes legislations in as much as legislations provide the structure and grounds for implementation of policies, strategies and priorities. Forest policy and legislations flow in India constitute a part of the national land use and legislative framework for natural resource management and use.

### **The National Forest Policy 1988**

The rich traditions of modern scientific forest management began in 1864 under the British administration with the establishment of the Indian Forest Department. Since then, new forest policies have been issued in 1894, 1952, and 1988.

The recent forest policy formulated four years before the Earth Summit embodies the principles of SFM, and India's forests are treated primarily as environmental and social resources and only secondarily as a revenue or commercial resource.

The Non-legally Binding Statement of Forest Principles for sustainability of all types of forests were adopted during the United Nations Conference on Environment and Development (UNCED), and followed by the IPF (Intergovernmental Panel on Forests) and IFF (Intergovernmental Forum on Forests) processes which produced a body of more than 270 proposals for action towards SFM. The National Forest Policy 1988 covers most of the thematic elements of IPF/IFF proposals for action to achieve sustainability of all types of forests, which are mainly:

- Increase in the extent of forest and tree cover
- Maintenance, conservation and enhancement of bio-diversity
- Maintenance and enhancement of ecosystem functions and vitality
- Conservation and maintenance of soil and water resources
- Maintenance and enhancement of forest resource productivity
- Optimization of forest resource utilization
- Maintenance and enhancement of social cultural and spiritual benefits
- Adequacy of policy, legal and institutional framework for these objectives

### **National Conservation Strategy and Policy Statement on Environment and Development**

National Conservation Strategy and Policy Statement on Environment and Development 1992 are the guidelines helping to weave environmental considerations into the fabric of national life and development process.

### **Legislations**

In India the protection and improvement of the environment and the safeguarding of forest and wildlife is ensured under the directive of state policy Articles 48 A and 51 A (g), Part IV of the Constitution. The Constitution directs citizens to protect nature and also provides for forests and wildlife as concurrent subjects under Schedule 8, List III, and Entry 17-A and 17-B.

### **Biological Diversity Act 2002, and Biological Diversity Rules, 2004**

Taking cognizance of the provisions of the Convention of Biological Diversity (CBD), India has enacted an umbrella legislation called the Biological Diversity Act 2002, and also notified the Biological Diversity Rules 2004 (National Biodiversity Authority 2004). The Act and Rules are for guidance of and complacence by various stakeholders, including the Union and State Governments, non-state sectors and individuals.

Salient features of the Biological Diversity Rules 2004 are as follows:

- To regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources; and associated knowledge relating to biological resources.
- To conserve and sustainably use biological diversity
- To respect and protect knowledge of local communities related to biodiversity
- To secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources
- Conservation and development of areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites.
- Protection and rehabilitation of threatened species

The Act also envisages constitution of National Biodiversity Authority, State Biodiversity Boards, Biodiversity Management Committees and Local Biodiversity Fund.

The **Indian Forest Act 1927** is the main act, which regulates the management of forests by the states, and together with the **Wildlife Protection Act 1972**, provides the principal legal framework. **The Forest Conservation Act 1980**, among the most stringent of regulatory statutes in the country, is intended to control deforestation. It has placed strict controls on the diversion of forestland for non-forestry purposes. These Acts are the basis for the protection of the flora and fauna of the country. Within the framework of the legislation, there are 90 national parks and 502 wildlife sanctuaries, wetlands and a network of biosphere reserves covering about 15.6 million ha or 4.75% of the total area. Biodiversity conservation has been made an integral part of forest conservation and various legislative measures have been taken to strengthen conservation. The **Biological Diversity Act 2002** aims to protect the biological resources of the country, and thus, addresses forest ecology in its totality.

The **73rd amendment to the Indian Constitution (1992)** makes it mandatory for all states to decentralize governance through a three-tier structure viz. the state, district and local bodies (called Panchayati Raj Institutions or PRI in brief). Among the 29 functions recommended for decentralization, three related to forestry: Social Forestry, Fuel Wood Plantations, and Non-Timber Forest Products (NTFP).

### ***Updates and happenings***

#### **Recent legislations**

India is a party to the CBD whose objectives include conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of benefits arising out of the utilization of genetic resources and traditional knowledge. CBD envisages that benefits accruing from commercial use of traditional knowledge have to be shared with the people responsible for creating,

refining, and using this knowledge. **Article 8(j) of CBD** provides for respecting, protecting, and rewarding the Knowledge, Innovations and Practices (KIP) of local communities. The **Biological Diversity Act 2002** (and **Biological Diversity Rules 2004**) address the basic concerns of access to, and collection and utilization of biological resources and knowledge by foreigners, and sharing of benefits arising out of such access. **The National Biodiversity Authority** envisaged under the act will grant approvals for access, subject to conditions, which ensure equitable benefit sharing. The documentation of traditional knowledge and preparation of village wise **Community Biodiversity Registers (CBRs)** will be established for documenting all knowledge, innovations, and practices, and are measures to protect the traditional knowledge, innovations, and practices. The CBRs are expected to function as a tool to establish claims of individuals and communities over knowledge and use of biodiversity resources, and to bring them equitable share of benefits flowing from the use of such knowledge and resources. It has also been made incumbent upon patent applications to disclose the source of origin of the biological material used in the invention in their patent application and compliance with national laws on the subject. Provisions in Biological Diversity Act 2002 ensure equitable sharing of benefits arising from the use of traditional knowledge with the holders of such knowledge. India has initiated an exercise to prepare an easily navigable electronic computerized database of documented, traditional knowledge relating to the use of medicinal and other plants. Such database would enable patent offices all over the world to search and examine and prevalent use / prior art, and thereby, prevent grant of fake patents and bio-piracy.

### **New Projects**

Some of the important research projects initiated recently to address the concerns of conservation and management of forest genetic resources in India have been listed below:

#### *MoEF sponsored:*

1. *In vitro* screening and multiplication of tree species of coastal agro ecosystems for abiotic stress tolerance.
2. Studies on the biodiversity of sholas and grasslands and their restoration in the Nilgiris Plateau, Southern India.
3. Bioprospecting of potential rare and endangered ethnobotanical important plant species of Jharkhand.
4. A study on floral diversity of Bhadra Wildlife Sanctuary, Karnataka.
5. Characterization of plant biodiversity, community structure and population behaviour of some important tree species at the community forests of Nagaland.
6. Conservation through micro-propagation and restoration of endemic endangered and economically useful plants of the Kolli Hills in the Eastern Ghats of Tamil Nadu.

7. Study of conservation biology, propagation and assessment of genetic diversity of some rare and endangered tree species of Eastern Ghats through molecular techniques.

#### *ICFRE projects*

1. Studies on cataloguing the genetic variation in teak species (*Tectona grandis* and *T. hamiltonii*) using molecular markers.
2. Creation of germplasm resource bank of threatened medicinal plants of Darjeeling Himalayas
3. Studies on plant diversity of Renuka and Simbalwara Wildlife Sanctuaries of Himachal Pradesh.
4. Development of ecologically viable and socio-economically accepted integrated model for arresting Willow (*Salix*) mortality in Lahaul Valley of Himachal Pradesh.
5. Germplasm collection, conservation and mass multiplication of selected medicinal plants of northeast India.
6. Estimation of gene diversity and drift pattern in natural stands and plantations of South Indian forest tree species.
7. Inventorization and monitoring of biodiversity of threatened wetland sites of Doon valley and surroundings.

#### **New research achievements**

Various research institutions of the country have provided significant impetus in the area of forest genetic resources:

1. Selection and progeny trial of wild and cultivated potential populations of *Artocarpus integrifolia*.
2. Establishment of SPA of *A. hirsuta*, a threatened endemic species of Western Ghats.
3. Analyses of the genetic variability among 20 provenances of *E. camaldulensis* using AFLP markers and 12 provenances of *Casurina equisetifolia* using RAPD markers.
4. Species distribution mapping for 21 threatened medicinal plants in Kolli hills.
5. Genetic diversity among *Taxus wallichiana* growing in north Himalayan region has been estimated by RAPD analysis.
6. Analysis of genetic diversity of teak plus trees assembled in the National Germplasm Bank, Chandrapur, using RAPD and ISSR markers.

#### **Capacity building of IFS Officers**

A one-week compulsory training for Indian forest service officers on “new approaches to biodiversity conservation” was organized at the Tropical Forest Research Institute, Jabalpur, from 31 January to 4 February 2005.

#### **Events**

Major happening in the field of forest genetic resources in India include the following conferences, symposia and workshops:

- International Conference on “Quality Timber Products of Teak from Sustainable Forest Management”, 2-5 December 2003, KFRI, Peechi.
- VII World Bamboo Congress, 28 February - 4 March 2004, New Delhi.
- National workshop on “Conservation and Sustainable Utilization of Lesser Known Tree Species”, 8-10 March 2004, Forest research institute, Dehradun.
- International Conference on “Multipurpose Trees in the Tropics: Assessment, Growth and Management”, 22-25 November 2004, Arid Forest Research Institute, Jodhpur.
- National Symposium on “Emerging Technologies and their Application in Assessment, Conservation and Management of Threatened Wild Medicinal Plants and their Habitats”, 23-24 January 2005, State Forest Research Institute, Jabalpur.

### **Case studies**

- a. A recent case study (Bose and Saigal 2004) has shown that more than 340 million people in India depend on forest-based livelihoods such as collection, processing and sale of fuelwood and non-timber forest produce. The bulk of the forest produce processing is being carried out by small scale forest entrepreneurs who include individuals, community groups and small companies who are involved in the growing, harvesting, processing and marketing of the timber and non-timber forest products. It is reported that more than 3 million people are employed in the tendu-leaf collection and beedi-rolling industry and nearly half-a-million people are employed in safety-match making, sawmilling and wood carving industries (Bose and Saigal 2004).
- b. Indigenous tribes, the Sholigas, who live within the forest areas of Biligiri Rangaswamy Temple Wildlife Sanctuary, depend upon many forest product species for their sustenance and economy (Uma Shaanker *et al.* 2004).
- c. Sandal, prized for its heartwood and oil, is an economically important tree species, which has been a major source of forest-based revenue for the government for the past several decades. Many traditional craftsmen are dependent on a regular supply of sandalwood for their livelihood. But, due to overexploitation over 50 years, the sandal genetic resources are fast declining. This has not only resulted in considerable reduction of income to the government but also in losing of hereditary source of income as well as skills associated with the sandalwood handicraft. Allozyme analysis of sandal populations in the Western Ghats and Deccan Plateau regions, showed significant decrease in the heterozygosity of populations. This is an example where there is a great dependency of local livelihoods on sandal resources as well as the need to have a sustainable genetic resource to support their socio-economical situation.

### ***Species conservation strategy: teak***

Teak, which is native to tropical and sub-tropical regions of Southeast Asia with India being its center of origin and genetic diversity, represents 8.9 million ha of forests/plantation. Discrete and distinct populations of this species are distributed in various agro-geo-climatic regions of India. Under genetic improvement programme, plus/elite (phenotypically/genetically superior) trees have been identified. Procedures for mass clonal multiplication of superior individuals have also been developed (Ansari and Singh 2003, ICFRE 2004). In addition, some trees with high combined ability have also been identified to act as parents in breeding programme for genetic improvement of the species. Population genetic studies have been carried out using molecular markers to find out intra and inter-population genetic variability in various teak populations (Nicodemus *et al.* 2003, TFRI, unpublished). Genetic variation in teak populations from Western Ghats and Central Indian Region studied using RAPD markers (Nicodemus *et al.* 2003) showed that many sub groups existed within these broad regions, and hence *in situ* conservation of multiple populations within these two major groups has been suggested. Similarly, another project funded by DBT is being carried out at the Tropical Forest Research Institute, Jabalpur, focuses on DNA fingerprinting of teak plus trees using RAPD, ISSR and AFLP markers. Results of RAPD and ISSR marker studies showed that these trees possessed high genetic diversity and the information generated can be used for developing and implementing suitable conservation and breeding strategies. Similarly, various teak populations collected from natural forests as well as very old plantations of teak will be studied for their genetic variation using the above molecular markers. These investigation will establish genetic and phylogenetic relationship of various teak populations and help analyze genetic variations at inter-and intra-population level, leading to *ex situ* conservation as well as utilization of diverse genotypes by tree breeders.

### ***Suggestions***

There exist immense possibilities for coordination and collaboration in the Asian/South Asian region for sustainable management, research and conservation of FGR. This may include:

- Coordination to evolve integrated FGR conservation and tree improvement programmes for threatened and economically important tree species among the member countries.
- Constitution of forest tree genetic resource information and research network, which will evolve mechanism for dissemination of scientific progress as well as awareness for FGR conservation.

For efficient coordination and management of FGR at national and regional level, APFORGEN should develop mechanisms to strengthen and support networking, information sharing, capacity building and research endeavours by:

- Establishment of regional centers of IPGRI in the representative countries.

- Avenues for collaborative research and scientist exchange programmes.
- Human resource development for FGR: trainings and study tours.

### **Conclusions**

The management of genetic resources aimed at their conservation, enhancement and sustainable use is a complex challenge necessitating varying strategies according to variation patterns of target species, their intrinsic genetic characteristics, biological and silvicultural behaviours, and the amount of basic knowledge available on these species, perceived threats, and the immediacy of use. There exists an urgent need to inform decision-makers and the public at large of the strategies and methodologies available to respond to the challenges of conservation and genetic management, priorities, and likely consequences of non-action. It is imperative to harmonize conservation and sustainable utilization of biological diversity and forest genetic resources by including a strong element of active gene management. Close and continuing collaboration, dialogue and involvement of all stakeholders, including government and national academic and research institutions, private sector, and non-governmental organizations, in the planning and execution of FGR related programmes, should be ensured. The range of recent scientific tools and biotechnological methods, generating information at a pace never possible before will assist in making informed decisions and implementing effective conservation strategies. India with its extensive and varied forests is a key country globally for conservation of forest genetic resources. The country has shown appropriate concern for the purpose by establishment of strong organizational set up, legal-constitutional framework and research and development institutions. However, the efforts need to be further intensified.

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