on forests as 95% of the medicinal plants at present are collected from the wild.

To compliment *in situ* conservation, attention has been paid to *ex situ* conservation measures through setting up of botanical gardens, zoos, deer parks, safari parks, aquaria, etc. Central Zoo Authority has been set up to ensure better management of zoos. Under a plan scheme 'Assistance to Botanic Gardens', financial assistance is provided to strengthen measures for *ex situ* conservation of threatened and endangered species. Guidelines for botanical gardens have been finalized and the vision is to have at least one botanical garden per district. The Indian Council of Agricultural Research has set up a number of gene banks for *ex situ* conservation under the National Bureau of Plant Genetic Resources (NBPGR), New Delhi **(Table 10)**, National Bureau of Animal Genetic Resources (NBAGR), Karnal, National Bureau of Fish Genetic Resources (NBFGR), Lucknow, and National Bureau of Agriculturally Important Microorganisms (NBAIM), Mau. A large number of microorganisms of agricultural importance also form a vital part of the diversified Indian agricultural ecosystem **(Table 11)**.

Table 10: Base Collections of Crop Genetic Resources in India

S. No.	Crop groups	Base collections holdings
1.	Cereals	134,953
2.	Pseudo Cereals	5,508
3.	Pulses	53,074
4.	Millets and minor millets	48,727
5.	Oilseeds	47,924
6.	Vegetables	21,334
7.	Medicinal & aromatic plants	5,461
8.	Fruits	265
9.	Fibre crops	9,572
10.	Spices & Condiments	1,681
11.	Agro-forestry	2,167
12.	Released crop varieties and Elite Genetic Stocks	3,978
13.	Reference samples (Medium term)	53,161
14.	Duplicate Safety Backup (for IARC Banks)	10,235
	Total	**393,040**

Source: The National Gene Bank, NBPGR, New Delhi

Table 11: Micro-organisms kept under Storage

Group	No. of Accessions
Fungi	1368
Yeast	40
Actinomycetes	18
Bacteria, and others	103
Total	1529

Source: National Bureau of Agriculturally Important Micro-organisms.

Projects have been initiated for reintroduction of threatened species into their natural habitats under appropriate conditions. Examples include mass propagation of pitcher plant, rehabilitation of mangroves in degraded open mud flats, and the effort towards relocation of rhinoceros from Kaziranga to Manas and tigers from Ranthambore to Sariska in Rajasthan.

The Department of Biotechnology (DBT) has been implementing focused programmes on biodiversity conservation through biotechnological interventions since 1991, inter alia by developing techniques, tools and technologies for ex situ conservation. Many tissue culture protocols have been developed for regeneration of endangered and threatened species. The DBT has established a national facility "Laboratory for conservation of species" – LaCONES, at Hyderabad jointly with the help of Central Zoo Authority (MoEF), CSIR and Andhra Pradesh Government for the conservation of endangered animal species like tiger, lion, black buck, vulture, etc. Some other programmes supported by the DBT have focus on animal biotechnology, medicinal plants and aromatic grasses including

societal programmes specifically for the cultivation of medicinal plants/aromatic grasses and extraction of valuable chemicals/products for economic upliftment of SC/ST and weaker sections.

Traditional Indian farming systems are characterized by remarkable diversity owing largely to wide spectrum of agro-climatic situations and indigenous cultivars and native breeds adapted to specific local conditions. Notable efforts to collect crop diversity and documenting of livestock breeds notwithstanding, there is a need for on-farm conservation providing appropriate incentives. *Ex situ* conservation is expected to provide a strong backup to the efforts to facilitate access and meet unforeseen natural calamities.

While there is an increasing coherence of policies and programmes on *in situ*, on-farm and *ex situ* conservation, there is need to further strengthen these efforts.

Action Points

***In situ* conservation**

- Expand the PA network of the country including conservation and community reserves, to give fair representation to all biogeographic zones of the country. In doing so, develop norms for delineation of PAs in terms of the objectives and principles of the National Environment Policy, in particular, participation of local communities, concerned public agencies, and other stakeholders, who have direct and tangible stake in protection and conservation of wildlife, to harmonize ecological and physical features with needs of socio-economic development.
- Establish self-sustaining monitoring system for overseeing the activities and effectiveness of the PA network.
- Ensure that human activities on the fringe areas of PAs do not degrade the habitat or otherwise significantly disturb wildlife.
- Mitigate man-animal conflicts.
- Promote site-specific eco-development programmes in fringe areas of PAs, to restore livelihoods and access to forest produce by local communities, owing to access restrictions in PAs.
- Promote voluntary relocation of villagers from critical habitats of PAs.
- Devise effective management and conservation techniques for the forest preservation plots to ensure conservation of representative areas of different forest types.
- Strengthen research work on PAs, biosphere reserves and fragile ecosystems by involving local research institutions and universities, so as to develop baseline data on biological and managerial parameters, and functional properties of ecosystems.
- Strengthen the protection of areas of high endemism of genetic resources (biodiversity hotspots), while providing alternative livelihoods and access to resources to local communities who may be affected thereby.
- Continue to promote inter-sectoral consultations and partnerships in strengthening biodiversity conservation activities.

- Strengthen capacities and implement measures for captive breeding and release into the wild of identified endangered species.
- Reintroduction and establishment of viable populations of threatened plant species.
- Control poaching and illegal trade in wild animals and plant species.
- Periodically revisit the norms, criteria and needs of data for placing particular species in different schedules of the Wildlife (Protection) Act.
- Promote ecological and socially sensitive tourism and pilgrimage activities with emphasis on regulated and low impact tourism on a sustainable basis through adoption of best practice norms.
- Formulate and implement partnerships for enhancement of wildlife habitat in conservation reserves and community reserves, on the lines of multistakeholder partnerships for afforestation, to derive both environmental and eco-tourism benefits.
- Promote conservation of biodiversity outside the PA network, on private property, on common lands, water bodies and urban areas.
- Formulate and implement programmes for conservation of endangered species outside PAs.
- Ensure conservation of ecologically sensitive areas, which are prone to high risk of loss of biodiversity due to natural or anthropogenic factors.
- Ensure that survey and bioprospecting of native economically important biological resources is undertaken on a priority basis.
- Integrate conservation and wise use of wetlands and river basins involving all stakeholders, in particular local communities, to ensure maintenance of hydrological regimes and conservation of biodiversity.
- Consider particular unique wetlands as entities of incomparable values, in developing strategies for their protection and formulate conservation and prudent use strategies for the identified wetlands with participation of local communities and other stakeholders **(Box 7)**.

On-farm conservation

- Identify hotspots of agro-biodiversity under different agro-ecozones and cropping systems and promote on-farm conservation.
- Provide economically feasible and socially acceptable incentives such as value addition and direct market access in the face of replacement by other economically remunerative cultivars.
- Develop appropriate models for on-farm conservation of livestock herds maintained by different institutions and local communities.
- Develop mutually supportive linkages between *in situ*, on-farm and *ex situ* conservation programmes.

***Ex situ* conservation**

Box 7: Regulatory Framework for Wetlands

Recognizing the value of wetlands and taking cognizance of the fact that there does not yet exist a formal system of wetland regulation, the National Environment Policy seeks to set up a legally enforceable regulatory mechanism for identified valuable wetlands to prevent their degradation and enhance their conservation. It also undertakes to develop an inventory of such wetlands. In pursuance of the policy resolution a draft regulatory framework for the wetlands has been formulated for wider consultation.

Source : Conservation of Wetlands in India: A Profile Ministry of Environment and Forests, Government of India 2007

- Promote *ex situ* conservation of rare, endangered, endemic and insufficiently known floristic and faunal components of natural habitats, through appropriate institutionalization and human resource capacity building. For example, pay immediate attention to conservation and multiplication of rare,

endangered and endemic tree species through institutions such as Institute of Forest Genetics and Tree Breeding.

- Focus on conservation of genetic diversity (*in situ, ex situ, in vitro*) of cultivated plants, domesticated animals and their wild relatives to support breeding programmes.
- Strengthen national *ex situ* conservation system for crop and livestock diversity, including poultry, linking national gene banks, clonal repositories and field collections maintained by different research centres and universities.
- Develop cost effective and situation specific technologies for medium and long term storage of seed samples collected by different institutions and organizations.
- Undertake DNA profiling for assessment of genetic diversity in rare, endangered and endemic species to assist in developing their conservation programmes.
- Develop a unified national database covering all *ex situ* conservation sites.
- Consolidate, augment and strengthen the network of zoos, aquaria, etc., for *ex situ* conservation.
- Develop networking of botanic gardens and consider establishing a 'Central Authority for Botanic Gardens' to secure their better management on the lines of Central Zoo Authority.
- Provide for training of personnel and mobilize financial resources to strengthen captive breeding projects for endangered species of wild animals.
- Strengthen basic research on reproduction biology of rare, endangered and endemic species to support reintroduction programmes.
- Encourage cultivation of plants of economic value presently gathered from their natural populations to prevent their decline.
- Promote inter-sectoral linkages and synergies to develop and realize full economic potential of *ex situ* conserved materials in crop and livestock improvement programmes.

5.2 Augmentation of natural resource base and its sustainable utilization: Ensuring inter and intra-generational equity

Conservation and sustainable use of biodiversity have been integrated into national decision-making through policy statements, legislative measures and programmes. Sustainable use of biological diversity is emphasized in various policy statements of the Government, notably the National Conservation Strategy and Policy Statement on Environment and Development, 1992, the National Forest Policy, 1988, the National Wildlife Action Plan (2002-2016), and the National Environment Policy, 2006. NEP does not substitute the preceding policy frameworks but is an adjunct to previous policies. Several initiatives have been taken to implement various aspects of these policy statements. Sustainable utilization, underscored in these policy statements, recognizes the interdependence of local communities and people on biological resources, and emphasizes the need to draw upon the existing resources keeping long-term conservation in view.

Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act enacted in 2006, is a tool to provide occupational and habitational rights to the people. Empowering people, particularly assigning the ownership of minor forest produce for the purpose of access, processing and trade would enhance their livelihood. The Ministry of Tribal Affairs have allocated financial resources to the development of forest villages which have hitherto been totally cut off from the mainstream development in the country. This Ministry also implements various schemes and programmes for socio-economic development of scheduled tribes such as special central assistance to tribal sub plan under which grants-in-aid to State Governments is provided, integrated

development of forest villages to raise Human Development Index, and 100% central grants-in-aid to States under Article 275(1) of the Constitution.

The National Rural Employment Guarantee Act, 2005 entitles a rural household for 100 days of work in a financial year. Many of the works permissible relate to forestry, like afforestation, tree plantation, water conservation and water harvesting, etc.

Pressure on natural resources in biodiversity-rich areas needs to be diverted by bringing additional areas under green cover to satisfy local demands, encouraging environment-friendly substitutes to meet the needs, promoting energy efficient devices, and creating awareness and an enabling environment. There is also a need to devise techniques/tools to restrict use and extraction of only desired part of the organism rather than the entire organism.

Economically effective and socially viable incentives for conservation and sustainable use of biological diversity are being encouraged. These include use of wood substitutes, alternative energy sources (biogas, wind mills, solar cookers, wave energy, fuel efficient stoves, etc.), establishment of nurseries, tree planting, stall feeding, water harvesting and pollution abatement measures.

The forestry sector in India is being reoriented with growing emphasis on poverty alleviation and livelihood opportunities, while at the same time ensuring sustainable management and use of forest resources. The current trend in forest management is towards greater participation and involvement of all stakeholders dependent on the forests. The National Forest Policy (1988) and National Forestry Action Programme (1999) also endeavour to address some of the concerns towards Sustainable Forest Management (SFM). According to National Status Report on Forests and Forestry in India, 2006, SFM would, *inter alia*, involve:

- Production of wood and non-timber forest products, first for meeting subsistence needs and then the surplus for commercial purposes.
- Protection and setting aside of areas to be managed as wild life reserves or plantations for recreational and environmental purposes.
- Regulating the conversion of forest lands for non-forestry uses.
- Regeneration of wastelands and degraded forests.

- Functional and land capability classification of forests and land use planning to ensure healthy and sustainable land use systems with acceptable safe minimum standards.
- Protection of adequate extent of natural forests for their long-term contributions including conservation of biodiversity.
- Management and utilization of forest resources for maximizing their sustainable contribution and value addition towards improved welfare of society.
- Promotion of efforts for producing forest goods and services outside forest areas (e.g. agroforestry plantations, home gardens) and development of potential substitutes for wood from non-forest sources (e.g. rubber wood, coconut wood).
- Waste reduction and recycling programme.
- Feasible medium for encouraging participation of people and the private sector.
- A proper and realistic system for cost, values and benefits attributable to forestry to ensure a strong ecology - economy interface.

The Joint Forest Management (JFM) programme in the country has emerged as a powerful tool to achieve sustainable management of forestry in India. A decentralized two-tier institutional structure [Forest Development Agency (FDA) and JFM Committee] facilitates greater participation of the local communities, both in planning and implementation, to conserve forests as well as secure livelihoods. At present, more than 22.02 million ha of forests are managed by around 1.06 lakhs JFM Committees

(JFMCs) involving 21.99 million people living in and around forest areas. The major problems faced under JFM include lack of permanent institutional arrangement and regular sustained income flows to participating communities. JFM's performance is also found to be highly varying across the participating States. Cases have been reported regarding conflict between Panchayati Raj Institutions (PRIs) and JFMCs. The need to forage linkages is essential to synergise the efforts and activities of both the Institutions i.e. PRIs and JFMCs. There is a need to involve JFMCs in biodiversity mapping and conservation for which synergy between JFM micro planning and biodiversity conservation activities needs to be promoted.

Indian forests are rich in several types of Non-Timber Forest Products (NTFPs) such as honey, bamboo, cane, gums and resins, leaves used for country smoke and plate- making, several types of flowers, dye plants, fruits, nuts, seeds and roots. Sustainable management of NTFPs is one of the main objectives of forest management. NTFPs contribute to over 75% of total forest export revenue, and add significantly to the income of about 30% of rural people. NTFPs play an important role in the social and traditional life of forest dependent populations. According to a study, about 67% of all gatherers are women and 13% are children.

Trade in some items such as tendu leaves, sal seeds, myrobolans, gums and resins is nationalized in some States. In Madhya Pradesh and Chhattisgarh, the major share of net revenue goes back to NTFP gatherers. Sustainability of the management of NTFPs is one of the major concerns which is being ensured through development and application of non-destructive methods of NTFP collection.

Despite very high potential of NTFPs, their sustainable management is a major issue requiring urgent action. NTFP gatherers are highly unorganized with little market access. Because of lack of inventory data or value addition, and resultant non-remunerative prices, the gatherers often resort to unsustainable and destructive harvesting to maximize their collection. Further, in the forestry sector, the local organizations such as cooperatives are either still rare or in infancy. There is a need to strengthen the useful link between NTFP management and JFM so that the benefits accruing from NTFPs can be profitably channelised for the well-being of the forest dependent communities, ensuring sustainable forest management. The high potential of NTFPs is to be rationally and optimally utilized through scientific approaches, research, acquisition of appropriate technology and greater people's participation.

The constraints in forestry sector, among others, include: (i) lack of adequate awareness about the multiple roles and benefits of forests and their relevance to poverty alleviation and sustainable development; (ii) low priority for forestry in national planning process; (iii) slow pace of policy reforms and inadequate implementation of regulatory mechanisms; (iv) over-emphasis on government control and involvement, and difficult administrative procedures; (v) weak forestry information system rendering decision-making difficult; (vi) inadequate investment in forestry, not-commensurate with its role in sustainable development; (vii) inadequate space for

private participation; (viii) lack of full realization of people's participation; (ix) inadequate targeted research and extension studies; (x) inadequate frontline staff and that too of older age group; (xi) less emphasis on forestry research; (xii) lack of on-job training and capacity building for forest officers especially for the frontline staff; (xiii) general neglect of full potential of NTFPs; and (xiv) lack of supportive land use policy.

Remedial actions for restoration of degraded areas have been undertaken through eco-restoration programmes by involving local people. Special attention has been given to coastal zones through Coastal Zone Regulation Rules, 1991 under the Environment (Protection) Act. This notification is under reformulation based on scientific principles as recommended by Swaminathan Committee (2005), and a draft notification on Coastal Management Zone 2008 has been issued.

NAEB in the MoEF gives special attention to regeneration of degraded forests and lands adjoining forest areas, national parks, sanctuaries and other PAs as well as ecologically fragile areas such as the Himalayas, Aravallis and Eastern Ghats. The functions of NAEB involve evolving mechanisms for ecological restoration of degraded forests and adjoining lands through systematic planning and implementation in a cost effective manner. It also sponsors projects for extension of research findings to disseminate new and proper technologies for the above. To complement the initiatives of JFMCs, a new programme called National Afforestation Programme (NAP) was launched during 2002-03. Under this programme, an extent of 14.1 lakh ha is being covered by 28,181 JFMCs under 782 FDAs in 28 states.

Various programmes initiated by the MoEF including NAP, setting up of JFMCs and Hill Area Development Programme focus on greater participation of the communities with the objective of improving their livelihoods. These programmes also help in poverty alleviation in the respective areas.

The involvement of private sector is encouraged in activities for the sustainable use of biodiversity. For example, both public and private sectors – comprising individuals, companies, cooperatives, and industry -

are playing key roles in the management of forests. The private sector has also demonstrated its ability to enhance the productivity of wastelands and is dominant in the areas of wood harvesting and processing.

'Honey Bee Network' is an important example to illustrate the measures taken to protect and encourage customary use of biological resources in India.

Current efforts at promoting conservation and sustainable use notwithstanding, there is a need to further augment the natural resource base and integrate sustainable use concept in all relevant economic sectors (such as agriculture, animal husbandry, fisheries, forestry and industry) so as to ensure intra- and inter-generational equity .

Action Points

- Secure integration of biodiversity concerns into inter-sectoral policies and programmes to identify elements having adverse impact on biodiversity and design policy guidelines to address such issues. Make valuation of biodiversity an integral part of pre-appraisal of projects and programmes to minimize adverse impacts on biodiversity.
- Promote decentralized management of biological resources with emphasis on community participation.
- Promote sustainable use of biodiversity in sectors such as agriculture, animal husbandry, dairy development, fisheries, apiculture, sericulture, forestry and industry.
- Promote conservation, management and sustainable utilization of bamboos and canes, and

establish bambusetum and canetum for maintaining species diversity and elite germplasm lines.

- Promote best practices based on traditional sustainable uses of biodiversity and devise mechanisms for providing benefits to local communities.
- Build and regularly update a database on NTFPs, monitor and rationalize use of NTFPs ensuring their sustainable availability to local communities.
- Promote sustainable use of biological resources by supporting studies on traditional utilization of natural resources in selected areas to identify incentives and disincentives, and promote best practices.
- Encourage cultivation of medicinal plants and culture of marine organisms exploited for drugs to prevent their unsustainable extraction from the wild.
- Promote capacity building at grassroot level for participatory decision-making to ensure eco-friendly and sustainable use of natural resources.
- Develop *sui generis* system for protection of traditional knowledge and related rights including intellectual property rights.
- Encourage adoption of science-based, and traditional sustainable land use practices, through research and development, extension of knowledge, pilot scale demonstrations, and large scale dissemination including farmer's training, and where necessary, access to institutional finance.
- Promote reclamation of wasteland and degraded forest land through formulation and adoption of multistakeholder partnerships involving the land owning agency, local communities, and investors.
- Promote sustainable alternatives to shifting cultivation where it is no longer ecologically viable, ensuring that the culture and social fabric of the local people are not disrupted.
- Encourage agro-forestry, organic farming, environmentally sustainable cropping patterns, and adoption of efficient irrigation techniques.
- Incorporate a special component in afforestation programmes for afforestation on the banks and catchments of rivers and reservoirs to prevent soil erosion and improve green cover.
- Integrate wetland conservation, including conservation of village ponds and tanks, into sectoral development plans for poverty alleviation and livelihood improvement, and link efforts for conservation and sustainable use of wetlands with the ongoing rural infrastructure development and employment generation programmes.
- Promote traditional techniques and practices for conserving village ponds.
- Mainstream the sustainable management of mangroves into the forestry sector regulatory regime so as to ensure the protection of coastal belts and conservation of flora and fauna in those areas.
- Disseminate available techniques for regeneration of coral reefs and support activities based on application of such techniques.
- Adopt a comprehensive approach to integrated coastal management by addressing linkages between coastal areas, wetlands, and river systems, in relevant policies, regulations and programmes.

5.3 Regulation of introduction of invasive alien species and their management

Plants, animals and micro-organisms that are not indigenous to a specific ecosystem and become established in a new environment, then proliferate and spread in ways that are destructive to human interests, ecosystems and environment are considered as Invasive Alien Species (IAS). These species cause billions of dollars of damages annually across a wide range of sectors including agriculture, forestry,

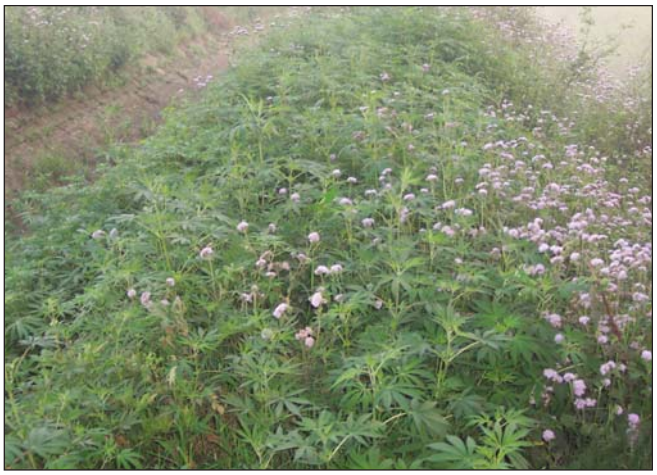
fisheries, ecosystem services, human health and tourism threatening economic growth, prosperity as well as the overall environment. Their spread has been aggravated by rapid developmental activities. IAS recognize no borders **(Box 8)**.

Invasive alien species (obnoxious weeds, fish, pathogens and pests, etc.) pose a serious threat to native species, their habitats and functioning of different ecosystems. In India, a multi-agency and multi-programme approach, involving several Ministries and agencies, is being followed for regulating introductions and managing invasive alien species. Major activities include regulation of introduction of exotic living materials, their quarantine clearance and release for research and direct use. In general, Ministry of Agriculture deals with cultivated plants, fish and farm livestock including poultry. It has sponsored projects on eradication and management of invasive weedy plants, pathogens, pests and harmful fish. The MoEF deals with all forest and wildlife related invasives. It also supports and coordinates programmes on eradication/control measures/ utilization of such species in different forest areas and conducts national surveys on their spread, prepares reports on damage caused and undertakes restorative measures. There is, however, a need to develop a unified national system for regulation of introduction and management of all invasive alien species across jurisdiction of all concerned Ministries and relevant sectors.

Box 8: Invasive Species

- India follows international quarantine regulations
- Presently, there is no exclusive legislation or policy in India to deal with the invasive alien species
- Directorate of Plant Protection, Quarantine and Storage, Faridabad, Ministry of Agriculture is the nodal agency to enforce the regulations.
- Latest regulations are 'Plant Quarantine Order 2003'
- On preliminary assessment, 61 species of plants (including 12 species of fungi) and 14 species of insects have been identified as invasive having national distribution and 36 species having regional distribution.
- About 28 species native to India have been found to be invasive to other biogeographical zones.
- ICFRE has established a 'FIS Cell' in FRI to deal with various aspects of management of FIS in the country.

Source: India's Forests, MoEF, 2007



Action Points

- Develop a unified national system for regulation of all introductions and carrying out rigorous quarantine checks.
- Strengthen domestic quarantine measures to contain the spread of invasive species to neighbouring areas.
- Promote intersectoral linkages to check unintended introductions and contain and manage the spread of invasive alien species.
- Develop a national database on invasive alien species reported in India.
- Develop appropriate early warning and awareness system in response to new sightings of invasive alien species.
- Provide priority funding to basic research on managing invasive species.
- Support capacity building for managing invasive alien species at different levels with priority on local area activities.
- Promote restorative measures of degraded ecosystems using preferably locally adapted native species for this purpose.
- Promote regional cooperation in adoption of uniform quarantine measures and containment of invasive exotics.

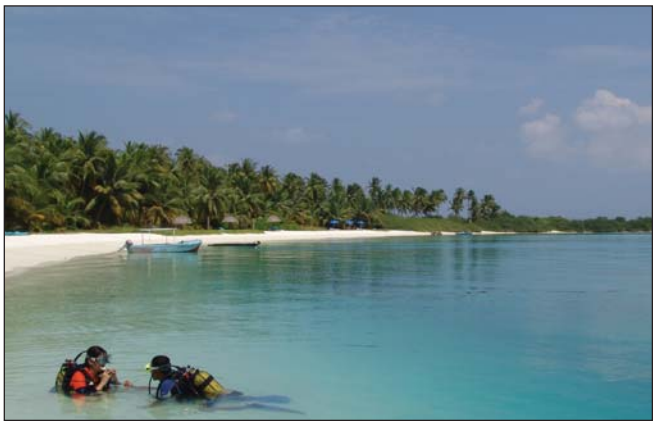
5.4 Assessment of vulnerability and adaptation to climate change, and desertification

India's vast majority of people depend directly on agriculture and forestry for food security and livelihoods. These sectors are considered more vulnerable to the projected climate change, particularly affecting water availability and temperature regimes. Preliminary assessments have indicated decline in agricultural productivity and shifts in cropping patterns, changes in species assemblage or forest types, changes in net primary productivity, and potential loss or distribution pattern of biodiversity. These consequences may have adverse socio-economic implications for farming and forest dependent communities, and national economy. Thus, there is a need for developing and implementing adaptation strategies to minimize and mitigate possible adverse impacts of climate change. Natural ecosystems such as grasslands, mangroves and coral reefs are also likely to be drastically affected by the projected climate change.

Preliminary research has been initiated on vulnerability assessment due to climate change on various production systems, socio-economic sectors and natural ecosystems in India. Some research activities have already been initiated in this direction and the Indian Agricultural Research Institute has undertaken research on impacts of climate change on crop productivity. Climate friendly initiatives being adopted in agricultural sector include water use efficiency, nutrient uptake, better crop management, enhanced organic fertilizer use and integrated pest management. Weather data collection and forecasting capabilities are being strengthened while taking lead in regional initiatives. Research efforts are also on to develop and refine capabilities in forecasting and assessment by developing suitable criteria and indicators.

India has established National Clean Development Mechanism Authority (NCDMA) for according host country approval to CDM projects as mandated under the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). One of the criteria used for approval of CDM projects is impact on biodiversity. Host country approvals have so far been accorded to 404 CDM projects facilitating investment of more than Rs, 22,000 crores.

The Government has set up an 'Expert Committee on the Impacts of Climate Change' on 7th May 2007 under the chairmanship of Dr. R. Chidambaram Principal Scientific Adviser to the Government of India to study the impacts of anthropogenic climate change on India and to identify the measures that may have to be taken for addressing vulnerability to anthropogenic climate change impacts. A high level coordination committee chaired by Prime Minister, namely, 'Prime Minister's Council on Climate Change' has been set up on 6th June 2007 to coordinate national actions for assessment, adaptation and mitigation of climate change. The Government of India has released 'National Action Plan on Climate change' on 30th June 2008, which outlines a number of steps to simultaneously advance India's development and climate change - related objectives of adaptation and mitigation, including through setting up of eight National Missions.



Nearly 228 mha (69%) of geographical area of India falls under drylands (arid, semi arid and dry sub humid). These ecosystems support large human and livestock populations, contain unique genetic adaptation mechanisms for stress tolerance, and are rich in flora, fauna and microorganisms adapted to extremes of climate. The Ministry of Rural Development through its various programmes such as Integrated Wasteland Development Programme (IWDP), Drought Prone Area Programme (DPAP) and Desert Development Programme (DDP) on watershed basis, strives for development of land resources, controlling desertification, and livelihood generation with the overall objective of poverty alleviation. The Ministry has invested Rs. 6714.11 crores since 1995-96 on these three programmes covering 32.40 mha in 576 districts of 28 states across the country. There is also a provision for development of forest lands forming part of watersheds through involvement of JFMCs in close coordination with the village Panchayats.

Accelerated desertification processes are likely to further compound the adverse impacts of climate change. Against this backdrop, there is also a pressing need for developing tools, methodologies and indicators for assessing impacts of climate change and desertification as well as developing appropriate mitigation and adaptation strategies.

Action Points

- Identify the key sectors of the country vulnerable to climate change, in particular impacts on water resources, agriculture, health, coastal areas and forests.
- Promote research to develop methodologies for tracking changes and assessing impacts of climate change on glaciers, river flows and biodiversity.
- Assess the need for adaptation to future impacts of climate change at national and local levels, and the scope for incorporating the outputs of such assessments in relevant programmes, including watershed management, coastal zone planning and regulation, agricultural technologies and practices, forestry management, and health programmes.
- Explicitly consider vulnerability of coastal areas and their biodiversity to climate change and sea-level rise in coastal management plans, as well as infrastructure planning and construction norms.

- Participate in voluntary partnerships with other countries both developed and developing, to address the challenges of sustainable development and climate change, consistent with the provisions of the UNFCCC.
- Identify the most important gaps in knowledge that limit the national ability to develop and implement climate change adaptation strategies for species, and ecological processes and functions.
- Enhance the capacity of climate modeling in the country substantially to get clear idea on the impacts of climate change on biodiversity at national and local levels.
- Develop ecological criteria for identifying the species and ecosystems that are at great risk from climate change and identify their priority habitats.
- Identify information requirements and priorities, through expert consultative processes, for long-term monitoring of climate change impacts on biodiversity.
- Establish a climate change and biodiversity website for decision makers concerned with national resource management to facilitate information exchange about the actual and potential impacts of climate change and relevant policies, strategies and programmes.
- In view of the multidisciplinary nature of the subject, undertake an 'All India Coordinated

Research Project on Impacts of Climate Change' on various facets of wild and agricultural biodiversity.

- Integrate biodiversity concerns into measures for energy conservation and adoption of renewable energy technologies with a focus on local biomass resources and dissemination of improved fuelwood stoves, and solar cookers.
- Strengthen efforts for partial substitution of fossil fuels by bio-fuels, through promotion of biofuel plantations, promoting relevant research and development, and streamlining regulatory certification of new technologies.
- Strengthen and augment the existing programmes and activities of the Central and State Governments relating to drylands.
- Prepare and implement thematic action plans incorporating watershed management strategies, for arresting and reversing desertification and expanding green cover.
- Promote reclamation of wastelands by energy plantations for rural energy through multistakeholder partnerships involving the land-owning agencies, local communities, and investors.

5.5 Integration of biodiversity concerns in economic and social development

Policies and legislations enabling proper assessment and adopting measures towards minimizing adverse impacts of developmental activities are in place. The Environment (Protection) Act is an umbrella Act which enables Central Government to promulgate notifications and rules thereunder for regulating various activities for conservation of environment. The EIA notification, 2006, the Coastal Regulation Zone notification 1991 and the notification pertaining to ecologically sensitive areas have been issued to regulate development activities **(Box 9)**. To address biodiversity related issues in EIA, the baseline status of biological diversity and its components is ascertained and information on habitat resilience is also collected for assessing the likely impacts of proposed developmental activities.

Ecologically sensitive areas are also notified under the Environment (Protection) Act with the objective of imposing restrictions on the industries, operations, and other developmental activities in the region which have detrimental effect on the environment, to provide for restoration of denuded areas, management of catchment areas, watershed management etc., for a planned development. It is also intended to ensure sustainable livelihood for the local communities and stakeholders.

Box 9: Management of Coastal Zones

The MoEF had constituted an expert committee under the chairmanship of Prof. M.S. Swaminathan in July, 2004, to review and make recommendations with regard to implementation and amendments if necessary, of Coastal Regulation Zone Notification, 1991. The Expert Committee submitted its report alongwith recommendations, which were accepted by the MoEF in April, 2005. The major recommendations include:

- Implementation of Integrated Coastal Zone Management Plan rather than uniform regulatory approach.
- Development along the coastal stretches based on the vulnerability of the coast, taking into account the natural and manmade hazards.
- Inclusion of the ocean zone for regulation.
- Setting up of an Institute for Coastal Zone Management to address the policy and legal issues.
- Abatement of the pollution of coastal areas and marine waters in a time-bound manner.
- Identification and mapping of the coastal eco-sensitive areas such as mangroves, corals, and turtle breeding areas.
- Development of coastal bio-shield.

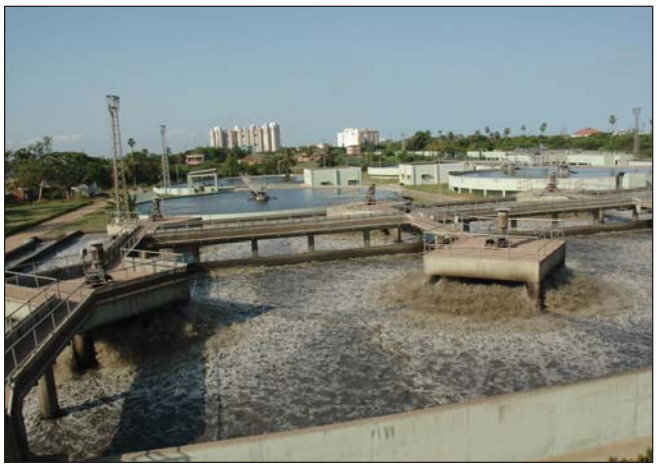
The MoEF has initiated steps for implementing the above recommendations which include:

- Preparation of a national action plan for control of pollution of coastal waters from land based activities.
- Pilot scale studies for demarcation of vulnerability line along identified coastal stretches through scientific organizations namely, Survey of India, Dehradun, Space Application Centre, Ahmedabad and Centre for Earth Science Studies, Thiruvananthapuram.
- Seeking technical and financial assistance from multilateral agencies for implementing the recommendations pertaining to mapping of ecologically sensitive areas along the coastline, control of pollution in the coastal waters from land based activities and capacity building and institutional development.

The development of these areas and setting up of industries therein are regulated in accordance with the provisions made in the respective notifications issued in this regard. The various areas which have been declared ecologically fragile/eco-sensitive or where development/setting up of industries has been regulated are: (i) Murud-Janjira area in Raigarh District, Maharasthra (6th January, 1989); (ii) Doon Valley, Uttarakhand (1st February, 1989); (iii) Dahanu Taluka, District Thane, Maharasthra (20th June 1991); (iv) Aravali Range, Gurgaon District, Haryana and Alwar District, Rajasthan (7th May, 1992); (v) No Development Zone around Numaligarh Refinery Site in Assam (5th July, 1996); (vi) Mahabaleshwar, Panchgani, Satara District, Maharashtra (17th January, 2001); and (vii) Matheran, Maharashtra (4th February, 2003).

Recognizing the importance of disaster management as a national priority, a National Disaster Management Authority (NDMA) headed by the Prime Minister, and State Disaster Management Authorities (SDMAs) headed by the respective Chief Ministers, have been set up under the Disaster Management Act, 2005, to spearhead and implement a holistic and integrated approach to disaster management in India.

Policies and programmes are in place for management of chemical emergencies, hazardous wastes and solid wastes. Planning and overseeing the implementation of the extant policies and programmes are carried out to promote safe handling, management and use of hazardous chemicals and wastes, in order to avoid damage to health and environment. For example, handling of 70 cancer causing azo dyes and the processes incidental thereto in the course of which these substances are found or transported throughout the country, have been prohibited vide notification dated March 26, 1997 **(Box 10).**



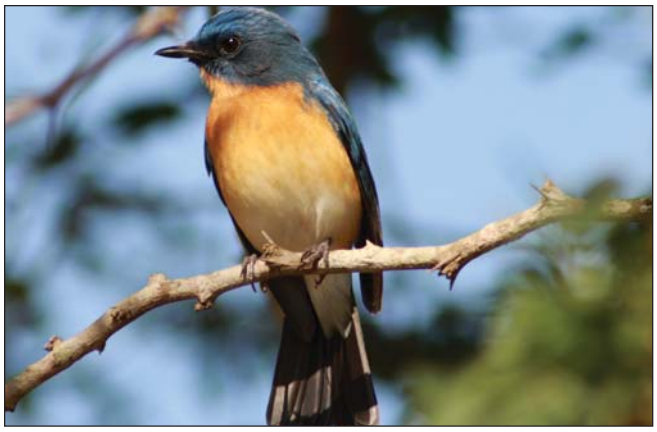
India is a Party to Rotterdam Convention on the Prior Informed Consent Procedure for Hazardous Chemicals, Stockholm Convention on Persistent Organic Pollutants, and the Basel Convention on Transboundary Movement of Hazardous Waste and their Disposal.

Box 10: Azo dyes

- Azo dyes are dye stuffs used for colouring textiles and leather products. Such dye stuffs have significance in production of rubber, epoxy resins, polyurethane foam, fibres and polyamids.
- Seventy azo dyes derived from 20 arylamines, a number of them confirmed human carcinogens, have been prohibited for handling by the Ministry of Textile and Department of Chemicals and Petrochemicals considering the number of safe substitutes, both of chemical and natural origin and also keeping in view nominal increase in the cost of these substitutes.

Action Points

- Develop strong research base on impact assessment and conduct rigorous impact assessment of development projects, with a focus on biodiversity and habitats.
- Integrate biodiversity concerns across development sectors (such as industry, infrastructure, power, mining, etc.) and promote use of clean technologies.
- Accord priority to the potential impacts of development projects on biodiversity resources and natural heritage while undertaking EIA. In particular, ancient sacred groves and biodiversity hotspots should be treated as possessing incomparable values.
- Take steps to adopt and institutionalize techniques for environmental assessment of sectoral policies and programmes to address any potential adverse impacts, and enhance potential favourable impacts.



- Develop and integrate pre-project plans for reallocation and rehabilitation of local people likely to be displaced by development projects keeping in view their socio-cultural and livelihood needs.
- Ensure that in all cases of diversion of forest land, the essential minimum needed land for the project or activity is permitted. Restrict the diversion of dense natural forests, particularly areas of high endemism of genetic resources, to non-forest purposes, only to site-specific cases of vital national interest.
- Give priority to impact assessment of development projects on .wetlands; in particular, ensuring that environmental services of wetlands are explicitly factored into cost-benefit analysis.
- Promote integrated approaches to management of river basins considering upstream and downstream inflows and withdrawals by season, pollution loads and natural regeneration capacities, in particular, for maintenance of in-stream ecological values.
- Consider and mitigate the impacts on river and estuarine flora and fauna, and the resulting change in the resource base for livelihoods, of multipurpose river valley projects, power plants and industries.
- Adopt best practice norms for infrastructure construction to avoid or minimize damage to sensitive ecosystems and despoiling of landscapes.
- Support practices of rain water harvesting and revival of traditional methods for enhancing groundwater recharge.
- Give due consideration to the quality and productivity of lands which are proposed to be converted for development activities, as part of the environmental clearance process.
- Ensure provision for environmental restoration during commissioning and after decommissioning of industries. For example, in all approvals of mining plans, institutionalize a system of post-monitoring of projects to ensure safe disposal of tailings and ecosystem rehabilitation following the principles of ecological succession.
- Promote, through incentives, removal of barriers and regulation, the beneficial utilization of wastes such as fly ash, bottom ash, red mud, and slag, minimizing thereby their adverse impacts on terrestrial and aquatic ecosystems.
- Promote sustainable tourism through adoption of best practice norms for tourism facilities and conservation of natural resources while encouraging multistakeholder partnerships favouring local communities.
- Develop and implement viable models of public-private partnerships for setting up and operating secure landfills, incinerators, and other appropriate techniques for the treatment and disposal of toxic and hazardous wastes, both industrial and biomedical, on payment by users, taking the concerns of local communities into account. The concerned local communities and State Governments must have clear entitlements to specified benefits from hosting such sites, if access is given to non-local users. Develop and implement strategies for clean-up of toxic and hazardous waste dump legacies, in particular in industrial areas, and abandoned mines, and reclamation of such lands for future, sustainable use.
- Survey and develop a national inventory of toxic and hazardous waste dumps, and an online monitoring system for movement of hazardous wastes. Strengthen capacity of institutions responsible for monitoring and enforcement in respect of toxic and hazardous wastes.
- Strengthen the legal arrangements and response measures for addressing emergencies arising out

of transportation, handling and disposal of hazardous wastes as part of the chemical accidents regime.

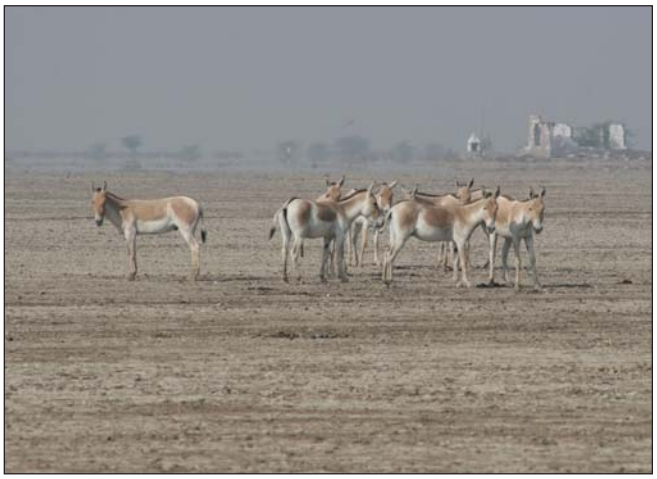
- Promote organic farming of traditional crop varieties through research in and dissemination of techniques for reclamation of land with prior exposure to agricultural chemicals, facilitating marketing of organic produce in India and abroad, including by development of transparent, voluntary and science-based labeling schemes.
- Develop and enforce regulations and guidelines for management of e-waste as part of the hazardous waste regime.
- Promote, through incentives, removal of barriers, and regulations, the beneficial utilization of generally non-hazardous waste streams such as fly ash, bottom ash, red mud, and slag, including in cement and brick-making, and building railway and highway embankments.

5.6 Pollution impacts

Pollution is inevitable generation of waste from the anthropogenic activities involving production and consumption. Ecosystems have some natural capacities to assimilate pollution, however, these vary considerably with the nature of the pollutant and the ecosystem. In general, it is cheaper to reduce the emission of pollution, than to mitigate it after generation, or to treat the receiving medium or receptor. The impacts of air and water pollution may differentially affect the poor, women, children, and developing regions, which may also be having relatively low contributions to its generation. Accordingly, the costs and benefits of abatement may have important implications for equity.

Similarly, the immediate and deeper causes of soil pollution as well as management of industrial and municipal wastes are serious challenges in terms of magnitude and required resources.

The present legislative framework is broadly contained in the umbrella Environment (Protection) Act, 1986; the Water (Prevention and Control of Pollution) Act, 1974; the Water Cess Act, 1977; and the Air (Prevention and Control of Pollution) Act, 1981.



Action points

- Minimise and eliminate activities leading to loss of biodiversity due to point and non-point sources of pollution and promote development of clean technologies.
- Strengthen the monitoring and enforcement of emission standards for both point and non-point sources.
- Develop location-specific work plans focusing on biodiversity conservation while managing pollution problems.
- Treat and manage industrial effluents so as to minimize adverse impacts on terrestrial and aquatic biological resources.
- Promote biodegradable and recyclable substitutes for non-biodegradable materials, and develop and implement strategies for their recycle, reuse, and final environmentally benign disposal, including through promotion of relevant technologies, and use of incentive based instruments.
- Avoid excessive use of fertilizers, pesticides and insecticides while encouraging integrated pest management practices, and use of organic manures and biofertilisers.
- Promote organic farming of locally adapted and traditional crop varieties through appropriate incentives, and direct access to markets duly supported by credible certification systems.

- Develop a strategy for strengthening regulation, and addressing impacts, of ship-breaking activities on human health, coastal and near marine bio-resources.
- Accord priority to potential impacts on designated natural heritage sites in view of their incomparable values that merit stricter standards than in otherwise comparable situations.
- Promote R&D on impacts of air, water and soil pollution on biodiversity and use of biological methods for pollution amelioration.

5.7 Development and integration of biodiversity databases

Developing national strategy and action plans for biodiversity conservation are severely constrained because of inadequate database on different components of biodiversity and their geographical distribution. Even the limited available information is scattered and held by a number of organizations working independently on the subject. Further, there is no unified format for collection, retrieval and dissemination of data on biodiversity. Realizing this need, the Central Government while framing Biological Diversity Rules, 2004 under the Biological Diversity Act, mandated the NBA to build up database and to create documentation system for biological resources, develop PBRs and electronic databases to ensure effective management, promotion and sustainable use (Rule 12 (xiii). There is thus an urgent need for integrating data from all available sources into a national network with distributive linkages for facilitating data dissemination and interface with managers and users. There is also a need to accelerate and intensify the survey and inventorization of unexplored areas, with focus on endangered, endemic and insufficiently known species.

Action Points

- Develop an integrated national biodiversity information system with distributive linkages for easy storage, retrieval and dissemination including through augmentation of extant efforts of spatial mapping of natural resources and development of interactive databases at national level.

Box 11: Important Central Acts and Rules having Relevance to Biodiversity Conservation

- Fisheries Act, 1897.
- Destructive Insects and Pests Act, 1914.
- The Indian Forest Act, 1927.
- Agricultural Produce (Grading and Marketing) Act, 1937.
- Indian Coffee Act, 1942
- Import and Export (Control) Act, 1947.
- Rubber (Production and Marketing) Act, 1947.
- Tea Act, 1953.
- Mining and Mineral Development (Regulation) Act, 1957
- Prevention of Cruelty to Animals Act, 1960.
- Customs Act, 1962.
- Cardamom Act, 1965.
- Seeds Act, 1966.
- The Patents Act, 1970.
- Wildlife (Protection) Act, 1972.
- Marine Products Export Development Authority Act, 1972.
- Water (Prevention and Control of Pollution) Act, 1974.
- Tobacco Board Act, 1975.
- Territorial Water, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976.
- Water (Prevention and Control of Pollution) Cess Act, 1977.
- Maritime Zones of India (Regulation and Fishing by Foreign Vessels) Act. 1980.
- Forest (Conservation) Act, 1980.
- Air (Prevention and Control of Pollution) Act, 1981.
- Agricultural and Processed Food Products Export Development Authority Act, 1985/ 1986.
- Environment (Protection) Act, 1986.
- Spices Board Act, 1986.
- National Dairy Development Board, 1987.
- Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells, 1989
- Foreign Trade (Development and Regulation) Act, 1992.
- Protection of Plant Varieties and Farmers' Rights (PPVFR) Act, 2001
- Biological Diversity Act, 2002
- Plant Quarantine (Regulation of Import into India) Order, 2003
- Biological Diversity Rules, 2004
- The Food Safety and Standards Act, 2006
- Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.

- Intensify survey, identification and inventorization activities, involving local institutions and giving priority to hitherto unexplored areas.
- Conduct regular surveys to monitor changes in populations of target species (wild and domesticated), using remote sensing and other updated tools and techniques.
- Update list of endangered species of flora and fauna on priority, based on internationally accepted criteria.
- Extend listing of keystone, umbrella and endemic species for conserving them on priority basis, and develop models/packages for their conservation.
- Update database on sacred groves and sacred ponds documenting bio-resources and associated knowledge conserved at these sites.
- Promote DNA fingerprinting, other molecular analytical techniques and studies on genetic diversity of critically endangered species to develop appropriate conservation strategies.
- Expand area specific surveys of land races, traditional cultivars of crops, wild relatives of crop plants and breeds of domesticated animals inter alia through application of appropriate statistical techniques.
- Use modern taxonomic methods for documentation/identification of species.
- Strengthen and build capacity for taxonomy and biosystematics, particularly for groups of plants, animals and microorganisms which are as yet inadequately understood.

5.8 Strengthening implementation of policy, legislative and administrative measures for biodiversity conservation and management

Subject relating to environment and forests is on the concurrent list of the Constitution of India. Both Central and State Governments legislate and formulate policies and programmes on this subject.

Policies on environmental management include the National Forest Policy, the National Conservation Strategy and Policy Statement on Environment and Development, and National Policy and Macrolevel

Action Strategy on Biodiversity. Some other sectoral policies (e.g. National Agriculture Policy and National Water Policy) have also contributed towards environmental management. As our development challenges evolved and understanding of the centrality of environmental concerns in development sharpened, the National Environment Policy was developed in 2006. The NEP builds on the earlier policies and strengthens them.

Major Central Acts having direct bearing on biodiversity issues are: Indian Forest Act, Wildlife (Protection) Act, Forest (Conservation) Act, Environment (Protection) Act, and the Biological Diversity Act. In addition, there are several other Acts which have relevance to biodiversity **(Box 11)**. These Central Acts are supported by a number of State laws and statutes as provided under the Constitution. An Inter-State Council has been set up under article 263 of the Constitution for co-ordination on inter-state matters.

While there exists a strong body of legislative and policy framework relevant to biodiversity, there is need to develop synergies among various Acts. Some efforts have been made in this direction which would have to be further strengthened.

The Biological Diversity Act enacted in 2002 in pursuance to the CBD is a comprehensive legislation, the primary aim of which is to conserve biodiversity through regulating access to biological resources and associated traditional knowledge, and to ensure

equitable sharing of benefits arising out of their use as envisaged under the CBD.

The Patents Act, 1970 provides for mandatory disclosure, in patent application, of the source and geographical origin of the biological material and associated traditional knowledge used in the invention. This Act also provides for pre and post grant opposition of applications and revocation of granted patents on grounds of non-disclosure or wrongful disclosure of source or geographical origin of biological resources and traditional knowledge.

Issues relating to benefit sharing and protection of traditional knowledge are rather complex and still evolving. Being a megadiverse country rich in associated traditional knowledge, effective implementation of the Biological Diversity Act and Rules is in the interest of the country and its people, and therefore needs to be strengthened. Experience gained in implementation of the national legislation on Access and Benefit Sharing (ABS) would be of much value in strengthening and effectively articulating the developing country perspective for an international regime on ABS presently being negotiated under the CBD.

Action Points

- Accelerate effective actions at the central, state and local levels to implement provisions under the Biological Diversity Act.
- Review enabling policies to prevent transfer of prime agricultural land to non-agricultural purposes, and promote sustainability of agricultural lands.
- Formulate suggestive policies for strengthening and supporting conservation and management of grasslands, pastoral lands, sacred groves and other areas significant for biodiversity conservation.
- Support preparation of PBRs with technical help by the scientific institutions.
- Strengthen systems for documentation, application and protection of biodiversity-associated traditional knowledge, providing adequate protection to these knowledge systems while encouraging benefits to communities.
- Revive and revitalize sustainable traditional practices and other folk uses of components of biodiversity and associated benefits to local communities with a view to promoting and strengthening traditional knowledge and practices.
- Create public education and awareness about the need to conserve, protect and gainfully use traditional knowledge systems.
- Identify emerging areas for new legislation, based on better scientific understanding, economic and social development, and development of multilateral environmental regimes, in line with the NEP.
- Review the body of existing legislations relevant to biodiversity conservation to develop synergies among relevant statutes and regulations, eliminate obsolescence, and amalgamate provisions with similar objectives, in line with the NEP. Further, encourage and facilitate review of legislations at the level of state and local governments with a view to ensuring their consistency with this policy.
- Review the regulatory processes for LMOs so that all relevant scientific knowledge is taken into account, and ecological, health, and economic concerns are adequately addressed.
- Periodically review and update the national biosafety guidelines to ensure that these are based on current scientific knowledge.
- Ensure conservation of biodiversity and human health while dealing with LMOs in transboundary movement in a manner consistent with the multilateral biosafety protocol.
- Develop appropriate liability and redress mechanisms to internalize environment costs and

address economic concerns in case of any damage to biodiversity.

- Harmonise provisions concerning disclosure of source of biological material and associated knowledge used in the inventions under the Patents Act, Protection of Plant Varieties and Farmers' Rights Act, and Biological Diversity Act, to ensure sharing of benefits by the communities holding traditional knowledge, from such use.
- Develop supportive regulatory regime for protection of identified wetlands and biosphere reserves.
- Develop appropriate system and modalities for operationalizing provisions for prior informed consent and benefit sharing under the Biological Diversity Act, working towards greater congruence between these provisions and trade related aspects of intellectual property rights.

5.9 Building of national capacities for biodiversity conservation and appropriate use of new technologies

By and large, the country has, over a period of time, developed a stable institutional structure for environmental management.

The MoEF interacts with the Ministry of Human Resource Development, University Grants Commission, National Council of Educational Research and Training and other educational bodies for introducing and expanding environmental concepts, themes and issues in the curricula of schools, colleges and universities. In order to generate awareness regarding the need to conserve and sustainably utilize biological resources, the various means of communication such as TV, radio and press are being utilized. The education system, both formal and non-formal, is also being mobilized to this end.

The Indian Council of Forestry Research and Education (ICFRE) is the premier organization which imparts education, creates awareness and undertakes research and extension activities on forestry and environmental issues, through its institutes located in various regions of the country. The Indian Institute of Forest Management imparts education and training in forest management. The Wildlife Institute of India imparts training on wildlife management and undertakes research on various related issues.

The Centre for Environment Education (CEE), CPR Environment Education Centre, and other Centres of Excellence supported by the MoEF, organize activities aimed at creating environmental awareness among all sections of the society.

The National Museum of Natural History is devoted to environment education and creation of conservation awareness among public through exhibit galleries, mobile museums, discovery rooms and various other activities.

However, there are still a number of gaps which need to be adequately addressed. Human resource development for scientific management of biodiversity has suffered because of inadequate infrastructure for research and development, shortage of organizations capable of imparting technical skills, limitations of education and public awareness through formal and non-formal means, and inadequate training facilities for various stakeholders.

The current efforts for environmental education and awareness should be strengthened to highlight the importance of conservation and sustainable use of biodiversity especially focusing on new and emerging issues such as biosafety, climate change, and biofuels. Towards this, the audio, visual and the print media could be more effectively used. There is a need to strengthen the in-service training and orientation courses for personnel engaged in conservation programmes.

There are a number of Ministries/Departments, agencies, and organizations which are supporting research relating to biodiversity. To illustrate, the major thrust areas of Department of Biotechnology (DBT) and Ministry of Tribal Affairs relating to conservation and management of biodiversity are given in **Boxes 12 and 13**. Coordination among these organizations needs to be enhanced. There is also need to effectively integrate findings of research projects into policy-making and implementation of programmes.

There is a need for capacity building in the field of livelihood diversification opportunities for local

Box 12: Biotechnological Approaches to Biodiversity Conservation: Some Initiatives by Department of Biotechnology, Ministry of Science and Technology

1. **Ecosystem conservation**
   - Restoration of degraded habitats/landscapes/ecosystems
   - Molecular markers for assessing evolutionary potential of populations/species in ecosystems.
   - Molecular ecology of invasive species and their control through development of host specific biological methods.
   - Assessment of genomic diversity and conservation of gene pools and establishment of DNA banks of grasses, legumes, orchids, etc.
   - Assessment of genetic diversity of rare and endemic species and species that are critical for ecosystems functioning.
   - Use of bioinformatics.
   - Training and capacity building in molecular tools and techniques.
2. **Environmental biotechnology**
   - Bio and phyto remediation for restoration of environmental quality.
   - Biodegradation of xenobiotics
   - Resources/wastes utilization/treatment through application of rDNA technology.
   - Augmentation of production of biodegradable plastics.
   - Use of GMOs for pollution control.
   - Biotechnological interventions for crop protection.
3. **Medicinal plants and aromatic grasses**
   - Scaling up of research leads, product development and value addition in respect of medicinal plants.
   - Development of standard and safe herbal products or isolation and characterization of therapeutically active compounds from medicinal plants.
   - Cell-culture production of therapeutic agents from plants.
   - Studies on herbal drug-modern drug interaction
   - Network projects, mission mode programmes and creation of associated infrastructural facilities for optimal utilization of selected medicinal and aromatic plants species.
4. **Animal biotechnology**
   - Genomics, genetic characterization and development of vaccines and diagnostics for livestock.
5. **Bioresources development and utilization**
   - Biodiversity characterization through remote sensing and database development.
   - Bioprospecting of plants, microbes, marine organisms etc. for development of novel products.
6. **Societal programme**
   - Promote entrepreneurship development, public private partnership particularly in agro - food processing, self-help groups and Anganwadi workers for undertaking village based activities and micro-financing.
   - Create and strengthen herbal venture fund to support product development through linking traditional knowledge base with various biotechnology labs in private, public and NGO sectors.
   - Establish model bio-villages, support mobile research labs, organize training programmes, bio-melas, traditional food festivals / shows etc. and use other mass communication tools to create education and awareness among local people including panchayat members for judicious use of bioresources.