National Biodiversity Strategy and Action Plan
Wild Plant Biodiversity

Final Report

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Name of the contributor	Contribution
B.R. Ramesh	• Strategies for the conservation of biodiversity of the Western Ghats • Biodiversity conservation with emphasis on capacity building for adaptive management and sustainable development. • Assessment & conservation of forest biodiversity in the Western Ghats of Karnataka, India. and bibliography
D.K.Singh	• Liverworts of India
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V.B. Hosagoudar	• Black Mildews in India

Documents communicated by NBSAP

- Integrating biodiversity into sectoral planning. A note for executing agencies
- A package on the basic legal right of tribals/indigenous people (Adivais) in relation to biodiversity and the CBD
- Prioritization of wild relatives of crop plants and domesticated animals of India
- Paper on issue of Gender and biodiversty in NBSAP
- Cross-references to National documents
- Communities do conserve! Statement of the national workshop on community conserved biodiverse areas
- The Concept of Participatory Forest Management, its Rational and Implications for Karnataka
- Prioritization of endangered species

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Introduction

1.1. Introduction

Biodiversity is the total diversity and variability of living organism and of the system of which they are a part. According to the Rio Convention on Biodiversity, 1992, Biodiversity indicates the variability among living organisms from all source including, *inter alia,* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and ecosystems. Current estimates of world's diversity range from 5-50 million species, of which only 1.7 million are known by human beings.

Biodiversity provides enormous economic benefits directly or indirectly to the human beings. Inspite of the fact that biodiversity is important for human sustenance, human action is eroding this resource at an alarming rate. This wealth is threatened by an alarming rate of over exploitation resulting in devastation of natural habitat and ecosystems across the globe. Considering all these facts, conservation of biological diversity has received an impetus especially in the aftermath of Convention on Biological Diversity, which covers all aspect of sustainable utilization of biological resources.

India is one of the rich centres of biodiversity with wide representation of biodiversity at all levels i.e. ecosystem, species and genes. The country has been recognized one among twelve centres of origin of diversity of several plant species in the world. It contributes as many as 167 species of plants whose origin and diversity is attributed to the country. Within the biodiversity of the country, wild plants contribute a major portion and have a very wide taxonomic range representing enormous diversity at the species, sub species and variety levels. This wide ranging diversity can be attributed to the wide range of ecosystem components, geographical conditions and ongoing evolutionary processes. However, in the last couple of centuries and more especially in the last few decades, this diversity has faced increasing erosion. Habitat loss, hunting, over-exploitation, introduction of exotics and other factors including progressive disempowerment of local communities, destabilization of their traditional management systems have contributed towards the present situation. As baseline

data, research and monitoring is poorly developed in this country. Therefore, the dimensions of the loss are as yet unclear. Some elements of the loss, which have remained, undetected or severely under studied, include decline of the sub species and varieties of a species. This silent erosion is not necessarily due to any anthropogenic factor, but often due to complex and less understood environmental factors (NBSAP, 2000).

Realizing the vast diversity of the country and its rate of depletion, several Governmental and non-governmental organizations initiated programmes focussing on conservation and sustainable utilization of bioresources. However, due to the vastness of the area, heterogeneity and variations in topoclimate, the diverse and unique floristic and faunal elements, developing a common approach for conservation is not an easy task. Therefore, there is a need to develop a holistic approach wherein all the strengths and gaps of nation's biodiversity are duly recognized to address the issues related to conservation. Also, to understand the extent of biodiversity at national, state, district, ecoregional and local level, it is essential to conduct surveys, collect and collate information.

Parties signatory to the Convention are required to prepare strategies and Action Plans on biodiversity and link this to various sectoral or cross sectoral plans and policies. Being a signatory of CBD, the process for developing the National Biodiversity Strategy and Action Plan (NBSAP) is one such initiative. The process is being executed by Ministry of Environment and Forest, Government of India (funding agencies UNDP/GEF) and implemented through a Technical and Policy Core group co-ordinated by Kalpavriksha (an environmental action NGO). The NBSAP is proposed to be developed through a 'participatory planning process involving all major stakeholders and recognizes the term 'biodiversity' in its holistic sense to encompass all level of biodiversity and their ecological/evolutionary processes.

1.2. Scope of the SAP

The resources are limited while the population is increasing continuously. Therefore, while developing the SAP one must consider dependency of human population on the biodiversity elements. The ultimate aim of the process is the production of a comprehensive, ready to act action plan. As aimed under NBSAP process, the gaps identified and Strategies and Action Points proposed in this document on different aspects of wild plant diversity would be helpful in planning for the overall development of the country.

1.3. Objectives of the SAP

- To develop methodology for collecting, organization and analysis of the data available on wild plant diversity.
- To review the status of wild plant diversity in the various biogeographical regions, state and district level.
- To identify the mode of selecting special groups such as medicinal, rare, endemic etc. for collating and analyzing the available information.
- To develop approaches to link forms of wild plant diversity with livelihood needs and other development initiatives
- To develop mechanism for identifying the gaps in our knowledge.
- To prioritize the area of interest on the basis of collecting information.
- To develop strategies for filling up the gaps.
- To develop action points for strengthening and enhancing the sustainable utilization of wild plant diversity

1.4. Content of the SAP

The present document provides fairly detailed account of the wild plant diversity of the country, and is unique in the sense that it deals with varied facets. The SAP document contain ten chapters i.e. Introduction, Profile of the area, Current knowledge and status of plant diverstiy, Major threats to biodiversity, Major stakeholders and their role in conservation, Ongoing biodiversity related initiatives, Gap analysis, Strategies and Action points and Follow up.

Chapter 1: Introduction contains brief background of SAP and its linkages to NBSAP process, scope, objectives, content and brief description of methodology followed for the preparation of SAP.

Chapter 2: Profile of the area deals with the geographical setting (climate, habitat types, forest cover and PA cover), brief description of wild plant diversity in different biogeographic regions, States and districts. Summary of the floristic diversity in unique biogeographic regions, ecosystems like Himalaya, Northeast, Western Ghats and Mangrove.

Chapter 3: Current knowledge and status of plant diversity describes status of wild plant diversity in different hierarchical group (angiosperm, gymnosperms, bryophytes, lichens, fungi and algae), special group (medicinal plants, endemics, and rare) and use value

(plants related to livelihood, traditional knowledge, ethnobotany, cultural, religion and health care needs).

Chapter 4: Major threats to biodiversity deals with proximate cause (e.g. habitat destruction and conversion, introduction of exotics and monoculture, poisoning, loss of source of knowledge) and root causes (unsustainable models of development) of biodiversity erosion.

Chapter 5: Major stakeholder and their role in biodiveristy conservation deals with the major actors and their current role relevant to biodiversity. The major actors include governmental organizations, non- governmental organizations (NGO's), local communities, donors, industries and corporate sectors.

Chapter 6: Ongoing themes includes the ongoing initiatives related to biodivestiy conservation undertaken by the government (policy and legal measure, administrative measures, programmes and schemes, integration into economy, social sector, etc.), NGOs, communities and peoples participation (farmers participation, women participation, environmental education etc.).

Chapter 7: Gap analysis deals with the gaps in information- existence and availability to key actors, gaps in vision, gaps in policy framework and gaps in institutional and human capacity.

Chapter 8: Interaction with the various stakeholders and their suggestion in biodiversity conservation is duly acknowledged. Also proceedings of the three consultation meetings is summarized.

Chapter 9: Strategies and Action points describe the strategies and action points for different aspects of wild plant diversity and their sustainable utilization.

Chapter 10: Follow Up deals with the follow up for required actions of the SAP. At the end references and bibliography have been appended.

1.5. Methodology

To begin with the SAP process various experts were identified. Each expert was contacted and consent was obtained to be associated as a member of Thematic Working Group (TWG) on wild plant diversity. After receiving the consent of all the members, a meeting was convened by the coordinator at Indian National Science Academy (INSA), New Delhi on (December 27, 2000). The following members and invitees attended the meeting.

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During the discussion, it was agreed by all the members that resource persons for various biogeographic regions could be identified so as to speed up the process. Following points emerged and discussed in the above meeting: (i) delineating special area, (ii) selecting special group, (iii) collecting information on traditional knowledge, (iv) link plant forms with livelihood, (v) reviewing and prioritizing the points in the concept note (vi) mode and mechanism of organizing meetings (vii) finalizing a time frame for each identified activity and communication from NBSAP. All the members agreed to contribute specific chapter on each point.

1.5.1. Approach for data collection

The data generated on wild plant diversity of India is based on available secondary data. An approach for collecting, updating, integrating and analyzing available information was developed. It was very difficult to collect the information, which at best is scattered and incomplete. In order to achieve the desired progress in developing a rational approach for prioritization it was thought to follow these lines " *instead of finding fault with the available data, it is important to make most of it. There is a need to collect and collate available information in a standardized format*" (Dhar, 1998). While database was being organized in format, the inputs of consultative meeting of eminent experts (described as above) were given due consideration to standardize the approach of analysis and interpretation of data for prioritization.

1.5.2. Organization of data

Considering the NBSAP guidelines a format was standardized for data entry (Format 1). For example: all the attributes were organized to accommodate relevant information irrespective of the gaps in available literature. Biogeographic region or state wise information in each aspect i.e. floristic diversity and special elements were taken into consideration. All this information was recorded on the basis of published/unpublished work (if state floras were not available district floras and the research papers on specific localities were consulted). Based on the available information data were organized for richness (no. of species), uniqueness (rarity status), endemicity and use value (edible, medicinal, ethnobotanically important, etc.).

1.5.3. Data availability and analysis

Information on wild plant diversity of India was obtained from various sources. An extensive survey of published literature on the subject matter was carried out. Source of information was drawn from floras, research papers, reports, monograph etc. Various journals related to floristic work e.g., Journal of Economic and Taxonomic Botany, Indian Forester, Indian Journal of Forestry, Journal of Bombay Natural History Society, Ethnobotany, Bulletin of Botanical Survey of India, Van Vigyan etc. were identified for detailed survey. Over the last 10 years (1990- 2000) research papers related to wild plant diversity were consulted for updating the information. Data on various parameters e.g., spatial area (biogeographic regions, states/UTs, districts), special area (Himalaya, Western Ghats, Northeast, Mangroves), hierarchical groups (angiosperms, gymnosperms, bryophytes, pteridophytes, algae, fungi),

special group (medicinal plants, orchids, endemic, threatened/rare), intrinsic characters (livelihood needs, rattan, bamboo, traditional knowledge, ethnobotany, religious, social and cultural, primary healthcare), threats (natural and anthropogenic pressure) and mechanism (documentation/publication, data base, *in situ*, *ex situ*, participatory approach, awareness/education, policies, acts/bills) were recorded and analyzed. Data on special elements i.e. edible, medicinal, threatened/rare, ethnobotanically important and other important ones were obtained from various published/unpublished sources. The total area, forest cover and agricultural area were obtained from the Agriculture Statistics of India.

For fixing conservation priorities of each state, range of data available for non cultivated land against total land, protected area against total land and protected area against non cultivated land area were considered. States were grouped under 5 classes (1-5), as follows:

(i) Available non cultivated land (%) against total land area

1: <20

2: 20-40

3: 40-60

4: 60-80

5: >80

(ii) Available protected area (%) against total land area

1: <10

2: 10-20

3: 20-30

4: 30-40

5: >40

(iii) Available protected area (%) against non cultivated land area

1: <6

2: 6-12

3: 12-18

4: 18-24

5: >24%

Available information was pooled for the identified attributes (richness, uniqueness, representativeness and use value) to calculate the number of species present in each state. Computation was made on the each species individually. Later the data were analyzed for the

total land area of the state, protected area, cultivated land, non-cultivated land area and finally pooled for the country. Species richness, uniqueness, representativeness and use value for each state was separately analyzed.

Box 1

Format 1

STATE

Geographical area (sq km)	Percentage of total area
Cultivated Land (sq km)	Protected area (sq km)
Forest cover (sq km)	Plant species richness
Botanical gardens	

Special elements

Medicinal plants	Edible plants
Other uses	Ethnobotanically important
No. of Rare/threatened	No. of Endemic species

Profile of the area

2.1. Status

India is one of the most important biogeographic regions of the world bounded by Tibet, Nepal and Bhutan (in the North), Pakistan (in the Northwest), Myanmar (in the Northeast) and Bangladesh (in the east). The Southern Peninsula extends into the Indian Ocean with the Bay of Bengal lying to the Southeast and the Arabian Sea to the Southwest. India with geographical area of 329 million ha and over 6000 km of coastline, is the seventh largest country in the world and second largest country in Asia. The total land area under various sectors is shown (Table 1).

Table 1. Land area under different sectors

India (Total)	Area (sq km)	% of total area
Geographical	3287263	-
Cultivated	1417690	43.12
Barren and Wasteland	755980	22.99
Protected Area	153000	4.65
Forest cover	633397	19.26

Climate

A great variety of climatic and altitudinal variations coupled with varied ecological habitats have contributed immensely to the rich vegetational wealth. There are almost rainless areas to the highest rainfall areas. The climate ranges from the temperate to the arctic in the Himalayas, to tropical and subtropical in its Indo-Gangetic plains and the Peninsular region. The mountain ranges in the north exert a major influence on the climate of India. The northern part of the India reveal a colder climate, often classified as montane temperate. A larger part of the Deccan Peninsula and northeastern part of the country present a tropical climate. Central and northern India is nearly subtropical with a strong seasonality of the climate. In the Himalayan foothills the climate is warm temperate or montane temperate.

Habitat types

The vast geographical expanse of the country has resulted into enormous habitat types, which is varied from the humid tropical of Ghats to the hot desert of the Rajasthan, from cold desert of Ladakh and icy mountains to the Himalaya to the long warm coastline stretch of Pennisular India. The extreme diversity of the habitat has resulted in a great variety of flora and all types of forests ranging from scrub forest to the tropical evergreen rain forests, coastal mangrove to the temperate and alpine scurb. Mainly four types of soils – alluvial, black, red and lateritic soils are predominant in the region (Raychaudhary et al., 1963).

Land use pattern

On the basis of nine-fold land use classification, the land use statistics are available for roughly 305 million ha, which account for over 93% of the total land. Of the reported land use area, about 22 million ha are occupied by the housing, industry and other non agricultural uses, 19.5 million ha are snow bound and remote, 264 million ha are covered by agriculture, forestry pasture and other biomass production activity (ESI, 1998). Agriculture is the key user of land in India and the net sown area of approximately 142 million ha takes up nearly half (43%) of the reported land area. About 23% of the total land mass of the country are barren and wasteland. This is mainly due to the increasing pressure of both human and livestock population. According to an estimate, nearly 93 million ha of agriculture land and about 36 million ha forests are suffering from various kind of degradation which shows that more than half of the area is degraded.

Forest cover

Forestry ranks second, in terms of land use classification; however, the recorded forest area is estimated to be 77 million ha. Of these 69 million ha is classified as 'forest' in the land use statistics (FSI, 2000) and about 63 million ha (19.26%) of land has forest cover. Of the reported forest cover, only 37 million ha comprise dense forests (crown density of 40% and above) open forest (crown density (10-40%) and mangroves. Per capita forest cover in the country is 0.08 ha which is quite less than the world average of 0.64 ha. Though forest cover in India is less than the world average and in most of the developed countries, it compares favorably with Asia, Africa and adjoining countries such as China, Pakistan and Bangaldesh (Anonymous, 2000). The forest cover in the country has declined from 19.49% (64.08 million ha) to 19.39% (63.73 m ha) i.e. the country has lost 0.35 m ha of forests in the period of about

15 years. The dense forest has decreased by 9312 km^2, whereas open forest and mangroves have increased by 5386 km^2 and 400 km^2 respectively. On the basis of land use classes India have been classified in 16 major forest types under 4 major forests i.e. tropical, sub tropical, temperate, sub alpine and alpine (Champion and Seth, 1968). Of these the tropical moist deciduous forests represent maximum (37%) while the tropical dry deciduous forest form 28.6% of the forest cover in India.

Protected area

Protected Area (PAs) constitute 4.65% of the total land area of the country and regarded as the repositories of biological diversity. In India about 573 PAs are notified, which include 89 National Parks (NPs) and 494 Wild Life Sanctuaries (WLS) covering an area of 15,4040 sq km (Rodgers et al., 2000). Recently 10 NPs and 127 WLS covering an area of 25,000 sq km have been further notified (Mathur, 2000). The NPs and WLS, cover approximately 1.13% and 3.56% of the land area, respectively. Also, there are 11 Biosphere Reserves (BRs), which comprise existing parks, sanctuaries and adjacent reserved forests, essentially to manage the entire landscape according to principle laid by Man and Biosphere Reserves Programme of UNESCO. The existing PA network covers varied ecosystems and communities and a large number of terrestrial habitats including 27 Tiger Reserve (TRs), over 21 distinct wetlands (including 6 Ramsar sites), 15 mangroves and 4 sites of coral reefs.

2.2. Spatial area

Considering the vast extension of the country and the variation in vegetation patterns in the different area and within the same area, India is broadly classified into 10 biogeographic regions (Table 2, Rodgers et al., 2000). Deccan Peninsula is the largest biogeographic region covering nearly half of the total land area (41.9%), however, the Islands cover relatively small area (0.25%). Deccan Peninsula covers over 10 states and the Trans Himalaya and Desert, each cover only two states.

Table 2. Distribution of representative political boundaries within biogeographic regions

Biogeographic Regions	Political boundaries	Area (sq km)	Total area (%)
Trans Himalaya	Jammu and Kashmir, Himachal Pradesh	184823	5.6
Himalaya	Uttaranchal, Jammu and Kashmir, Himachal Pradesh, Arunachal Pradesh, Sikkim	210662	6.4
Desert	Rajasthan, Gujarat	215757	6.5
Semi arid	Punjab, Rajasthan, Gujarat, Haryana, Delhi, Madhya Pradesh, Uttar Pradesh	545850	16.6
Western Ghats	Maharashtra, Karnataka, Goa, Kerala, Tamil Nadu	132606	4.0
Deccan Peninsula	Maharashtra, Madhya Pradesh, Uttar Pradesh, West Bengal, Andhra Pradesh, Orissa, Tamil Nadu, Bihar	1380380	41.6
Gangetic Plain	Uttar Pradesh, West Bengal, Bihar	354782	10.7
Coast	Konkan region of Karnataka, Kerala, Goa, North Maharashtra, Orissa, Gujarat, Tamil Nadu, Andhra Pradesh	82813	2.5
Northeast	Assam, Nagaland, Manipur, Mizorum, Tripura	171341	5.2
Island	Andaman and Nicobar group of Islands, Lakshadweep	8249	0.25

2.2.1. Biogeographic Regions (*input from G.S. Rawat and P.K. Hajra*)

2.2.1.1. The Trans Himalaya

The trans Himalayan region (5.6% of the Indian region) covers the entire Ladakh district of Jammu and Kashmir and the Lahul Spiti districts of the Himachal Pradesh. The area is characterized by great extremes of heat and cold coupled with extreme dryness. The region is the most elevated zone on the earth (2900-5000m). The Indian Trans Himalaya has approximately 9.20% area under PA coverage. Literature on the flora of this zone reveals that this region has 750 species of flowering plants (Rao, 1994; Kachroo, et al, 1977). This is considerably low as compared to the flora of comparable altitudes in main Himalayan region (Table 3). For example - from the alpine region of Kumaon Himalaya (7000 km²), 830 species of vascular plants have been reported (Rawat, 1984). The large PAs in the region give protection to the endemic species, specific communities and habitats. A small portion of Indian Trans Himalaya (Sikkim) is relatively higher in species diversity compared to the northwest region.

2.2.1.2. The Himalayan region

The Himalaya consists of an area of 236300 sq km, which is approximately 7% of the country's total land surface. The Himalayan region includes northwest (Kashmir to the Sutlej in HP), west (Sutlej to the Gandak in Nepal), Central (Gandak in Nepal through West Bengal and Sikkim to Central Bhutan) and east Himalaya (Central Bhutan and all Arunachal Pradesh). The flora of the Himalayan region is fairly well known and maximum 8000 species is reported (Table 3). The region has 88 PAs including 17 NPs and 71 WLS, which is nearly 6% and 3.6% respectively of the total Himalayan region.

2.2.1.3. The Indian Desert

The Indian desert consists of Thar and Kutch containing 6.6% of country's total land surface. It is the northwestern boundary of India, which covers mainly the western and northwestern region of Rajasthan and part of Kutch region of Gujarat in the southwest. The Indian Desert is characterized by high atmospheric temperature and low and erratic rainfall, high wind velocity, low relative humidity, high evaporation, non-existence of perennial water source and scanty vegetation. It is estimated that the Indian Desert supports 2000 species of vascular plants (Table 3). Presently there are 7 PAs representing arid ecosystem covering 7.45% of the zone. The Indian Desert is a storehouse of genetic resources of a number of life-support species, and conservation of these species needs focussed attention.

2.2.1.4. The semi- arid

Semi arid region is a region of transition between the true desert in the west to extensive Deccan communities of Peninsular India, the south and east. This region include Punjab plains, Delhi, Haryana, fringes of J&K, Himachal Pradesh, western edges of UP, eastern Rajasthan, eastern Gujarat, northwest Madhya Pradesh and constitute an area of 16.6% of country's total land area. The Semi-arid region represents a characteristic Savannah woodland, dry deciduous and tropical thorn forest zone in the Western India. The floristic diversity reveals that as much as 2500 species of flowering plants occur in the region (Table 3). This region has 91 PAs but they are smaller in size and constitute only 2.80% area of the region. The semi-arid region is a region of transition towards true desert in the west, moist deciduous forests of Western Ghats and dry deciduous forests in the east. The Aravalli System constitutes the heart of this zone that supports primarily two types of vegetation viz., Tropical Dry Deciduous Forest and Tropical Thorn Forest.

2.2.1.5. The Western Ghats

The Western Ghats stretches from the south of Tapti in the north to Kanyakumari in the south along the West Coast of India. This zone covers an area of 5% of the total land cover of the country. The Western Ghat is one of the major tropical evergreen forested regions in India and exhibit enormous plant diversity. About 4000 species of flowering plants occur in the region, which harbors nearly 24% of total flora (Table 3). Among these 1500 species are endemic. Currently Western Ghats has 56 PAs covering approximately 10.12% of the region. The Western Ghats region is a major genetic estate with an enormous biodiversity of ancient lineage.

2.2.1.6. The Deccan Peninsula

The Deccan Peninsula biogeographic region in India is the most extensive but relatively a homogenous region covering about 43% of the total Indian landmass. This region includes major portion of Maharashtra, Madhya Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and Bihar. Deciduous forests, thorn and scrublands cover most parts of the region. The Deccan Peninsula, the largest of biogeographic zone of India (1380380 km) is also the most diverse. There are 137 PAs, which cover only 3.71% of the total geographical area of the region. The region is relatively homogenous and ranges from semi-arid to moist deciduous/semi evergreen type of climate. The central highlands comprising Vindhya and Satpura hill range, Chota Nagpur Plateau, Eastern Ghats, Tamil Nadu Plains and Karnataka Plateau biogeographic provinces have been identified within this region. Vindhya and Satpura hill range are known for a rich diversity of flora. The literature reveals that the region is endowed with 3000 species of flowering plants which is very less as far as area is concerned (Table 3). A series of PAs exist in these ranges but most of them continue to face anthropogenic pressures. Sri Venkateshwara NP in Seshachalam Hills, Gundlabrahmeshwaram WS and Nagarjuna Sagar-Srisailam Tiger Reserve TR in Nallamalais, Gudam Maripakhala proposed WS in Andhra Pradesh and Lakhiri Valley and Sonabara WLS in southwestern Orissa are the important PAs in this zone. Srivenkateshwara NP represents an interesting mosaic of woodlands and mesic evergreen groves.

2.2.1.7. The Gangetic Plains

The Gangetic plain biogeographic region is mostly under agriculture and support dense human population stretching from eastern Rajasthan through UP to Bihar and West Bengal. The entire region consists of an area of 10.8% of the total land of country. The Gangetic plain goes from acidity in the west below 500 mm rainfall to moist condition in the east with above 4000 mm annual rainfall. The Gangetic plain (354782 km) includes the area adjacent to Terai-Bhabar tracts in UP, Bihar and West Bengal. Owing to intensive agriculture and ever increasing human population this region has very few PAs (36) covering only 2.16 % of the total geographical area. Important PAs in Uttar Pradesh and Bihar representing this region include Hastinapur WLS, Dudhwa NP, Kishanpur WLS, Katarniaghat WLS and Valmiki TR. Jaldapara WS, Gorumara NP and Buxa TR. These PAs are located at the junction of Eastern Himalayan foothills and Gangetic plains with tremendous human influence. The region harbours 2000 species of flowering plants, which are nearly 12% of the total flowering plants of the country (Table 3).

2.2.1.8. The Coasts

The coastline of India stretches from Gujarat to Cape Commarin (Kanyakumari) in the west and from Sunderbans to Cape Commarin in the east. Approximately 5400 km long stretch of coastline in the mainland has very diverse set of biotic communities. The Indian coast region includes 2.5% of the total landmass of the country. There are as many as 26 PAs along the Indian coasts, most of them have only small portion of their geographical area under coastal ecosystem. The PAs along the Indian coasts cover 6.79% of the entire zone. The prominent areas; the West Coast and East Coast under the coastal ecosystem can be recognized in the country. This ecosystem largely includes two types of vegetation viz., mangrove forests and dry sand dunes. In the extreme west, Marine National Park (169 km in Gujarat) has 20 km area under mangrove vegetation. Other PAs covering mangrove vegetation along the west coast include Phansad WLS (Maharashtra), Chorao Island WLS (Goa) and Aliabet WLS (mouth of Narmada River). Along the east coast important PAs include Pichavaram WLS, Gulf of Mannar, Point Calimere WLS, Sriharikota, Lake Chilika, Gahirmatha (Bhitarkanika WLS), and Sunderbans TR. Literature reveals that the region support nearly 500 species of flowering plants (Table 3).

2.2.1.9. Northeast Region

The northeast Indian biogeographic region is the most significant one and represents the transition zone between the Indian, Indo-Malaya, Indo-Chinese bigeographic regions as well as a meeting place of Himalayan mountains with that of Peninsular India. Therefore, this region acts as a biogeographic gateway for plant migration. The region is the richest in the biological diversity and nearly 5000 species of flowering plants occur in the region (Table 3). Most of the species contributing to the biological diversity of northeast India are either restricted to the region as a whole or even to smaller localities as in Khashi and Jaintia hills, a set of twin hills which are perhaps the richest botanical habitats in entire Asia. The present network of PAs in northeast covers only 2.54% of the region is quite inadequate given the diversity of the area.

2.2.1.10. Islands

This constitutes two major groups of islands i.e., Lakshadweep and Andaman group of islands. The Lakshadweep Islands are an archipelago of 27 small Islands stretching from 8^0 to 12^0 N latitude and 71^0 to 74^0 longitude in the Arabian Sea. The Islands are 320 km away from the Kerala coast. The Islands are of coral origin and most of the Islands are crescent shaped with lagoons and coral reefs on the western side, which protect the islands from the fierce southwest monsoonic winds and floods.

The Andaman Nicobar Islands are an elongated north south oriented group of 348 Islands in the Bay of Bengal stretching for 590 km from $6^0$45' – $13^0$4' N and $92^0$12' – $93^0$57' E. The Andaman Islands are about 190 km distant from Cape Negrais in Burma, the nearest point in the mainland. Five Islands close together constitute the Great Andaman (300 km long) and the little Andaman lies to the south. The Nicobar groups of Islands are separated from the mainland, from the Andaman and internally from each other by 800 m deep channels. There are 103 PAs covering this biogeographical region (18.54 % of the total area).

The presence of over 2000 indigenous and 500 non-indigenous angiosperm species within a land area of 8290 sq km is a significant feature of Andaman and Nicobar Islands (Table 3). About 14% of angiospermic species are endemic to Islands. Among non endemic angiospermic species about 40% are not found in mainland of India. The Islands are rich in cryptogamic flora i.e. Pteridophytes with over 125 species, lichens 307 species of which 73 and endemic. About 53 species of Liverworts are reported from the region. Over 11% of the total geographical area is occupied by Mangrove forest with more than 20 species which are

considered the best formation in the entire southeast Asia providing natural habitat for varied aquatic life offshore and climbing and epiphytic plants on shore. Nearly half of the angiosperm of Andaman and Nicobar do not occur anywhere else in India. About 110 taxa comes under the rare and endangered endemic category, whereas 125 taxa belong to rare and endangered non endemic extra Indian category.

Table 3. Richness of the floristic diversity in different biogeographical regions *(Source: Rawat and Hajra, 2001)*

Biogeographic zone	Approx. area (sq km)	No. of PAs	No. of species
Trans Himalaya	184823	7	1000
Himalaya	210662	67	8000
Desert	215757	7	2000
Semi-arid	545850	91	2500
Western ghats	132606	56	4000
Deccan Peninsula	1380380	137	3000
Gangetic Plain	354782	36	2000
Coasts	82813	26	500
North East	171341	37	4000
Island	8249	103	2500

Action Points	
Bioloigical Units	Plant biodiversity research, be it explorations, inventorization, monitoring, assessment or gap analysis, biogeographic regions should be considered as biological units.
Grid System	The information on wild plant biodiversity must be collected, collated and analysed keeping grid units as the baseline. This will help in identifying priority grid units for immediate conservation attention. The number of such sensitive grids will determine the importance of a particular biogeographic region for priority action. If this action point is to be implemented, the prerequisite would be to divide the country into grid units (as is the case with topo-sheets of Survey of India). The data in grid formats will also help in assessing the endemic rich centres. Elaborate mapping is required for this purpose. Such an attempt has been a very useful in Western Ghats where endemic tree species have been mapped. This has also helped in biodiversity monitoring. Similarly, an attempt in west Himalaya has been successfully made in prioritizing the conservation sites in timberline zone. In this, grid system for 2095 sq km area was developed. The study area was divided into uniform grid units (74.45 sq km) on the basis of intersection of longitudes and latitudes at 5′ interval. The uniqueness, richness, naturalness, endemicity and use value of each grid was assessed. Finally clusters of similar grids and unique grids were identified on the basis of available secondary data. However, this process has to be supplemented by primary data to I) authenticate the reported occurrences and ii) monitor change if, any in the composition of biodiversity elements (Dhar 1998, BCPP-WWF Report).

2.2.2. States

The state and Union Territories of India constitute the adminisrative units. In all, the country is divided into various states (29) and Union Territories (6). Madhya Pradesh (including Chattishgarh) covers the largest area (44,3446 sq km) accounting for over 13.5% of the total land area of the country, whereas, Goa has the minimum land area (3702 sq km). As far as Union Territories are concerned Andaman and Nicobar Islands have the maximum land area (8289 sq km) and Lakshadweep the least (32 sq km). Details of the each state and Union Territory is presented (Table 4).

Table 4. Details of the state and union territories

State	Area (100 sq. km)	Total Forest Cover (100 sq km)	PAs (100 sq. km.)	Spp. Richness	Cultivated land (100 sq km)
Andhra Pradesh	2750.45	432.90	12.83	1020	1350.82
Arunachal Pradesh	837.43	686.02	95.82	4007	17.40
Assam	784.38	238.24	21.13	3014	279.41
Bihar	1738.77	265.24	44.49	2650	940.42
Delhi	14.83	0.26	0.13	962	5.09
Goa	37.02	12.52	7.54	1115	13.20
Gujarat	1960.24	125.78	169.02	2106	1033.79
Haryana	442.12	6.04	2.79	1227	373.38
Himachal Pradesh	556.73	125.21	71.66	3365	62.12
Jammu & Kashmir	2222.36	204.40	148.22	4252	83.26
Karnataka	1917.91	324.03	64.02	3849	1169.35
Kerala	388.63	103.34	26.79	4000	229.19
Madhya Pradesh	4434.46	1311.95	171.78	2317	2030.16
Maharashtra	3077.13	461.43	153.43	3225	1931.03
Manipur	223.27	174.18	2.24	2376	14.01
Meghalaya	224.29	156.57	3.01	3000	26.13
Mizoram	210.81	187.75	0.88	2141	24.81
Nagaland	165.79	142.21	2.26	2431	31.23
Orissa	1557.07	469.41	79.61	2630	647.40
Punjab	503.62	13.87	3.17	1843	430.59
Rajasthan	3422.39	133.53	95.69	1910	1794.79
Sikkim	70.96	31.29	20.49	4500	9.88
Tamil Nadu	1300.58	170.64	29.09	5640	678.72
Tripura	104.86	55.46	6.03	1463	28.16
Uttar Pradesh	2409.26	169.86	54.80	4250	1770.69
Uttaranchal	534.85	170.08	75.25	3710	67.41
West Bengal	887.52	83.49	27.96	3580	572.84
UTs					
Andaman & Nicobar	82.49	76.13	15.29	2500	3.86
Chandigharh	1.14	0.07	0.25	574	0.25
Dadra & Nagar Haveli	4.91	2.04	0	407	2.49
Lakshadweep	0.32	0.03	0	238	0.27
Pondicherry	4.92	-	0	-	3.00
Daman & Diu	1.12	-	0.02	285	0.37

Forest Cover

The analysis of the forest as per the latest assessment showed that Madhya Pradesh accounts for 11.79% of the forest cover of the country followed by Arunachal Pradesh (10.80%), Orissa (7.38%), Maharashtra (7.32%) and Andhra Pradesh (6.94%). The northeast states together comprise 25.70% of the total forest cover of the country. No discernible forest cover has been found in the Union Territories i.e. Lakshadweep and Pondicherry. About 85% of the total mangroves are distributed in West Bengal, Gujarat, and Andaman Nicobars Islands (Pandey, 2000).

Protected Area

The protected area cover in different states showed that Madhya Pradesh has maximum PA cover (17178.74 sq km) followed by Gujarat (16902.38 sq km), Maharashtra (15343.71 sq km), Jammu and Kashmir (14822.22 sq km), Andhra Pradesh (1253.32 sq km), whereas, minimum PA cover is in the northeastern states (Manipur, Meghalaya, Mizorum, Nagaland, Tripura), Delhi, Goa, Haryana and Punjab. Inspite of the large geographical area (342239 sq km) in Rajasthan, the proportion of the protected area is very low (9569.36 sq km). Although northeastern states are known for mega biodiversity states, the PA network is negligible. It is true with Union Territories where some of the UTs have no protected area i.e. Dadra and Nagar Haweli, Lakshadweep and Pondicherry.

Analysis

2.2.2.1. Status of plant biodiversity

State and Union Territory floras have been published periodically and are a useful source of information. Statewise analysis of plant biodiversity reveals that Tamil Nadu has the maximum number of species (5640) as far as angiosperm diversity is concerned. This is followed by Sikkim (4500), Jammu and Kashmir (4252) etc. The largest 10 states on the basis of angiosperm plant diversity are presented (Table 5). Likewise in the Union Territories, Andaman and Nicobar is a widely explored UT for wild plant diversity and as many as 2500 flowering plants are reported.

Table 5. State with rich angiosperm plant diversity (*Compiled from Mudgal and Hajra, 1999*)

State	Number of species
Tamil Nadu	5640
Sikkim	4500
Jammu & Kashmir	4252
Uttar Pradesh	4250
Arunachal Pradesh	4007
Kerala	4000
Karnataka	3849
Uttaranchal	3710
West Bengal	3580
Himachal Pradesh	3365

2.2.2.2. Gaps in knowledge

The type of data available on the floristic diversity of the state is not in tune with the contemporary requirements. What is lacking in most cases is the location specific information and detailed ecological data. These gaps are primarily due to the mandate of the organizations responsible for embarking on developing state floras. Nevertheless, these floras do provide wealth of information on species richness, distribution, rarity status and endemism.

2.2.2.3. Prioritization

The analysis of various aspects of plant biodiversity in States and UTs reveals some interesting facts (Table 6).

- Large number of states (10) i.e. Arunachal Pradesh, Jammu and Kashmir, Gujarat, Karnataka, Manipur, Himachal Pradesh, Meghalaya, Mizorum, Uttaranchal and Sikkim have >80% area under non cultivated (wild) land respectively, followed by states with 40-60% (6 No.), 20-40% (3), <20% (3) and 60-80% (2).
- Non-cultivated land against total land area was highest in Arunachal Pradesh and lowest in Madhya Pradesh.
- With respect to protected area, maximum states have <6% PA cover and Sikkim has the maximum protected area cover (>24%).

Table 6. Ranking of the state on the basis of total land area, non cultivated land, protected area and species richness on non cultivated land

State	Total land area 1	Non cultivated land 2	PA 3	Species /sq km (NCL) 4	Total 1+2+3+4	Rank
Andhra Pradesh	4 (24)	16 (11)	12 (15)	24 (1)	51	9
Arunachal Pradesh	13 (15)	1 (26)	5 (22)	17 (8)	71	2
Assam	14 (14)	14 (13)	18 (9)	16 (9)	45	12
Bihar	9 (19)	19 (8)	19 (8)	18 (7)	42	15
Delhi	27 (1)	13 (14)	25 (2)	1 (24)	41	16
Goa	26 (2)	14 (13)	2 (25)	4 (21)	71	2
Gujarat	7 (21)	3 (24)	6 (21)	22 (3)	69	4
Haryana	18 (10)	24 (3)	26 (1)	9 (16)	30	18
Himachal pradesh	15 (13)	6 (21)	4 (23)	3 (22)	79	1
Jammu & Kashmir	6 (22)	2 (25)	8 (19)	21 (4)	70	3
Karnataka	8 (20)	4 (23)	15 (12)	20 (5)	60	6
Kerala	19 (9)	20 (7)	7 (20)	6 (19)	55	7
Madhya Pradesh	1 (27)	26 (1)	14 (13)	23 (2)	43	14
Maharashtra	3 (25)	21 (6)	11 (16)	19 (6)	53	8
Manipura	21 (7)	5 (22)	24 (3)	12 (13)	45	12
Meghalaya	20 (8)	7 (30)	23 (4)	10 (15)	47	11
Mizoram	22 (6)	8 (19)	13 (14)	11 (14)	53	8
Nagaland	23 (5)	11 (16)	22 (5)	8 (17)	43	14
Orissa	10 (18)	15 (12)	10 (17)	19 (6)	53	8
Punjab	17 (11)	25 (2)	26 (1)	5 (20)	34	17
Rajasthan	2 (26)	18 (9)	17 (10)	22 (3)	48	10
Sikkim	25 (3)	10 (17)	1 (26)	2 (23)	69	4
Tamil Nadu	11 (17)	17 (10)	21 (6)	13 (12)	45	12
Tripura	24 (4)	12 (15)	9 (18)	7 (18)	55	7
Uttar Pradesh	5 (23)	23 (4)	20 (7)	15 (10)	44	13
Uttaranchal	16 (12)	9 (18)	3 (24)	14 (11)	65	5
West Bengal	12 (16)	22 (5)	16 (11)	12 (13)	45	12
UTs						
Andaman & Nicobar	1 (3)	1 (3)	2 (2)	3 (1)	9	2
Chandigharh	2 (2)	2 (2)	1 (3)	1 (3)	10	1
*Dadra and Nagar Haveli	-	-	-	-	-	-
Daman & Diu	3 (1)	3 (1)	3 (1)	2 (2)	5	3
*Lakshadweep	-	-	-	-	-	-
*Pondicherry	-	-	-	-	-	-

**Excluded for ranking due to nonavailability of data*

The analysis of various biological parameter reveals some trends as far as wild plant diversity is concerned (Table 7).

- Considering the richness per sq km of the species, Sikkim, Himachal Pradesh and Goa rank among the first three (1-3 respectively) and Gujarat, Rajasthan, Madhya Pradesh and

Andhra Pradesh rank the least (18-20). Punjab (rank 4) inspite of low non-cultivated land area (<20%) ranked high in species richness per sq km (0.252). Punjab, Nagaland, Meghalaya, Mizoram and Manipur inspite of having <6 % PA cover ranked 4th, 6th, 7th, 8th and 9th respectively as far as richness of the species is concerned.

- Considering the use value of species in various state West Bengal, Orissa and Rajasthan ranked 1st, 2nd and 4th, inspite of the low PA cover (<6%). Among states with >80% noncultivated land cover have high species richness and high protected area coverage (12-18%), Uttaranchal ranks high (rank 3) on the basis of species use value.
- Representation of rare species was high in Bihar (rank 1), Tamil Nadu (rank 2) and Maharashtra (rank 3). These states represent low species richness (rank above 10) due to the lesser uncultivated area (Bihar and Tamil Nadu, 40-60%), Maharashtra (20-40% class) and low coverage under protected areas (<6%; except Maharashtra 11-20%). Of these, three states Tamil Nadu (1), Arunachal Pradesh (2) and Maharashtra (3) are also among top ranking states with respect to endemism.
- The states which rank no. 2 with regard to PA cover is ranked 20th as far as plant endemics are concerned.
- Cumulative score of all the attributes i.e. richness, use value, rarity and endemicity against NCL, PA and TLA ranked Uttaranchal on top priority followed by Tamil Nadu and Kerala.
- Considering the cumulative score (richness, use value, rarity and endemicity) following states need special attention: Tamil Nadu (2), Kerala (3) and Orissa (4) with high biological values but relatively less wild land cover (40-60%), protected area (<6%) against total land and <10% protected area against non cultivated land area (except Kerala under class 10-20%).
- Uttaranchal (1) with high cumulative scores of biological values emerges as a unique state with relatively high use value (rank 3), rarity (rank 8), endemicity (rank 5) and richness (rank 11) of wild plants.

Table 7. Ranking of the state on the basis of various biological parameters

State	Richness	Use value	Rarity	Endemicity	Total	Rank
Andhra Pradesh	26 (2)	18 (6)	20 (3)	13 (9)	20	18
Arunachal Pradesh	5 (23)	14 (10)	12 (11)	2 (20)	64	5
Assam	12 (16)	7 (17)	11 (12)	8 (14)	59	7
Bihar	14 (14)	11 (13)	1 (22)	17 (5)	54	9
*Delhi	27 (1)	-	-	-	-	-
Goa	25 (3)	19 (5)	6 (17)	20 (2)	27	17
Gujarat	20 (8)	13 (11)	10 (13)	14 (8)	40	13
*Haryana	24 (4)	-	-	-	-	-
Himachal Pradesh	10 (18)	12 (12)	15 (8)	18 (4)	42	12
Jammu & Kashmir	3 (25)	5 (19)	18 (5)	5 (17)	66	4
*Karnataka	7 (21)	-	-	-	-	-
Kerala	6 (22)	16 (8)	5 (18)	7 (15)	63	6
Madhya Pradesh	18 (10)	9 (15)	7 (16)	16 (6)	47	10
Maharashtra	11 (17)	6 (18)	3 (20)	3 (19)	74	2
Manipura	17 (11)	23 (1)	17 (6)	9 (13)	31	16
Meghalaya	13 (15)	20 (4)	9 (14)	10 (12)	43	11
Mizoram	19 (9)	15 (9)	19 (4)	12 (10)	32	15
Nagaland	16 (12)	8 (16)	19 (4)	15 (7)	39	14
Orissa	15 (13)	2 (22)	4 (19)	13 (9)	63	6
Punjab	22 (6)	22 (2)	16 (7)	21 (1)	16	19
Rajasthan	21 (7)	4 (20)	21 (2)	11 (11)	40	13
Sikkim	2 (26)	21 (3)	14 (9)	4 (18)	56	8
Tamil Nadu	1 (27)	17 (7)	2 (21)	1 (21)	76	1
*Tripura	23 (5)	-	-	-	-	-
Uttar Pradesh	4 (24)	10 (14)	22 (1)	19 (3)	42	12
Uttaranchal	8 (20)	3 (21)	8 (15)	6 (16)	72	3
West Bengal	9 (19)	1 (23)	13 (10)	15 (7)	59	7

**Excluded for the prioritization due to nonavailability of the data on all the biological parameters*

The above analysis shows some trends, which are useful in developing action points on what States and Union Territories should do to maintain Wild Plant Biodiversity. On the basis of above analysis following action points are proposed:

Action Points	
Review of existing status	Before embarking on conservation initiatives, it is recommended to critically analyze the reasons of the state of richness or otherwise of the political units. Among others, the reasons of these trends include poor exploration, lack of resources for publication of findings, scattered information published in obscure journals and overall poor dissemination mechanisms. Notwithstanding these, the above trends do justify recommending following action points:
Indicators-species richness	With the highest PA cover and strong influence of neighboring elements, Sikkim with high species richness per sq. km. of non cultivted land area should be considered a STATE HOT SPOT of Plant biodiversity. Likewise, Tamil Nadu and Maharashtra, with rich endemic elements and higher number of rare taxa (Tamil Nadu – rank 2, Maharashtra - rank 3) and West Bengal with strong traditional base (with highest number of species of known use value) are considered at par with Sikkim. However, Uttaranchal has highest representation values of various attributes, therefore, deserves special attention.
Uniqueness	Several states (e.g. Rajasthan) may not be species rich but do possess unique desert elements not found anywhere in the country. Therefore it is important to initiate conservation measure in areas with unique plant biodiversity feature.
Identification of Botanical Hot Spot	Within state, Botanical Hot Spots need to be identified for conservation of areas with unique patterns of plant diversity in each state/substate. Information on species/ population/community performance and distribution and other existing records need to be studied. For example: In Kumaun Himalaya, Uttaranchal, four "Hot Spots" i.e., The Pindari catchment, the Sandev area, Gori-Ganga catchment and Gola catchment were identified on the basis of high community diversity, high plant (species/community) diversity, small population of many rare/endangered orchid species and the ethnobotanical value and human impacts on natural resources (Samant et al., 1993). Likewise in Tripura state 36 sites were prioritized on the basis of biodiversity values (representativeness, vulnerability, ecosystem diversity, conservation threat), taxa based values, socioeconomic values, and conservation feasibility value (Gupta 2000).
Poor information on lower groups	As far as the diversity of lower groups is concerned, the available information is very poor for both States and Union Territories. Except for a few scattered reports of Pteridophytes from Kerala, Karnataka, Jammu and Kashmir, Mizoram, Goa and Orissa, the information is almost lacking. A major thrust is required to compile state of knowledge on lower groups of plants. This will help in identifying gaps and subsequently in setting targets for adequate inventorization.
Involvement of students and capacity building	School and college students should be involved in future explorations and inventorization. This can happen through capacity building measures. This activity should be incentive driven and not regarded as an academic exercise

2.2.3. Districts

Considering the better management and for administrative purposes each state has been divided into several districts. At present the country is comprised of over 1000 districts. In the present study apart from the state floras, several (32) district level floristic investigations have also been undertaken particularly in Madhya Pradesh, Karnataka, Tamil Nadu, Uttar Pradesh, Maharashtra, Rajasthan, Bihar, Uttaranchal and West Bengal. As a result of the review of district floras following action points are proposed:

Action Ponts	
	The district floras should cover detailed information on various aspects of plant biodiversity. They should not be a repeat of what is included in State floras. The state of knowledge at district level can enrich and update database of grid units (biogeographic regions). It is high time to consider constituting a Core Committee comprising of representatives of Line Departments, local panchayats, gram sabhas or local village bodies, NGOs, University/College Departments and other stakeholders who could develop mechanisms for need based assessment of state of knowledge of biodiversity and its relevance in the overall development of the administrative unit (district). Such a committee should decide about the future activities on biodiversity related issues. This is possible through periodic interaction among the above mentioned bodies/ representatives. This is not happening at present because the importance of maintaining local biodiversity for the welfare of the district is not considered a thrust area of activity. Any district flora activity should be limited to those areas (Biogeographic region/State/Grids), which are known to support unique features or have not been explored floristically. Relevant line departments at district level need to be involved in this exercise.

2.3. Spatial Area

2.3.1. Northeast (*input from Umashanker, P.K. Hajra and K.P. Singh*)

The Northeast biogeographic region is the transition zone between the Indian, Indo Malayan and Indo- Chinese biogeographic region and meeting place of Himalayan mountain system with that of the Peninsular India. More than 150 tribes of different ethnic groups and cultural entities inhabit the region comprising the states of Assam, Manipur, Mizoram, Meghalya, Nagaland and Tripura, which constitute 5.2% of the total land area of the country. Agriculture is the main occupation and many of these people practice Jhum or shifting cultivation to grow cereals, vegetable and fruits. This region is the most significant and acts as a biogeographic gateway for plant migration and richest in biological diversity, community diversity and species diversity. The Khasi and Jaintia hills, a set of twin hills in Meghalaya are the richest botanical habitats in entire Asia (Rao, 1994).

The region forms richest reservoir of floristic diversity on account of its unique geographical, topographical, altitudinal and ecological gradient. The vegetation and flora of this region has been studied by several workers (Panighrahi and Joseph, 1966, Rao and Joseph, 1965, Das and Rajkhowa, 1968, Rao, 1970-74, Haridasan and Rao, 1985-86, Rao and Hajra, 1986, Jamir and Rao, 1988). Of the total geographic area, 171336 sq km area is covered by forest, which account for 55.41% of the total geographical area (FSI, 1999). The legal status of the forest of northeast India is interesting. The Unclassed State Forest (USF), although, legally claimed to be owned by the Government are in practice, under the use and control of the local communities. About 45% of the recorded forests (24% of the total geographical area) is under the control /management of the Government and 55% of the recorded forests (30% of the geographical area) under the control/management of the communities. According to remote sensing Satellite (IRS-1B) data (1997), there is a loss of 5,482 sq km of forest cover in India and 523 sq km in northeast region only between 1993-1997. However the State Forest Report 1999 indicates an increase in the forest cover of the country to an extent of 3,896 sq km and the loss of forest cover in the North Eastern region shows declining trend with only (-) 278 sq km net change/loss (Hegde, 2000).

Protected Areas (PAs) of the region comprises of over 3% of the total geographical area of the state. It may also be noted that the Manas Project Tiger area and the Kaziranga National Park have been included under the World Heritage Sites and the Loktak Lake as the Ramsar Site. The present network of PAs (37 in number) in this region, covers only 2.54% of the region is quite inadequate given the diversity of the area (Table 8).

The vegetation of northeast is classified as tropical, subtropical, temperate and subalpine. Each comprising numerous subtypes primarily based on altitudinal and climatic factors. It is interesting that out of nine vegetation types of India, 6 are found in northeast only. Champion and Seth (1968) identified 51 distinct forest types in this region. The important ones are (i) tropical semi evergreen to evergreen forests (upto 800 m), (ii) tropical semi deciduous forests (upto 1000 m), (iii) sub tropical broad leaved forests (1000-2000 m), (iv) sub tropical pine forests (1500-1800 m), (v) temperate forests (1800-3500 m), (vi) sub alpine forests (3500-4000 m) and (vii) alpine forests (4500-5000 m) (Rao and Hajra 1986), which exhibit innumerable varieties of plant wealth

Table 8. Total area, forest cover and protected area of northeast region

Area (sq km)	1,71,336
Forest cover (%)	55.41
Protected area (%)	2.54

2.3.1.1. Floristic diversity

Perusal of the literature on floristic diversity of the region reveals that more than 5,000 species are found in northeast region, which account for nearly 28.9% of the total angiosperm flora of the country. These species fall under 200 families of the reported representative 315 families of the country. Similarly the region harbors 83.3% of gymnosperms, 44% of Pteridophytes, 68.8% of orchids, 88.8% of *Rhododendron*, 54.5% of Bamboo, 41.6% of canes (Table 9). Family Poaceae is the most dominant family followed by Orchidaceae, Fabaceae, Asteraceae, Cyperaceae, Lamiaceae, Scrophulariaceae, Acanthaceae, and Euphorbiaceae in the region. Besides these, there are some families, which have evolutionary significance. These are Nepenthaceae, Illiciaceae, Clethraceae, Turneraceae, Tetracentraceae and the genus represented by *Nepenthes khasiana, Illicium griffthii, Clethera monostachya* and *Tetracentron sinensis*. Inspite of the rich repository of flowering plants complete inventory is not available. For example, there is no comprehensive list of the flowering plants of Mizorum, Manipur and Nagaland. Similarly the diversity of the lower groups of plants is not available i.e. Algae and Fungi, even number of species are not available. Based on the available literature it was noticed that floras are not available for all the region, states, and groups. The cryptogamic flora of the region is very rich in diversity but poorly documented. The most studied group is the pteridophytes. Likewise, studies on lichens are also very meager. Other groups like algae, fungi, bryophytes are poorly studied except few sporadic publications. Very little work is

done on the taxonomy of the fungi. As a whole the region is intact for cryptogamic studies, it needs immediate attention for its proper evaluation and investigations by the specialists. Keeping in view the rich floristic diversity of the region it is considered as one of the worlds 18th biological hot spots. Inspite of the significant progress in the field of floristic botany one has to go a long way to document complete diversity of the region because the area is still unexplored, or under explored. Efforts need to be made to explore the cryptogamic flora of the region, which have immense potential for the welfare of the human being. Various biotic and abiotic causes influencing the floristic diversity of the region need to be identified and accordingly conservation programme should be initiated.

Table 9. Status of floristic diversity in Northeast Region.

Hierarchical group	**No. of species**
Angiosperms	5000
Gymnosperms	40
Bryophytes	818
Pteridophytes	500
Algae	-
Fungi	-
Lichens	759
Special groups	
Wild relatives	300
Medicinal	1000
Endemic	751
Threatened	800

This region is also known for botanical curiosities due to the presence of saprophytic and parasitic plants some of which are highly endangered. A few of these include *Sapria himalayana*, *Rafflessia* (world's largest flower)*, Mitrastemon yamamotoi*, *Rhopalocnensis phalloides, Balanophora dioica, Boschinackia himalaica* etc. which are all parasites. Saprophytic plants include *Monotropa uniflora, Epipogium roseum, Galeola falconerii* and *Burmania* sp. Besides these, a variety of insectivores plants occur in the region and Meghalaya is particularly rich in this group.

2.3.1.2. Diversity in wild edibles

In India, about 1000 species are consumed as food plants (Arora and Pandey, 1996). Of these, about 300 species occur in northeast region. Various studies show that nearly 323 species of wild relatives of crop plants is concentrated in the warm humid tropical and subtropical regions of northeast India (Arora et al., 1983). Besides these, the region is also regarded as a center of origin of 5 species of palms of commerce coconut (*Cocos nucifera*), areca nut (*Areca catechu*), Palmyra palm (*Borassus flabellifer*), Sugar palm (*Arenga saccharifera*) and wild date palm (*Phoenix sylvestris*).

2.3.1.3. Primitive flowering plants

Eastern Himalaya including northeast India has been considered a sanctuary of ancient angiosperms. A number of primitive flowering plant species grow in eastern Himalaya and further eastwards but do not occur in other parts of India. Takhtajan (1969) based on the analysis of distribution of primitive angiosperm traced the East Himalaya, Fiji region as the 'Cradle of flowering plants' where angiosperms have diversified (Table 10). East Himalyan flora, therefore, has great phytogeographical significance.

Table 10. Some of the Primitive flowering plants occurring in Northeast *(Source: Nautiyal and Kaul, 1999)*

Species	Family
Magnolia griffithii	Magnoliaceae
M. gustavii	Magnoliaceae
M. pterocarpa	Magnoliaceae
Manglietia spp.	Magnoliaceae
Euptelea spp	Magnoliaceae
Tetracentron sinense	Tetracentraceae
Pycnarrrhena pleniflora	Menispermaceae
Haematocarpus thomsonii	Menispermaceae
Aspidocarya uvifers	Menispermaceae
Decaosnea insignis	Lardizabalaceae
Holboellia latifolia	Lardizabalaceae
Stauntonia spp.	Lardizabalaceae
Parvatia brunoniana	Lardizabalaceae
Exbucklandia populnea	Hamamelidaceae
Distylum indicum	Hamamelidaceae
Altingia excelsa	Hamamelidaceae
Houttuynia cordata	Piperaceae
Myrica esculanta	Myricaceae
Betula alnoides	Betulaceae
Alnus nepalensis	Betulaceae

2.3.1.4. Medicinal plant diversity

Northeast region of India is considered a storehouse of medicinal plants. Of the total flowering plants (5000) occurring in northeast region, over 1000 plants are reported to be used as medicine in one or the other way by the local people of the region.

These medicinal plants have been used traditionally in the form of extracts, after mixing with honey, milk and other juice, as vegetable or use directly. Different medicinal plants used by local people living in the region include *Coptis teeta, Aconitum ferox, Panax sikkimensis, Valeriana* sp., *Taxus baccata, Acorus, Rauvolfia*, *Piper, Andrographis*, etc. Due to the maximum utilization of these species by the native people the population of these are depleting very fast in the natural habitat. A comprehensive conservative programme (both *in situ* and *ex situ*) need to be initiated. Besides these, nearly 1200 species are known for their ethnobiological importance, of which about 500 species are edible. Many of these are not much known outside the region and may have potential of providing alternative for food and medicines in the region and elsewhere. Such crops have also been reported to be pest resistant and stand long storage. Medicinal plants are reported to be unscrupulously collected and taken away from the region. Such unregulated collection should be checked immediately and sustainable conservation of MPs could be one of the urgent needs.

Box 2
Some important medicinal plants of northeast India
Sarmah et al., 2000

Botanical name	Local name	Habit
Abroma angusta	Ulat kamal	Shrub
Aconitum ferox	Aconite	Herb
Acrous calamus	Boch	Herb
Amomum subulatum	Bora elaichi	Shrub
Andrographis paniculata	Kal megh	Herb
Aquilaria agallocha	Agar	Tree
Bergenia lingulata	Pashanbhed	Herb
Clerodendrum colebrookianum	Naphaphu	Shrub
Coptis teeta	Mishmi teeta	Herb
Costus speciosus	Kew	Herb
Dioscoria floribunda	Khamalu	Herb
Fritillaria cirrhosa	Yathum	Herb
Gaultheria fragrantissima	Winter green	Herb
Gentiana spp.	Pang-ghen	Herb
Gmelina arborea	Gamari	Tree
Gymnadaenia orchidis	Panch hath	Herb
Orchis latifolia	Salampancha	Herb
Gynocardia odorata	Chalmugra	Tree
Helinia elliptica	Chitraita	Herb
Hypericum spp.	-	Herb
Illicium griffithii	Lissi	Tree
Mesua ferrea	Nahar	Tree
Oroxylum indicum	Bhatghila	Tree
Panax sikkimensis	Ginseng	Herb
Panax pseudoginseng	Ginseng	Herb
Picrorrhiza kurroa	Kutki	Herb
Piper brachystachyum	Pipli	Shrub
Piper peepuloides	Pipli	Shrub
Podophylum hexandrum	Podophylum	Herb
Rauvolfia tetraphylla	Sarpangandha	Shrub
Rauvolfia serpentina	Sarpangandha	Shrub
Rheum emodi	Rhubarb	Herb
Rheum nobile	Rhubarb	Herb
Rhododendron anthopogon	Dhah thee	Shrub
Rubia cordifolia	Manjishta	Shrub
Taxus baccata	imalayan yew	Tree
Terminalia bellirica	Bohera	Tree
Terminalia chebula	Hilika	Tree
Tinospora cordifolia	Amarlata	Shrub
Valeriana spp.	Jatamansi	Herb
Withania somnifera	Aswagandha	Herb
Zanthoxylum armatum	Timur	Tree

2.3.1.5. Endemism in Northeast flora

The region contains very high number of endemic plants, however, there is no comprehensive work available on the subject. Some studies on endemism has been carried out by Nayar (1996) but he also does not mention the exact figure in the region. Chatterjee (1940) estimated that flora of eastern India including Assam and Arunachal Pradesh exhibit 50% endemism. However, present estimate indicates that the region may have up to 30% vascular plants endemic to the region. The genera, which are endemic to the region, are *Biswarea, Bryocarpum, Hymenandra, Jejosephia, Lepidostemon, Neoluffa, Pauia, Pareyaeschkea, Pleurospermopsis* and *Trentlera*.

Box 3
List of some important and unique plants of northeast India. *(Sarmah, et al 2000)*

Species	Family	Status	State	Remark
Nepenthes khasiana	Nepenthaceae	Endemic	Meghalaya	Insectivorous
Balanophora dioica	Balanophoraceae	Rare	Meghalaya	Parasite
Mitrastemon yamamoti	Rufflessiaceae	Endemic	Meghalaya	Parasite
Amentotaxus assamica	Taxaceae	Endemic	Arunachal	Tree
Panax pseudoginseng	Araliaceae	Endemic	Meghalaya	Medicinal Herb
Sapria himalayana	Rufflessiaceae	Rare, Endemic	Arunachal	Root parasite
Helwingia himalaica	Helwingiaceae	Rare	E. Himalaya	Shrub
Paphiopedilum insignis	Orchidaceae	Rare	Mizoram	Ladies slipper
P. venustum	Orchidaceae	Rare	Meghalaya Arunachal	Ladies slipper orchids
Elaecarpus ganitrus	Elaeocarpaceae	Religious	Arunachal, Assam	Rudraksh tree
Platycerium	Platyceraceae	Rare	Manipur	Staghorn fern
Ixonanthus khasianus	Ixonanthaceae	Rare	Meghalaya Arunachal	Tree
Plectocomia assamica	Arecaceae	Rare	Arunachal	giant cane
Gastrodia exilis	Orchidaceae	Rare	Meghalaya	Saprophyte
Podophyllum hexandrum	Podophyllaceae	Rare	Arunachal	Medicinal herb
Coptis teeta	Ranunculaceae	Endemic	Arunachal	Medicinal herb
Livistona jenkinsiana	Arecaceae	Rare	Nagaland Arunachal	Palm
Renanthera imschootiana	Orchidaceae	Rare	Nagaland	Red Vanda
Dischidia rafflesiana	Dischidiaceae	Rare	Arunachal	Pitcher leaved herb
Cymbidium macrorhizon	Orchidaceae	Rare	Arunachal	Saprophyte
Tetracentron sinensis	Tetracentraceae	Rare	Arunachal	Vessel less Angiosperm
Boschniakia himalaica	Orobanchaceae	Rare	Arunachal	Root parasite
Panax sikkimensis	Araliaceae	Rare	Arunachal	Medicinal herb
Edgeworthia gardeneri	Thymaeliaceae	Rare	Arunachal	Currency paper
Albizia arunachalensis	Mimosaceae	Endemic	Arunachal	Tree
Monotropa uniflora	Monotropaceae	Rare	Meghalaya Arunachal	Saprophyte
Illicium griffithii	Illiciaceae	Rare	Arunachal	Star Anise
Gnetum gnemon	Gnetaceae	Rare	Nagaland Arunachal	Shrub (Gymnosperm)

Epipogum sessanum	Orchidaceae	Endemic	Arunachal	Saprophyte
Psilotum sp.	Plitosaceae	Rare	Arunachal	Fern
Rhododendron tawangensis	Reicaceae	Endemic	Arunachal	Tree
Vanda coerulea	Orchidaceae	Endemic	Meghalaya Nagaland	Blue Vanda
Stylidium kunthii	Stylidiaceae	Endemic	Meghalaya	Herb
Meconopsis betonicifoila	Papaveraceae	Rare	Arunachal	Yellow poppy

2.3.1.6. Rarity

Studies on the flora of this region have also revealed many of the plant species, which have become rare, threatened and endangered in their natural habitats. About 800 species have become endangered from northeast region (Hegde, 2000). An assessment of endangered status of various plants of Northeast shows that 300 species are endangered and equally the same number of species is vulnerable which needs immediate conservation measures. This variation in the rarity of the plants need more detailed study for estimating the exact figure.

2.3.1.7. Threats to biodiversity of Northeast region

The Northeast region is also one of the 18 identified 'Hot Spot' with reference to threats faced by the biological diversity (Myers, 1988, MoEF, 1994). Threats to biological diversity or causes of loss of biodiversity in NE India is manifold. Floods are perpetual threats to the biodiversity rich Brahmaputra and Surma (Barak) Valley. Threat to Kaziranga National Park by yearly flooding of the river Brahmaputra is a typical example. But human induced threats are more serious in the region. Most serious immediate causes of biodiversity loss are due to shifting cultivation, habitat loss/degradation/fragmentation and overexploitation.

Shifting cultivation has been a traditional mode of raising food for the indigenous societies for millennia. Shorting of Jhum cycle has posed serious environmental threats, such as deforestation, biodiversity loss, soil and nutrient erosion and a loss of a variety of food crop. Several research institutions are working hard to tackle this problem, and testing various causes of success and failure in modifying the jhum are needed to be documented. Continuance of jhum with shortening jhum cycle has turned out to be a major cause of deforestation. Earlier only the land under current year cultivation was deforested and the rest remained in a successional forest state. For example, with a 20-year jhum cycle, only 5% land remained under cultivation at a given time. However, with a 3-4 year jhum cycle now, almost all the land under jhum is deforested. Extraction of timber to generate revenue for the state

has been even more severe after the Supreme Court's ban on timber extraction in northeast region. Extraction of wood for fuel and house construction is another important cause of deforestation. Establishment of the PAN in the form of Biosphere Reserves, National parks and Wildlife Sanctuaries has come to rescue of some of the most important ecosystems. Involvement of local communities in Government sponsored programmes is desirable and need to be ensured. More importantly, proper enforcement of rules and maintenance would only guarantee the well being of the habitat and biodiversity.

Mining of mineral and ores is another threat to biological diversity of the region occurring in the forests. Mining is not desirable in many areas for fragile nature of ecosystems. The disappointing fact is that private operators without proper technology do most of the mining and Government has little control over it. Coal and limestone quarrying in Meghalaya are the classical examples of disorganized and environment-damaging practices. Therefore, there is an urgent need to legalize, regulate and control mining in NE region.

There is a wealth of knowledge with indigenous tribes pertaining to various activities of day-to day life. These tribes are sustaining with this knowledge without depending on 'foreign' materials. However, the traditional way of life is changing very fast because of increasing exposure, education, development and cash need. The indigenous knowledge systems is losing hold on societies and thus this knowledge is vanishing. Strengthening and documentation of indigenous knowledge is warranted on priority, before it goes extinct. The northeast is the house of many tribal communities. More than 150 tribes of different ethnic groups and cultural entities inhabit the region and partially depend on these forest resources. Agriculture is the main occupation and many of these people practice 'jhum' or 'shifting' cultivation to grow cereals, vegetables and fruits. About 1.73 million ha land is under shifting cultivation in the region (FSI 1999), which is affecting wild plant diversity alarmingly.

Action Points	
Inventorization	Inventorization of plant resources and assessment of their distribution and status in natural habitats. Documentation of lower plants should be initiated keeping in view the importance for the human beings. Documentation of indigenous knowledge about the use of lower group of plants.
Assessment	Intensive exploration of the area/habitats that are reported to be threatened. Indicator and keystone species should be identified especially in the areas, which show unique dominant biodiversity elements, such as, on endemics and wild relatives. Indigenous knowledge base can be effective mechanism in identifying indicator/keystone elements.
Education and awareness	Conservation of plant diversity related programme need to be developed for educating the people, so that plant biodiversity of the region can be maintained.
Policies	Prohibition of illegal collection/harvesting of forest resources through legislation. Impact analysis of such legislation should be a part of terms of reference. Policy should be developed for patenting the process/products derived from economically important species and the royalty obtained should reach to the local people where the patented raw material occurs.
Conservation measure	Establishment of botanical gardens for ex situ conservation. Adequate recognition to the efforts to conserve biodiversity in Sacred Groves.
Domestication and value addition	Domesticate high value taxa that have small population size (enterprise based conservation). Indigenous technologies need to be used for adequate utilization of dominant weeds of the area. This will provide economic benefits to the local people.

2.3.2. The Himalaya

The Himalaya constitute a vast stretch of mountain range about 2500 km long between 27º-36º N Lat. and 73º-97º E Long. covering an area of about 4,23,000 sq km which is approximately 7% of the country's total land surface. Indian Himalaya has been classified into two biogeographic regions i.e. Trans Himalaya and Himalaya. According to Forest Conservation Act 1988, 60% of the land area in the hills has to be under forest cover, while for country as a whole it should be 33%. However, forest cover of Himalayan belt is only 32.36%. The Protected Areas in the Himalayan region (9.6%) is higher than the national average (4.65%). The PA coverage of the region will further increase to over 12%, if the proposals of Rodgers et al., (2000) are implemented. This will correspond well with the accepted realistic target of 10% coverage. The existing figures of PAs and locally conserved protected units are apparantly indicative of the satisfactory state of network system for conservation of representative ecosystem in the region (Table 11).

Table 11. Area, forest cover and protected area of Himalayan region

Area (sq km)	4,23,000
Forest cover (dense>40%)	32.36
Protected area (%)	9.6

2.3.2.1. Status of plant diversity

The floristic wealth of the Himalaya comprises of more than 8000 species belonging to 180 families, both sub-tropical and temperate region (Jain and Sastry, 1978), which is nearly 45% of the Indian angiosperm flora. Of these, 5000 are reported from west Himalaya and 5500 from east Himalaya and majority of these are common to both the sector (Kachroo, 1993, Khoshoo, 1993, Rao, 1993,1994, Singh et al., 1994, Hajra et al, 1996, Singh and Hajra, 1996). The non flowering plant comprise of about 4520 species, which is approximately 16% of total non vascular plants of India. Under this category, gymnosperms account for nearly 81%, pteridophytes (59%), bryophytes (61%), Lichens (59%) and fungi (53%) of India's total (Table 12).

Table 12. Distribution of the various group of plants in Himalayan region

Hierarchical groups	No. of species
Angiosperms	8000
Gymnosperms	44
Bryophytes	1737
Pteridophytes	600
Algae	-
Fungi	6900
Lichens	1159
Special groups	
Wild relatives	675
Medicinal	1748
Endemic	3471
Threatened	121

Plant taxonomy studies have most often focused on higher groups right from the beginning of 19th century in the region. As a consequence, lower groups are poorly studied. Consider the estimated world figure of 35,000 species of algae, only 2.4% have been described so far. Barring scattered reports on algae, list on the recorded species in the region is not known. Of the 1.5 million species of fungi, only 70,000 are known to science. It is, however, interesting to note that over 50% of the total Indian fungi (13,000) are reported to occur in the Himalaya. Besides this huge diversity in the region, there are certain areas, which are not explored so far.

2.3.2.2. Wild edible

Of the reported 1000 edible taxa from India (Arora and Pandey, 1996), about 675 species (67.5%) occur in Himalayan region (Samant and Dhar, 1997). This proportion is comparatively higher than northeast parts of India (Watt, 1989-99, Kanjilal et al., 1934-1940). These wild edibles are utilized in various forms such as tender shoots, leaves, whole plant, seed, fruits, root, tuber and rhizomes. The reported species from the Indian Himalaya region belongs to 384 genera and 149 families. The family Rosaceae (45) showed the highest number of edible species followed by Polygonaceae (30), Moraceae (26), Asteraceae (20), Fabaceae (20) and Euphorbiaceae (15). Among the genera, *Rubus* showed the maximum species (20) followed by *Polygonum* (18), *Ficus* (15), *Allium* (12) and *Dioscorea* (9). The richest diversity of wild edibles (50.96%) exhibited in west, however, trans/north west Himalaya with a wide geographical area showed least (25.04%) of wild edibles. These plant species are collected or

gathered by the local people either for daily consumption or for sale. Of the 675 wild edible species, 39 are restricted to Indian Himalaya. East Himalaya shows the highest number (18 species) of endemics. Potential of deriving value added products from wild edibles has not been attempted so far. The value addition of wild edibles can supplement the economy of rural hilly people as can be seen in some Himalayan multipurpose tree species (Dhyani and Khali, 1993, Dhyani and Dhar, 1994).

The conservation value of wild relatives of cultivated plants is well known. The uniqueness of biodiversity is largely determined by the richness of the wild relatives of crop plants, such as cereals, legumes, nut etc. The Himalayan region is very well known for the occurrence of some important wild relatives restricted to the region. In order to ensure diversification of resource base, maintenance of genetic diversity of wild relatives assumes significance. Of the 320 species of wild relatives and related taxa occurring in India, approximately 60% occurs in the Himalayan region. The Western Himalaya has the more number of wild relatives than the Eastern Himalaya. Considering the rich repository of wild relatives and other valuable species, documentation and utilization practices by local people and their conservation approaches should be followed for further improvement.

2.3.2.3. Medicinal Plants

Indian Himalayan region supports over 1748 (23.2%) of medicinal plant (MP) species. Among these angiosperm are represented by 1685 species followed by Pteridophytes (51) and Gymnosperms (12) (Samant et al., 1998). Over 51 million people of Indian Himalayan region utilize this resource for the treatment of various diseases (Anonymous, 1992). This unique diversity of MPs in the region is manifested by the presence of native (31%), endemic (15.5%) and threatened elements (14%) of total Red Data plant species of Himalayan region and 3.5% of total MPs in different threat categories (Dhar et al., 2000). The maximum diversity of medicinal plants exist in zone <1800 m (1417 species). The species richness is lowest in the zone >3801m. About 62 species of medicinal plants are restricted to the region and identified as endemic, however, 208 species extend their distribution to adjacent areas and classified as near endemic. About 17 species are reported to be rare from the region (Samant et al., 1998). Besides the listing of the species in the different provinces assessment for utilization pattern of these species have not been carried out with the result several high value species remain neglected. Also, most of the high value taxa are endemic to the region, heavy pressure of exploitation has made these taxa rare, and vulnerable, therefore, conservation of

these taxa in their natural habitats and development of suitable cultivation packages need prime importance. Besides these, assessment of variability at different level for identifying superior individuals will be beneficial.

2.3.2.4. Rarity in Himalayan wild plant diversity

The Himalayan wild plant diversity is declining due to various biotic and abiotic factors. In the Himalayan region about 121 species are under different threat categories; estimated to be over 20.7% of the total threatened plants (583) of India (Nayar and Sastry, 1987-1988). The distribution of these plants in different threat categories suggest that about 10 species have been extinct from this region and several others are at the verge of extinction. About 22 species are endangered, 24 are vulnerable, 53 are rare and 12 are indeterminate (Nayar and Sastry, 1987-88). Considering the rate of depletion of habitats of rare species, it is imperative to initiate conservation practices using *in situ* and *ex situ* methods for maintaining this very valuable asset.

2.3.2.5. Endemism in Himalayan flora

The Himalayan region is considered one of the mega hot spots of endemic plant diversity. The region is known to represent over 3471 endemic species. Endemism at high altitude is higher as compared to estimates of entire Himalaya among the temperate families (Dhar et al., 2002). This feature suggests that high altitude could be considered as one of the endemic centers. According to Nayar (1996), 71 genera are found restricted to the Himalaya, 42 confined to the eastern Himalaya while 12 genera are confined to the western Himalayas. The Kashmir Himalaya shows high degree of endemism in dicotyledons (31.38%) than monocotyledons (Dhar and Kachroo, 1983). A report on the endemics of lower group shows that about 58 endemic species of pteridophytes occur in the Himalaya (38 in eastern sector, 4 in western sector and 16 in east and western sector) (Dhir and Saiki 1984). Of the total 480 species of ferns, about 180 are distributed throughout the Himalayan range, 82 are restricted to west and 218 species reported from eastern parts. About 57 endemic ferns have been reported from eastern Himalaya (Bir, 1987). Eastern Himalaya (133) and western Himalayan (22) region are considered centres of rich endemic lichen and liverworts (438) species diversity. Inspite of the higher endemics in the region as compared to northeast and Western Ghats, complete list of plant endemics are not available. Therefore, there is need for documentation, listing and

mapping of the endemic species. Also the studies on population need to be carried out for knowing the status and recruitment behavior of these species.

Action Points	
Survey and assessment	Intensification of exploration in under explored/unexplored areas of the region to develop effective baseline data so as to bridge the gap in our knowledge of floristic diversity in the Himalaya
Monitoring	Studies on population dynamics need to be initiated initially on these plant species with restricted geographic range, high economic value, small population size and high habitat specificity. Permanent plots should be established for monitoring of recruitment behavior of rare, threatened and high value plant species
Sustainable utilization	Sustainable harvest of non-timber forest resources need to be identified for economic enterprises. For example: Fruits of Myrica esculenta can contribute to the cash economy of local rural inhabitants of Kumaun Himalaya if harvested properly. At village level, an average of 60% of households are involved in the harvest and trade of Myrica fruits wherever the resource is available. An average collection of 73-297 kg per households/per season fetches a household Rs 913-3713 (US$ 26-106) per season. This income is significant considering the low annual per capita income in the region (Bhatt et al., 2000). And the production of squash and syrup from the fruits of the species can have contributed much more (Dhyani and Dhar 1994). Likewise, systematic harvest of other NTFPs suggest that these plants could play an important role in the development of economic enterprises
	Assessment of the current requirement of raw material based on the analysis of market trends of herbal drug formulation need to be carried out so that alternative measures can be planned for sustainable utilization. For example- In the Himalayan region assessment of medicinal plants requirement was carried out on the basis of use value index. Assessment of the stock (175 MPs) revealed that users (industry) rely more on exclusive wild form (64.6%) compared to wild cultivated (20%) and cultivated (15.4%) ones. Among wild forms the UVI (Use Value Index) suggest that some of the plants are the most important to users but their focus is more in non Himalayan plants (except Aconitum ferox, Picrorhiza kurrooa) none of high use taxa is Himalayan in origin. Cultivated and wild cultivated forms of users interest, together account for more than 52% of UVI among herbs and contribution of such forms was comparatively low in other life forms (shrubs 28.6%, Trees 17.2%) (Dhar et al., 2000).
Research	Assessing variability of selected species at macro and molecular level will prove useful in identifying traits for better yield.

	Research including the documentation of bioresource utilization practices by local communities and their traditional conservation approaches should be carried out. Field gene banks need to be established for maintenance of diversity in Himalaya.
Participation	Local biodiversity conservation efforts like people's participation programme should be promoted. For example initiatives in this direction have proved very useful in the Himalaya (Dhar 1995-2002). The main aim of these programmes is to involve school children and inculcate awareness through on site training on local biodiversity assessment, documentation, value addition and methods of revegetating degraded lands, development of nurseries and propagation packages. Also the development of preservation models in school/college campuses and on community lands as demonstration plots ensures establishment of area-specific ex situ gene bank.
Database	Electronic databases on subject experts, NGO's, community groups engaged in biodiversity conservation need to be prepared and periodically updated. Electronic database on floristic diversity (including localities, habitat, use pattern) need to be developed which should be accessible to all users.
Capacity building	Biodiversity assessment conservation techniques should form essential component at school and college curriculum.

2.3.3. Western Ghats (*input from B.R. Ramesh*)

The Western Ghats is a unique stretch running from the hills, south of Tapti River in the north to Kanyakumari in the south, along the West Coast of India. The zone lies between 22ºN to 8ºN and covers an area of 1,32,606 sq km. Of the total area, 18.35% is reported to be forest cover and 10.12% in the Proected Area Network (Table 13). Administratively the 1600 km. long mountain range runs through six states, from Tamil Nadu to Gujarat, which include interesting eastern offshoots like the Palni, Annamalai, Nilgiri, Biligiri Rangan, Bababudan and Satmala hills. Based on the floristic composition and other natural factors, the Western Ghats have been divided into 4 phytogeographical units (a) the Western Ghat from river Tapti to Goa, (b) from river Kalinadi to Coorg (c) the Nilgiri and (d) the Anamalai, Palni and Cardamon hills. The Western Ghats is characterized by a wide array of diversity in term of climate, geology, soil and biota.

The vegetation of the Ghats is relatively well known compared to other tropical areas (Ramesh and Pascal, 1997). The region is characterized by 12 main evergreen vegetation types grouped into three main categories according to the altitude: (i) those occurring in the plains and at low elevation, (ii) at medium elevation and (iii) at higher altitude. The forest of the Western Ghats, are some of the best representatives of nonequatorial tropical evergreen forests in the world (Pascal, 1988,1991).

Table 13. Area, forest cover and protected area of Western Ghats

Area (sq.km)	1,32,606
Forest cover (dense>40%)	18.35
Protected area (%)	10.12

2.3.3.1. Status of plant diversity

The Western Ghats cover only 5% of total area of the country but host nearly 4000 species (27% of the total) flowering plant (Nayar, 1996). Of these, about 3,100 species occur in the close wet evergreen and dry evergreen forest. The family Poaceae represents maximum number of species (420) followed by Fabaceae (220), Orchidaceae (250), Acanthacee (165), Cyperaceae (160), Euphorbiaceae (140). Bamboos are also well represented (8 genera and 24 species). Gymnosperms are poorly represented in Western Ghats. Only 4 species (*Cycas circinalis, Podocarpus wallichianus, Gnetum ula, G. latifoila*) are known from this region. Western Ghats support about 321 species of ferns and 23 species of fern allies (14).

Table 14. Distribution of various groups of plants in Western Ghats

Hierarchical groups	No.of species
Angiosperms	4000
Gymnosperms	4
Bryophytes	963
Pteridophytes	321
Algae	-
Fungi	600
Lichens	800
Special groups	
Wild relatives	
Medicinal	200
Endemic	1500
Threatened	700

The analysis of the biodiversity in pteridophytes shows that the family Aspleniaceae consist maximum number of species (27) followed by Polypodiaceae (25), Athyriaceae (24), Thelypteridaceae (23) and Selaginellaceae (20), however, *Asplenium* (27), *Selaginella* (20) and *Pteris* (17) are the dominant genera of this region.

Of the total lichen diversity (800 species), 519 are crustose, 220 foliose and 61 fruticose forms within 104 genera and that is the highest estimate recorded so far for any lichenogeographical region in India (i.e. 39.6% of the total Indian flora). The Palni hills comprises of about 318 species in 75 genera. A small collection of lichens from the rain forest of Silent Valley revealed 77 species. At the species level family Graphidaceae contains 97 species and 5 genera ranks first in order of dominance and *Graphis* is the largest genus of about 38 species. This region also shows 20.1% (161 spp.) of endemism among lichens.

As far as bryophitic diversity of this region is concerned this bryogeographical territory comprises two distinct physiographic regions (a) the West Coast (b) the Western Ghats. This territory supports about 280 taxa spreading over to about 32 families and 79 genera, which accounts for about 35% of the total liverwort flora of the country. Of these, family Chonecoleaceae and Schistochilaceae, 9 genera and about 121 species are confined to this region alone in Indian bryoflora. Lejeuneaceae, with 85 taxa is the largest family and Cololejeunea (23) is the largest genus in this territory. These territories are further characterized by the presence of 65 endemic species including intraspecific taxa. Of these 41 taxa are confined to this region only. The genera *Archilejeunea, Cololyeunea, Fossombronia, Metzgeria* and *Notothylas* shows higher endemism in these territories as compared to any

other bryogeographical region of the country. It is interesting to note that this territory is considered to be the center of origin and diversity for the genus *Notothyles* (Singh, 1995).

The Western Ghat is further characterized by the moss diversity. Nearly 540 species of mosses have been recorded with 3 endemic genera i.e. *Hyophilopsis, Nanothecium* and *Trigonodictyon.* The mosses represent over 190 species, which are endemic to Western Ghats of Maharashtra and Karnataka.

2.3.3.2. Medicinal plant diversity

The region constitute very valuable species of medicinal importance. About 200 species of such important medicinal trees used for treating various diseases, from cancer to rheumatism occur in the Western Ghats. According to Ramesh and Pascal (1991) there are 490 arborescent taxa represented in the low and medium elevation to the region. Further, the southern part, corresponding to the hills of southern Kerala and the hills comprises 87% of the total endemic tree species of the Western Ghats. This is regarded as a main center of endemism in southern India. With regard to the important medicinal trees endemic to the Ghats, over a dozen species are endemic. *Vepris bilocularis* and *Humboldtia vahliana* are considered to be rare and endemic to the hills whereas *Buchanania lanceolata* and *Myristica malabarica* are considered endemic, rare, and threatened.

2.3.3.3. Endemic diversity

Because of its geographic isolation and subsequent evolution, the Western Ghats is one of the richest centers of endemism in India. Of the 4,000 species of flowering plants in Western Ghats, 1500 species are endemic (Nayar, 1996). There are about 60 endemic genera of which 49 genera are monotypic.

Nearly 63% of India's arborescent evergreen taxa are endemic to the Western Ghats (Ramesh and Pascal 1991). Among the evergreen tree species, 56% are endemic (Ramesh and Pascal 1997). A database has also been created for these species to analyze species distribution pattern in relation to ecological gradients and for assessing the possibilities of conservation in their natural habitat (Ramesh and Pascal, 1997). The high level of diversity and endemism in Western Ghats has given it the status of one of the hot spot of the world (Myers, 1988). Two mega centers of endemism i.e. Southern Western Ghats and Northern Western Ghats fall in this region. Southern Western Ghats is rich in endemic plant diversity and shows the presence of 1051 endemic species of flowering plants, however, the North Western Ghats shows only 140 species (Nayar, 1996). Considering the status of a mega

endemic center, a detailed study of endemism in the Western Ghats is also necessary to provide precise scientific information to the decision makers to help them define the priorities in the conservation policy for the forests and species of this region (Ramesh and Pascal, 1997). The southern section of the Western Ghats is by far the richest area in context of floristic composition and concentration of endemic taxa (1286 spp.). Some of the extremely threatened /endangered plants of this sector of the Western Ghats are *Caralluma truncatao-coronata, Cynoglossum ritchiei*, *Hubbardia heptaneuron, Leea talbotii, Leucas angustissima, Neanotis ritchiei* and *Viscum mysorense*. These plants are on the verge of extinction. The montypic genus *Hubbardia* is feared to be already extinct as in *Viscum mysorense*, both of these could not be located even in type localities.

The Western Ghats considered to be 'Biological treasure' of India has more than 6000 species of flowering and non-flowering plants (Manilal, 1988). More than 700 species of flowering plants of Western Ghats have become endangered. The montane Shola, (a very special biome in the Western Ghats) consists of evergreen forest and 'grassland' occurring above an altitude of 1,800 m in the high range. The montane Shola forests possess over 60% flora restricted to the Western Ghats, with 20% tropical montane and 5% Indo-Malayan elements. The shola have been drastically altered by wholesale plantation of wattle, tropical pines and other commercial species so that no more than 5% of the potential area of 5,000 sq km now remain under natural forest cover.

Box 4
Silent Valley in the Western Ghats- The Seat of origin and Evolution of Biological species on Earth
(Sinha 1997)

India's richest evergreen forests are located in the Silent valley of Western Ghats. It covers only 5% of India's land surface and they have more than a fourth (about 4000) of the country's plant species. about 1500 species are endemic. The Silent Valley forests are complex natural ecosystems with many are varied ecological niches providing ideal habitats for specialist species of all kinds. The cryptogamic flora of Silent valley is unique, containing many new and rare species. Many medicinal plants and wild relatives of species such as *Piper, Myristica, Elettaria* etc. are found to be growing abundantly in Silent valley. Some new records of medicinal plants, such as *Cyclea barbata* Miers, a native of Malaysia and adjoining islands are also reported from Silent valley. The vegetation of Silent valley is quite varied with rich diversity of flora

The increase in anthropogenic pressure in and around the Western Ghats in the last few decades have changed the forest cover considerably. In Kodagu district of Karnataka nearly 18% of the forest area has been degraded or lost to coffee and cardamom plantation. In the entire Western Ghats of Karnataka, Tamil Nadu and Kerala states, 40% of the natural vegetation has been reported by commercial and forest plantation between 1920 to 1990 (Menon and Bawa, 1997). Shifting cultivation, domestication, grazing of cattle, mining in the mountainous valleys and the hills causes depletion of forests and their regeneration.

Action Points	
Characterization	Current sampling strategies and information storage and handling capabilities should be further strengthened to characterize biodiversity elements and their habitats. This will also help in building the conservation value maps.
Monitoring	Effective monitoring of endemic rich plant biodiversity areas must be initiated.
Exotic invasion	Measures should be taken to prevent the invasion of exotic species especially in reasonably pristine areas to ensure maintenance of ecosystem health. Naturalized exotic elements (35 in number) in the region provide opportunities for research in terms of adaptability and suitability in varied climatic conditions.
Prioritization	Prioritization of sites and species for people oriented conservation action must be taken up.
Permanent plots	Establishment of permanent biodiversity monitoring plots to gauge the state of the forest, to provide baseline data, and to monitor ecosystem changes will help in creating "permanent representative observatory" for developing management practices.
Development initiatives	Sustainable utilization of useful plant biodiversity elements could be taken up through appropriate intervention of Self-Help Groups, NGOs and Cooperative Sector after identifying potential sectors of economic activity, such as, medicinal plants cultivation, Orchid development and Marketing of Rattan and Bamboo products. Joint Forest Planning and Management (JFPM) experiment in some parts of the region have proved useful to bring paradigm shift in overall approach. Participatory mode of this experiment should be further strengthened and extended. For example: In Karnataka, the Joint Forest Planning and Management Programmes (JFPM) was started in 1993 coincided with the initiation of the Western Ghats Forestry and Environment project. Forest provides different levels of benefits to society, which comprises food medicine, fodder, fuel wood, fibres etc. In order to ensure proper flow of benefits to all groups, the people of Karnataka, under JFPM practice have been differentiated into two groups, based on the dependence on forests i.e. primary stake holders and secondary stake holders. On the basis of Karnataka JFPM policy following fundamental changes are required: Villagers must be given full (100%) and sole right over all extractable

	forest produce, including autonomy in marketing. Village-level bodies must have full autonomy in day-to-day decision-making processes regarding all aspects of forest and public land management. Village-level institution must govern all public lands that are used for extraction of biomass resources by the village community and which the villagers are willing to manage together including degraded and undegradedlands, other revenue department lands, panchayat and other common lands. Efforts to promote eco-tourism activity in potential areas of the region must be undertaken.

2.4.4. Mangroves (*input from L.K. Banerjee*)

Mangrove ecosystem is well known for greater diversity of fauna and flora as well as a greater degree of specialization in structure and function. Though species diversity is very low in this ecosystem due to dominance of large physiological forces of saline tidewater and lack of stable substrate but it commands the highest importance by virtue of their biological productivity, specialized adaptive diversity, complexity in the ecological process and finally the importance of the biodiversity resources, which are used directly or indirectly.

About 6740 sq km littoral region including deltas, estuaries, backwaters, Bay Island and lagoon in India are protected by extensive cover of mangrove community. The distribution of mangrove diversity is found in Andaman and Nicobar group of Oceanic island, Sunderbans in the gangetic delta of W. Bengal, Mahanadi deltaic complex of Orissa coast, Coringa, Godavari and Krishana delta of Andhra Pradesh, Pitchavaram and Muthuet in Tamil Nadu, Khambat, Cambay, Saurashtra and Kutch in Gujarat, Bombay, Ratanagiri, Malvan, Devgad and Vijayadurg in Maharashtra, Mandovi-zuari estuary of Goa, Coondapur, Hannover and Malpe in Karnataka and Koch, Vembanad, Quilon, Trivandrum, Kananore, Kozhikod and Kottayam in Kerala.

2.4.4.1. Status and distribution

Represented by 30 families, 43 genera and 68 species excluding salt marshes and some orchids available in mangrove habitat is an interesting feature in Indian mangroves. The richness of the species decreases from the East Coast towards the West Coast and finally from monotypic strand in the western part of the Gulf of Kutch (Table 15).

Table 15. Diversity of families, genera and species of mangroves in India (*Source: Banerjee, 2001*)

	India	East Coast	West Coast	Andman and Nicobar
Families	29	28	20	22
Genera	43	42	26	32
Species	69	63	35	49

The major mangrove area along the east coast of India are found in the Gangetic Sunderbans region in West Bengal, The Mahanadi deltaic complex in Orissa, The Godavari-Krishna deltaic system in Andhra Pradesh and Couveri estuarine complex in Tamil Nadu. These east costal mangrove areas are considered to be the best habitat and commonly harbor about 63 mangrove spp out of the total 69 species in India. The associated mangrove flora in the area belong to so-called “Indo-Pacific”origin from Malaysia, Australia and East Africa,

and the biodiversity is appreciably more rich and diversified than that of 'Australia' or 'Atlantic' region.

Along the West Coast, no major deltas are found except the small estuaries of the Narmada and the Tapti River and a few other hyper saline shallow estuaries in Saurashtra, Gulf of Khambat and Gulf of Kutch. Mangroves are found confined here towards the small pockets of backwater system such as Mandovi-Zuaria estuarine in Goa, along the intertidal creeks and canals of Kalinadi in Karowar, Coondapur, Honover and Malpe in Karnataka, eight minor lakes in Kerala, Cochi, Vembanad, Quolon, Trivandrum, Cannanore, Kozhikode, Kottayam and along some creeks and estuaries in Maharashtra.

2.4.4.2. Pecularities of mangrove ecosystem

Mangroves are found mainly in the tropical and sub tropical sheltered coastline with dark green shining foliage and negatively geotropic roots. They show maximum modification in their morphology, physiology and biochemical activities with superficial adaptive characteristics like pneumatophores, stilt roots and vivipary for withstanding partly submerged saline situation. There are about six species, which are endemic. Some species are threatened due to excessive demographic pressure, over utilization, over exploitation and the loss of habitat. About 57 species were categorized as threatened in India. Compared to other taxa, a large percentage of these were also in higher threatened categories, 12 (20.3%) were critically endangered and 42 (71.15) were endangered (Kumar, et al., 2000). The highly restricted distribution of most species is considered the major threat. The decline in habitat quality due to pollution, siltation, timber harvesting was the assessed sub criteria. However, over exploitation especially from timber and firewood is identified as a major threat, with local trade in most of the species. Some species of mangroves are used in various life support systems such as medicinal (6 spp), fodder (2 spp) and others (5 spp).

Besides the angiosperms, mangrove ecosystem is represented by number of marine macro algae. About 48 species have been reported from mangrove ecosystem. Of these, 23 species belonging to three major groups are: green algae (Chlorophyta), brown algae (Phaeophyta) and red algae (Rhodophyta). Marine algae have important industrial application as dyes and bioactive substances. Out of the 23 species that were assessed 14 were threatened, two being Critically Endangered and 12 being Endangered (Kumar et al., 2000).

2.4.4.3. Threats to mangroves

During the past, mangrove forests were exploited by the traditional users for firewood, domestic fuel, charcoals, fodder, etc. and for that many of the mangrove forests were destroyed in different parts of India. Subsequently other uses like timber, plywood, paper pulp, conversion of mangrove forest areas into other land use pattern and construction of railway lines were the serious problems for conservation of mangrove forests. In the present day the problems of conservation have become more serious due to increased population pressure, political division of the country, encroachment of land or rehabilitation, development of different industries, thermal and hydroelectric power projects, diversion and blockage of natural canals and creeks, resettlement, aquaculture and agricultural activities, construction of new ports and conversion of mangrove land to urban development scheme along the coastal belt. Increased population pressure and exploitation over the last hundred years have led to noteworthy reduction of both floristic components as well as areas of mangrove cover in India. The Kerala back water system was once supported by luxuriant growth of mangrove formation but now very few mangroves are seen in the midst of coconut plantation. During the last 2-3 centuries the mangrove forest areas in Sunderbans have been seriously reduced due to agricultural and aquacultural practices. The remote sensing study indicates a reduction of 20 sq km of area of mangrove forests during last 10 years in Orissa. In Saurashtra, Gulf of Kutch and Gulf of Khambat significant reduction of mangrove forests were seen due to constant pressure for fodder, fuel and camel grazing. Mangroves in Maharashtra, Andaman and Nicobar Island and Sunderbans are facing major problems for more land required in Urban Development Scheme and for agricultural practices. All the above destructive activities of the mangrove forests have given the chances to realize the practical value of the mangrove ecosystem in India by several ways.

Action Points	
Conservation measure	Conservation of small and big islands for speciation and addition of new lands. There is a need to develop an effective, ecologically based land use policy in mangrove areas Fodder banks need to be established to prevent ruthless ravaging of mangroves

Current knowledge and status of wild plant diversity

India is among 12 mega-biodiversity countries, which together harbor 70% of the world's flowering plants (McNeely et al., 1990) and rightly called mega biodiversity center. Over 45,000 plant species are reported to occur in India, representing 11% of the known world flora (Mudgal and Hajra, 1997-1999, Sharma et al., 1997, Karthikeyan, 2000). About 33% flowering plant and 29% of the total Indian flora is endemic which contributes to the rich plant diversity in the country (Table 16)

Table 16. Floristic diversity in different groups

Groups	Species	Endemic	References
Angiosperm	17672	5725 (32.4%)	Nayar, 1996, Present study
Gymnosperms	48	7 (14.5%)	Singh and Mudgal, 1997
Pteridophytes	1135	193 (17%)	Ghosh and Ghosh, 1997
Lichens	2021	466 (23%)	Singh and Sinha, 1997
Bryophytes	2850	938 (33%)	Vohra and Aziz, 1997, Singh 1997
Algae	6500	1924 (29.6%)	Rao and Gupta, 1997
Fungi	14500	3500 (24.1%)	Sharma, 1997

The Indian flora shows affinity with several countries and regions due to continuity of India's northern part of landmass with Middle East, former USSR, Central Asia, China and East Asia. Some elements in Indian flora belong to distant places like Africa and Australia and thus show discontinuous distribution. Besides these, the flora of northeastern India has rich admixture of floristic elements of Malesian, Burmese, Sino Tibetan, Japanese and to a lesser degree even of Australian region. Similarly, certain floristic elements of Western India and the Ghats of Peninsular region are common with Sri Lanka and eastern parts of South Africa. The flora of Andaman group of Islands is more common with the flora of Mayanmar while the Nicobar group of Islands show affinity with the flora of Indonesia and Malaysia (Jain and Sastry, 1983).

Box 5
Affinity of Indian Flora

Considering the great affinity of the Indian flora with the surrounding countries Hooker (1904) arrived at the erroneous conclusion that India has no flora as a separate entity but is an admixture of the floras from the adjacent countries. Subsequent phytogeographrs after critical analysis of flora convincingly concluded that India has a flora of its own and in fact as many as 5000 species are endemic to this region (Chatterjee 1940, 1962; Nayar, 1980)

India's rich vegetational wealth and diversity is undoubtedly due to the immense variety of climatic and altitudinal variations coupled with varied ecological habitats. For example: almost rainless areas to the highest rainfall areas in the world, the altitude varies from the sea level to the highest mountains range in the world, with the habitat type variation from the humid tropical Western Ghats to the hot desert of Rajasthan, from the cold desert of Ladakh and icy mountains of the Himalayas to the long, warm cold line stretches of Peninsular India. The extreme diversity of the habitat has resulted in such luxurious and variety of flora and fauna that almost all types of forest ranging from scrub forest to the tropical evergreen rain forest, coastal mangrove to the temperate and the alpine flora occur in this region. Status of floristic diversity in India can be described as follows:

3.1. Hierarchical groups

3.1.1. Species richness

3.1.1.1. Angiosperms

The reported number of species for the flowering plants varies between 16,500–19,395 taxa (including intraspecific categories) under 247-315 families and represent roughly 7% of the described species in the world (Mudgal and Hajra, 1997-1999, Sharma et al., 1997, Karthikeyan, 2000). However, the present analysis (review of available information) suggests presence of 17672 species in the country. Family Poaceae is the largest in India being represented by 1291 species followed by Orchidaceae, Fabaceae, Asteraceae, Rubiaceae, Cyperaceae, Euphorbiaceae, and Acanthaceae, Lamiaceae and Scrophulariaceae (Table 17). About 42 families have more than 100 species, however, 33 families are represented by only one species. Among genera, *Impatiens* with 205 taxa is the largest genus in Indian flora followed by *Primula* (135), *Ficus* (132), *Carex* (117), *Crotalaria* (104), *Habenaria* (100), *Dendrobium* (100), *Pedicularis* (98), *Rhododendron* (97) and *Syzygium* (91). About 189 genera are monotypic (Uniyal and Mathur, 1991). These genera add significantly to the conservation of the world genetic resources, as there are no closely related genomes of these anywhere in the world.

Table 17. Distribution of the species in dominant angiospermic families *(Source: Sharma 2000*)

Family	No. of genera	No of species
Poaceae	263	1291
Orchidaceae	184	1229
Fabaceae	133	1192
Asteraceae	166	800
Rubiaceae	113	616
Cyperaceae	38	545
Euphorbiaceae	84	527
Acanthaceae	92	500
Lamiaceae	72	435
Scrophulariaceae	62	368

Indian region has approximately 107 species of aquatic angiosperms, which represent nearly 50% of the total aquatic plants of the world (Rao, 1994). The most dominant families of aquatic angiosperms are Alismataceae (14), Hydrocharitaceae (18), Najadaceae (14), Nymphaeaceae (7), Podostemaceae (20), Lemnaceae (14), Potamogetonaceae (18) and Ceratophyllaceae (3). Presence of insectivores plants such as *Aldrovand* (1), *Drosera* (3), *Nepenthes* (1), *Pinguicula* (1), *Utricularia* (36), parasites (*Balanophora, Boschniakia himalaica, Orobanche* sps, *Aeginetia indica, Rhopalocnemis phalloides, Saparia himalayana* and saprophytes (*Monotropa* sps, *Cymbidium macrorhizon)* are the rich source of botanical curiosities in Indian flora (Sharma and Singh, 2000).

Box 6
Hot spot of angiosperms flora
(Source: Rao and Bhaskar Dutt 1994)

The large size of the country and variety of habitat conditions have contributed to great biological diversity particularly in the flora of India. About 315 families of flowering plants (out of about 400 are now defined) are represented here. Richness of flowering plants suggests three hot spots of wet humid tropical forests i.e. Andaman & Nicobar Islands, Eastern india and Southern Western Ghats, which require conservation protection. Considering the different biomes of the Indian subcontinent the wet evergreen forests of India occupy 51249 sq km of area and hold about 7000 species, which is 46% of Indian flora.

In the angiosperm plants certain families have immense ornamental value. For example - the orchids, represented in India by over 1200 species with maximum representation in the Eastern Himalaya and Northeast region; the *Rhododendron*, 90 taxa in India, of which 80 species are confined to east Himalaya. Besides these, the diversity of *Hedychium* (40 spp.), *Primulas* (135 spp.), *Pedicularis* (98 spp.), *Corydalis* (53 spp.), *Geranium* (32 spp.) etc. are noteworthy. Furthermore, on account of the presence of over 131 species of primitive angiosperms the region is considered as a 'Cradle of Flowering Plants' (Takhtajan, 1969). Some important ancient genera are as fallow (Table 18).

Table 18. Distribution of ancient genera in different families (*Source: Nautiyal and Kaul, 1999, Takhtajan, 1969*)

Families	Genera
Magnoliaceae	*Magnolia, Manglietia, Michelia, Pachylarnax, Paramichelia, Talauma*
Tetracentraceae	*Tetracentron*
Annonaceae	*Alphonsea, Annona, Artabotrys, Cythocalyx, Desmos, Fissistigma, Friesodielsia, Goniothalamus, Melodorum, Miliusa, Mitrephora, Orophea, Polyalthia, Trivalvria, Unona, Uvaria*
Myristicaceae	*Horsfieldia, Knema, Myristica*
Schisandraceae	*Kadsura*
Lauraceae	*Actinoodaphne, Alseodaphne, Beilsahmiedia, Cinnamomum, Cryptocaria, Dehaasia, Endiandra, Lindera, Litsea, Machilus, Neocinnamomum, Persea, Phoebe*
Chloranthaceae	*Cholaranthus*
Menispermaceae	*Pycnarrrhena, Haematocarpus, Aspidocarya*
Lardizabalaceae	*Decaisnea, Holboellia, Stauntonia, Parvatia*
Hamamelidaceae	*Exbucklandia, Distylum, Altingia*
Piperaceae	*Houttuynia*
Myricaceae	*Myrica*
Betulaceae	*Betula, Alnus*

The immense diversity met in flowering plants of India not only provides ecological security to the nation, but also contributes significantly towards the economic benefits. It is estimated that about 3000 species of flowering plants are of potential medicinal value, of these 1300 species are extensively used in different systems of medicine, such as Ayurveda, Siddha, Unani and Allopathic system of medicine. Besides these, there are large number of species, which are important source of essential oils, spices, gums, resins and oleoresins, fatty oils, tannins, dyes, fibres, beverages and fodder.

India is one of the worlds 12 Vavilovian Centre's of origin and diversification of cultivated plants known as the "Hindustan Centre of Origin of Crop Plants" (Vavilov, 1951). These wild relative of crop plants (WRCPs) constitute a rich reservoir of genetic variation of immense value to plant breeders. They have evolved to survive drought and floods, extreme heat and cold and have been adapted to cope with natural hazards (Hoyt, 1988). They have often developed resistance to pests and diseases and are thus crucial to crop improvement. About 320 species of these wild relatives (116 genera and 48 families) are known to have originated in India (Arora and Nayar, 1984). The distribution of these crop groups is presented (Table 19).

Box 7
Status of WRCPs
(*Source: Arora and Nayar, 1984*)

The wild relatives of crop plants are distributed through out the country. The diversity in different region is as follows: Malaya/Western Peninsular Region (145), followed by Northeastern region (132), Western Himalaya (125), Deccan/ Eastern Peninsular Region (91), Eastern Himalaya (82), Gangetic Plains (66), and Indus Plains (45).

Table 19. Distribution of wild relatives in different crop groups (*Source:Arora 2000*)

Crop groups	No. of species
Cereals and millets	51
Legumes	31
Fruits	109
Vegetable	54
Oilseeds	12
Fibre plants	24
Spices and condiments	27
Others	26

Inspite of the migration of floristic elements from other contiguous or neighboring regions, India has rich number of endemic elements. About 33% of the Indian flowering plants (5725 species, 146 genera, 47 families) are regarded as endemic and they are mainly located in 24 centers of the country (Nayar, 1996). Besides endemics, nearly 10% of flowering plants are assessed under various categories of threatened species. Red Data Book of Indian plants listed 620 threatened species. Of these, 28 are presumed extinct, 124 endangered, 81 vulnerable, 160 rare and 34 insufficiently known (Nayar and Sastry, 1987, 1988), however, RED list of threatened plants indicates 19 species as extinct. Among others, 1236 species are assessed as threatened. Of these, 41 taxa are possibly extinct, 152 endangered, 102 vulnerable, 251 rare and 690 of indeterminate status (IUCN, 1997).

Action points	
Conservation measures	Establish gene banks (ex situ) for conservation of angiosperms. Ex situ conservation can be initiated for rehabilitation of rare/threatened, endemic and economically important species. Methods should be developed for sustainable utilization mechanisms of economically important taxa and domestication of such species. Research and monitoring of important angiosperms should be carried out. Promotion of community based regeneration programme for economically useful species must be undertaken.

3.1.1.2.Gymnosperms

Gymnosperms are lesser in number as compared to angiosperms. They occupy extensive tract of sub tropical and temperate regions of Himalaya and the hilly areas of Andhra Pradesh and Andaman Island (Singh and Mudgal, 1997). However, they are not found in Central India (Basu, 1994). They are represented by members of Cycadales, Coniferales, Ginkgoales, Taxales and Gnetales (Biswas, 1933, Sahni, 1953, Raizada and Sahni, 1960). The Cycadales with palm like habit are confined to limited area in the tropical and sub tropical region of the world. The order Ginkogales with a monotypic family Ginkgoaceae is represented by a single species *Ginkgo biloba*. The order Coniferales form the most conspicuous order constituting major forest type primarily in temperate region of the northern and southern hemisphere. The most familiar and economically important genera in this group include *Pinus, Cedrus Abies, Juniperus*, *Cupressus* and *Tsuga*. The order Gnetales are represented by living genera in this group include *Gnetum, Ephedra*, *Welwitschia* and *Sarcopus.* The order Taxales comprise of single family and two genera i.e. *Taxus* and *Amentotaxus.*

Of the total 750 species (53 genera) of Gymnosperms in the world, about 60 species (17 genera) occur in Indian subcontinent. However, in the present boundaries of India, 48 species and 10 varieties under 14 genera are known to be growing in wild. Out of the 11 families of living gymnosperms found in India 3 families i.e. Ginkgoaceae, Araucariaceae and Taxodiaceae are exotic. Among the remaining 8 families, Pinaceae is the richest family represented by 6 genera and 17 species (Table 20).

Table 20. Distribution of the genera and species in different families of gymnosperm *(Source: Singh and Mudgal, 1997)*

Name of the families	No. of genera	No. of species
Pinaceae	6	17
Cupressaceae	2	8
Ephedraceae	1	8
Gnetaceae	1	5
Cycadaceae	1	4
Taxaceae	2	2
Cephalotaxaceae	1	2
Podocarpaceae	1	2

Apart from 48 indigenous species, about 26 species are exotics, which are now flourishing profusely in Indian climate and thus enriching the species diversity of Indian

Gymnosperms. For example: *Cycas revoluta* a native of Japan and China is cultivated in Indian gardens for its beauty. *Ginkgo biloba* is a living fossil and native of Chekiang and Anhewi provinces in Eastern China is in cultivation at Dehradun, Mussoorie, Shimla, Srinagar, Shillong and other places having moist and cool climate. Three species of *Araucaria* (*A. bidwillii, A. columnaris, A. cunninghamii*), which are found in Southern Hemisphere are successfully introduced in Indian gardens and parks between 1000-1500 m altitude. Out of the 48 species found in India, 23 species occur in Western Himalayan region, 28 species in Eastern Himalayan region, 5 species in Andaman and Nicobar Islands and 4 species known to occur in Western Ghats (Table 21).

Table 21. Distribution of the Gymnosperms in different region *(Source: Singh and Mudgal, 1997)*

Region	**No. of species**
Western Himalaya	23 (48%)
Eastern Himalaya	28 (58.3%)
Andaman and Nicobar Islands	5 (10.4%)
Western Ghats	4 (8.3%)

Conifers are the most dominant among the Gymnosperms and largely confined in the Himalayan landscapes except *Podocarpus wallichianus* (Peninsular India and Andaman) and *P. nerifolius* (Eastern Himalaya and Andaman). The present coniferous flora of India is dominated by the genera of Northern Hemisphere viz. *Pinus, Abies, Cedrus, Picea* etc. whereas the genera from Southern Hemisphere like *Agathis* and *Araucaria* are only introduced. In the Himalaya, the species diversity is not much prevalent in western Himalayan region but the coniferous forests are more extensive and dense than Eastern Himalayan region (Singh and Mudgal, 1997). Out of the 48 species of Gymnosperms, 7 are endemic to Indian flora (Table 22).

Table 22. Distribution of the endemic species in different region *(Source: Basu, 1994)*

. **Name of species**	**Area**
Cycas beddomei	Andhra Pradesh
Amentotaxus assamica	Assam and Arunachal Pradesh
Pinus wallichiana	Arunachal Pradesh
Gnetum montanum	Assam
G. contractum	Kerala and Nilgiri
G. latifolium	Andaman and Nicobar
Ephedra przewalskii	Kashmir

Like other plant species, gymnosperms are also under threat. Their extensive population in nature is gradually depleting due to great demand of timber for various purpose. The activities of human population particularly in Western Himalayan region have posed numerous problems. The extraction of resin from the very young trees of *Pinus* species at various places has affected the growth and finally reduced the life span of tree. About 6 species and 2 varieties are reported to be threatened (Table 23).

Table 23. Status of threatened gymnosperms *(Source: Basu, 1994)*

Species	Status	Remark/causes of threat
Amentotaxus assamica	Vulnerable to extinction	Deforestation, shifting cultivation, grazing and road building,
Pinus gerardiana	Restricted distribution	Seeds of economic product
Cedrus deodara	Endangered	Deforestation
Picea brachytyla	Restricted	Ruthless and reckless cutting
Gnetum ula	Scarce	Planting of Eucalyptus, Pinus and other fast growing species
Cephalotaxus mannii	Very scarce	Shifting cultivation

Gymnosperms are most important for providing timber, wood, pulp, resin, tar, turpentine and also planted for checking soil erosion. They also produce about 25% of the wood requirement of the country. Cones of pines and other conifers are used for interior decoration as green plants. The hilly tribal communities of Meghalaya and Assam eat tender shoots of *Cycas pectinata* as vegetable. The leaves of *C. cercinalis* are used in making mats in south India and Sago is also obtained from the trunk. *Cupressus corneyana* are planted as sacred trees around villages and monasteries in Sikkim and Arunachal Pradesh. *Ginkgo biloba* is known for its scientific purpose, as an interesting "living fossil". The Andmanese tribe eats the cooked fruit of *C. rumphii*. The seeds of *Pinus geradiana* commonly known as 'Chilgoza' are relished as dry fruit during winter season.

Gymnosperms are also known to be medicinally important. For example: the taxol extracted from *Taxus wallichiana*, is used in curing the ovarian and breast cancer. Similarly, Ephedrine a drug obtained from some species of *Ephedra* is of great importance in the treatment of asthma and other bronchial troubles. *Cycas revoluta* is said to be a tonic and expectorant. The oil extracted from *Pinus gerardiana* is applied on wounds and ulcers.

Box 8
Conservation issues of Indian Gymnosperms
(Source: *Basu, 1994*)

Some of the Gymnosperms in India require immediate conservtion attention:
Amentotaxus assamica – requires urgent steps to identitfy and demarcate certain areas in Arunanchal Pradesh which are rich in rare taxa e.g. *Cephalotaxus, Amentotaxus* as nature reserve sanctuary, National park or biosphere reserve. In any case *A. assamica* must be preserved urgently at Lloyed Botanic Garden Darjeeling and experimental garden of the Botanical Survey of India at Shillong. It is certainly vulnerable to extinction in view of activities like shifting cultivation and afforestation.

Ginkgo biloba – an interesting "living fossils" is recommended for ceremonial plantings in cooler climates. It is tolerant to smoke and pollution and reputed to live over 1000 years in and around temples. In the Indian subcontinent it would flourish in the Himalayas, adjacent hills and hilly region of peninsular India.

Cephalotaxus mannii and *C. griffithii* – These two species are very scarce in the Eastern Himalaya and Naga hills. They occur in areas of shifting cultivation and are recommended to be put on endangered flora list. Propagation by seed or cutting is in practice. Germplasm multiplication and conservation is a practical step requiring special efforts.

Action points	
Research and Monitoring	Methods should be developed for sustainable utilization mechanism of highly valuable taxa e.g. *Juniperus macropoda, Taxus baccata, Ephedra, Abies, Pinus* etc. Research and monitoring of important gymnosperms should be carried out

3.1.1.3. Pteridophytes (inputs from R.D. Dixit)

In Indian sub-continent, the Himalayas, Gangetic plains and Thar Desert are recognised as pteridophyte centers. Maximum diversity of Pteridophytes is observed in the Himalaya. The lesser rainfall from Eastern to Western Himalaya is responsible for decline in species number. About 10,000 species of pteridophytes occur in the world flora, of these 1135 species occur in different parts of the India. The Polypodiaceae is the largest (137 species) family and *Selaginella* is the largest genus. An analysis of species diversity in different pteridophytic zones is given (Table 24).

Table 24. Distribution of pteridophytes in different pteridophytic zones *(Source: Ghosh and Ghosh, 1997)*

Pteridophytic zones	No. of species
Eastern India	810
Southern India	336
Western India	321
Andaman and Nicobar Island	125

The pteridophytes grow in a variety of habitats and in all climatic zones of the country showing maximum diversity between 1300-2400 m. Several species like *Woodsia andersonii, W. alpina, Dryopteris wallichiana* and *Cystopteris fragilis* occurs at high altitude (4200 m), however, certain species like *Acrostichum speciosum* and *A. cureum* grow in Mangrove forest. The pteridophytes prefer shady and moist places but a few species like *Adiantum lunulatum, Psilotum nudum* also grow on rocks covered with mosses and *Woodsia elongata, Actiniopteris radiata* survives in dry places.

Nearly 17% (193 species) of pteridophyte flora is endemic to India. Considering richness and uniqueness of pteridophytic flora, Himalaya constitute a very significant and phytogeographically important region in the world. Of the total 480 fern species in the Himalayas about 12% are endemic (Dhir and Saiki, 1984). Majority of endemic elements are reported from eastern Himalayan region (Dixit, 1984).

Box 9
Monotypic genera of pteridophytes
(Source: Dixit and Papia, 1994)

About twenty monotypic genera of pteridophytes occur in India. The species represented by monotypic genus are being considered in the category of threatened taxa by virtue of their representation by a singler species and even a slight disturbance in their habitat may be responsible for turning their fate from endangered to extinct category.

The monotypic genera are: *Ampeloptris prolifera, Blechnedium molanopus, Brainia insignis, Cheilanthopsis stramine, Christensenia aesculifolia, Diacalpe aspidiodes, Dictyocline griffithii, Didymochlaena truncatula, Gymnogramitisdareiformis, Helminthostachys zeylanica, Idiogramma microphylla, Kuniwatsukia cuspidata, Leptogramma totta, Lithostegia foeniculacea, Lauerssenia kehdingiana, Lycopodiastrum casuarinoides, Palhinhaea cernua, Pseudodrynaria coronans, Quercifilix zeylanica, Sinephropteris delavayi*

About 254 species (21.58%) of pteridophytes fall under different categories of threat (Ghosh and Ghosh, 1997). Forest cutting and mining are mostly affecting the pteridophytic population. For example: throughout the Himalaya (excluding Kashmir and beyond Banihal range) oak forest are the rich repositories of ferns, both in number of individuals and variety of species. Rich assemblages of fern thrive on the moss laden moist bark of oak trees. The tree trunks and branches are heavily laden with ferns. Thus each oak tree cut in the Himalaya brings down with it fern individuals in their hundreds and amongst these are included very valuable species from botanical and phyto-geographical points of view. Mining has done great damage to terrestrial species in Kashmir, Jammu, Mussoorie, Dehradun, Pauri and Kumaon region. About 20 genera of pteridophytes represented by single species occurring in India have been prioritized for conservation (Dixit, 1994).

Box 10
Tree Ferns: an urgent need for conservation
(Source: Dixit 1994)

Tree ferns are most attractive plants among pteridophytes and are well known for their gigantic foliage. The main trunk is considered best habitats for growing orchids at home or sending outside the country. The pith of main trunk is edible by Adivasis in Eastern India. All the species of tree ferns are fast disappearing from the Indian scenario due to its exploitation for trade and habitat destruction. The biosphere reserve established so far would serve the purpose of their conservation, however, its exploitation by local, naturalists and collectors should be strictly banned. The species of tree ferns occurring in India are: *Alsophila andersonii, A. balakrishnanii, A. constularis, A. gammei, A. gigantes, A. khasiyana, A. nilgirensis, A. spinulosa, Sphaeropteris albosetacea, S. brunoniana, S crinita, S. glauca, S. holttemiana, S. nicobarica*. In all 14 species of tree ferns occur in India, of which 5 are endemic.

Pteridophytes are used as medicine and ornamental since ages. They are widely used as a dye i.e. *Sphenomeris chinensis*. There are numerous species, which have great ornamental and medicinal value. Several species of *Selaginella, Pteris, Adiantum, Nephrolepis* and *Asplenium* are becoming popular in horticulture for beauty and variety of their fronds are on demand and find place on terraces of houses in corridors of hotels, parks and gardens. Various species of pteridophytes i.e. *Anisogonium esculentum, Botrychium lanuginosum, Ampelopteris prolifera* and *Ceratopteris thalictroides* are used as a vegetable. *Adiantum capillus-veneris* and *Marsilea minuta* are mentioned as of medicinal importance in 'Charak Samhita'. *Selaginella bryopteris* known as 'Sanjivani' is widely used as tonic. The spores of *Glycopodium* are used as powder on skin. The decoction of fronds of *Actinopteris radiata* is used against excessive bleeding during abortion. The decoction of *Adiantum lunutam* is used as diuretic. The fronds of *Asplenum adiantum-nigrum* are used in Unani System of Medicine, and leaves are used in spleen complications.

Action Points	
Sustainable use	Considering pteridophytes as ornamental (*Selaginella, Pteris, Adiantum Nephrolepis* and *Asplenium*) and medicinal *(Adiantum capillus-veneris*, *Selaginella bryopteris*, *Lycopodium spp*, *Actiniopteris spp.*, *Polystichum* etc.), cottage industry could be developed to augment economy and meet livelihood needs.
Research thrust area	To promote taxonomic studies, viz., autecology and role of gregarious species within PAs/ managed areas need to be studied so that biology of the pteridophytes and its linkages with other corresponding biodiversity components could be understood. *Ex situ* conservation can be initiated for rehabilitation of rare/threatened and endemic species.

3.1.1.4. Bryophytes

The bryophytes, hitherto less known group of plants, comprising of 2850 species, are the 2nd largest group of green plants in India (Vohra and Aziz, 1997). They are considered as the first colonizers of the terrestrial habitats. They usually inhabit narrow ecological niches with preference for damp and shady condition. The vast areas in Himalayas and Peninsular India with abundant precipitation and high humidity are rich in bryophytes as compared to the large plains stretching over greater part of the country. An interesting feature of the bryophytes is the heteromorphic alteration of generations wherein the dominant phase is represented by haploid gametophytes subtending a short lived, diploid sporophyte, fully or partially dependent on it. Based on the structure and characteristics of two, bryophytes have been broadly grouped into Mosses (Musci) and liverworts (Hepaticae).

3.1.1.4.1. Mosses

Mosses constitute the major component of Indian bryoflora with about 2000 species (342 genera and 54 families) (Vohra and Aziz, 1997). Of these, 1030 occur in Eastern Himalaya, 751 in Western Himalaya and 540 in Western Ghats (Table 25). About 608 taxa of mosses are endemic to India and eastern Himalaya support maximum number of species (270) followed by Western Ghats (190) and western Himalaya (144).

Table 25. Distribution of mosses in different bryological zones *(Source: Vohra and Aziz, 1997)*

Zone	Family	Genera	Species	No. of endemic
Eastern Himalaya	53	276	1030	270 (26.2%)
Western Himalaya	47	215	751	144 (19.2%)
Western Ghats	42	171	540	190 (35.2%)

Eastern Himalaya is considered richest both in number of species as well as their abundance. The semi evergreen and evergreen forests support luxurious moss vegetation. The maximum number of taxa occurs at high elevation. Of the 1030 species, 509 taxa are acrocarpic while the rest are pleurocarpic. The eastern Himalaya have a high proportion of endemics (270 spp., 27%) is considered a region of active speciation. The genus *Fissidens* show highest number of endemic species (17) followed by *Calymperes* (10), *Entodon* (9), *Brachymenium* (6). Many of the species have not been collected again and remain represented by types only. Many of them are generally confined to smaller areas and have a preference for a particular habitat or a niche. For example: *Andreaea commutata, A. densifolia, A. indica, A. rigida, Polytrichastrum xanthopilum, Polytrichum densifolium, Pleuridium tenue, Ditrichum laxissimum, Trematodon megapophysatus* and *Dicranoweisia alpina* (Vohra and Aziz, 1997).

The Western Ghats support over 540 species of mosses (171 genera and 42 families). Of these, 347 are acrocarpic while 355 are pleurocarpic. The humid tropics of Southern Western Ghats (500-1500 m) shows richness in moss vegetation (Vohra, et al., 1982). These areas are among the least explored areas of the country. The region has higher number of endemics (190 spp., 35%). Of the reported species, 30 species are confined to Western Ghats of Maharastra and Karnataka and remaining species are endemic to Palni, Nilgiri or some other places of Peninsular India.

The Western Himalaya comprises of 751 species (215 genera and 47 families) of mosses. Of these, 443 taxa are acrocarpic and 308 are pleurocarpic. About 144 species (19.2%) are endemic to the area. There are few monotypic genera endemic to the region i.e. *Cyathothecium, Mitrobryum, Octogonella, Orthotheciadelphus* and *Retidens*. Except for *Mitrobryum koelzii*, which was collected from its type locality from Tehri Garhwal in recent years, none of these genera have been collected again. The genus *Brachythecium* contains large number of endemic species (21). Most of the endemics are confined to the high altitude areas of the Himalaya (Kashmir and Himachal Pradesh). Also, endemics occurring in Kumaon and Garhwal are considerable in number. Some of the important endemic plants are

Buxbaumia himalayensis, Andreaea kashyapii, Campylium gollani, Hygroamblystegium gangulianum, Hygrohypnum nairii, Brachythecium chakratense, B. garhwalense, Pseudoleskea laevifolia, Thuidium contortulum, Plagiothecium dehradunense, Hydrogonium mussoorianum, Anoectangium kashmiriense.

3.1.1.4.2. Liverworts (Inputs from: D.K. Singh)

The liverworts are represented by 852 species (141 genera and 52 families) and accounts for nearly 14% of global liverwort flora (Udar, 1976, Kachroo et al., 1977, Srivastava and Udar, 1979, Singh and Semwal, 2000-2001). The order Jungermanniales (629 spp.) alone account for above 74% taxa (Singh, 2001). The varied phytoclimatic conditions, met in different parts of the country are fully manifested in the distribution pattern and composition of liverwort flora in India. They show maximum diversity in the eastern Himalaya, with about 548 species accounting for over 64% of the total liverwort flora of the country. The Western Ghats (280 species, 30%) and the Western Himalaya (235 species 28%) are two other liverwort rich areas. Considering bryological territories, three major centers of diversity and diversification of liverworts are present in India. The rest of the country together accounts for only 135 species (15.8%). Based on the liverwort vegetation in different regions, seven bryogeographic units have been set up in India (Pande, 1958, Singh, 1992, Singh and Semwal, 1995). The distribution of liverworts in different bryogeographical territory is presented (Table 26).

Table 26. Distribution of liverworts in different bryogeographical territories (*Source: D.K. Singh, 2001)*

Bryogeographical region	Family	Genera	Species
Eastern Himalaya	44	111	548
Western Himalaya	40	77	235
Punjab & W. Rajasthan	13	17	34
Gangetic plains	9	11	18
Central India	21	32	61
Western Ghats	32	79	280
Eastern Ghats & The Deccan Plateau	14	14	33
Andaman & Nicobar	12	40	53
India (Total)	52	140	850

About 260 species (30%) of the Indian liverwort taxa are endemic to the country (Srivastava, 1994; Singh 1997; 1999; 2001). This includes one family Aitchisoniellaceae and four genera. The east Himalayan region hosts the maximum of 150 (58%) of the total endemic taxa of the country. Out of these, 90 taxa are confined to this territory alone, the rest are common with other bryogeographical regions (except the Gangetic Plains, Central India and the Andaman & Nicobar Islands). This is followed by the Western Ghats (65 taxa, 25%) with 4 taxa restricted to this region alone. The western Himalaya (54 taxa, 21%) have 34 taxa (including the monotypic family Aitchisoniellaeae) confined to this territory. The remaining bryogeographical regions, Punjab and West Rajasthan have 12 taxa, Andaman and Nicobar Island eight, the Central Indian region 6, the Gangetic plain 5 and Eastern Ghats and the Deccan plateau have only one (*Antoceros bharadwajii)* endemic taxa, which also occur in Himalaya, the Central India and the Western Ghats.

The family Notothylaceae (70%) followed by Anthocerotaceae (68%), Exormothecaceae (67%), Haplomitriaceae (67%), Scapaniaceae (58%), Plagiochilaceae (52%), Tarioniaceae (50%), Cephaloziaceae (42%), Cephaloziellaceae (38%) and Metzgeriaceae (33%) are the endemic rich families of liverworts in India (Singh 1997).

An analysis of the composition of liverwort flora in different bryogeographical regions highlights their uniqueness with each of them being characterized by some of their own floristic elements. For example: The west Himalayan region is characterized by the presence of four endemic, monotypic genera, like *Aitchisoniella, Sewardiella, Sanchia* and *Stephensoniella,* an endemic monotypic family Aitchisoniellaceae and 34 species endemic to this territory alone. The east Himalayan region hosts 6 out of 14 species of family Haptomitriaceae, a phylogenetically as well as phytogeographically important group, which is

highest for any geographic region in the world (Chandra et al., 1987). This territory is also characterized by the presence of such monotypic genera as *Gerhildiella, Schiffneria and Diplocolea* and about 90 species endemic to this region alone. The genus *Cyathodium,* which is represented in India by 8 species, is also endemic to the region (Singh, 1983; Srivastava and Dixit, 1996). On the other hand the Liverwort flora of Western Ghats is characterized by the dominance of Afro-tropical elements and the presence of such phytogeographically interesting genera as *Choneolea, Lethocolea, Tylimanthus*, species of *Schistochila* and about 41 taxa endemic to this territory alone. This bryological zone also hosts maximum number of species of the genus *Notothylas* and is regarded as its center of origin and diversification (Singh, 1994).

Box 11
Threat to liverwort flora
(Source: Singh, 1997)

The populations of a number of species of liverworts have shown considerable decline in recent years. Nearly 100 species of liverworts are rare and vulnerable to various threats due to biotic as well as natural factors The major biotic factors responsible for depletion of liverworts are the habitat destruction. Because of highly circumscribed habitat requirements of the bryophytes together with the niche specificity of different communities, they are extremely vulnerable to any change in the environmental regime. The removal of vegetal cover not only affects the epiphytic as well as epiphyllous communities directly, but also exposes the terrestrial communities to various environmental rigors. Construction or broadening of roads are often scrapping of roadsides during tourist/pilgrimage season also take a heavy toll of terrestrial liverwort communities. The disappearance of *Notothylas khasiana* from its type locality on Shillong-Cherrapunjee highway near Shillong is one such case in point. The natural factors, which affect the liverworts, include earthquake, flood and biological impurities of the species for example: the major earthquakes in the Assam region during the close of 19th century might have totally destroyed the type locality of *Monoselenium tenerum.*

Action Points	
Explorations in potential sites	Extensive Bryological Explorations in different bryogeographical regions of the country, especially the Himalayas, the Western Ghats and Andaman and Nicobar Islands should be undertaken. Species-specific surveys to relocate the rare and threatened species with maps.
Conservation measures	Declaring Bryophyte-rich sites as "Bryophyte sites" for *in situ* conservation of species. Establishment of Bryophyte gardens in different altitudinal zones for ex-situ conservation and education.

	Ex situ conservation can be initiated for rehabilitation of rare/threatened and endemic species Capacity building, both in terms of HRD and institutional infrastructure coupled with more opportunities need to be initiated.
Environmental indicators	Considering the role of bryophytes in habitat modification, nutrient cycling and pollution detection and monitoring, taxonomic research and training should be promoted/encouraged. This will help in capacity building.
Indicators of mineral wealth	Autoecology of species on biogeochemical aspects should be carried out for understanding the biology and linkages with other biodiversity elements and as indicators of mineral deposits.

3.1.1.5.Lichens (Inputs from: K.P. Singh)

Lichens are an interesting group of plants representing a symbiotic association of fungi and algae and constitute a dominant component of epiphytic and saxicolous vegetation. They constitute one of the dominant life forms (a little over 8%) on earth's surface (Ahmandjian, 1995). The diverse climatic and altitudinal conditions coupled with varied ecological habitats of the country have contributed immensely to the rich lichen wealth of India. At present about 2021 species of lichens in 248 genera are known to be distributed on various substrata in different lichenogeographical region of India (Singh and Sinha, 1997), and constitute an interesting component of Indian flora across the tropical to alpine zone. Western Ghats are the richest with 800 species (39%), growing predominantly in tropical and subtropical shola forests, followed by Eastern Himalaya with 759 species (37%) and Western Himalaya with 550 species (27%). The other region has comparatively poor representation of lichen species primarily due to their meager survey and collection. For example, Andaman and Nicobar islands are represented by about 307 species, followed by Gangetic plain (224), Central India (48), Western Dry Region (39), Eastern Ghats and Deccan Plateau (31) (Table 27).

Table 27. Distribution of lichens in different lichenographical regions (*Source: K.P. Singh and Sinha, 1997)*

Region	No. of genera	No. of species
The Western Himalayan region	119	550
The Eastern Himalayan region	147	559
The Western dry region	24	39
The Gangetic plain	63	224
The Central India	23	48
The Western Ghats	140	800
The Eastern Ghats	23	31
Andaman & Nicobar Island	66	307

A large number of Indian lichen species are cosmopolitan in distribution and show phytogeographical affinities with the flora of adjacent and distant regions. The eastern Himalayan lichen flora has several species common with Sino-Japanese and Southeast Asian countries. The lichens from the western Himalayas show closer affinity to the northern European elements. As far as rare lichens are concerned it is difficult to pin point rare lichen in Indian flora because vast area (90%) of the country remained either unexplored or under explored, and data on exact location, taxonomy, population studies and distribution of species are not well known. However, estimate suggest that over 300 species would be rare in Indian lichen flora. Similarly endemic lichens are quite large in number (446 species, 23%) and majority of them confined to microlichens.

Lichens have great economic as well as ecological significance. Lichens and lichen substances have great economic value as food, antibiotics, accumulators of radioactivity, anti-toxicants, dye stuffs, fodder, perfumes, etc. Further due to their physiological sensitivity, lichens are reliable indicators and useful biological measuring devices for atmospheric pollution. The lichens produce primary and secondary metabolites. Besides, polysaccharides, etc., the majority of the organic compounds in lichens are secondary metabolites, which have great economic potential. According to a report, about 630 secondary metabolites are known to occur in lichens and most of them are unique and do not occur in other plants. They are mainly used in dying, flavoring, smoking tobacco and cigar, sambar masala, scenting soaps and cosmetics and the manufacture of ‘Dhoop’ and ‘Hawan Samagri’. Besides, a large number of tribal population in Madhya Pradesh, Andhra Pradesh, Santhal Parganas in West Bengal, and Chotanagpur in Bihar, used many species such as *Heterodermia tremulans, Everniastrum cirrhatum, Parmotrema reticulatum, P. tinctorum, Ramalina subcomplanata*,

Usena longissima, Roccella montagnei, R. belangeriana, etc. as spices and flavoring agents to increase the taste and fragrance of nonvegetarian preparation. A large number of tribal population of Baiya, Bhil, Bhielala, Gond, Korka and Muria communities inhabiting Bastar, Bilaspur, Dhar, Jhabua, Madla, Shahdol and Surguja districts of Madhya Pradesh, bring lichens to their local markets for sale to earn money for their livelihood. Lichens are also used in industry because they contain aromatic resinoids. The bulk of Indians for this purpose, commercially known as 'Charila' or 'Jhoola','Salaj phool' and 'Hara phool' are transported from Western and Central Himalayas and are sold in the market at a rate of about Rupees 2500/- 4000/- per tonne. About 1000 tonnes of lichen material are collected from nature to meet the industrial requirements every year. 'Charillal' consists of *Everiastrum nepalense* and *E. cirrhatum* and is utilized by the manufactures of smoking tobacco, kitchen masalas and dhoop. *Parmotrema nilgherrense* popularly known as 'Salaj phool' is used in leather industry. The 'Hara phool', which is a mixture of *Usnea lucea* and *Ramalina subcomplanata*, is used as adulterant of 'Charilla' or as an ingredient in dhoop mixtures. In folklore also, the medicinal uses of lichens are often mentioned. For example, *Peltigera canina* is eaten as a remedy for liver ailments.

Action Points	
Documentation	National compilation of the lichen flora with special emphasis on protected areas needs to be started. Preparation of Red Data List, management of rare and endangered species and definite guidelines for monitoring as well as publication of the available information on the status and trends of these resources. Institutionalize surveys of lichens to determine the distribution pattern and their screening for discovery of potential biomolecules.
Conservation and awareness	Explore the possibilities of in-vitro studies of rare and endangered taxa Creation of public awareness for lichen conservation.

3.1.1.6. Fungi (Inputs from: J.R. Sharma, V.B. Hosagaudar)

The majority of non-flowering plants are fungi. They constitute a group of heterotrophic organism subsisting as parasites or as saprophytes on other organisms or their residue. They range from microscopic organism to huge solid bodies from lifesavers like penicillin to killers such as ergot, from rusts and mildews which damage growing crops to yeasts which have been used since time immemorial in the preparation of food and drinks. Fungi of all kinds are of vital important to nature house keeping as they breakdown and recycle all the organic debris of the world which would otherwise long since have smothered and buried all the plants and animals that yielded it. Approximately 14,500 species in 2300 genera have been reported from India (Bilgrammi et al., 1991, Sharma, 1997). Deuteromycotina, Ascomycotina and Basidiomycotina account for more than 88% of the Indian mycoflora. Deuteromycotina, alone represents 40% followed by Ascomycotina (25%) and Basidiomycotina (23%) (Table 28). It is interesting to note that out of 2300 genera of Indian fungi, 1050 (46%) have only one species while 1237 (53%) have 2-100 species. *Cercospora* is the genus having over 500 species followed by *Puccinia* (320), *Phyllosticta* (280), *Aspergillus* (140), *Meliola* (130), *Phyllachora* (116) and *Aecidium* (100). Of the total 14500 species, 3500 (24%) species are endemic to India.

Table 28. Distribution of fungi in various groups *(Source: J.R. Sharma, 1997)*

Groups	Genera	Species	Endemic
Myxomycota	50	365	30
Mastigomycotina	87	710	140
Zygomycotina	45	300	40
Ascomycotina	680	3500	900
Basidiomycotina	520	3400	500
Deuteromycotina	900	6000	1850

Fungi constitute a useful resource in the Indian flora and have been used as edible elements from prehistoric times. They are also used in making antibiotics. Atleast over 60 species belonging to genera *Polyporus, Bjerkendera, Schizophyllum, Trametes, Amantia, Fomes, Fomitopsis* and *Ganoderma* find use in folk medicines. *Lentinus edodes* (anticancerous), *Ganoderma lucidum* (tonic, anticancerous, diabetes), *Amantia muscaria* (epilepsy), *Trametes versicolor* (anticancerous), *Agaricus campestris* (heart and mental disorders) are some medicinal mushrooms that dominate in the market. *Agaricus* is used as a remedy in goiter disease. The fungus is dried in sunlight and tied around the neck. In modern

times, some edible mushrooms have also gained importance on the basis of their pharmacological values. *Agaricus campestris*, *Flamulina mellae* and *F. odilpsis* are known to possess antibacterial activities. A wide variety of antifungal activities have been attributed to *Lentinus edodese, Cortinellus shiitake* and *Coprinus comatus. Tricholoma populinum* is claimed to be of value against hay fever and allergic blood vessel inflammation if consumed regularly. In India, the tribes use macrofungi for medicinal purposes i.e. *Astraeus hygrometricus, Calvatia cyathiformis, Cyathus stercoreus, Cyathus limbatus, Lycoperdon pusillum, Microporus xanthopus, Phallus rubicandus, Termitomyces microcarpus, Xylaria polymorpha.* Inspite of the fact that this group has been estimated as a most valuable group among the plant kingdom no serious work has been carried out.

Action Points	
Comprehensive inventories	Initiate the preparation of Red Data List of large fungi (habitat wise) and assessment of occurrence and general distribution of larger fungi is required.
Conservation initiatives	Conservation of those habitats (grasslands, pastures etc) which may be less worthy for flowering plants but are important for mycoflora. Ex situ initiatives should be promoted for multiplication of wild edible mushrooms. Preservation of natural and semi natural habitats by establishing protected areas in different geographical zones. Selected plantation of certain trees (oak, pines etc.), which support a specific groups of ectomycorrhizal/wood-rotting fungi, to facilitate potentially favorable habitats for these fungi. Legal protection to a few charismatic and popular fungus species needs to be initiated.
Management intervention	Wise management of harvesting wild edible mushrooms for commercial purposes by way of over picking, habitat disturbance, overturning logs and trampling. The preparation of code of conduct for collection issue of license for picking up mushroom will help to some extent. While limited harvest may be allowed in some forest areas but the picking should be strictly regulated in protected areas. Reduction of environmental pollution (acidification, nitrogen concentration) in densely populated and industrialized regions will help in maintaining and restoring the ectomycorrhizic flora including edible mushrooms.
Thrust areas	Biochemical analysis of important plants should be conducted to understand its economic importance. Ultrastructural studies are needed.
Enriching knowledge base and capacity building	To develop broad based mycology curriculum in Indian Universities, increase number of workers on taxonomy and ecology of fungi, use of rural adults as parataxonomists – persons trained to collect, sort and prepare material for subsequent examination by taxonomists to be ensured so that the skill and knowledge of retired persons is properly used. Also, rural knowledge on traditional use be blended with this activity. To sell mycology to younger generation by arranging short courses, delivering lectures and leading fungus foray for general public. The

	ventures like cryptogamic sanctuary gardens may be used as potential basic tools for educating children and public about the role fungi play in the ecosystems.

3.1.1.7. Algae

Algae is represented by over 6500 species in 666 genera. They are found growing in variety of habitats ranging from fresh water terrestrial and marine soil. The fresh water algae dominated by chlorophyceae (green algae), bacillariophyceae (diatoms) and Cynophyceae (blue green algae) represent the majority of Indian algal flora accounting for 390 genera and 4500 species followed by terrestrial algae (125 genera and 615 species), soil algae (80 genera and 1500 species), marine algae (169 genera and 680 species) (Rao and Gupta, 1997).

The marine algae (sea weeds) known for their varied colours, are an attractive group of plants found growing on the ocean floor and the long stretches of Indian sea coasts. Out of 680 species, so far recorded, 50% belong to Rhodophyceae, 25% to Chlorophyceae, 22% to Phaeophyceae and 3% to Cyanophyceae. The Gujarat coast, the Islands in Gulf of Mannar and Andaman and Nicobar group of Islands shows the luxuriant growth of marine algae. The coastal population of Tamil Nadu use one of the red seaweeds *Gracilaria edulis* as food. The east coast with about 2600 km coastline, which is an integral part of the Eastern Ghats, supports luxuriant seaweed vegetation. The biodiversity of marine algae is highest along the Tamil Nadu coast and decrease towards Andhra Pradesh and Orissa with predominance of vegetation representing 299 species in Tamil Nadu, 89 species along Andhra Pradesh coast 3 species along Orissa coast and 9 species along West Bengal. Along the coastline of India, the littoral and sublittoral rocky areas support a good growth of different seaweed. There are luxuriant growth of seaweeds along the south east coast of India from Mandapam to Kanyakumari, Gujarat, Lakshadweep, Andaman and Nicobar Islands, fairly rich seaweeds beds are presently in the vicinity of Bombay, Ratnagiri, Karwar, Vorkale, Kovalam, Vishkhapatanum, Vizhinyam and few other places like Chilka and Paulicat lakes. The total standing crop of the seaweeds in the country estimated so far is 2,60,876 tonnes. More than 806 species of seaweeds belonging to 4 groups of algae namely green, brown and red were recorded from Indian coastal waters.

The utilization of seaweeds in India at present is restricted to extraction of phycocolloides agar-agar and algin form red and brown seaweeds such as *Gelidiella acerosa*,

species of *Gracilaria, Sargrassum* and *Turbinaria*. Although all the seaweeds are beneficial to mankind in one way or the other, only 49 species which are presently found useful either directly as edible and industrial raw material. At present *Gelidiella acerosa* and *Gracilaria edulis* are used as raw material for the production of agar agar in India. The most economically important seaweeds are the members of Phaeophyceae and Rhodophyceae i.e. species of *Sargassum, Gelidium, Gelidiella, Gracilaria* and *Gigartina*. The recent findings showed that some seaweeds might be utilized for the production of biogas and as biofertilizers may lead to indiscriminate exploitation of our seaweed resources little realizing that eventually some species may be lost forever.

Action Points	
	Promotion of algae as biofertilizers. Taxonomic research and training should be promoted/encouraged, which will help in capacity and opportunity building. Indiscriminate collection of marine algae in bulk for their biological screening should be checked and monitored.

3.2. Special Groups

3.2.1. Medicinal Plants

India is bestowed with the rich heritage of medicinal plants (Jain, 1990). The use of medicinal plants for curing disease in human society in the country is almost as old as man himself. The earliest mentioned use of medicinal plant is found in the Rigveda. After the Vedas there is no information on the development of this science for a period of about 1000 years. It is stated that during this phase all relied on herbal treatments as their major health care system. Considering the importance of the medicinal plants in the primary health care need the people used to conserve these plant resources. At that time the science of medicine was not highly developed and also the pharmaceutical industries had not become a part of large industrial houses for production of medicinal formulations. Following the advent of modern medicines, herbal medicine suffered a setback. However, in recent years advances in phytochemical analysis and identification of new chemical compounds was found effective against various disease i.e. cancer, vascular disorders. This renewed interest in herbal medicine and medicinal plants have registered a new high. Even the developed world, which is mostly dependent on modern medicine, is looking towards the benefits of herbal drugs. In India, the indigenous system of healthcare covered under Ayurvedic, Unani and Siddha suggest over 95% prescriptions contain plant products.

3.2.1.1. Status

India probably has the oldest, richest and most diverse, cultural traditions in the use of medicinal plants and about 3000 flowering plants are known for their medicinal uses (Ved Prakash, 1998). Of these, over 2000 medicinal plants have been documented (Pandey and Bisaria, 1998) and 600-700 species are commonly used in the country by rural inhabitants. They use these plants as a household remedy in several diseases. About 150 species find place in commerce and many of these are exported. Studies reveal that village communities use a large proportion of the medicinal plants for human and veterinary health care. As per the survey of AICEP and Anthropological Survey of India, 1994, over 7,500 species of plants have estimated to be used by “the ecosystem people” who belong to over 4635 ethnic communities. Majority of these have medicinal importance. Status of medicinal plants under different system is presented (Figure 1).

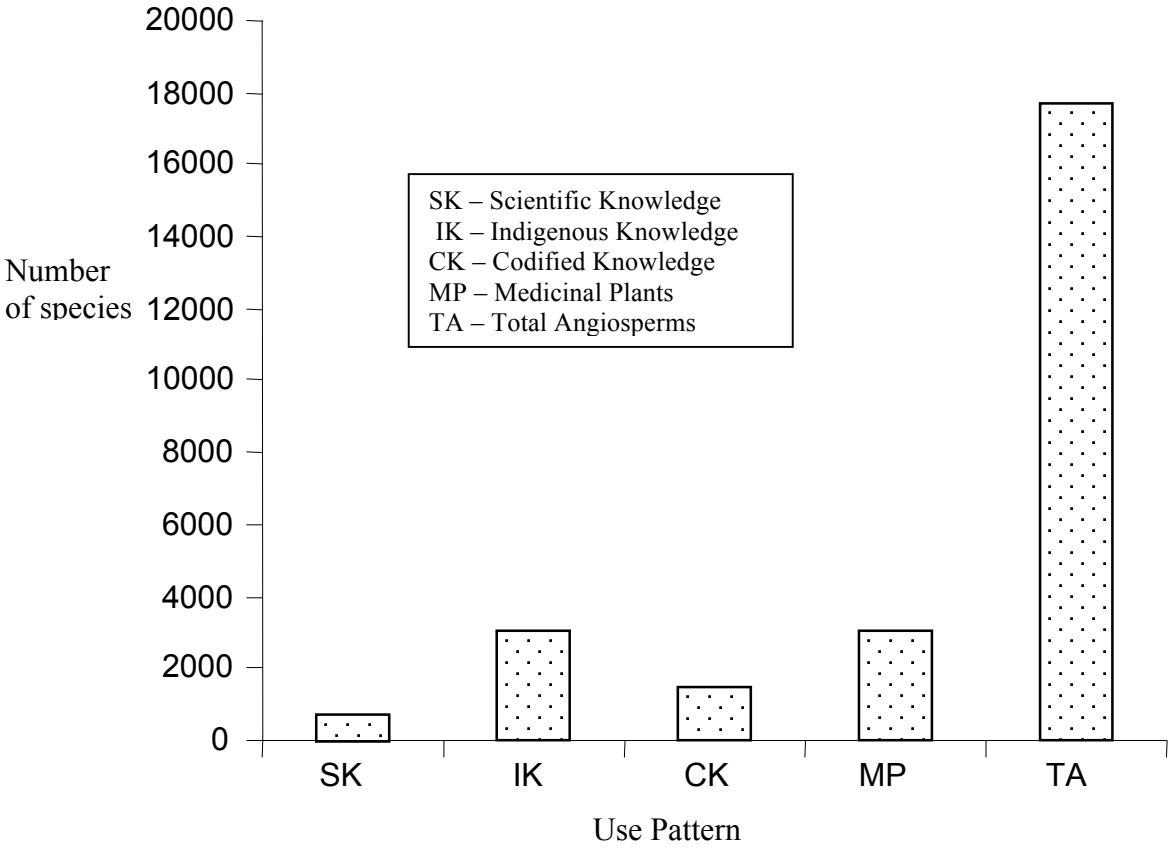

Figure 1. Status of medicinal plants in different systems

Source: Modified after Ved Prakash, 1998

Evidences suggest that the experimental investigation on medicinal plants used in folk or indigenous system can lead to identification/extraction of many novel molecules. At present, 121 biologically active substances of known structure are extracted from 105 plants, which produce different useful drugs throughout the world. About 74% of these compounds have same or related uses from which they are derived (Farnsworth et al, 1991). These compounds are the major source of pharmaceuticals, food additives, fragrance and pesticide. It is estimated that the market potential for herbal drugs in the western world alone could range from US $ 4.9 billion to 47 billion by the year 2000. A similar situation is existing for plant based food additives, fragrances and biopesticides. Natural resources for plant based chemicals are limited but the consumer preference for natural products is large.

Box 12
Examples of some plant derived natural products and their industrial use
(Source: Merillon and Ramawat 2000)

Industry	Plant product	Plant species	Industrial use
Pharmaceuticals	Codeine, Morphine	*Papaver somniferum*	Antitussive, Analgesic
	Diosgenin	*Dioscorea deltoidea*	Antifertility agent
	Quinine	*Cinchona ledgeriana*	Antimalarial
	Digoxin	*Digitalis lanata*	Cardiotonic
	Ajmalicine	*Catharanthus roseus*	Antihypertensive
	Reserpine	*Rauwolfia serpentina*	Antihypertensive
Agrochemicals	Pyrethrin	*Crysanthemum cinerariaefolium*	Insecticide
Food and drink	Quinine	*Cinchona ledgeriana*	Bittering agent
	Thaumatin	*Thaumatococcus danielii*	Non nutritive
Cosmatics	Jasmine	*Jasminum* spp	Perfume

A statewise analysis of India reveals the occurrence of maximum number of medicinal plants species from West Bengal (850) followed by Orissa (600) and Arunachal Pradesh (500). The minimum number is reported from Delhi (28 spp). Similarly in Union Territories, Andaman and Nicobar Islands showed maximum number (750 spp) of medicinal plant.

Box 13
Medicinal Plants in demand
Source: Report of the task force on Conservation and Sustainable Use of Medicinal Plants 2000, Down to Earth 2001)

Planning commission list of most used plants in Indian System of medicine	*Aconitum heterophyllum, Aegle marmelos, Andrographis paniculata, Asparagus racemosus, Bacopa monnieri, Berberis aristata, Cassia angustifolia, Chlorophytum borivillanum, Commiphora wightii, convolvulus pluricaulis, Emblica officinalis, Embelia ribes, Garcinia indica, Glycyrrhiza glabra, Gymnema sylvestre, Nardostychus grandiflora, Piper longum, Picrorhiza kurrooa, Plantago ovata, Saraca asoka, Santalum album, Swertia chirata, Saussurea lappa, Tinospora cordifolia, Withania somnifera*
Plants whose requirements exceeds 50,000 kg annually	*Andrographis paniculata, Azadirachta indica, Cedrus deodara, Coleus roots, Garcinia cambogia + Garcinia indica, Phyllanthus emblica, P. niruri, Solanum nigrum, Terminalia arjuna, Terminalia bellerica, Tribulus terrestris*
Plants whose requirements exceeds one million annually	*Aegle marmelos, Aristolochia indica, Boerhavia diffusa, Ocimum sanctum, Piper longum, Sida cordifolia, Solanum nigrum, S. torvm, Vetveria zizanjoides*

3.2.1.2. Medicinal plant: a dwindling resource

The increased demand in plant based drug across the world has resulted in large-scale collection of several medicinal plants, as a consequence many of them are on the verge of extinction. During the last two decades, there has been uncontrolled growth of herbal products in India due to tax regulatory procedures and this has created increasing demand for large quantities of medicinal plants, resulting in serious danger to their survival in nature. A threat assessment exercise carried out by India's Biodiversity Conservation Prioritization Project (BCPP) through the Conservation Assessment and Management Plan (CAMP) process (1988) revealed that out of 75 taxa assessed under revised IUCN Red List criteria, 35 are Critically endangered, 16 Endangered, 15 Vulnerable, 7 Lower risk near threatened and 2 Data deficient. At the regional scale (Indian Himalayan Region) prioritization and assessment of medicinal plants has identified several high ranking taxa with both conservation and economic value (Dhar et al., 2000)

Box 14
Top ranking MPs used in preparation of herbal medicine – a case study from IHR (*Source: Dhar et al, 2000*).

Herbs

Zingiber officinale Rosc.	*Sesamum indicum* Linn.	*Aconitum ferox* Wall.
Allium sativum Linn.	*Cyerus rotundus* Linn.	*Centella asiatica* (Linn.) Urban.
Datura metel Linn.	*Picrorhiza kurrooa* Benth.	*Boerhaavia diffusa* Linn.
Sida cordifolia Linn.	*Eclipta prostrata* Linn.	*Swertia chirayita* (Roxb. Ex Flem.) Kars.
	Aconitum heterophyllum Wall.	*Glycyrrhiza glabr*a Linn.
Nardostachys jatamansi DC.	*Lilium polyphyllum* Don	*Saussurea lappa* (Decne.) Sch.-Bip.
Acorus calamus Linn.	*Solanum surattens*e Burm.F.	*Baliospermum montanum* Muell.-Arg.

Shrubs

*Woodfordia fr*uticosa (Linn.) Kurz.	*Withania somnifera* (Linn.) Dunal.	*Asparagus racemosus* Willd.
Embelia ribes Burm.f.	*Plumbago zeylanica* Linn.	*Tinospora cordifolia* (Willd.) Mires.
Berberis chitria Lindley	*Cissampelos pareira* Linn.	*Justicia adhatoda* Linn.
Vitex negundo Linn.	*Mimosa pudica* Linn.	*Cassia tora* Linn.
Clerodendrum serratum (linn.) Moon.		
Calotropis gigantean R.Br.	*Desmodium gangeticum* (Linn.) Dc.	*Leptadenia reticulata* W.&A.
Vitis vinifera Linn.	*Callicarpa nudiflora* W. & A	*Abrus precatorius* Linn.

Trees

Terminalia chebula Retz.	*Emblica officinalis* Gaertn.	*Holarrhena antidysentrica* Wall.
Terminalia bellirica (Gaertn.) Roxb.		*Acacia catechu* (Linn.f.) Willd.
Melia azedarach linn.	*Acacia nilotica* (Linn.) Del.	*Bambusa arundinacea* Wills.
Symplocos racemosoa Roxb.	*Terminalia arjuna* (Roxb. Ex DC.)	*Butea monosperma* (Lam.) Loud.
Mesua ferra Linn.	*Cedrus deodara* (Roxb.) Loud.	*Aegle marmelos* (Linn.) Corr.
Madhuca longifolia (koen.) Mac.	*Moringa oleifera* lamk.	*Punica granatum* Linn.
Semecarpus anacardium Linn.	*Bombax ceiba* Linn.	*Gmelina arborea* Roxb.

The demand of drug manufactures and trade has been continuing without bothering for replenishment of the natural sources. The main trade areas of medicinal plants are the borders stretching between India, Nepal and Bhutan, especially through the states of West Bengal and Bihar. The Calcutta drug market is the hub for raw materials coming from the east and northeastern part of the country as well as Nepal, China, Myanmar and Bhutan. Species in high demand include critically endangered species like *Coptis teeta* (mamira), *Aquilaria malaccensis* (agar-wood), *Rauvolfia serpentina* (Sarpagandha) and *Withania somnifera* (talisapatra). States like Arunachal Pradesh provide the maximum supply, especially of ginseng and *Taxus* leaves. Consignments usually pass through the boarders unheeded through many channels. In order to import or export commodities one requires a permit but forged certificates are easily available. Traders who find it very easy to con the check-post that exist in the region, exploit the close social contact between villagers located on either side of the borders. Herbs are put in gunny bags and hide within materials of daily use and pass it on to the villages at the other side of the border.

The other channels used are of re-export and substitution of names of banned species with the ones that can be legally traded. The collection from forest areas in Assam and Arunachal Pradesh are smuggled into Nepal from where it is re-exported to India with a certificate of cultivation. They are collected from the wild usually by the local people and sold to an agent, who then plants it in nurseries across the country. The bigger traders or wholesalers from various parts of the country also come directly or send their agents to certain towns in the northeastern region of the country to procure material collected from the forests in these states. Traders from Punjab, UP and West Bengal go the places like Pasighat, Dibrugharh, Guwahati and Silchar in Assam and wait in various hotels known for medicinal plant trade in the state. They lodge themselves till they garner a truckload. Each truckload contains about 2-5.5 tonnes of MPs and each truckload is worth Rs 2.5-5 lakh.

Box 15

MPs: Export from India *(Source: Down to Earth 2001)*

Species Name	Part Used	Species Name	Part Used
Aconitum species	Root	*Acorus calamus*	Rhizome
Adhatoda vaisaca	whole plant	*Berberis aristata*	Root
Cassia angustifolia	Leaf and pod	*Colchicum leutium*	Rhizome and seed
Hedychium spicatum	Rhizome	*Heracleum candicans*	Rhizome
Inula racemosa	Rhizome	*Juglans regia*	Bark
Juniperus communis	Fruit	*Juniperus macropoda*	Fruit
Picrorrhiza kurrooa	Root	*Plantago ovata*	Seed and husk
Podophyllum emodi	Rhizome	*Punica granatum*	Flower, root and bark
Rauvolfia serpantina	Root	*Rheum emodi*	Rhizome
Saussurea lappa	Rhizome	*Swertia chirayita*	whole plant
Valeriana jatamansi	Rhizome	*Zingiber officinale*	Rhizome

Heavy extraction and local processing of various medicinal plants by the traders lead to scarcity in some areas. For example, unregulated harvest i.e. *Taxus baccata* leaves and bark in the Sainj Valley of Kullu in the 60's led to disappearance of the tree in some pockets. More recently, medicinal plants and their habitats are under severe threat of erosion due to their over-exploitation mainly for export under the liberalized economic policy of the Govt. of India. An estimated 100 medium-scale herbal drug industries and over 5000 small-scale (including cottage level) industries are using around 450 species of medicinal plants. Among these 95% of the raw materials are collected from the wild. For example: in Kerala alone, 8000 to 10,000 air-dry metric tones (ADMT) of a single species of medicinal plant like, *Andrographis paniculata* which have remarkable "hepato-protective" and "immuno-stimulant" properties, is consumed annually by these industries and more than 40,000 ADMT's of *Sida rhombifolia* are used nationwide. It is projected that in the next 10 years some 80,000 tonnes of *Sida rhombifolia* will be required. *Rauvolfia serpentina, Dioscorea deltoidea* and *Cassia senna* are currently being exported at ranges from 10,000 to 50,000 tonnes/year (Anonymous, 1996). To add to this about 4 lakh registered physicians of traditional medicinal systems also use huge amount of medicinal plants procured through the crude herbal drug dealers who get their supplies mainly from the wild collectors. It is estimated that 70% of the collection of medicinal plants from the wild habitat take place in a most destructive manner (Table 29).

Table 29. Harvesting pattern of medicinal plants (***Source: FRLHT Research Department)***

Parts Used	**Percentage of parts used**
Whole plant	16.3
Leaves	6.6
Flowers	5.2
Fruits	10.3
Seed	6.6
Stem	5.5
Wood	2.8
Bark	13.5
Rhizome	4
Root	29

Action Points	
General	Develop criteria for prioritization of species based on use value, availability (e.g. status, population dynamics, and intensity of use for domestic consumption and trade) and identify coordinating nodal agencies. As they are mostly habitat specific, protect, as is possible, natural habitats of the MPs.
Area specific qualities	Specific quantities of secondary metabolites (phytochemicals) are found in specific climatic zones, soil and temperature. Accordingly areas for demonstrating agrotechnological measures and subsequent domestication should be undertaken in identified areas.
Local participation	Local people must be trained periodically for authentic identification and scientific collection of medicinal plants as different parts of the plant need to be collected at various maturity stages. A blend of traditional knowledge and scientific technique would be required for this purpose. Large size cooperative societies need to be setup in the tribal areas for procurement and marketing of MPs so as to prevent exploitation of middlemen and unethical trading practices. Because there are such cooperatives in many areas e.g. LAMPS, but they have often run into problems because these often remains a bureaucratic control over them and they are not internally democratic. These are challenges to be met. The constitution of cooperative societies should be completely/ wholly democrative for efficient and sustainable utilization of the resources.
Equitable benefits	Pharmaceutical industries based on the local innovative processing and scientific techniques should be established in the proximity of the area of their availability to ensure that the benefits of the resource are accrued equitably.
Conservation measures	In situ as well as ex situ conservation techniques should be developed for fulfilling the ever-increasing demand of MPs. Priority should be given to the threatened/rare, endemic and high value medicinal plants. Research priority should be given to develop appropriate technology for propagation, cultivation, processing, chemical characterization and marketing of medicinal plants.

	Phytochemical and pharmacological investigations should be carried out to find out active principles present in lesser known but potentially high value MPs. Herbal gardens should be established and local people (particularly women) should be trained how to propagate, preserve and monitor the growth performances of medicinal plants as a part of extension activity.
Technology demonstration	Demonstration plots for transfer of technology in rural areas for community welfare should be promoted.
Policies	Review the existing agrotechnology on cultivation of medicinal plants and accordingly carry out further research. Develop species specific plans, which contain documentation of the ethnomedicinal traditional knowledge. e.g. Angelica glauca occurs in the forest in Jammu and Kashmir, Himachal Pradesh and Garhwal Himalaya. Its roots are used by local inhabitants for seasoning curry and also in medicine for the treatment of stomach and urinary disorders and rheumatism. This species has become critically endangered in the Himalaya due to its habitat loss, fragmentation and human interference.
Regulations for collection and trade	Bulk collection of medicinal plants growing in wild need to be regulated/ banned as several pharmaceutical industries and Research/Academic Institutions use bulk collections for screening. In order to ensure monitoring such activities, nodal agency need to be established. Trade of crude drugs of plant material should be checked. It should be allowed only after thorough monitoring by some competent organization. Compulsory declaration of where, which and how species are collected and at what cost/benefit to local people. This could be made legally mandatory now under the Biodiversity Bill, when it becomes an act.

3.2.2. Endemism

Endemism is the phenomenon of confinement of species, genera or other group to a particular area or habitat beyond which they do not exist and indicates the importance and uniqueness of flora. India possesses a high degree of endemism in flowering as well as non flowering plants and the diversity of endemism in flowering plants is next to Australia.

3.2.2.1. Endemic Centers

The distribution and concentration of endemic plants in a particular region is an index of the overall uniqueness of that region. This phenomenon is usually governed by biogeographic provinance, patterns of unique ecological features, topographical and climatic interferances. Considering variables (including shift in climate, topographical discontinuities, rainfall change, edaphic isolation and windward and leeward side of mountains) 3 macro and 24 micro centers of endemic plants has been identified in the country (Nayar, 1996). These centers form suitable ecological niche for speciation of plants. For example: High mountain peaks behave like islands in their endemic content. Anamalais (Anaimudi alt. 2695 m), Nilgiris (Doddabeta alt. 2677m.) are some of the important centers of endemism in the Western Ghats. In the same way high degree of endemism in the Sikkim Himalayas where generally mountains rise to elevations of 7000m. (Kanchenjunga 8579m) and Garhwal Himalayas (Nanda Devi 7817 m) has varied topographical terrains and climatic shifts which support endemics. Besides these, Islands because of insularity, peninsular regions isolated by physical, temporal, geographical or climatic factors, the Western Ghats Satpura ranges on the northern side and the semi arid Deccan plateau on the eastern side behave like an oceanic island. Therefore, the biodiversity elements reflect high degree of uniqueness (endemism).

Box 16
Endemic centres in India
(Source: Nayar, 1996)

Megacentres

1-Eastern Himalaya
2-Western Ghats
3-Western Himalaya

Microcentres

1. Andaman Group of Islands
2. Nicobar Group of Islands
3. Agasthyamalai Hills
4. Anamalai and High Ranges (Cardamon Hills)
5. Palni Hills
6. Nilgiris, Silent Valley, Wynad, Kodagu
7. Shimoga-Kanara
8. Mahabaleshwar-Khandala ranges
9. Konkan-Raigharh
10. Marathwara-Satpura ranges
11. Tirupati-Cuddappa Nallamalai Hills
12. Vizagapatnam-Ganjam-Jeypore Hills
13. Southern Deccan (Leeward side)
14. Chotanagpur plateau
15. Kathiawar Kutch
16. Rajasthan-Aravalli Hills
17. Khasia-jaintia Hills
18. Patkoi-Manipur-Lushai Hills
19. Assam
20. Arunachal Pradesh Himalaya
21. Sikkim Himalaya
22. Garhwal Kumaon Himalaya
23. Lahul-Himachal Pradesh Himalaya
24. Kashmir-Ladakh Himalaya

3.2.2.2. Peculiarities of mega endemic centers

3.2.2.2.1. Eastern Himalaya

The peculiar topoclimatic variability in Eastern Himalaya supports maximum number of endemic species followed by Western Ghats and western Himalaya. The high precipitation for about nine months of year leads to richness of biodiversity elements. The mountain slopes of the region are the sanctuaries of *Rhododendron*, *Orchids*, *Primulas* and Poppies. The high humidity in the lower valleys, thick canopy plant competing for sunlight create a mosaic lifeforms of lofty trees, lianas, epiphytes, climbers and shade loving undergrowth. The region, which includes the eastern boarder mountains and Khasia, Jaintia hills, has a total of about 1808 endemic species, the largest concentration of endemics in India. The family Orchidaceae (144 spp), Asteraceae (87 spp), Ericaceae (70 spp), Saxifragaceae (52 spp) and the genus *Saxifraga* (40 spp), *Rhododendron* (38 spp), *Primula* (33 spp) reveal the highest representation of endemics in this region.

3.2.2.2.2. Western Ghats

The uniqueness of Western Ghats is attributed to higher alpha diversity, which is a manifestation of four niche characterstics (habitat, phenology, growth form and regeneration pattern). The variation in overall climate, rainfall patterns and the presence of mosaic of soil types, soil nutrients has resulted in a high degree of endemism, vicariants and relict species in the region.

The presence of endemic elements in flora, which are taxonomically isolated from the nearest taxonomic group, indicates its isolation from the main stock from a long period of time. Such taxonomically isolated endemic genera include: the genus *Haplothesmia*, a monotypic genus (*H. exannulata*) occurring in small restricted area, Parmbikulam hills in Kerala, represents the tribe Haplothismeae of the family Burmanniaceae, the genus *Hubbardia* (Poaceae) is monotypic and is the only representative of the tribe Hubbardeae and the structure of the spikelet in *H. heptaneuron* is unique, the genus *Dicoelospermum* (Cucurbitaceae) belongs to sub tribe Dicoelosperminae. The representative species *Dicoelospermum ritchei*, a climbing herb is endemic to W. India.

Reports suggest that nearly 38% of reported flowering plants in Western Ghats are endemics (Nayar, 1996). Most of the endemic plants of peninsular India are palaeoendemics. There are about 60 endemic genera of which 49 genera are monotypic. As such, presence of

two megacentres of endemism i.e. (i) southern Western Ghats and (ii) northern Western Ghats, make the area a cradle of endemic plants.

3.2.2.2.3. Western Himalaya

This includes west and trans northwest Himalaya of Rodgers and Panwar. Rainfall regimes are markedly different compared to eastern Himalaya. The region harbors 1195 endemic taxa. The endemic rich families are: Asteraceae (147 spp), Umbelliferae (43 spp), Fabaceae (41 spp), Ranunculaceae (38 spp), Rosaceae (29 spp) and Poaceae (29 spp). Among genera, *Taraxacum* (49 spp), *Astragalu*s (28 spp) and *Berberis* (18 spp) reveal higher number of endemic species.

3.2.2.3. Status of endemic species in different microcetnres

The maximum endemic species occur in Sikkim Himalaya followed by Kashmir – Ladak Himalaya, however, the minimum representation is in the Khatiwar Kutch region where only 8 endemic species are reported. Inspite of the maximum area covered (340700 sq km) the Rajasthan – Aravali hills have very less number of endemic (16). The detail status of each micro centre is presented.

Box 17

"Hot spot" of endemic plants (*Source: Compiled from Nayar, 1996; *Dhar and Kachroo,1983)*

SN	Name of centres	Total area (sq. km.)	No. of PAs	PAs (sq. km.)	Endemic species (Approx.)	Threats
1.	Andaman group of islands	6408	37		132	Small land area
2	Nicobar group of islands	1841	8		45	Small land area
3	Agasthyamalai hills	2450	5	1025	189	Anthropogenic
4	Anamalai and High Ranges	8000	11	2905.68	94	-
5	Palni Hills	2068	-		43	Habitat loss
6	Nilgiris – silent valley, Wyanad, Kodagu	12800	9	2687	150	Habitat loss
7	Shimoga – Kanara	12000	7	3088	58	Habitat loss
8	Mahabaleshwar – Khandala Ranges	11000	5	1370	63	Habitat loss
9	Konkan – Raigad	20000	5	467.48	50	Habitat loss
10	Marathwada – satapura ranges	10000	11	11930	27	Biotic pressure
11	Tirupati – cuddappa – Nallamalai hills	15000	6	2404.82	49	Biotic pressure
12	Vizagapatnam – Ganjam – Jeypore hills	105000	12	5830.53	30	Biotic pressure
13	Southern Deccan (Iceward side)	227000	10	1981.84	50	Biotic pressure
14	Chotanagpur plateau	202200	28	6342.12	18	Biotic pressure
15	Kathiawar Kutch	174800	14	15840	8	Biotic pressure
16	Rajasthan – Arawali hills	340700	25	9406	16	Biotic pressure
17	Khasia – Jaintia hills	22430	5	317.02	78	Biotic pressure
18	Patkoi – Manipur – Lushi hills	58990	9	888.3	74	Slash and Burn cultivation
19	Assam	78500	10	1604	25	Biotic pressure
20	Arunanchal Pradesh Himalaya	83000	6	3781	114	Slash and Burn cultivation
21	Sikkim Himalaya	53299	10	1018.66	569	Slash and Burn cultivation
22	Garhwal – Kumaun Himalaya	53000	9	6176.59	116	Grazing and Poaching
23	Lahul – Himachal Pradesh Himalaya	56000	32	4719.41	15	Biotic interference
24	Kashmir – Ladak Himalaya	222000	19	9350.07	224, 589*	Less protected areas

3.2.2.4. Endemism in higher group

About 33% of the Indian flowering plant (5725) species are endemic to India (Table 30, Nayar, 1996). Of these 3471 (60.6%) species are found in the Himalaya, 2051 (35.8%) in the peninsular India and 239 (4.2%) in Andaman and Nicobar Islands. At the higher taxa level, there are 147 genera known to be endemic to the Himalaya, 60 genera to Peninsular India and one genus *Pubistylus* is endemic to Andaman and Nicobar Islands, whereas 15 genera are widely distributed throughout the country. Out of the 71 genera endemic to the Himalaya, 42 are confined to Eastern Himalaya, while only 12 genera are confined to Western Himalaya. Acanthaceae and Poaceae have the highest number of endemic genera (17 each), whereas genera *Pteracanthus* have highest number of endemic species (20 each). The Eastern Himalaya, Western Himalaya and Western Ghats are considered as three-mega centres of

endemism in Indian flora. Besides these, 24 areas in different parts of the country have also been recognized as micro centers of endemism.

Out of the 48 species of Indian Gymnosperms known to occur in wild state in Indian Flora, 7 (17%) species are endemic. These taxa are distributed in a restricted area or region and thus enrich the diversity of species in particular area.

Table 30. Endemism in different groups *(Source: Compiled from Nayar, 1996; Mudgal and Hajra, 1997)*

Groups	Endemic	Percentage of endemism
Angiosperms	5725	32.4
Gymnosperms	7	17.0
Pteridophytes	193	17.0
Bryophytes	938	32.9
Algae	1924	54.9
Fungi	3500	24.1
Lichens	466	23.0

3.2.2.5. Endemism in lower groups

Among the lower group the endemic percentage is as follows: Bryophyta (32.9%), Pteridophyta (17%), Fungi (24.1%) and Algae (54.9%). Among Bryophytes, the liverwort shows 260 taxa (30%) endemic, including one family (Aitchisoniellaceae). The order *Anthocerotales*, considered to be representing a 'relict' taxon, exhibits as high as 61% endemism (Singh, 1993, Asthana and Nath, 1995). About 678 taxa of mosses are endemic to India of which eastern Himalaya account for 270 species followed by Western Ghats (190) and western Himalaya (144).

Box 18
Important Endemic liverwort species
(Source: D.K. Singh 1997)

Name of the species	Distribution
Calobryum dentatum	EH, rare, confined only to Darjeeling
C. indicum	EH, rare, confined only to Darjeeling
Haplomitrium grollei	EH, rare, confined only to Ghoom area
H. kashyapii	EH, rare, confined only to Darjeeling
Herbertus nilgerriensis	WG
H. pinnata	WG
H. lonchobasis	EH, rare
H. mastigophoroides	EH, rare
H. nicholsonii	EH, rare
H. darjeelingensis	EH
Pseudoleocolea trollii	EH
Lophochaete trollii	EH, extremely rare
Ttrichocolea indica	EH
T. tenera	EH, rare

T. udarii	EH
Cephalozia kashyapii	EH, rare
C. pandei	EH, rare
C. udarii	WH, rare
Nowellia indica	WH, rare
Pleuroclada albula	EH, rare
Cephaloziella dentifolia	EH, WH
C. indica	EH
C. magna	WH
C. meghalayensis	EH
Cylindrocolea reticulata	EH, rare
Anastrophyllum revolvens	EH
A. subacutum	EH
Cuspidatula nicholsonii	EH
Diplocolea sikkimensis	EH, monotypic taxon
Jungermannia appressifolia	EH
J.atrobrunea	EH
J. limbatifolia	EH
J. fleidereri	WG
J. pseudodecolyana	EH
J. purpurata	EH
J. schauliana	EH
J. subrubra	EH, rare
Heteroscyphus perfoliatus	WG, rare
Plagiochila richteri	WG, rare known only through the type collection
P. woronofii	WH, Rare, known only through the type collection
Chenecolea schusterii	WG, Rare, confined only to Bandishola
Lethocolea indica	WH, rare
Tylimanthus indicus	WG, rare
Isotachis indica	EH, WG, rare
Radula nilgiriensis	WG, rare
Porellia hattorii	WH, WG, Rare
Frullania hattoriantha	EH, rare, confined only to Darjeeling
F. pariharii	EH, rare, confined only to Darjeeling
F. pseudoschensiana	EH, rare, confined only to Shillong peak
F. sharpantha	EH, confined only to Tanglu
F. sphaerantha	EH, rare, confined only to Mawphlang
Drepanolejeunea pulla	EH, rare,
Leptolejeunea himalayensis	EH, rare
L. sikkimensis	EH, rare
Fossombronia foreaui	WG, rare
Petalophyllum indicum	P& WR; WG, rare
Sewardiella tuberifera	WH, monotypic taxon
Pallavicinia himalayensis	EH, rare
Riccardia cardotii	EH, extremely rare
Riccardia villosa	EH, rare
Riccia abuensis	P &WR
R. indica	WH, rare
R. pimodii	GP, rare, known only through type collection from Burdwan
R. reticulata	P & WR, rare

Lichens represent nearly 466 (23%) species endemic to the Indian boundaries. High degree of endemism is observed in *Crustose* genera. A large number of endemic species occur in moist tropical and subtropical forests and have restricted distribution in a particular lichenogeographical region, however, certain species show extended distribution and grow in

more than one lichenogeographical zone. The maximum representation of the endemic species is in Western Ghats (161, 20.1%), followed by Eastern Himalayan region (133, 17.5%), Andaman and Nicobar Islands (73, 23.7%) and Western Himalayan region (22, 4%) (Singh and Sinha, 1997). Family Graphidaceae (70 species) followed by Trypetheliaceae (45 species) have the maximum number of endemic species.

Box 19

Endemic Lichens species *(Source: Singh and Sinha, 1997)*

Western Himalayan Region	**Gengetic plain**	**Western Ghats**
Anaptychia pseudiromeri	*Buellia diorista*	*Anthracothecium awasthii*
Aspicilia almorensis	*Endocarpon nigrozonatum*	*A. nanosporum*
Caloplaca almorensis	*E. rosettum*	*Arthonia inconspicua*
C. pindarensis	*E. subrosettum*	*Arthothelium awasthii*
Hypogymnia alpina	**Western dry region**	*Brigantiaea nigra*
Lecanora dwaliensis	*Heppia trichophoria*	*Bulbothrix bulbochaeta*
Parmelia mussooriensis	*Phylliscum abuense*	*Catillaria nilgiriensis*
Physcia gomukhensis	*Physcia abuensis*	*C. obscura*
Stereocaulon himalayanse	*Thyrea indica*	*Heppsora indica*
Umbilicaria jingralensis	*Zahlbrucknerella indica*	*Parmelina simplicior*
		P. dodapetta
Eastern Himalayan region		
Acarospora indica	**Eastern Ghats and Deccan Penisula**	*Parmotrema kamatii*
Anthracothecium cristatellum	*Buellia hemispherica*	*Usnea nilgirica*
A. Pustuliferum	*Caloplaca orissensis*	*U. austroindica*
Arthonia collectiva	*Naevia pandani*	*Stereocaulon idicum*
A. recedens	*Roccella belangeriana*	
Aulaxina uniseptata		**Central India**
Baeomyces pachypus	**Andaman and Nicobar Islands**	*Buellia quartiziana*
Buellia pinicola	*Arthonia catenatula*	*B. subganlaziouana*
Cetraria isidioidea	*Arthothelium bessale*	*Diplotomma egasporum*
C . melaloma	*Astrothelium subvariolosum*	*Rinodina makenziei*
Coenogonium himalayense	*Bottaria awasthii*	
Collema hookeri	*Clathroporina duplicans*	
Graphis assamensis	*Ditremis andamanica*	
Heterodermia indica	*Laurera alboverruca*	
H. togashii	*Minksia alba*	
Hypogymnia thomsoniana	*Ocellularia guptei*	
Hypotrachyna rigidula	*Pleurotrema corticola*	
Nephromoa sikkimense	*Pyrenula andamanica*	
Parmelina manipurensis	*P. mestophoriza*	
Phaeographis indica	*Thelotrema rugetulum*	
Usnea mekista		

About 193 (17%) species of pteridophytes are endemic to different parts of India. Maximum endemic species (97) occur in eastern India particularly in Himalayan region, which is center of active speciation.

Box 20
Some Endemic pteridophytes
(Source: Nayar 1996)

Species	Distribution
Huperzia cancellata	Eastern Himalaya
Huperzia. Niligarica	Tamil Nadu, Kerala
Huperzia. Petiolata	Meghalaya
Selaginella adunca	UP, Himachal Pradesh
Selaginella. Blatteri	Maharashtra
Selaginella. Cataractrum	Tamil Nadu, Kerala
Selaginella. Coonoriana	Tamil Nadu
Selaginella. Jainii	Madhya Pradesh
Isoetes bilaspurensis	Madhya Pradesh
Isoetes coromandelina	India
Isoetes dixitii	Maharashtra
Isoetes indica	Madhya Pradesh
Isoetes mahadevensis	Madhya Pradesh,
Isoetes panchananii	Madhya Pradesh, Maharashtra
Botrychium lanuginosum	Himalaya
Angiopteris arnottiana	India
Angiopteris assamica	Assam
Angiopteris campsophlebia	India
Angiopteris distans	India
Angiopteris hookeriana	India
Angiopteris laciniata	NWH
Osmunda claytoniana	Eastern Himalaya
Osmunda regalis	Arunachal Pradesh, Sikkim
Plagiogyrea elongata	Eastern India
Plagiogyrea meghalayensis	Meghalaya
Pteris almeidiana	Maharashtra
Pteris argyraea	South India
Pteris furunculata	Kerala
Pteris khasyana	Himalayas
Pteris nepalensis	Eastern Himalaya
Adiantum assamicum	Eastrn India
Adiantum capillus	Tamil Nadu
Adiantum edgeworthii	N W Himalaya
Adiantum indicum	Bengal, Orissa
Marsilea condensata	Rajasthan
Marsilea coromandelica	Coromandel Coast
Crepidomanes euphlebium	Sikkim
Asplenium affine	S. India
Asplenium crinicaule	Sikkim
Aspleium khasianum	Sikkim
Woodsia elongata	Himalaya
Athyrium atratrum	Manipur
Ctenitopsis ingens	Himalaya
Dryopteris assamensis	Assam
Dryopteris gracilis	Sikkim
Dryopteris chingii	North west Himalaya
Polystichum garhwalicum	Meghalaya
Elaphoglossum nilgiricum	South India

Action Points	
Inventorization and documentation	Inventorizing plant endemics is not complete. A complete inventory would be a prerequisite for initiating any conservation related activity. Comprehensive mapping using Geographic Information System (GIS) of endemic species indicating their habitat, threat perceptions, rarity and rate of decline of populations and the degree of protection need to be developed. Identifying endemic rich areas and habitats. Plant taxonomist should develop standard format for collecting detailed information of endemic species. Causative factors of habitat loss and its consequent effect on endemic taxa need to be studied. Besides the habitat loss, there is a need to understand autecology, population/reproductive biology of endemic species in order to identify intrinsic causative factors leading to rarity of endemics.
Policy	All policies related to biodiversity conservation should give top priority to promote documentation of indigenous knowledge and hardcore research on reproductive mechanisms of endemic species.
Threats	Human population pressure is one of the cause for the loss or decline of endemic and threatened species, therefore, it is necessary to impart education and inculcate awareness among stakeholders about the importance of such species by formal/informal education programme.
Prioritization	Multiple attributes of conservation value need to be considered for developing a matrix. Using this matrix, priority can be established, indicating where maximum efforts of conservation may be focused. For example- narrow ecological amplitude, high anthropogenic pressure and restricted geographic range of species should be considered a top priority.

3.2.3. Rarity

The indiscriminate exploitation, habitat destruction, introduction of alien species etc. have adversely affected the wild plant diversity of the nation. This has resulted to a number of plants that have disappeared while others await a similar fate. Estimate suggests that nearly 10% (>1700) of the India's flowering plants are reported to be under various threats

As per the RED list of threatened plants (IUCN, 1997), 19 species are extinct and 1236 species are threatened. Of these, 41 taxa possibly extinct in the wild, 152 are endangered, 102 are vulnerable, 251 rare and 690 are of indeterminate status. However, 1080 species under threat require enlisting and categorizing in the view of new IUCN Red List. The Red Data Book of Indian plants gives an account of 620 species. Out of listed Red Data Book species of Indian plants about 550 species are endemic (Nayar and Sastry, 1987,1988,1990). Out of the reported 5725 endemics, about 2500 fall under threatened category. Further it is estimated that about 1950 narrow endemic plant species will become extinct in India in the foreseable future. Status of the rarity in different groups is presented (Table 31)

Table 31. Representativeness in various groups

Hierarchical groups	Rarity	Percentage of total	References
Angiosperm	>1762	>10.0	Chakraverty and Mukhopadhyay, 2000
Gymnosperm	8	16.6	Basu, 1994
Pteridophytes	254	21.58	Ghosh and Ghosh, 1997
Lichens	404	20.0	Singh and Singh, 1997
Liverwort	100	11.7	D.K. Singh, 1997

Box 21

Endangered species: Few examples *(Source: Ahmedullah, 2000)*

- *Buchanania barberi*: it is a narrow endemic tree species confined to southern Western Ghats. Other species of this genus are well known sources of edible fruits and oils, which are used in local medicine.
- *Euonymus angulata* and *E. assamica*: are endemic tree species, the former being confined to the 'hotspot' area of southern Western Ghats, while the latter is restricted only to Dalie valley in the NE region. The socio-economic potential of the two species is not known owing to their rarity, but other species of the group are used in medicine, the wood used for turnery and leaves as fodder.
- The endangered *Acers* are found only in the Himalayas. *Acer hookeri* var. *serrulatum* are confined to the Eastern Himalaya' hotspot' area. A. *oblongum* var. *membranaceum* is endemic to Mussoorie hills in Western Himalaya. The socio-economic profile of the species shows that *Acer hookeri* var. *majus* is used locally as fuel wood, while *A. oblongum* var. *membranaceum* is of horticultural value.
- *Elaegnus conferta* sp. *dendroidea* is an endemic tree species confined to Khasi hills in NE region, though this species is not known to have specific uses other species of the group have food value.
- *Nothepegia aureo-fulva*: is an endemic tree confined to the Tirunelveli hills of southern Western Ghats, the wood has low quality timber value.
- The endemic trees *Actinodaphne lanata* and *A. bourneae* are restricted to the Nilgiri and Palni hills in the southern Western Ghats 'hot spot' area. It has medicinal potential with some level of alkaloid 'actinodaphinim' in their bark.
- *Eugenia discifera* is an endemic tree species confined to a narrow range in the southern Western Ghast, it has potential value in food, medicinal and as low quality timber. The endemic tree *Syzygium gambleanum* is recorded so far only from the lower hills of Kothyar in southern Western Ghats.
- *Ceropegia lawii* and *C. panchganiensis* are endemic to Harischandragad hill and Panchgani respectively in northern Western Gahts at about 1000m altitudes. Apart from being narrow endemic these species have high food value, with their tubers being consumed by the local communities, which is a factor responsible for their endangerment.
- The Endangered palm *Livistona jenkinsiana* is spread over two biogeographic zones in NE region, it has high socio-economic value with its seeds (endosperm) being edible and of food value, the leaves used by local communities for thatching purpose and the plant as a whole being of high horticultural value.
- *Iphigenia sahyadrica* is endemic to the central Western Ghats is a source of alkaloid 'colchicine' used extensively as a drug in modern medicine.
- The high altitude endemic species S*aussurea costus* which is distributed in the Western Himalaya between 3200-3800 m altitude, is of very high economic value so much so that it has been listed in Appendix I of CITES, wherein the trade of the species is globally banned. The species is a source of 'kuth' aromatic oil extensively used in perfumery. It is also used in medicine.

Box 22
Rare and endangered species in different regions: some examples
(Source: Nautiyal and Kaul, 1999)

Himalaya and Eastern India

Abies delavay, Franchet
Acanthephippum sylthetense Lindl
Aconitum deinorrhizum Staph
Adinandra griffthii Dyer
Aglaia perviridis Hiern
Amblyanthus multiflours Mez
Amacppsa ilicoides Mast
Anoectochilus sikkimensis King & Plant
Angopteris evecta Hoffm
Aphyllorchis Montana Reichb
Arachnanthe cathcartii Ilindi)Benth
Arachnanthe clarker (Reichbff)Rolfe
Artemisia amygdalina Decne
Arundina graminifolia (D.Don)
Astragalus strobiliferus Royle
Atropa acumina Royle ex Lindl.
Balanophora dioica R.BR.
Botrychium virginianum Sw
Brainae insignis (Hook) J.Sm
Camellia caduca C.B.Cl.ex. Brandis
Catamixis baccharoides T.Thoms.
Colchicum luteum, Baker
Coptis teeta Wall
Cyathea gigantea (Wal ex Hook) Holtt
Cymbidium macrorhizon Lidl.
Cypripedium cordigerum D.Don
Cypripedium elegans Reichb.F.
Cypripedium himalaicum Rolfe
Cypripedium macranthon Sw,
Dendrobium densiflrum Wall ex Lindl
Dianthus coschemiricum Edgew
Didiciea cunninghamii King er Prian
Dioscorea deltoidea Wall, es Kunth
Dipteris wallichii (R.Br.) Moore
Dischidia benghalensis Cole
Dischidia rafflesiana Wall
Drosera burmanni Vahl
Drosera indica Inn.
Elaeocarpus prunifolius (C.Muell.) Mast
Eremostachys superba Royle ex. Benth
Eria crassicaulis Hook f.
Galeola lindleyana Reichb f.
Gentiana kurroo Royle
Hedysarum cachemirianaum Benth ex. Baker
Helminthostachys zeylanica (Linn) Hook
Helwingia hinalaica Hook.f& Thoms ex C.B.C.I
Liex embelioides Hook.f.
Lodes hookeriana Baill
Lavatera kashmiriana Camb
Loropetalum chinense Olive
Magnolia griffithii Hook. & Thomas
Magnolia gustavi King
Magnolia pterocarpa Roxb
Meconopsis betonicifolia Franchet
Nardostachys grandiflora DC
Nepenthes khasiana Hook.f.
Orimisia glauca Wall
Osmunda regalis Linn
Paphiopedilum druryi (Bedd.) Pfitz.
Paphiopedilum fairleanem (Lindl.) Pfitz.
Paphiopedilum hirsutissum (Lindl.) Pfitz.
Paphiopedilum insigne (Wall) Pfitz
Paphiopedilum spicerianum (Reichb.f.) Pfitz.
Paphiopedilum venustum (Lindl) Pfitz.
Paphiopedilum villosum (Lindl) Pfitz.
Phyllostachys bambusoides Sieb & Zucc
Picea brachytyla Pritz
Platycerium wallichill Hook
Pleione humilis D.Don
Podophyllum hexandrum Royle
Populus gamblei Dodo
Potameia paradoxa (Hook)
Psilotum nudum (Linn). Beauv
Rauvolfia serpentina (Linn) Benth ex Kruz
Renanthera imschootiana Rolfe
Rheum nobile Hook. F. & Thoms
Rhododendron arizelum Balf & Forr.
Rhododendron dalhousiae Hook f.
Rhododendron edgeworthii Hook F.
Rhododendron nivale Hook. .
Rhododendron nutallii Booth
Rhododendron santapaui Sastry et.al.
Rhododendron stenaulum Balf. & WW. Sm.
Rhus hookeri Sahni & Bahadur
Sapria himalayana Griff.
Saussurea bracteata Decne
Saussurea gnaphalodes (Royle) Sch-Bip
Saussurea lappa C.B.C.I.
Schizaea digitata Sw,
Tetracentron sinense Oliv. Var *himalense* Hara & Kanai
Thylacospermum rupifragrum Schrenk
Vanda coerulea Griff
Vanda pumila Hook.f.
Vanilla pilifera Holtt.
Viola falconeri Hook.f. & Thoms
Zanthoxylum scandens Bl

Gangetic plain

Aldrovanda vesiculosa Linn.

Peninsular India

Aparma barberi Gamble
Bentinkia condapanna Borty ex. Roxb.
Ceropegia fantastica Sedgw

Cycas beddomei Dyer
Dioscorea wightii Hook f.
Entada pursaetha DC.
Frerea indica Delz.
Gnetum ula Brongn.
Hoya-wightii Hook.f.
Lilium neilgherrense Wt.
Lobelia nicotianaefolia Roth ex Roem. & Schult.
Loeseneriella bourdillonii (Gamble)
Manisuris devergens (Hack) Kunntz.
Piper barberi (Gamble)
Podocarpus santalinus Linn. f
Podocarpus wallichianus

Pterocarpus santalinus Linn. F.
Pterospermum obtusifolium Wt.
Santalum album Linn.

Rajasthan and Gujarat

Commiphora wightii (Arn.) Bhandri
Helichrysum cutchicum (C.B.C.I.)

Hyphaene dichotoma (Baker) Furtado (H indica Becc.)
Rosa involllucrata Roxb. (R. Lyellii Linl.3)

Andaman and Nicobar

Ailanthus kurzii Prain
Canarium mannii King
Dipterocarpus kerrii King
Hippocratea nivobarica Kurz
Lagerstroemia hypoleuca Kurz
Myristica andamanica Hook. F.
Ophioglossum pendulum Linn.
Podocarpus nereifolius D.Don
Psilotum complanatum Sw.
Symplocos odoratissima (Bl) Choisy ex Zoll
Uvaria nicobarica Raizada & Sahni

Action Points	
Documentation	Comprehensive mapping, for focused conservation initiatives is required. The pattern of distribution of such species is not available. This will help in prioritizing species for conservation on the basis of status
Threats	There is a need to identify major threats (they are mostly specific), which cause depletion of threatened species.
Conservation measures	Species-specific conservation plan needs to be prepared which must include rehabilitation in-situ. Rehabilitation of threatened species should also be undertaken in sacred forests. School/college students on voluntary basis can effectively carry out this activity. A back up mechanism would be required for making it mission oriented. Gene sanctuaries should be declared where natural population of rare/threatened plants are growing

3.3. Use Value

The plant biodiversity support the human life in many ways such as food, fuel, fodder, fertilizer, fibre, timber, medicine, clothing and housing/ shelter. Many of these species have been fundamental to stabilization of climate, protection of watershed, protection of soil and balance of the ecological system. Undoubtedly it is the very basis of human existence on earth. One can not imagine the situation in which fungus *Pencillium* and *Cinchona* tree were to become extinct before mankind discovered penicillin and quinine respectively from them. Both these drugs save lives of millions of people every year and increase the economy of the country. This reflects that wild plants are the important source for income generation. Besides these, wild plant diversity produces potential future crops for different life support system and retains an exceptional importance for agriculture. The wild genetic resources are known as a key to the future production of existing crops. The high yielding and disease resistance varieties of crops have come from the gene pools of such wild genetic resources.

3.3.1. Wild plants in livelihood

Wild plants play an important role in livelihood needs particularly of the rural populace. Of the reported flowering plants in the country, nearly 1000 species have food value, 525 species are fibre yielding, 400 species have fodder value, 300 species yield gums and dyes, 100 species yield different types of scent and essential oil, 300 species are poisonous and 700 species are traditionally used in social and various religious ceremony. More importantly about 3000 species are used as medicine.

3.3.1.1. **Wild edible**

Wild edibles are the important source of staple food as well as income generation. In India over 1000 wild edible species are reported so far (Arora and Pandey, 1996). With the growing civilization and industrialization, mode of utilization of edible plant products has been changing and they have got their own importance. The distribution of the number of species and parts used are summarized (Table 32)

Table 32. Richness in wild edible plants of India (*Source: Arora and Pandey, 1996).*

Useful Plant parts	Families	Genera	Species	Domesticated/semi-domesticated species
Roots and tuber (underground parts)	42	98	145	33
Leafy vegetables/greens/pot herbs	156	377	521	72
Buds and flowers	47	88	101	15
Fruits	112	357	647	107
Seed and nuts	53	91	118	25

Box 23
Plants are the source of livelihood needs: A case study of Andamanese tribal area
(Source: Bhargava 1990)

Aesthetic sense: the tribal girls adorn their hair with flowers of *Crinum asiaticum*, *Gloriosa superba* and *Melastoma malabaricum*. The old settlers of village decorate the breakfast table with the leaves of *Panax fruticosum.*

Arm and instruments: In Andaman Islands, only the tribals use plant species for arms. The arms are bows and arrows, which are essential for any primitive tribe, for protection, hunting and fishing. *Manilkara littoralis, Sageraea elliptica* are used for bows, *Anodendron paniculatum*, *Ficus* sp. are used for making bow string and *Ancistrocladus tectorius* and *Desmos dasymaschalus* are used for making arrows.

The Onges prepare tea from the leaves of *Herritiera littoralis* and *Hibiscus tiliaceus.*

The Nicobarese make boats from stripped wood pieces of *Artocarpus chama*, *Lagerstroemia hypoleuca, Podocarpus nerifoilia* and *Sageraea elliptica*. The leaves of *Leea* sp. are used for making music during their dance and during the worship of evil sprits.

Religious ceremony: Leaves of *Caryota mitis* and flowers of *Melastoma malabaricum* are used by the Old settlers in the preparation of garlands and for decoration in Hindu or Buddhist religious ceremonies. *Ficus religiosa* and *Plumeria acuminata* planted near Hindu temples and Buddhist pagoda.

Source of water: about 3m long section of the stem of *Calamus andamanicus* are cut and held vertically to yield ssp. When the Onge tribal feels thirsty they chew the petioles of *Zingiber squarrosum*.

Utensils: the Shompens make boat shaped vessels from the bark of boiling *Pandanus* fruits. Leaves of *Macaranga indica* are used for wrapping up of articles and used as plates and saucers for serving food, the hollow tree trunk of *Pajanelia longifolia* are used as buckets for keeping honey combs during the collection of honey.

3.3.1.2. Fibre

In India, about 525 species of plant are known to yield fibres. The fibre has been used for meeting local and industrial needs of the people. The textile fibres are of commercial importance, however, the stem of grasses in addition to bamboos and canes are good for plating. Rough weaving fibres is important for mats and baskets and for making paper, ropes cordage and brush. Fibre obtained from the fruits of *Cocos nucifera* is used for making ropes especially for ships. The fibre obtained from *Agave* is very important and the requirement of this fibre is about 16,000 tonnes in India. At present only about 10,000 tonnes is being produced by the country and rest is imported from other countries.

3.3.1.3. Gums and resins yielding plants

Gums and resin are two important forest products with immense commercial value. A number of enterprises can be set up based on the natural gum production, grading and processing and earn foreign revenue. In India a large number of species are known to exudate gums and resins. Amongst them demand for exudate gums like karaya from *Stercularia urens* and Arabic gum from *Acacia* spp. has been growing tremendously to meet requirement of various industries such as chocolate and confectioneries, ice cream, ketchup, textile, leather, oil, cloth and linoleum. It has been reported that during 1988-89 India produced 25,718 tonnes of gum and 1831 tonnes of karaya gum has been exported (worth about Rs. 10 crores). The production of pine resin in India has fallen down considerably to about 40,000 per year, therefore great care in the forest management for resin and turpentine is needed so that the production of 72,000 tonnes of resin may be restored. Capacity of production of these gums is a limiting factor for meeting the export requirement. In the case of *Acacia* gums we are not able to meet our international requirement and India import true gum arabic from *Acacia sengal* from African countries to meet the requirement of the nation.

Box 24
Major Gums and resin yielding plants
(Source: Chakravarti and Uniyal 2000)

Name of the species	Part used	uses
Acacia nilotica	Stem, bark	Ink, paint
A.senegal	Bark	Food, medicine, Connectives, Inks, Adhesive, Paints
A.catechu	Bark	Textile and medicine
A.sundra	Bark	Substitute for gum Arabica
Albizia lebbeck	Bark	Adulterant of gum Arabica
Butea monosperma	Stem, bark	Medicine, edible
Grevillea robusta	Bark	Industrial application
Cyamopsis tetragonoloba	Seed/flowers	Food, textiles and paper Industry
Anogeissus latifolia	Bark	Substitute for gum Arabica, pharmaceutical
Stercularia urens	Bark	Paper industry, food, Textile, pharmaceuticals used for laxative

3.3.1.4. Oil seed

Essential oils are obtained from about 1300 plant species belonging to 60 families of the flowering plants. Some essential oils are medicinally importance and used in perfumery, flavoring and other industrial purposes. About 3000 tonnes of different essential oils are produced from various plant species and nearly 400 tonnes is imported for industrial requirements. Some of the essential oils are exported (i.e. about 800 tonnes of essential oils

like sandal wood oil, palmarosa oil and lemon grass oil). In India the total consumption of essential oils in various industries is about 2000 tonnes. Production of essential oil can generate considerable foreign exchange and revenue especially from Indian linaloe, spice, oils etc. Inspite of the large number (100 species) of tree borne oil seeds only 10-20 species have been exploited as cooking media and for soap making.

Action points	
Documentation of under exploited species	Potential of under exploited economically important plants need to be evaluated. Awareness campaigns on potential value of the important plants.

3.3.1.5. Bamboo

India has the richest diversity of bamboo species in the world and is second largest producer of bamboo after China. About 100 species of bamboo are known in India (Table 33). Northeast represents highest bamboo diversity and about 50% of the Indian bamboos are found in this region. Out of the total species of bamboo 30-40 are conspicuous and 8-10 are used for sustenance in our country in innumerable ways i.e. housing (20.0%), non-residential construction (0.5%), rural uses (20.0%), fuel and fodder (8.5%), paper pulp (35.0%), packing including baskets (0.5%), transport (1.5%), furniture (1.0%), other wood working industries like handicrafts (1.0%) and for other including ladders, staff, mats and food (3.0%) (Shiva 1998).

Table 33. Distribution of Bamboo in different regions of India *(Source: Uma Shanker 2001)*

Region	Species
World	136
India	100
Northeast India	58
Arunachal	34
Manipur	40
Mizoram	18

Of the reported genera, the commercially important are i.e. *Bambusa, Dendrocalamus, Melocanna, Ochlandra, Oxytenanthera* and *Phyllostachys.* More than 13 million ha of land

are covered under different bamboo species in various habitats in India. The maximum consumption of the bamboo is in paper industry and nearly 80 paper mills are dependent wholly or partially on bamboo. Approximately 2 million tones of bamboo are at present being utilized for paper in India and this leads to a production of nearly 600,000 tonnes of paper pulp every year (Vermah and Bahadur, 1980). It is estimated that annual outturn of dried bamboos in India is about 47.6 million tonnes and a single bamboo is priced between Rs 5-20 depending upon the species and locality. Although bamboo occurs naturally over a wide area in India, they deserve adequate attention in propagation in Social Forestry and may be grown in rural areas in the residential compounds, borders of farmlands, along water courses, stream banks and on wastelands with sound management system, scientific harvesting and utilization.

Action Points	
Inventorization	Inventory of bamboo with regard to taxonomic characters, use value, habitat ecology should be developed
Conservation measures	Considering the richness of bamboo in northeast, the region should be developed as bamboo sanctuary. Considering the importance of bamboo in various industrial sector, conservation techniques using in situ as well as ex situ initiatives should be started for important bamboo species. Harvest and post harvest technology need to be developed.

3.3.1.6. Rattans

Rattans are prickly climbing palms represented by 14 genera and 600 species all over the world. Of these, 5 genera and 60 species occur in India. The genus *Calamus* represent the maximum number of species (47) followed by *Daemonorops* (6), *Plectocomia* (4), *Korthalsia* (2) and *Zalacca* (1). The rattans are distributed in three major zones in the country, i.e. northeastern India, Western Ghats and Andaman & Nicobar Islands (Table 34). Rattans are largely used for furniture. Their application in construction is limited but they are mostly used in basket making and as rope substitution. A few species yield tender shoots that are edible.

Table 34. Diversity and distribution of the Rattans in three major zones (*Source: P.S. Rao 1999)*

Zone	Approx. no of spp
Western Ghats	19
Eastern & Northeast	30
Andaman & Nicobar	15

Considering the importance of rattan in various livelihood needs, this group seems to be under threat. The threat categories depend on the type and locality of the species. Besides these, several species are used as edible, medicinal and for other traditional importance e.g. *Calamus acanthospathus, C. erectus, C. flagellum, C. gracillus, C. inermis, C. khasiana, C. latifolius, Plectomia assamica, P. bractiaatis and Zalacca secunda*

Box 25
Rattan is under threat
(Source: Compiled from Basu, 1992)

Andaman & Nicobar

Korthalsia rogersii, Daemonorops kurziana, Daemnorops manii. Calamus andamanicus, Calamus nicobaricus,Calamus pseudorivalis, Calamus helferianus, Calamus dilaceratus, Calamus unifarius

Peninsular India

Calamus nagbettai, Calamus hookerianus, Calamus metzianus, Calamus delessertianus, Calamus dransfieldi, Calamus gamblei, Calamus huegelianus, Calamus brandisii, Calamus rheedii, Calamus vattayila, Calamus pseudofeanus

Eastern & Northeastern India

Plectocomia himalayana, Plectocomia assamica, Plectocomia bractealis, Plectocomia khasiyana, Calamus latifolius,Calamus inermis, Calamus nambariensis, Calamus khasianus, Calamus erectus, Calamus gracilis, Calamus kingianus, Calamus floribundus, Daemonocarpus jenkinsiana

Action Points	
Strategies	Inspite of the importance of Rattan in various sectors several species are under threat due to restricted distribution, habitat destruction and overexploitation. Therefore strategies should be developed for proper management and conservation of this important group.
Research	Research should be carried out to understand the causes of habitat destruction and proper methodology developed for management of the habitat considering the restricted distribution and importance of the group.
Conservation measure	In situ and ex situ strategies should be developed for the mass multiplication of the commercially important genera such as Calamus, Daemonorops, Plectomia and other taxa of traditional importance such as Calamus acanthospathus, C. erectus, C. flagellum, Plectomia assamica etc.

3.3.1.7. Orchids *(Inputs from S.P. Vij)*

Orchidaceae with about 800 genera and over 20,000 species are distributed all over the world, with over 30,000 varieties (Chadha, 1994). Orchids are well represented in India. Occurrence of nearly 1200 species in 166 genera has so far been authenticated and their number is likely to swell further as several areas in the major orchid rich belts in the Himalayan, north-eastern India and peninsular regions are yet to be botanically explored. The maximum representation of the orchids has been reported from northeast India (650 spp.) followed by Eastern Himalaya (612 spp). More than 30% species are endemic to the country (Vij, 2001). They are known for their therapeutic importance. They are inherently slow growers and regenerate poorly in nature because of their pollinator specificity and requirement for mycorrhizal associations. They have adapted to a variety of life modes i.e. terrestrial, epiphytic and saxalitic and live in a delicately balanced equilibrium with their surroundings. Distribution and status of orchids in India is presented (Table 35).

Table 35. Distribution of orchids in various regions (*Source:* ***Uma Shanker, 2001)***

Region	Species	Endemic	Extinct	Endangered
Peninsular India	250	13	5	25
Eastern India	130	6	-	5
Northeastern India	650	76	18	34
Eastern Himalayas	612	88	18	105
Western Himalayas	250	16	-	44
Andaman and Nicobar Islands	80	15	2	2
Central India	60	-	-	-
Western India	5	-	-	-
India	1100	314	41	215

Besides their ornamental significance orchids are medicinally important. The Indian orchids are, however, victims of their own beauty and utility, the size and frequency of their natural populations is declining rapidly under the commercial collection and habitat destruction pressures. India has been mainly exporting native species of orchids. In accordance with the convention on International Trade in Endangered species of Fauna and Flora (CITES), the trade in native species has been banned; India exports orchid flowers to Europe, Hongkong, Japan and Australia. However India's potential for the export of orchid flowers is rated as high. The export committee appointed by the APEDA identified orchids as one of the flowers suitable for export production. The European George committee appointed

by the Union Commerce Ministry recommended Rs 30.00 crore project for the development of the orchid industry in India.

Box 26
Medicinal importance of the Orchids (*Compied from Vij, 2001*)

Name of the species	Parts used	Medicinal importance
Vanda roxburghii	leaves	External application in rheumatism and allied disorders and diseases of nervous system
Cleisostoma williamsonii		Healing fractured bones
Pholidota species		Healing fractured bones
Vanda tastacea		Rheumatism, nervous disorders and scorpion stings
Satyrium nepalense		Tonic and useful in malaria and dysentery
Dendrobium nobile	powdery seeds	Freshly cut wounds for quick healing
Malaxis acuminaata	pseudobulbs	Nutritive tonic and known to cure tuberculosis
Bulbophyllum neilgherrense	pseudobulbs	Adolescence and as tonic
Ephemerantha macraes	pseudobulbs	Adolescence and as tonic
Flickingeria macraei,	pseudobulbs	Adolescence and as tonic
Eulophia nuda	tubers	Tonic, aphrodisiac and as blood purifier

Action Points	
Survey, inventorization and research	Extensive survey in orchid rich belt should be conducted and prepare inventories citing extent of intraspecific variation, status, habitat, database and ethnobotanic significance considering the importance of this group. Quantitative analysis and listing of potential species need to be developed. Research should be conducted in orchid ecology, reproductive biology, population dynamics, genetic diversity, pollination biology, its linkages with ferns and mosses keeping in view that orchids are slow grower and regenerate poorly in nature. It will help in understanding the biology and linkages with other corresponding biodiversity elements.

Developing floriculture	Considering the importance of this group in floriculture industry cost effective techniques for propagation of highly valued genera such as Aerides, Arachnis, Ascocentrum, Calanthe, Coelogyne, Cymbidium, Dendrobium, Paphiopedilum, Phalaenopsis, Renanthera, Rhynchostylis, Vanda etc. should be developed along with monitoring of wild habitats and population of these taxa.
Habitat restoration	Since some of the species like Aerides crispa, Bulbophyllum guttulatum, B. rothschilidianum, Calanthe alpina, Cymbidium hookerianum, Dactylorhiza hatagirea etc. have been endangered due to overexploitation, therefore, proper methods of orchid collection and habitat restoration and reintroduction projects should be initiated along with protection of key sites.
Rural development	Considering the importance in livelihood needs orchids should be promoted as a cottage industry. Promote orchid propagation in collection centres and encourage local growers to artificially propagate native species for reintroduction and supply for promoting horticultural trade to ensure their sustainable utilization.
Conservation	Properly manage orchid rich habitats and declare/notify orchid sanctuaries for maintaining and conservation of orchid gene pool. Also, rescue orchids from degraded habitats and reintroduce them into orchid rich habitats. Promote conservation of rare orchids of medicinal value through development of urban terraced home gardens.

3.3.2. Wild plants in traditional knowledge

The indigenous knowledge system about the use of the biological resources among the various human communities is ancient in India. There is an inextricable link between indigenous culture, ethnic diversity and biological diversity. Indigenous and ethnic people have symbiotic relationship with nature. They have their indigenous ways of protecting and managing the forest resources. For example: in the Himalayan region a number of ethnic groups use nearly 675 wild species as subsidiary food, 35 tree species as multipurpose, socio economically important species, 37 species for fiber and several hundred as medicinal plants. By their long association with nature, they also know the natural history of each species for obtaining sustained yield through managed harvesting. Many of the indigenous societies are highly primitive and still live close to the nature. They hold unique empirical knowledge system about the use of the biological resources. For example: in south India Yanadi tribe are experts in snake catching and possess the knowledge of over 22 wild plant species as antidotes for snake bites (Sudarsanam and Prasad, 1995). The traditional culture and associated knowledge system, which has persisted through several centuries, are today at the verge of extinction. Increased population pressure and the introduction of new food plants by government are forcing these people to abandon or greatly modify their traditional agricultural practices, food and medicine gathering activities. They often sell the roots/ rhizome of the plants as antidotes along with other medicinal herbs in the nearby town and cities.

Box 27
Increasing modernization and decreasing traditional knowledge
(Source: Srishti Jigyasa Parivwar, 2000)

In village Kaihad in Mandi district of Himachal all people put together have the knowledge of around 450 species of plants and animals. But there is a clear pattern of decline in this knowledge amongst the youth. The older (>50 years) can identify about 70% of the flowering plants, characterize 40% and mention uses of 5%. In the age group of 30 to 50 years, the ability to identify is down to 25%, characterize to 4% and knowledge of uses to 1% of the flowering plants. The youth below 25 years of age are almost ignorant about the identification, characterization and uses of these plants. This erosion of knowledge seems related to loss of application of the knowledge i.e. allopathic medicine overwhelms the use of herbal medicines.

In the Rajasthan the village Devli Machan in Kota district used to be called "Vaidyo Ki Deoli", because of the presence of many medicinal plants and herbal practitioner. But with extensive deforestation it has lost these valuable medicinal plants and the herbal practitioner migrated towards cities. Therefore, the name of the village has been changed by dropping the epithet 'Vaidyo Ki'. In another site that of Neralkoppa in Chikmagulur district in Karnataka the local medicine man decided to pass on this knowledge, earlier transmitted along male line to his daughter because his sons were not interested.

Traditional knowledge forms the basis for development of new products. Traditional formulations may prove effective against disease conditions that are now well defined. Single and multiple active principles responsible for the curative effect are already well known. Traditional knowledge may be recombined with other new knowledge to derive new therapeutics. The documentation of published and unpublished knowledge will pave the way for R&D for its wider applications in health services. The intellectual property of traditional medicinal systems needs to be protected.

Box 28
Traditional knowledge associated with plants species in Kerala
(*Source*: *Radhakrishnan et al., 2000*)

The tribal communities inhabiting the Western Ghats forest of Kerala state have been traditionally using a variety of artifacts composed of stones, minerals, metals, plants and animal products. Ethnobotanical studies conducted among them had led to the inventorization of a number of plant species employed for construction for traditional dwelling (Huts), Clothing and Protection, hunting and fishing, musical instruments, adornments, utensils and for magico religious performance.

Traditinal dwelling: wood and culms of *Bambusa arundinacea, Gmelina arborea* and *Ochlandra travancorica* are used for the construction. Leaves of *Cymbopogon flexuous, Ochlandra travancorica, Oriza sativa, Panicum maxicum, Sacchrum spontaneum* and whole plant of *Sida acuta* are used for thatching. The 'tree houses', a characteristic feature of tribal area is made of *Bambusa arundinacea*.

Clothing and Protection*:* the tribals to cover their bodies traditionally use the beaten bark of *Antiaris toxicaria*. The Paniyas and Adiyans of Wayanand district use a traditional umbrella known as "Koramba" made from the culms of *Bambusa arundinacea* and leaves of *Ochlandra travancorica* and *Sehumannianthus virgatus*.

Hunting and fishing: the bows are made of *Bambusa arundinacea* and the strings are derived from the fibres of *Butea parviflora, Debregeasia longifolia, Entada pursactha, Gnetum ula* and *Helicteres isora*.

Musical instrument: the Adiyans and Paniyas of Wayanad have musical instruments known as Thudi and Cheeni. The traditional drums of Mudugars are known as Perai and Thavil. Thudi is made either from the wood of *Artocarpus heterophyllus, Gmelina arborea* or *Vitex altissima*. The Cheeni are made up of the wood of *Alstonia scholaris, Gmelina arborea, Caryota urens, Phoenix loureirri*. The primitive tribal of Kerala "Cholanaikans" has a musical instrument made of dried fruit of *Lagenaria siceraria*, seeds of *Abrus Precatorius*. Musical dance is performed on auspicious occasions for removal of disease of Adiyans and death anniversaries of Mudugars being typical example.

Adornments: the Adiyans and Paniyas wear earrings known as Ola made from the leaves of *Pandanus fascicularis*.

Utensils: *Bambusa* (Culms) and *Lagenaria* (Fruits) are main sources from which vessels and storage container are made. Baskets of Cholanaikans, Known as Poonikotta are products of *Ochlandra travancorica* and *Calamusrotang.* Kunthani and Ulakka, the traditional pounders used for grinding cereals are made of the wood of *Terminalia paniculata* and *Gmelina arborea*. Adiyan tribals of Thirunelli, Wayanad district, use 'Idikincha urelu' small pounds made from the wood of Xylia xylocarpa for grinding betel leaves and arecanut.

Magio-religious performance: *Abrus precatorius, Calamus rotang, Glycosmis mauritiana, Poeciloneuron indicum* are some of the plants species used in magico-religious performance.

Local communities need to be helped to strengthen, or adopt practices of sustainable resource management. Several non-Govt. organizations are reviving specific traditions relevant to biodiversity conservation. The citizen's group "Lok Swasthya Parampara Samvardhan Samithi" of Coimbatore is working to revive interest in medicinal plants as used

in Ayurvedic and other local healthcare traditions, and attempting to set up medicinal plant conservation units in various parts of India. “Samvardhan” the association for the propagation of indigenous Genetic Resources in Ahmedabad is attempting to record and encourage the conservation of local crop varieties and livestock breeds. The “Kalpavriksha” in New Delhi and the Society For Research and Initiative for Sustainable Technologies and Institutions (SRISTI), Ahmedabad are also engaged in documenting innovations developed by farmers and herbal healers for biodiversity conservation at grassroots’ level. The knowledge about the traditional system is also covered under “Intellectual Property Right”. The knowledge itself may not be patentable, the products of that knowledge, namely “Folk varieties”, “land races” and genetic diversity at the intra-specific level provide the basic raw material for modern plant breeding and biotechnology development programme.

Box 29

List of rice varieties conserved by Centre for Indigenous Knowledge System

1. Arcot kitchili , 2. Aruvathan kodai, 3. Ariyan, 4. Bangalorekar, 5. Chengalpat sirumani, 6. Chithiraikar, 7. GEB-24, 8. Jiljil Vaigunda, 9. Kappakar, 10. Kappasamba, 11. Kalian samba, 12. Kadai kazhuthan, 13. Kalar palai, 14. Kattu kuthalam, 15. Kallunday, 16. Koomvazhai, 17. Kudaivazhai, 18. Kurangusamba, 19. Kullakar, 20. Kallimadayan, 21. Gawni nel, 22. Kollikar, 23. Konakuruvai, 24. Kuzhiadichan, 25. Kallurandaiyan, 26. Muttakar, 27. Mottakoor, 28. Maranel, 29. Mattanel (or) Mattakar (or) Sengar, 30. Mattaikuruvai, 31. Neelan samba, 32. Norungan, 33. Nootrupathu, 34. Pisin, 35. Pattar pisin, 36. Puzhuthisamba, 37. Perungar, 38. Pitchavari, 39. Periavari, 40. Poongar, 41. Samba, 42. Samba mosanam, 43. Sembalai, 44. Sadakar, 45. Sooran, kuruvai, 46. Sikappukuruvikar, 47. Sikappu kuzhiadichan, 48. Sandikar, 49. Seeraga samba, 50. Sithiraikar, 51. Sornavari, 52. Sornavali, 53. Thooyamalli, 54. Thidakal, 55. Thangam samba, 56. Vaigunda, 57. Vadan samba, 58. Vellai kariyan, 59. Varappu kundaingchan, 60. Vellai kuruvai, 61. Vadan samba, 62. Vadan samba, 63. Vellai Chithiraikar, 64. Kuthiraival samba, 65. Kuruvai , alangiyam, 66. Kar samba, 67. Karthigai samba, 68. Avasara samba, 69. Pattarai kar, 70. Ondrai samba, 71. Kattu samba, 72. Puzhuthi kal, 73. Puzhuthi kar, 74. Mathimuni (or) Mathi mudi, 75. Ninni dhan, 76. Rongabudimal dhan, 77. Kaliasipiri dhan, 78. Oldisaur dhan, 79. Rongalochi dhan, 80. Lendi dhan, 81. Amsipiti dhan, 82. Bhatta dhan, 83. Jogarnath dhan, 84. Bod dhan, 85. Chot dhan, 86. Biagunda dhan, 87. Rthanseedi dhan, 88. Salem samba (wetland), 89. Rasa kadam, 90. Gandasale

Action Points	
Issues and Policies	Traditional knowledge must be covered under Intellectual Property Rights. The Govt. of India should take effective steps to protect the rights of local communities particularly with regard to their knowledge on conservation and sustainable use of plant genetic resources.
Strategies	The traditional knowledge and resource management practice of the rural people should be integrated in modern/scientific developmental strategies. Steps must be taken to recognize "farmers and traditional healers" knowledge and expertise so that their potential is realized for healthcare needs. Use of renewable forest resources need to be encouraged.
Education and awareness	The rural communities need to be educated with regard to adequate time of harvesting of resources. Also, they must be imparted education on potential value of little known resources.

3.3.3. Wild plants and ethnobotany

India represents one of the great emporia of ethnobotanical wealth. Ethnobotany includes the studies of plant wealth used by tribal and other ethnic communities for various purposes and the impact of such uses on the survival of vegetation and of individual plant species. The vast heritage of Vedic literature such as Rigveda, Athravaveda, Kautilyas Arthsastra, Vishnupuran, Agnipuran, Vishnudharmottara Mahapuran, Apstanga Smiriti, Brihat Samihta, Upavanvinoda, etc. and with medieval literature in various regional languages e.g. Sanskrit, Pali, Tamil, Persian etc. possess huge wealth of ethnobotanical information. These informations tell us about the man and nature relationship. Realizing the importance of such relationship, man started to see nature with reverence. As a part of this process, they began identifying several species of flora with particular purpose and started to use these species in social, cultural and religious ceremonies.

Action Points	
Survey and assessment	Field studies should be conducted on the basis of geographic areas and tribal groups. Studies on folklore and folk taxonomy, palaeo-ethnobotany, folk medicine, veterinary medicine and household remedies need to be conducted and the results integrated. Uses of the known ethnobotanically important plants need to be investigated. Study on ancient and medieval literature relevant to ethnobotany should be conducted.
Participation	Role of tribal participation needs to be highlighted in forest management. Gender differences in plant based knowledge need to be documented.
Issues	Intellectual property rights and royalties from marketable plant product need to be suitably regulated.

3.3.3.1. Social, cultural and religious ceremonies

The indigenous culture has provided several "miracle plants" for specific purpose. The belief systems of the traditional people of India extended their relationship from social to the natural environment, treating river as a mother Goddess, forests as gods, totemic animals as breathen, prey species as mutualists. The social restraints developed by several tribal communities in India on resource conservation and utilization are noteworthy. For example, the Gond tribals of Madhya Pradesh never cut the branches of trees, particularly when it is in bloom. The Andamanese, never harvest all the tubers of yam (*Dioscorea* spp.) from a given locality (Rao, 1996). The Bhoxas, one of the primitive tribal group of sub-Himalayan tract of Bijnour, Dehradun, Pauri and Nainital district traditionally conserved forest recourses and worshipped the living *Ficus benghalensis*, *F. religiosa, Aegle marmelos, Bombax ceiba, Crateva magna, Mangifera indica* and never fell these plants. Even the fallen branches of these plant species are never been used for fuel purpose.

The traditional religious ceremonies and festivals are associated with specific plants. Many plants are important part of cultural life and tradition. Indians believe that many trees

and plants are possessed with spirits or have been blessed by the Gods. Association of plants like *Azadirachta indica* with 'Gudhipadava' *Ficus religeosa* with 'Vatpurnima', *Bauhinia racemosa* and/or *Prosopis cineraria* with Dashara and *Osimum sanctum* with Tulsi-vivaha is well known. Similarly, in many religious 'pooja ceremonies', Patra pooja is one of the rituals where leaves of specific plants in fixed number are offered to different dieties. Besides religious faith, the tradition of 'Patra Pooja' is useful for knowing plant resources of common use and commercial potential and by handling them in the name of 'Patra Pooja' people may take care of these potential resources properly.

Box 30
Plants in demand for relegious work
(Source: Ghate 1998, Saklani and Rao 1996)

In Maharashtra, the demand of leaves is significant in Marathi month (July to early September). Pooja-Patri is, therefore, available in the market at the time of 'Mangalagauri', 'Haritalika', 'Ganesh-pooja' and 'Anantpooja'. People residing in nearby village fulfill this demand from the surrounding forests. They collect leaves, make them into sets of patri and either bring these to be wholesale market or sell them personally in the retail market. Local inhabitant earns more than Rs 500 to 1000 in a season. Species like 'Bel', 'Durva', 'Kelva', 'Rau' and 'Shami' are said to be precious and are sold at higher rates.

Brahmakamal '*Saussurea obvellata* ' is considered sacred and is offered large quantities at the Shrines of Badrinath, Kedarnath and other temple in Garhwal. It has been admired in various folk songs, folk tales and more importantly in local festivals, apart from its uses in ethnomedicine. The ruthless collection of flowers by local people and tourists coupled with habitat destruction has rendered species endangered. Thousands of plants are removed by local people in the region for offering the various shrines and also for the local festival.

Action Points	
Inventorization	An inventory of plants, which are used in several social/cultural and religious ceremonies, should be prepared and popularized not only among rural communities but also in so-called advanced urban societies.
Policy	A thorough survey of religiously important sites need to be documented and policy should be made to conserve such sites Govt. should recognize that indigenous lands need to be protected from environmentally unsound activities

3.3.3.2. Wild plants in primary healthcare

Over 7500 species of plants are estimated to be used by over 46335 ethnic communities. The country has the oldest, richest and most diverse cultural traditions in the use of medicinal plants. In India the coverage of rural population by the modern health system varies between different regions from 3-30% and medicinal plants continue to provide health security for

primary health care. Traditional medicine is the only alternative for over 4-5 hundred million rural people. For example it has been reported that about 44 medicinal plants are used in traditional physiotherapy in the health care of Gond tribals of U.P.

Box 31
Plants used in primary health care: Examples of Gond Tribe
(Source: K.K. Singh et al., 1994)

The Gond medicine men of Sonbhadra district (U.P) uses 44 medicinal plants in traditional health care system. They are dependent on medicinal plants growing in nearby forests for treating various ailments. The indigenous knowledge and efficacy of these medicinal plants has been proven in their community since time immemorial. There is need to follow up with ethnopharmaclogical screening of the tribal claims, by testing these ethnomedicinal recipes in their crude form, aqueous extract and alcoholic extracts on animal models. There is enormous potential in the district for establishing herbal drug centres for collection, processing and preparation of ethnomedicine and to develop cultivation farming and domestication of potential and promising ethnomedicinal plants in social forestry operation for improving the economy of Gond tribe and for human welfare. Some of the plants practiced in traditional phytotherapy by Gonds medicine man are as follows

Name of the species	**Parts used**	**Uses**
Achyranthes aspera	Leaf juice	in the treatment of cataract
Adina cordifoila	Stem bark	Malarial fever and stomach disorder
Aegle marmelos	Stem bark	Treatment of inflammation of eyes
Alangium salvifolium	Stem bark	Treatment of asthma
Ampelocissus latifoilia	Root paste	In bone fracture
Bombax ceiba	Root extract	In dysentery
Buchanania lanzan	Leaf extract	Spermatorrhoea
Bauhinia vahlii	Root extract	Syphilis
Cajanus cajan	Leaves paste	Jaundice
Calotropis procera	Root extract	In snakebite
Casearia elliptica	Root extract	Cholera
Celastrus paniculatus	Root bark	Cancer
Cryptolepis buchananii	Root paste	Bone fracture
Cyperus scariosus	Tubers and leaves extract	Dog bites and snake bites
Dendrophthoe falcata	Leaves juice	Ear pain
Dillenia pentagyna	Stem, bark powder	Cuts
Ficus racemosa	Leaf juice	Paralysis
Ficus religiosa	Ash of stem bark	Eczema
Grewia hirsuta	Root extract,	Scorpion sting, boils and blisters
Hemidesmus indicus	Root extract, root bark	Diabetes, snake bite
Ipomoea carnea	latex	Scorpion sting
Leucas aspera	Root paste	Migraine
Madhuca longifoila	Powdered seed cake	Snake bite
Plumbago zeylanica	Root paste	Boils
Sarcostemma acidum	Extract of stem	Bone fracture
Sida cordata	Whole plant	Venereal disease
Tridex procumbens	Leaf juice	Inflammation
Xanthium strumarium	Seed oil	Skin diseases
Ziziphus mauritiana	Root extract	Malarial fever

Action Points	
Conservation measures	Herbal farms should be established for processing and production of herbal medicine as well as generating employment for the benefit of tribal and local population.
Policies	There is a need to develop a comprehensive approach under some form of coordinating mechanism to ensure therapeutic efficacy and safety of herbal medicine through pharmacological and clinical studies and to regulate over- exploitation of plants through cultivation and conservation policies
Documentation	Information on folklore medicine and their utilization patterns from different tribal region should be collected
Assessment	Forest area must be surveyed extensively to assess the potential of medicinal and aromatic plants and their utilization.
Technology development	Multipurpose co-operative societies should be established in tribal areas to perform manifold functions of providing investments, procurement and marketing of medicinal plants Modern technology should be transferred to poor people by using appropriate extension methods. Setting of demonstration farms–cum- nurseries for transfer of technology in rural areas for community welfare should be promoted
Education and awareness	Local people/tribals must be trained for authentic identification and scientific collection of medicinal plants from time to time, as the different parts of the plants are to be collected as per their availability and maturity. The active participation and cooperation of local people especially the tribals should be considered for implementation of legislation measures as well as other conservation practices

Major Threats to plant biodiversity

4.1. Threats to biodiversity – General facts

Biodiversity of India is subject to many threats and the most serious threats include loss of vegetal cover and extinction of the species. We are losing biodiversity at different levels. Consequent upon the increase in demand of natural resources, the ecosystem and communities are being degraded and species are being driven to extinction. The factors responsible for this state of affairs include natural calamities and diverse range of human activities that alter and destroy natural habitats to fulfill human demands. For example the current productivity of the country's forest is only $0.7 m^3 ha^{-1} yr^{-1}$ and forest land for every individual needs a minimum of 0.47 ha against the actual availability of 0.11 ha. Similarly, India has less than 0.5 percent of pastures in the world but the livestock population constitutes more than 13 percent of the world's 3 billion head of domesticated animals. The paucity of pasture has forced people to graze their animals in forests (Singh and Vishwakarma, 1997). All these factors singly or collectively are responsible for the loss of biological diversity. The major causes of loss of biological diversity can be grouped into two categories: (1) Root causes and (2) Proximate causes

4.1.1. Root causes of biodiversity loss

These mainly include:

- Population pressure
- Developmental activities
- Commercial agriculture
- Unsustainable harvesting
- Shifting cultivation

4.1.1.1. Population pressure

Developing countries, including India, account for a greater share of the world's population and it is expected that by 2030 this share will increase from 78% to 86% of the world's population. Human population of India, which is 17% or 1/6th of the total humanity of the world (estimated 5.29 billion in 1999), is highly disproportionate keeping in view the land area of the country and the available resources. In India, almost 10 million entrants a year are projected in the coming decade. Agricultural lands and forests will need to absorb 7 million new workers each year placing additional pressure on already degraded resources. The various activities, which are directly related to the increasing human population such as developmental activities, modern farming system, unsustainable harvesting and shifting cultivation, are briefly summarized.

4.1.1.2. Developmental activities

Construction of multipurpose dams for harnessing hydroelectric projects has been part of developmental process all over the world. Sufficient source of running water is generally located in the thick forest areas with perennial river courses rich in both terrestrial as well as in aquatic biodiversity. Damming a watercourse inevitably leads to submergence of vast tract of forest and aquatic flora. For example: In the 1970 the proposed dam in the 'Silent Valley' of Kerala destroyed nearly 100 hectares of pristine forest and underlying biodiversity in the initial phase of construction before the work was finally stopped. The 'Idukki Dam' over the Periyar River in Kerala in the 1980s resulted the degradation of vast tract of vegetation in the pristine forest.

Box 32
Developmental activities caused extinction of endemic species
(Source: Nayar 1996)

Haplothismia exannulata is an endemic species, the only representative of the tribe Haplothismieae of the interesting family Burmanniaceae. The species was collected from Prambikulam in Kerala by Prof. Erady in 1951 and sent to Kew for identification. Airy Shaw of Kew published it as a new species under the newly established tribe Haplothismieae in Kew Bull 1952:227, 1952. This species is not collected since then and the area was submerged due to Parambikulam hydro project. The species is presumably extinct.

The 'Bhopalpatnam' and 'Inchampalli' dams on the borders of Andhra Pradesh, Madhya Pradesh and Maharashtra threaten to submerge 40,000 hectare of prime deciduous forest (Sinha, 1997). The proposed 'Manibhadra dam' in Orissa is being constructed in one of the prime pristine forest area remaining in the country. It is estimated that during the period 1951-1976, 0.49 million-hectare forest of India and the biodiversity it contained has been lost

due to major river valley projects and dam construction. The Tehri and Vishnu-Parayag dams is being constructed in the environmentally fragile and sensitive Himalayas and will destroy the rich Himalayan biodiversity and similarly the Narmada Sagar and the Sardar Sarovar dam in Madhya Pradesh.

Box 33
Developmental activities cause serious destruction
(Source: Raman 1997)

The roads and railways constructed across the Western Ghats mountainous region causes the destruction of forest resources and imbalance the ecological system. The Western Ghats are the source of all major rivers in southern India. The initiative to construct large dams on these rivers and their tributaries with a view to provide irrigation facilities and to generate hydroelectric power was taken during the colonial era itself. The first major investment was the Periyar Power Project, commissioned in 1986, which submerged not less than 8000 acres of forests in Thiruvithamkur alone. The Panshet dam on the river Mula and Mose in Pune is a classical case of deforestation not only in terms of submersion area, but in terms of the entire catchment area as well. The 645-km long Tungabadra has a total of 13 dams on it. There are 35-odd dams on the rivers in Kerala. Certain rivers, like the Bharathapuzha, which is only 250 km long, bear 10 major dams, 9 minor ones, with 5 more under construction. The Kunthi, a tributary of the Bharathapuzha originating in the Silent Valley, remained untouched by dams, as a result of massive public protest against the construction of a proposed 200 MW hydroelectric dam. It is to be noted that only a meager 5 of the 32 valleys in the Western Ghats have been left unaffected by the inexorable process of 'development'.

4.1.1.3. Unsustainable harvesting

Unsustainable and selective harvest of wild resources motivated by cultural tradition, survival need and for generating cash income to supplement earnings from other resources, have endangered certain groups of plant. Commercial exploitation of entire plants, roots, rhizomes, tuber, bulbs, seeds and fruits are the prime cause of depletion of important wild plants for lucrative financial gain in the trade, which flourishes both by legal and illegal means. For example: in Northeast India large-scale exploitation of *Dipterocarpus macrocarpus, Shorea assamica, Taxus baccata, Cephalotaxus* etc., made these species highly threatened. Similarly the most exploited and highly endangered ornamental family Orchidaceae, is facing a threat in its natural habitat. A perusal of distribution of number of species of orchid in northeast region reveals that out of about 850 species, ±187 are endemic, 108 endangered or threatened, 18 extinct or nearly extinct (Hedge, 2000). The famous lady's slipper orchids (*Paphiopedium*), blue vanda and red vanda (*Renanthera imschootiana*) once abundant in the region are facing a threat to their survival due to over-exploitation by the unscrupulous traders and unabated forest destruction.

4.1.1.4. Commercial Agriculture

Commercial agriculture has led to considerable changes in landscape and causes an adverse impact on physical environment through the degradation of land, the depletion of water resources and the loss of genetic diversity. The inception of canal irrigation in the last century has led to the increasing trends towards water logging, salinity and desertification. The use of artificial fertilizers and pesticides has caused widespread poisoning of land. Introduction of hybrids has the serious effect on the traditional varieties and thousands of varieties of rice, millets, oil seeds, vegetables and legumes have been lost. It is estimated that 60,000 local varieties of rice has existed only in the paddy diversity rich areas like northeast India and tribal areas of Bihar, Andhra Pradesh, Orissa and Madhya Pradesh, however, a small number of varieties (6000-7000) is grown over 70% of the paddy land. Similarly, hybrid wheat is grown over 90% of the land allocated to wheat. Studies in India indicate that in Godavari district of Andhra Pradesh, an estimated 95% of the rice varieties have been lost. In the northeast several varieties of sugar cane have given way to a single, hybrid variety. Similarly the expanding agriculture has caused a serous threat to Tropical Thorn forest communities in arid zones of Western India and it is on the verge of extinction (Khan, 1994).

4.1.1.5. Shifting cultivation

Shifting cultivation, popularly known as 'jhum' in various parts of the country, has been a traditional mode of raising food for the indigenous societies for millennia. Although jhum has fed people for generations, it is not viewed sustainable any more. The main reason is a drastic shortening of jhum cycle. This has posed serious environmental threats such as deforestation, biodiversity loss, soil and nutrient erosions and a loss of a variety of food crops. This practice is unsustainable and maladaptive because of increased human population, decreased jhum cycle or intervening fallow lands, soil erosion, declining soil fertility and productivity, persistent weeds like *Imperata cylindrica*, cultivation of dry forests, reduced litter and poor/slow recovery and danger of forest fires.

4.1.2. Proximate causes of biodiversity loss *(Source: Darlong, 1998)*

The proximate causes of biodiversity loss include default human management system of the biological resources which is stimulated by misguided economic policy and faulty Institution that enable exploiters to avoid paying the full costs of their exploitations. Both problems and solutions are built on economic foundation and the major threats to biodiversity are degradation and habitat include the following:

(i) Development pressure

- Road and transport
- Construction
- Mining
- Oil drilling
- Pollution
- Resource extraction
- Hydel/irrigation projects
- Forest based industries

(ii) Encroachment

- Expansion of forest villages
- New settlements
- Agriculture
- Shifting cultivation
- Monoculture forestry
- Teak rubber cultivation
- Horticulture
- Grazing/increased domestic animals
- Habitat depletion/change
- Siltation of river beds/wetlands

(iii) Exploitation

- Food gathering
- Trophies/specimen collection as hobbies
- Firewood/MFP collection
- Unregulated collection of medicinal plants and orchids
- Collection made by scientific/educational institutions
- Unregulated trade/market forces
- Influences of money power
- Exploitation by local authorities as revenue resources
- Smuggling of timber/forest produce across international border

(iv) Management of human resources

- Inappropriate land use
- Negative attitude
- Ignorance/lack of awareness
- Inadequate trained human resources
- Lack of effective management

- Tourism development/impact
- Conflicting/increasing demands
- Human harassment
- Change in people's life style
- Dilution of traditional values
- Generation gap
- Erosion of indigenous knowledge

(v) Political and policy issues

- Insurgency/armed conflict
- Inter community conflict
- Civil unrest/political movements
- Military activities
- Reduction in size of PAs
- Change in use/tenure/legal status people's/political pressure
- Persecution/refugees
- Lack of intervention
- Intervention failure
- Lack of interdepartmental coordination
- Lack of clear policy implementation

Box 34

Threats to biodiversity: region specific ***(compiled from Mudgal and Hajra 1999)***

States	Major threats
Andaman & Nicobar	• Habitat destruction
Andhra Pradesh	-
Arunachal Pradesh	• Industrialization and Urbanization • Clearing of vegetation for agriculture, including ' Jhum' cultivation. • Browsing and overgrazing by domestic cattle. • Logging and exploitation of forest for timber and fuel wood. • Hydroelectric schemes/construction of Dams and Reservoir. • Mining and Quarrying. • Drainage and water pollution. Construction of roads. • Tourism. • Fires. • Selective removal of plants species (economically important groups). • Pressures from introduced plants and weeds. • Collection of botanical specimens, flowers and horticulture (usually uprooting the plants).
Assam	• Agriculture • Urbanization • Mining • Hydro electric projects • Excessive use of fire wood. • Encroachment in the Reserved forest areas for settlement and rehabilitation programmes • Over collection of some economically important species. • Raising of artificial forest by monoculture of some economically important

	species like Sal and Teak.
Bihar	• Mining operation rich coal and mineral deposits. • Industrialization • Urbanization • Expansion of agricultural land • Biotic interference's • Socio-economic factors.
Chandigarh	• Urbanization • Tourist influx
Dadra & Nagar Haveli	• Biotic interference's • Over collection of economically important species by local people for various purpose. • Agricultural practices such as 'Tahal' cultivation • Grazing. • Urbanization and Industrialization.
Daman & Diu	• Ecological degradation due to steadily dwindling areas of natural vegetation and due to biotic and abiotic interference's. • Collection of coconut leaves and leaves of other palms for thatching purpose cause injuries particularly to young plants may result in decrease in number of these species. • Industrialization • Gradual increase in areas of salt production by salt producing agencies along the sea shore are destroying the vegetation cover. • Illicit cutting of trees and shrubs by local people. • Grazing • Other developmental activities.
Delhi	• Encroachment activities.
Goa	• Shifting cultivation • Illicit cutting of trees • Abuse of user rights • Forest fire • Mining operation • Tourism • Over grazing • Over exploitation of leaves, fruits, wood etc. • High velocity of wind • Cyclones
Gujarat	• Drought • Expanding agriculture • Over harvesting of forest produce • Grazing • Other developmental activities.
Haryana	• Developmental activities. • Indiscriminate felling of trees
Himachal Pradesh	• Natural calamities • Indiscriminate extraction of timber, fuel wood and fodder • Grazing • Forest fire • Exploitation of economically important plant species • Agricultural activities • Other developmental activities.

Jammu & Kashmir	• Over exploitation of economically important species • Habitat destruction
Karnataka	• Construction of Dams, Hydroelectric project etc. • Cane industries and the coal industries
Kerala	• Grazing • Shifting cultivation • Logging • Tourism
Lakshdweep	• Natural factors
Madhya Pradesh	• Various human activities
Maharashtra	• Over exploitation of natural resources • Habitat destruction • Natural calamities
Manipur	• Shifting cultivation • Over grazing • Socio- economical developmental activities • Forest fire
Meghalaya	• botanical specimen • collection of medicinal plant
Mizoram	• Shifting cultivation • Other human activities
Orissa	• Shifting cultivation • Burning of forest for hunting
Pondicherry	-
Punjab	• Destruction of habitats
Rajasthan	• Over exploitation
Sikkim	• Large scale extraction of Medicinal Plant • Illegal poaching and encroachment in the natural habitat
Tamil Nadu	• Grazing • Forestry operation • Traditional destruction practices • Pressure from introduced plant
Tripura	• Shifting cultivation
Uttaranchal	• Over harvesting, tourism, fire forest and hydro electric projects
West Bengal	• Industrial development, tourism and agriculture

Box 35

Threats to biodiversity: biologically sensitive areas (Hot-Spots) of India *(Source: Sinha 1997)*

Hot spots of biodiversity	Threat
Silent Valley (Kerala)	Massive destruction of pristine biodiversity due to the proposed Hydroelectric Dam in the 1970,s. several species are threatened with extinction.
Pooyamkutty Valley (Kerala)	Rich biodiversity threatened due to the construction of yet another Dam.
Palni Hills (Tamil Nadu)	Destruction of pristine "Shola Forest" due to population pressure and invasion of tourists.
Nilgiri Hills (Tamil Nadu)	Original climax forest being replaced by the Tea and Coffee plantations. Rapid urbanization and massive tourist invasion is also destroying large patches of vegetation.
Himalayas	Massive biodiversity destruction due to population pressure, construction of hydroelectric dams, expansion of apple orchards (horticulture) and pine plantation for 'resin tapping'.
Shivalik Hills (Himachal Pradesh)	Massive habitat destruction due to mining activities.
Doon Valley (Uttaranchal)	Massive deforestation due to mining activities.
Aravalli Hills (Rajasthan)	Massive habitat destruction due to mining activities and population pressure.
Chilka Lake (Orissa)	Destruction of rich aquatic biodiversity due to commercial exploitation for fish and shrimp farming.
Pulikat Saltwater Lake (Tamil Nadu)	Destruction of aquatic life due to siltation.
Narayan Sarovar (Gujarat)	Pristine Wetlands Ecosystem threatened with destruction due to revived mining activities in the area. It has been denotified by the Govt. of Gujarat.
Gir Forests (Gujarat)	Only home for the last surviving Asiatic Lions, threatened with destruction due to population pressure.
Manas (Assam)	Ecological "Gold-Mine" of India rich in Wildlife diversity. Threatened with destruction due to population pressure and illegal hunting, poaching and wildlife trade.
Sariska (Rajasthan)	Tiger Reserve of India threatened with destruction due to mining activities for procuring marbles. Supreme Court of India stopped mining in 1993.
Loktak Lakr (Manipur)	Pristine Wetland and only home for the surviving Brow-Antlered Deer. Lake threatened with drying up.
Bharatpur Lake and Wetland (Rajasthan)	Habitat of wide Varity and diverse species of birds and winter home for the Siberian Cranes. Threatened due to tourist invasion and urban expansion.
Thar Desert (Rajasthan)	Highly generic desert in world and seat of some elusive flora and fauna. Endemic species are threatened due to desertification intensified by population pressure of humans and expanding livestock.
Sunderbans (West Bengal)	Seat of "pristine mangrove forest" and biggest home for the tigers. Threatened due to erosion f coastal habitats
Little Rann of Kutch (Gujarat)	Only home for the last surviving due to massive tourist invasion.
Renuka Lake and Wetland (Haryana)	Aquatic life threatened due to massive tourist invasion.
Andaman and Nicobar Island	Elusive flora and fauna have become endangered due to tourist invasion.

Western Ghats	Seat of richest biodiversity in India threatened with destruction due to intense developmental activities. The Konkan Railway Project has particularly threatened the flora and fauna of the region.
North-eastern Himalaya	Richest biodiversity after the Western Ghats threatened due to population pressure and short cycled "shifting agriculture" practiced by the tribal inhabitants.
Dal Lake (Jammu & Kashmir)	Lake is dying due to destruction of aquatic life and human encroachment. The lake area, 58 sq. km in 1856 has shrunk to mere 24 sq. km in 1995.
Kodai Lake (Tamil Nadu)	Lake is dying due to destruction of aquatic life by vehicular pollution and dumping of garbage by massive tourist influx.
Ooty Lake (Tamil Nadu)	Lake is dying due to destruction of aquatic life by massive tourist invasion and dumping of garbage and sewage.

Box 36

Threats to biodiversity: few examples

Enchroachment *(Source: Singh and Vishwakarma 1997)*

Severity of the encroachment in the forest land in various states suggest that about 7,00, 627.62 ha of forest lands are under encroachment. This type of activities are greatly affecting the plat biodiversity of these regions.

States/UTs	Area in ha	States/UTs	Area in ha
Andhra Pradesh	76,116.00	Nagaland	900.00
Assam	1,31,196.00	Orissa	8595.51
Bihar	9,943.73	Punjab	3177.00
Gujarat	17,265.76	Rajasthan	22000.00
Haryana	287.00	Tamil Nadu	20,899.57
Himachal Pradesh	16,667.56	Tripura	1,522.00
Jammu Kashmir	5,370.00	Uttar Pradesh	14,493.00
Karnataka	12,395.00	West Bengal	14,275.00
Kerala	20.800.00	Andaman and Nicobar	2,847.37
Madhya Pradesh	2,47,189.00	Arunachal Pradesh	34,226.99
Maharashtra	22,758.30	Goa, Daman and Diu	6,638.07
Meghlaya	11,216.34	Dadra and Nagar Haveli	698.12
Manipur	57.00	Chandigarh	3.30
		Total	**7,00,627.62**

Forest fire in Himalaya *(Source: **Rautela et al,1999**)*

Forest fire is a common feature in the Himalayan forests and occurs in an approximately 4-year cycle. In 1995 nearly 93000 ha of forests has been lost due to the forest fire, however, in 1999 it is apparently more devastating. The fire appeared at diverse localities and lacks geographical continuity, it is expected that human factors be involved in one way or other in such fire.

Monoculture and habitat destruction *(Source: Saraswat and Thakur 1998)*

Factors responsible for gene erosion of plant species are monoclture and habitat destruction. In Himalayan region monoculture is not a prevalent practice except plantation of *Pinus roxburghii.* The deteriorated habitats are further invaded by secondary pioneer species. For example: *Gnaphalium* sps invades into open grasslands pastures and dominates the area due to over and unregulated grazing, *Euphorbia royleana* grows on xerophytic degraded habitats in open grasslands, *Lantana camara* grows on xerophytic habitat where Pines and deciduous broad leaf forests have been felled, *Cannabis sativa* grows in wasteland, *Rumex nepalensis* replaces *Trifolium pratense, T. repens* and grasses in temperate pastures due to heavy grazing,, *Parthenium* spp grows on degraded and wasteland. Many other non-palatable/dominates the heavily grazed and browsed area. Inferior grass and bushes

Action Points	
Agriculture	
Promotion of eco-friendly fertilizers	Imbalance and non-integrated fertilizers use can be disastrous, therefore leads to micro nutrient deficiencies The efficiency of fertilizers need to be improved The integrated uses of organic fertilizers along with chemical fertilizers need to be promoted and optimum doses of farmyard manure need to be determined
Research	In view of the toxicity of the pesticides there is need to search environment friendly molecules and need-based improvement in integrated pest management modules
Grazing/Browsing	
Conservation practices	Grazing in forest needs to be regulated, stall-feeding should be encouraged Use of crop residue as fodder should be encouraged Fodder can be grown on land under agroforestry and Joint Forest Management Programme, where local farming communities are active participants Silvicultural practices with respect to forest should be initiated
Tourism	
Participatory approach	Involvement of local people and promotion of ecotourism should be initiated. This can be achieved by awareness programmes on ecotourism related issues Tourism and forestry department should develop mechanism for ensuring the management of plant biodiversity especially during peak tourist season
Capacity building	Develop education programs aimed at tourists to explain the importance of maintaining local plant diversity and measures needed to conserve it
Exotic invasion	
Documentation	Taxonomic studies should be initiated for identifying the exotic elements and prepare a comprehensive list
Monitoring and value addition	Proper detection and monitoring technology need to be developed Evaluate the economic potential of these species for income generation

Scientific collection	
	Collection of material for scientific purpose from wild is a major threat to plant biodiversity. In India thousands of the researchers are presently collecting the material for their study
Strategy	Sampling strategy should be developed to collect minimum plant samples from the wild
Urbanization	
Issues	Amenities and infrastructure should be created at village level and various self-employment schemes be provided to villagers to overcome out migration
Socioeconomic	
Action point	Distribution mechanism of LPG cylinders and low smoke-high energy chulas among rural inhabitants should be promoted so that dependence on natural resources on fuel wood needs is drastically reduced
Encroachment	
Action points	Regulatory mechanisms need to be developed to prevent illegal encroachments in pristine systems

Major stakeholders and their role in biodiversity conservation

A number of organizations are working in the conservation of biological diversity. They can be categorized into the following:

5.1. Governmental Organizations and donors (*Source: Kushwah and Kumar 2001*)

5.1.1 Ministry of Environment and Forests (MoEF): At the Government of India level, MOEF is the nodal point for implementation of the Convention on biodiversity as well as the nodal Ministry for all environment and forest related matters. The main activities of the Ministry include conservation and survey of flora and fauna, forests and wildlife, prevention and control of pollution, afforestation and regeneration of degraded areas and protection of environment.

5.1.2. Ministry of Agriculture: The Ministry of Agriculture is responsible for the conservation of domesticated biodiversity, fishery resources, protection of forests through control of shifting cultivation, soil and water conservation, production of fertilisers, seed certification, agricultural marketing, procurement and stock of food grain and watershed management.

5.1.3. The Department of Biotechnology (DBT): DBT provides the technical support for biological control of plant pests, disease and weeds, biofertilizers, biodiversity conservation and environment, bioprospecting, *ex situ* conservation of medicnal and aromatic plants, genome development and bio-safety.

5.1.4. The Department of Science and Technology (DST): The DST is concerned with the development of technology for environment protection.

5.1.5. Ministry of Rural Development (MRD): The responsibility of regeneration of biomass outside recorded forest areas lies with the MRD.

5.1.6. The Ministry of Power, Industry and Non-Conventional Energy Sources: The matter related to energy conservation and development of alternative sources.

5.1.7. The Ministry of Commerce: The Ministry of Commerce is dealing with aspects of biological resources (e.g., TRIPS in the WTO).

5.1.8. The Department of Industrial Development and Policy (DIDP): The patent act and other IPRs are the concern of the DIDP.

5.19. The Department of Ocean Development (DOD): DOD support an All India Co-ordinated Project on Drugs from the Ocean and is also providing funds to promote research on regeneration of corals in the Andaman Islands and seaweeds in Mandapam in Tamil Nadu.

Besides these, a number of departments of forests, Pollution Control Board (PCB), Wildlife Advisory Board (WLAB), Biosphere Reserve, etc. collectively or singly look after biodiversity and environment of the States and Union Territories (UTs). In addition, some of the states also have specialized institutions, e.g. the Kerala Forest Research Institute, Tropical Botanical Garden and Research Institute in Kerala, the Environmental Protection and Coordination Agency in Madhaya Pradesh and the Gujarat Ecology Commission in Gujarat etc. Apart from these, a number of professional academic bodies in the country have been contributing actively through research and training on biodiversity related subjects.

5.2. Academic Institution and R&D Bodies

The important step taken by the academic sector in integrating biodiversity concerns with the existing programmes in universities and colleges is the attempt to introduce concepts of biodiversity in the curricula. Efforts are being made by National Council of Educational Research and training (NCERT) to include lessons on biodiversity inventorying in the biology text books of higher grades of schooling. The existing Centres of education are being strengthened by MOEF, UGC and CSIR to undertake research and training activities in conservation of biodiversity. The Indian Academy of Science and Indian Institute of Science have jointly launched a countrywide programme called India's Lifescape. The MOEF, Department of Agricultural Research and Education, Department of Science and Technology, DBT, DOD, Department of Science and Industrial Research and Ministry of Health are the principal departments/ministries, which have Research and Development initiatives and support research activities related to biodiversity. Many of these departments and ministries have a host of subject-specific or goal-specific organization. These institutes have contributed and are contributing significantly towards biodiversity conservation especially in plant biodiversity.

Box 37

R&D organizations *(Source: Kushwah and Kumar, 2001)*

Indian Council of Agriculture Research (ICAR)

- Central Arid Zone Research Institute, Port Blair and Jodhpur
- Central Institute for cotton Research, Nagpur
- Central Institute of Horticulture for Northern Plains, Lucknow
- Central Plantation Crops Research Institute, Kasuragod
- Central Potato Research Institute, Shimla
- Central Research Institute for Dryland Agiculture, Hyderabad
- Central Research Institute for Juit and allied fibres, Barrackpore
- Central Rice Research Institute, Avikanagar
- Central Tobacco Research Institute, Rajamundry
- Central Tuber Crop Research Institute, Thiruvananthapuram
- Cotton Technology Research Laboratory, Mumbai
- Directorate of Oilseeds research (ICAR), Hydrabad
- Directorate of Pulses Research (CAR), Kanpur
- Directorate of Rice Research (ICAR), Hydrabad
- ICAR Research Complex for North Eastern Hill Region, Shillong
- Indian Agricultural Research Institute, New Delhi
- Indian Grassland and Fodder Research Institute, Jhansi
- Indian Institute of Horticultural Research, Sadashivanagar
- Indian Academy of Agricultural Research Management, Hydrabad
- National Bureau of Plant Genetic Resources, New Delhi
- National Research Centre for Groundnut, Junagadh
- National Research Centre for Sorghum, Hydrabad
- National Research Centre for Soyabean, Indore
- Vivekanand Parvatiya Krishi Anusandhan Shala, Almora

Council of Scientific and Industrial Research (CSIR)

- CSIR Centre for Biochemicals, Delhi
- CSIR Complex, Palampur
- Central drug Research Institute, Lucknow
- Central Food Technology Research Institute, Mysore
- Central Fuel Research Institute, Dhanbad
- Central Institute of Medicinal And Aromatic Plants, Lucknow
- National Botanical Research Institute, Lucknow
- National Institute of Science, Technology and Development Studies, New Delhi
- Regional Research laboratory, Bhopal, Bhubaneswar, Jammu Tawi, Jorhat Thiruvananthapuram

Ministry of Environment and Forest (MoEF)

- Botanical Survey of India, Calcutta
- Central Pollution Board, Delhi
- Centre for Ecological Research and Training, Bangalore
- Centre for Environment Education, Ahmedabad
- Centre for Mining Environment, Dhanbad
- Forest Survey of India, Dehradun
- G.B. Pant Institute of Himalayan Environment and Development, Kosi,-Katarmal, Almora
- Indian Council of Forestry Research and Education, Dehradun
- Indian Institute of Forest Management, Bhopal
- Indian Plywood Industries Research Institute, Banglore
- Institute of Arid Zone Forestry Research, Jodhpur
- Institute of Deciduous Forest, Jabalpur
- Institute of Forests Genetics and Tree Breeding, Coimbatore
- Institute of Moist Deciduous Forests, Jorhat
- Institute of Wood Science and Technology, Bangalore
- Wildlife Institute of India, Dehradun

5.3. Citizens groups and Non-Governmental Organizations (NGOs)

NGOs have played a significant role in functioning as facilitators between the tribal, rural communities and Government Department. There have been a number of non governmental organizations (NGOs) initiatives to integrate biodiversity conservation in sectoral programmes in the country. According to WWF, there are about 1400 active environmental NGOs working all across the country. The area of focus of a majority of NGOs has been in awareness building through a variety of methods and tools. Celebration of Environment days, Vanamahostavs, propagation of environment messages through traditional folk media, street plays, campaigns, and Yatras are some of the ongoing activities. Of these, some are fully involved in the biodiversity conservation while others are conserving biodiversity through environmental education and campaigns. Some of the NGOs like SRISTI and Navdhanya have their own programmes for *in-situ* conservation of crops. Some NGOs have also helped in building the capacity of local people in the technique. Many of the activities are carried out through a network. A list of NGOs working in the conservation of plant biodiversity is summarized (Table 36).

Table 36. Citizens groups and Non Governmental Organization engaged in plant biodiversity conservation (*Source: Anonymous, 1999*)

Name of the Citizen group/NGOs	Location
Anamalai Environmental Society	Pollachi, Tamil Nadu
Andaman and Nicobar Environmental Team (ANET)	Portblair, Andaman and Nicobar
Andhra Pradesh Natural History Society	Vishakhpatanam, Andhra Pradesh
Ankur	Chamoli district, Uttaranchal
Antoydaya Research and Action Group (ARAG)	Jagatsinghpur district, Orissa
Assam Valley Wildlife Society	Sonitpur district, Assam
Ashoka Trust for Research in Ecology and Environment (ATREE)	Banglore
Bharat Environment Seva Team (BEST)	Pudukkottai, Tamil Nadu
Bombay Natural History Society (BNHS)	Mumbai, Maharashtra
C.P.R. Foundation for Environment Education	Chennai
Cenrtre for Environmental Eucation	Ahmedabad
Centre for Ecology and Reasearch	Thanjavur
Centre for Science and Environment	New Delhi
Centre of Minor Forest Product (COMFORPTS)	Dehradun, Uttaranchal
Confederation of India Industry	Chemmai
Conservation of Nature Trust	Calicut
Development Alternatives	New Delhi
Dr. Salim Ali Memorial Nature Club (SAMNC)	Hamirpur district, Uttar Pradesh
EPTRI	Hydrabad
French Institute Pondicherry	Pondicherry
Friends of Trees	Trivandrum
Good Shepherd Rural Development Trust	Tirunelveli, Taml Nadu
Gramin Vikas Evam Paryavaran Sanstha	Dausa district, Rajasthan

Gramium	Tiruchirapalli
Green Earth Foundation	Jaipur, Rajasthan
Gujarat Ecological Education and Research Foundation	Gandhinagar, Gujarat
Himalayan Eco-Horticulture Society (ECO Horts)	Shimla, Himachal Pradesh
Himalayan Nature and Environmental Preservation Society	Shimla, Himachal Pradesh
Himalayan Vanya Jeev Sansthan (HVJS)	Gopeshwar, Uttaranchal
Indian Society for Wildlife Research	Calcutta, West Bengal
Indian Society of Environment	Kanpur, Uttar Pradesh
Jamboji Silvicultural League	Tiruchirapalli
Kalpbriksh	Pune
Karnataka Rajya Vijnana Parishat	Banglore
Kerala Forest Research Instiutue	Peechi
Krishi Vigyahn Kendra	Trivandrum
Megamix Nature Club	Lakhimpu, Assam
Merlin Nature Club	Banglore, Karnataka
Nature	Hanamkonda, Andhra Pradesh
Nature Conservation and Education Council (NCEC)	Thanjavur, Tamil Nadu
Nature Wildlife Conservaton Society of Orissa	Bhubanesvar
Navdhanya	New Delhi
Orissa Environmental Society	Bhubanesvar
Palni Hills Conservation Council, Kodaikanal	Kodaikanal, Tamil Nadu
Paryavaran Samrakshan Committee	East Sikkim district, Sikkim
Peoples Environment Protection Society	Waltair, Andhra Pradesh
Peoples Re-construction Movement (PRM Project)	Krishnagiri, Tamil Nadu
Ramanyam Foundation for Agriculture and Human Potential Development	Chennai, Tamil Nadu
RASTA	Kerala
Research in Environment, Education and Development Society	Hydrabad, Andhra Pradesh
Rural Environment Service Society	Warangal, Andhra Pradesh
Sahyadri Nisarga Mitra	Ratnagiri District, Maharashtra
Samvardhan- Association for Propagation of Indigenous Genetic Resources (SAMVARDHAN APIGR)	Ahemdabad, Gujarat
Save Nilgiris Campaign	Niligiri, Tamil Nadu
Society for Environment and Development	Calcutta
Society for Preservation of Environment and Quality of Life (SPEQL)	Hydrabad, Andhra Pradesh
Society for Royalaseema Integrated Rural Education and development (SRIRED)	Anantapur district, Andhra Pradesh
Society of Appeal for Vanishing Environment (SAVE)	Nainital, Uttaranchal
Society for Himalayan Environment and Research	Dehradun
Tamilnadu Green Movement	Erode
Tropical Botanical Garden and Research Institute	Trivandrum
Tata Energy Research Institute	New Delhi
The Himalayan Lovers	North Pargana, West Bengal
The Junglees	Calcutta, West Bengal
Tirunelveli Wildlife Association	Tirunelveli, Tamil Nadu
Voluntary Organization for Integrated Community Emancipation	Anantapur Andhra Pradesh
Wildlife Conservation Society Hydrabad	Hydrabad, Andhra Pradesh
World Wide Fund for Nature, India	New Delhi

5.4. Community groups

Population dependent on local forests contributes to a major threat to biodiversity by over exploiting forest produce in the absence of livelihood alternatives. Therefore, there is a need for involving people and their knowledge base for protection and management of biodiversity. Some of the community groups like Vivekananda Girijana Kalayana Kendra (VGKK) and Ashoka Trust for Research in Ecology and Environment (ATREE) are involved in biodiversity consevation. The main objectives of these community groups are to conserve biodiversity and its sustainable development, improve institutional and policy framework on protection of the environment, strengthen the capacity of governmental and NGOs to use the best knowledge and data to solve environmental problems. These groups are working on research programme, such as, conservation and livelihood change, land use changes, mapping biodiversity and conservation planning, agrobiodiversity and forest genetic resources. An example of community groups on biodiversity conservation is presented and these are called community-conserved areas (CCAs).

Box38
Examples of CCAs
Source: NBSAP Contribution

- Protection of 1800 hectares of forest by Mendha (Lekha) village in Gadchiroli district, Maharashtra, Gond tribal community.
- Regeneration and protection of 600-700 hectares of forest by Jardhargaon village in Uttaranchal state.
- Conservation of Gursikaran and Sheikha wetlands in Uttar Pradesh by surrounding villagers.
- Community-based monitoring and enterprise by the Soliga tribal at the Biligiri Rangaswamy Temple Sanctuary, Karnataka.
- Community forestry initiatives in several thousand villages of Orissa.
- 600 ha. of regenerated village forest in the Loktak Lake Catchment by Ronmei tribe in Tokpa Kabui village, Churachandpur district, Manipur.
- Orans in the desert region of Rajasthan including Barmer district, by the local community.

Ongoing biodiversity related initiatives

It is well known fact that biological diversity is subject to various types and intensities of anthropogenic pressure. Collosal increase in human population has put tremendous pressure on non-renewable resources that have accumulated over hundreds of million of years. Age-old cultures based on sustainable use of renewable resources are being steadily replaced by modern culture. The profound changes in the human society called for by the World Commission on Environment and Development (WCED, 1987), the World Conservation Strategy (IUCN, 1980) and the World Charter for Nature can become a reality only when government seriously invest in implementing innovative technologies for conservation of biodiversity for sustainable development. Recognizing these facts various initiatives have been taken to conserve biological diversity. These include: (i) Conservation mechanism (*in situ* and *ex situ)*, (ii) Research and development, (iii) Participatory approach and (iv) Policy and legal measures

6.1. Conservation mechanism

6.1.1. In situ

The *in-situ* conservation of biodiversity mainly deals with the conservation of biodiversity in its natural habitat. From the open, stunted, scrub forests of cold and windy deserts of Ladakh in the north, to the tropical moist rainforest of Kerala in the south, and the northeast, India supports rich and most interesting wild plant diversity of the world. Considering the rich flora and fauna of the country Government of India has setup a scheme for conservation of biological diversity in the form of protected areas.

6.1.1.1. Protected Areas (PAs)

Protected Areas (PAs) are regarded as the ultimate repositories of biological diversity. Currently there are 573 PAs in India covering 154040 sq km area (nearly 4.69% of the country's land surface). These include 89 National Parks (NPs) and 484 Wildlife Sanctuaries (WLS). The NPs and WLS cover approximately 1.13% and 3.56% of the land area respectively. Also, there are 11 Biosphere Reserves (BRs) which comprise existing parks, sanctuaries and adjacent reserve forests, essentially to manage the entire landscape according to the principles laid by the Man and Biosphere Programme of the UNESCO. The existing PA

network covers varied ecosystems and communities such as a large number of terrestrial habitats. Among the PA coverage within various zones, maximum number of angiosperms has been reported from Himalayan region (5000 species from 67 PAs), however, the lowest number of species is recorded from the coast (400 species from 26 PAs).

The floristic studies within Indian PAs are largely confined to well known Tiger Reserves (TRs), a few NPs and well established WLS, however, most of these studies are restricted to the angiosperms. Perusal of the literature on the floristic studies in different states reveal that most of the workers have enumerated the species based on a few collection trips. Detailed inventories and conservation status have been rarely worked out. Similarly, distribution of threatened taxa in relation to PAs have been analysed only by a few researchers (Rawat, 1994). Among various biogeographic regions, best surveyed PAs are within the western Himalaya. For example, within Uttaranchal 8 PAs (out of 11) have been extensively surveyed in terms of floristic diversity. Level of exploration within northwestern, central and eastern Himalaya, however, varies. Least explored PAs being in Arunanchal Pradesh. Phytogeographic uniqueness, popularity among the conservationists and relative age of the PAs (in terms of establishment) has also influenced the level of floristic exploration. Status of PAs and species richnes within each biogeographic region is summarized (Table 37).

Table 37. Distribution of angiosperms in different biogeographic regions *(Source: Rawat and Hajra, 2001)*

Biogeographic regions	Approx. area	No. of PAs	% of zone	No. of species	No. of species in PA
Trans Himalaya	184823	7	9.20	1000	500
Himalaya	210662	67	9.92	8000	5000
Desert	215757	7	7.45	2000	1500
Semi-arid	545850	91	2.80	2500	2000
Western ghats	132606	56	10.12	4000	3000
Deccan Peninsula	1580380	137	3.71	3000	2000
Gangetic Plain	354782	36	2.16	2000	1000
Coasts	82813	26	6.79	500	400
North East	171341	37	2.54	4000	2500
Island	8249	103	18.54	2200	2000

Statewise analysis reveals that the PAs are not distributed uniformly across the states of the country. Some states are best covered while others are very poorly covered. The protected area rich state are Sikkim (28.88%), Goa (20.39%), Uttaranchal (14.66), Himachal

Pradesh (12.87%), Arunanchal Pradesh (11.44%), Gujarat (8.62%), Kerala (6.90%), Jammu and Kashmir (6.67%), Tripura (5.76%) and Orissa (5.11%), however, Sikkim, Uttaranchal, Arunanchal Pradesh, Goa, Himachal, Jammu and Kashmir are best represented by National Parks. Nagaland, Meghalaya, Manipur, Haryana, Delhi and Punjab have very less protected areas. Analysis of UTs reveal that National Parks are only present in the Andaman and Nicobar Islands. Dadra Nagar Haveli, Lakshdweep and Pondicherry have no PA coverage. Details of NPs and WLS in each state are presented (Table 38).

Table 38. PA network in States and Union Territories (*Source: Rodgers et al., 2000)*

State	PAs (sq. km.)	No. of NP	% of state	WLS	% of state	% of state area
Andhra Pradesh	128.53	4	0.14	21	4.56	4.7
Arunachal Pradesh	95.82	2	2.95	10	8.50	11.45
Assam	21.14	3	1.50	13	1.20	2.7
Bihar	44.49	2	0.33	19	2.23	2.56
Delhi	0.13	0	0.00	1	0.89	0.89
Goa	7.54	1	2.89	6	17.50	20..39
Gujarat	169.02	4	0.24	21	8.38	8.62
Haryana	2.79	1	0.02	9	0.63	0.63
Himachal Pradesh	71.66	2	2.57	32	10.30	12.87
Jammu & Kashmir	148.22	4	2.09	15	4.58	6.67
Karnataka	64.02	5	1.29	20	2.05	3.34
Kerala	26.79	3	1.38	12	5.52	6.9
Madhya Pradesh	171.78	11	1.46	35	2.41	3.87
Maharashtra	153.43	5	0.31	33	4.68	4.99
Manipur	2.24	1	0.18	1	0.83	1.01
Meghalaya	3.01	2	1.19	3	0.15	1.34
Mizoram	8.84	2	1.19	4	3.10	4.2
Nagaland	2.26	1	1.22	3	0.15	1.37
Orissa	79.61	2	0.64	18	4.48	5.12
Punjab	3.17	0	0.00	11	0.63	0.63
Rajasthan	95.69	4	1.13	24	1.67	2.8
Sikkim	20.49	1	25.14	5	3.74	28.88
Tamil Nadu	29.09	5	0.24	20	2.00	2.24
Tripura	6.03	0	0.00	4	5.56	5.76
Uttar Pradesh	54.80	7	1.48	29	2.58	4.42
Uttaranchal	75.25	6	9.66	5	5.00	14.66
West Bengal	27.96	5	1.91	15	1.24	3.15
UTs						
Andaman & Nicobar	15.29	9	14.03	94	4.51	18.54
Chandigharh	0.25	0	0.00	1	25.42	25.42
Dadra & Nagar Haveli	0	0	0.00	0	0.00	0
Lakshdweep	0	0	0.00	0	0.00	0
Pondicherry	0	0	0.00	0	0.00	0
Daman & Diu	0.02	0	0.00	1	3.03	3.03

Action Points	
Policies/Acts	The type localities, areas of special conservation significance and botanical hotspots both in side and out side the PAs should be brought under the umbrella of wildlife protection. The government's policy on the protection of highly threatened species need to be made stringent. The Wildlife (protection) Act, which is currently under revision, should make special provision for the protection of the threatened type localities and botanical hotspots. The plant conservation strategies for the country need wider publicity Establish a link between the field managers, ecologist and systematic botanists so as to gear up the plant conservation activities within various PAs. As part of conservation planning and habitat management activities the PA managers should draw a plan for the conservation of rare plants in their area in collaboration with the regional botanists. Develop guidelines for selection, establishment and management of protected areas. Priorities for management inputs should be established on the basis of thorough assessment of biological values.
Education and Awareness	The PA managers should train their field staff in identification and monitoring of critically endangered plant species in their respective areas. The conservation programmes can be more successful by involving the local people and para-taxonomists who possess rich traditional knowledge on species and conservation ethos. Encourage biodiversity conservation and sustainable use of bioresources on private land.
Assessment and conservation	Prioritize the species for protection and rehabilitation within each botanical hotspot. Identification of habitat for a critically endangered species and protection (of the habitat) would be a better strategy than focusing on the species particularly if it is an inconspicuous herb. Provision for reintroduction/introduction of rare species within PAs from the surrounding areas in the event of such species being present only outside the PAs, and assessment of human pressure or biotic interference on various species within PAs for evolving better conservation strategies should be taken up by PA management.

	Promote environmentally sound and sustainable development (ecodevelopment) in areas adjacent to protected areas. Protection of ecosystem/habitats for maintenance of viable population of species. Prevent introduction of and control or eradicate alien species, threatening ecosystems/habitat/species. Respect/ uphold relevant knowledge, innovations and practices of local communities to promote wider applications.

6.1.1.2. Sacred Groves

Apart from the PA there is another mean for conservation of biological diversity which is completely in the control of local communities and these communities protect patches of forests by dedicating them to deities or ancestral spirit. This mechanism of conservation of biodiversity is known as sacred groves. In other words sacred groves are segments of landscape, containing vegetation and other forms of life and geographical features that are delimited and protected by human societies under the belief that to keep them in a relatively undisturbed state is expressive of an important relationship of human with the divine or with nature (Hughes and Chandran, 1998). The degree of sanctity of sacred groves varies among regions (Box 39).

Box 39
Diversity in conservation mechanism *(Source: Sinha, 1997)*

In India Sacred Groves (SGs) occur under a variety of ecological situations. They have evolved under resource rich situations such as in Meghalaya in northeast India, Western Ghat region in southern India or in the Bastar region in the state of Madhya Pradesh in Central India. The degree of sanctity of sacred forests varies. In some forests, even dry foliage and branches and fallen fruits and seeds are not touched. In some SGs, the dead wood or the fallen foliage may be picked up, but never the live tree branches. The Garo and the Khasi tribes of eastern India completely prohibit any interference in their SGs (Jain, 1986). According to a report by the Centre for Earth System studies in Kerala, at present there are 240 groves in the western region of Kerala, in south India. The largest of these (20 ha) is the famous Iringola Kavu. Many of them are linked to temple premises. These 'Kavus" contain all the rare and endangered species of the Western Ghats and rare medicinal plants of the region.

In Meghalaya, many SGs are still well protected, inspite of a rapid decline in the traditional value system, with the advent of Christianity. The traditional religious belief tells that Gods and the spirit of the ancestors live in these groves. The Mawphlang grove close to shillong town is one of the best preserved set in a degraded landscape all around. The Mawsmai grove in Cherrapunji of about 6 km² of protected mixed broad-leaved rainforest, though subject to some disturbance along the peripheral region. Ceremonies used to be performed regularly in this grove and other in the region, to propitiate the ruling deity, the rituals have been stopped in many of them for the last year. Removal of plants or plant parts is considered to offend the ruling deity, leading to local calamities.

On the basis of available literature it is estimated that about 13,720 SGs have been reported from different states of India, which cover an area of about 33,000 ha (0.01%) of the total geographic area of the country (Gokhale et al., 1998). This figure is only an indication of the extent and magnitude of the presence of SGs in the country. Detail inventory of the SGs of Chattishgarh, Jharkhand, Orissa, Uttaranchal, Madhya Pradesh and West Bengal is not known inspite of the known presence and pattern of distribution. This could increase the number and expected to reach about 100,000 to 150,000 (Malhotra, 1998). The analysis of available data reveal that the maximum number of SGs has been reported from Himachal Pradesh followed by Kerala (2000), Maharashtra (1600) and Jharkhand (1424). In the Uttaranchal region only one SG has been reported, however, there are several Bugyals and forests, which are known to be sacred. The number of reported sacred groves from each state is presented (Table 39).

Table 39. Sacred groves in India *(Source: **Malhotra et al., 2001)***

State	No. of SGs
Andhra Pradesh	750
Arunachal Pradesh	58
Assam	40
Chhattisgharh	600
Gujarat	29
Haryana	248
Himachal Pradesh	5000
Jharkhand	21
Karnataka	1424
Kerala	2000
Maharashtra	1600
Manipur	365
Meghalaya	79
Orissa	322
Rajasthan	9
Sikkim	56
Tamil Nadu	448
Uttaranchal	1
West Bengal	670

The total area of the SGs in India as a whole is reported to be about 33000 ha or 0.01% of the total area of India (Gokhle et al., 1998). This is far from expected that just 4415 SGs reported so far cover over 42000 ha area (Table 40). Based on the incomplete data it is not possible to come up with reasonable estimate. However, it can safely be said that the area under SGs will be many times more than the estimated (Malhotra et al., 2001).

Table 40. Reported area of SGs in India *(Source: **Malhotra et al., 2001)**.*

State	No. of SGs	Area (ha)	References
Kodgu (Karnataka)	1214	5947	Kalam,1996
Kerala	2000	500	Rajendra Prasad, 1995
Maharastra	483	3570	Gadgil and Vartak, 1981
Meghalaya	79	26326	Tewari et al., 1998
Orissa	322	50	Malhotra et al., 1998
Rajasthan - 1	1	83	Singh and Saxena, 1998
Rajasthan - 2	8	158	Jha et al., 1998
Tamil Nadu	10	127	Swamy et al., 1998
Uttaranchal	1	5500	Sinha and Maikhuri, 1998
West Bengal - 1	7	2	Malhotra et al., 1998
West Bengal - 2	290	15	Malhotra et al, 2001

Sacred groves play an important role in the religious, socio-cultural, economic, political, biological and ecological services. SGs constitute pristine vegetation particularly rich in trees and associate groups of organisms.

Box 40
SGs are a genepool of valuable species *(Source: Malhotra et al., 2001)*

With the continuing destruction of forest all around them, the SGs have become fragmented habitats housing a variety of genetic pools and become the last refuge for many threatened endangered and endemic plant and animal species. Tree species like *Phoeba hainsiana* (vulnerable), *Rhus hookeri* (endangered) and *Flacourtia cataphracta* (endangered) have been found to be well represented in two SGs in Manipur valley. *Syzygium travancorium*, an endemic tree reported from the low level evergreen forests of Kulathupuzha (South Kerala) has been totally eliminated from its type locality. Haridasan and Rao (1985) reported at least 50 endangered and rare species in SGs of Meghalaya. SGs of Kerala are also found to harbor a number of plant species that are wild relatives of many crop species. SGs in general, act as a nursery and storehouse of many of the Ayurvedic, tribal and folk medicines. Species not under any immediate risk of extinction if preserved in SGs, may not become rare and threatened. The SGs may be served to preserve genotypes and useful in forest tree-breeding programmes. The sacred forests are also of great forestry interest as indicators of the natural productivity of the region. Ecologically valuable species like *Albizia lebbek* and *Ficus glomerata*, which conserve high amount of N_2, Phosphorus, Magnesium and Calcium in their leaves, are found in several SGs of Manipur. Besides these, there are various species represented in SGs which are used by local communities for cultural or religious reasons. These species play an important role in the maintenance and enhancement of biodiversity.

include commercial forestry, developmental projects, shift of belief system, sanskritisation, pilgrimage, tourism, enchroachment and modernization. The magnitude of these threats is even region and grove specific. The most recent threat to SGs comes from the process of modernization. Local traditions are being challenged by westernized urban cultures. Modern education system fails to respect the local traditions. As a result, the SGs is losing its cultural importance among the younger generation of local people (Malhotra et al., 2001).

Despite all these threats SGs are still alive in many parts of the country. Local people maintain these groves as a part of the culture. This fact indicates that there are ample

opportunities for strengthening the SGs. Realizing this fact various Institution of the country have initiated work on SGs.

Box 41
Initiative of Indira Ghandhi Rashtriya Manav Sangrahalaya (IGRMS)
(Source: Malhotra et al., 2001)

Considering the biological and ecological importance of the SGs in our country, IGRMS Bhopal has undertaken a number of activities in collaboration with many academic institution and NGOs like Indian Statistical Institute, Calcutta; Centre for Interdisciplinary Studies, Barrackpore; Department of Anthropology, University of Pune; Indian Institute of Science, Bangalore; Kerala Institute of Research and Training in Anthropology and Development Studies, Kozhikode; St. Joseph College, Thiruchirapalli; Applied Environmental Research Foundation, Pune; Indian Institute of Forest Management, Bhopal; North Eastern Hill University, Shillong; World Wide Fund for Nature India and many others. The museum was established in 1999 on its 200 acre campus at Bhopal and replicas of SGs from Arunanchal Pradesh, Chattishgarh, Kerala, Maharastra, Manipur, Meghalaya, Rajasthan, Tamilnadu and West Bengal. Plants from groves of these states were planted in their respective replicas on IGRMS campus, after a very careful selection, taking into consideration the geoclimatic conditions of Bhopal. These groves were ritually established, accompanied by dances and ceremonies performed by the local communities of the respective states. These SGs replicas are means to serve as living nurseries of ancestral and community identity, purity and longevity in the community habitats.

Action Points	
Documentation	Sacred Groves and their plant biodiversity status in all states need to be documented Genesis of their sacred identity need to be known and popularized
Research and Management	Ecological and biological studies need to be initiated Management options need to be properly monitored and implemented

6.1.2. Ex-situ

The most effective and efficient mechanism for the conservation of biodiversity is habitat protection (Conway, 1988; Ashton, 1988). However, for many rare species *in situ* preservation is not a viable option due to increasing anthropogenic pressure. The population of species may decline leading to extinction in the wild due to over exploitation and habitat loss. Besides these, genetic drift and inbreeding, demographic and environmental variations, deteriorating habitat quality, competition from exotic species make the species vulnerable in natural populations. In such circumstances, maintenance of individuals in artificial conditions under human supervision is the only way to conserve species (Conway 1980, Dresser 1988, Cohn 1991). This strategy is known as *ex situ* preservation. In order to conserve biological diversity Governement of India has setup various botanical gardens and seed bank all over the country.

6.1.2.1. Botanic Gardens

Botanic gardens play a pivotal role in conservation, propagation, public education and sustainable utilization of the genetic resources. Conservation of many economically important plants in their natural habitat is not always possible or feasible. Severe genetic erosion in a wide ranging species has resulted in the decline of population size of many economically important species. Thus steps need to be taken to collect and maintain the germplasm of these plants in botanic gardens for effective conservation.

Box 42
Herbal Garden for conservation of Ayurvedic medicinal plants
(*Based on the report of Indian Institute of Ayurveda for Research, Tarikhet, Ranikhet*)

The herbal garden located at Ranikhet (1829 m asl), covers >2.5 acres of cultivated land. The main aim of this garden is to cultivate Saffron and assess possibilities for cultivation of different medicinal plants drawn from wild sources. Presently about 200 medicinal plant species, mostly of Ayurvedic importance, are growing in the garden. The various agro-chemical experiments under the saffron cultivation project (initiated in the year, 1971), have yielded highly satisfactory results for the successful propagation of saffron at Ranikhet, Chamba and Joshimath areas in Uttaranchal. The herbal garden at Chamba, district Tehri (1,800 m asl) has about 70 medicinal plants species of Ayurvedic importance growing in about 2 acres of land. In addition about 300 saffron corms are also successfully growing.

During the past the most extensive efforts in *ex situ* conservation have been applied on crop species, some trees and pasture plants by FAO. The Consultative Group on International Agricultural Research (CGIAR), International Board on Plant Genetic Resources (IBPGR), 12 other International Agricultural Research Centres, over 150 gene banks across the world and other crop genetic resources centers have been set up. All these cover about 0.2% of the total

floristic diversity. The majority of germplasm is maintained by over 1,300 botanic gardens all across the world. International coordination of the *ex situ* efforts are maintained by the Botanic Gardens Conservation Secretariat (operated under the auspices of IUCN). This body holds record of 20,000 species, which are grown in botanic gardens (roughly 8% of the world's plants).

Box 43
Wild Plant Diversity in Indian Botanic Garden *(Source: Singh, J.N., 1996)*

Indian Botanic Garden Howrah, has 2350 species of trees and shrubs together with several thousands of herbaceous plants grow in the twenty five division, five glass houses, five green houses and conservatories in the garden. The garden maintains germplasm of Bamboo (26spp), *Bougainvillias* (148 cultivars in 3 species), *Citrus*, *Jasmine* (25 spp each), Palms (109 species) and water lilies (30 cultivars in 4 species)

In India about 150 Botanical Gardens are maintained under various sectors which is only 0.1% of the world's total. Among these, 33 gardens under Government control, 77 gardens and parks of public and academic interest and 40 gardens are mantained by the Universities. Out of these there are 8 major Botanical Gardens which were established during British period. These are: (1) The Royal Botanic Garden (Indian Botanic Garden 1787), (2) Botanic Garden at Saharanpur 1817, (3) Lloyd Botanic Garden, Darjeeeling 1878, (4) Government Gardens, Ootty 1947, (5) Sim's Park, Coonoor 1974, (6) Botanic Garden, Coimbatore 1908, (7) Bryant Park, Kodaikanal 1900 and (8) Forest Research Institute, Dehradun 1934. The literature reveals that the maximum number of Botanic Gardens are present in Uttar Pradesh (10) and West Bengal (08), however, there are several state and UTs where no Botanic Gardens have been established so far. The number of species grown in each Botanic Garden is not known.

Box 44
Distribution of Botanic Gardens in different states
(Source: Complied from Chakraverty and Mukhopadhyay, 2000)

State	No. of botanical gardens	State	No. of botanical gardens
Andhra Pradesh	02	Orissa	03
Arunachal Pradesh	02	Punjab	03
Assam	03	Rajasthan	03
Bihar	04	Sikkim	01
Delhi	04	Tamil Nadu	08
Gujarat	07	Uttar Pradesh	10
Himachal Pradesh	02	Uttaranchal	04
Karnataka	03	West Bengal	08
Kerala	04	**UTs**	
Madhya Pradesh	04	Andaman & Nicobar	01
Maharashtra	06	Chandigharh	01
Meghalaya	03	Pondicherry	01

The Botanical Gardens serve as living repository of refugia of plants of the country and also of selected exotic flora. They serve as excellent *ex situ* conservation and multiplication centres of threatened rare, endemic, ornamental, medicinal plants and their wild progenies for future genetic source materials. In India about 19 Botanic Gardens are engaged in conserving the rare, endangered, endemic and interesting species of the Indian flora.

Box 45
Botanical gardens engaged in conservation of rare and threatened species
(Complied from Chakraverty and Mukhopadhyay, 2000)

Name of Botanic Garden	Location	No. of species
Botanic Garden – Orchid Research and Development Centre	Tipi	17
Andaman and Nicobar Circle	Port Blair	26
Botanical Survey of India – Southern Circle	Yercaud	34
Botanical Survey of India – Eastern Circle	Shillong	43
Botanical Survey of India – Northern Circle	Dehradun	58
Lalbagh Garden	Banglore	03
Forest Research Institute	Dehradun	10
Jawahar Lal Nehru Botanic Garden	Rumtek	01
Government Botanic Garden	Udhaymandal	02
Indian Botanic Garden	Howrah	42
Botanical Survey of India – Western Circle	Pune	21
Lloyd Botanic Garden	Darjeeling	12
National Boatanical Research Institute	Lucknow	08
Arunanchal Field Station	Itanagar	02
Botanical Survey of India – Central Circle	Allahabad	02
Tropical Botanic Garden and Research Institute	Thiruvananthapuram	01
State Botanic Garden	Barang	01
Sikkim Himalayan Circle	Gangtok	08

6.1.2.2. Seed banks

Seed storage has considerable advantages over other methods of *ex situ* conservation, including ease of storage, economy of space, relatively low labor demands and consequently the ability to maintain large sample at an economically viable cost. The seeds of many rare and endangered plants can be collected and stored in seed banks under low temperature so that the seeds will remain viable for a long period. The seeds thus stored can be utilized when a crisis situation arises and the species can be saved. Since the seeds of most tropical evergreen species are recalcitrant and lose viability in a short span of time, such seeds can be temporarily stored in seed-banks without loss of viability so that they can be used as and when needed.

Germplasm facilities in India

Recognizing the need for sophisticated facilities for research and development and providing services germplasm facilities have been setup in India. Some of them are: (i) National Bureau of Plant Genetic Resources (NBPGR), (ii) Indian National Gene Bank (INGB), (iii) Central Institute of Medicinal and Aromatic Plants, Lucknow and (iv) Tropical Botanical Garden and Research Institute, Trivandrum.

All these centres are well equipped and conserving all type of plant biodiversity. For example: Indian National Gene Bank (INGB) handles the genetic resources of nearly 200 cultivated plants and their wild relatives. Refrigerated modules currently store over 160,000 seed samples of different crops at –20º C. in addition, cryotanks using liquid nitrogen (-196ºC) hold some 1250 samples of small-seeded crops, gametes and embryonic accessions. Tissue culture is used to preserve other vegetatively propagated material (850 samples covering 25 genera). This capacity for preservation of genetic material has been increased several fold in the new facility for the INGB.

Box 46
INGB Base Collection
(Source: MoEF Report, 1994)

Crop Groups	No. of Accessions
Cereals	67,613
Pseudo-cereals	1,364
Millets and Minor millets	16,585
Oil seeds	24,857
Pulses	26,542
Fibre crops	5,872
Forage crops	24
Vegetables and spices	9,225
Medicinal and aromatic plants	338
Narcotics	778
Released varieties	949
Genetic stocks	4
Safety duplicates	9,004

Action Points	
Propagation methods	Methodology need to be developed for mass culture of threatened Red Data Book species, through conventional and biotechnological approaches. Botanic gardens, live gene banks need to be developed, which will act as centres of nature conservation activities Botanic gardens should take into account for the preservation of plants growing in the nearest endemic centres and exchange freely all rare and endangered species.

6.2. Research and Development

6.2.1. Trans boundaries (inputs from Eklabya Sharma, TWG-NTE)

Wild plant diversity is spread over different biogeographic regions of the country. Some of the biogeogaphic regions are contagious with adjoining countries such as Pakistan, Afghanistan, China, Nepal, Bhutan, Myanmar and Bangladesh. About two-third of India's terrestrial boundary is internationally shared with these countries. Therefore, it is imperative to select transboundary landscapes where candidate priority complexes are identified for integration of landscapes continuity and biological importance.

Indian subcontinent is one of the twelve mega-biodiversity centers of the world with two biodiversity hotspots viz. the Western Gahts and Eastern Himalaya. The Western Ghats does not share any international boundary, while the Eastern Ghats that includes northeastern part encompasses areas of India, Nepal, China, Bhutan, Myanmar and Bangladesh. The Eastern Ghats is the most important biodiversity 'Hotspot' of the Indian subcontinent that harbors the largest number of endemic and endangered species (Khoshoo, 1992). Therefore, research and development initiatives should be carried out in such areas.

Keeping in view the importance of transboundaries, some candidate priority complex has been identified in Eastern Himalaya. These were selected on the basis of (i) representation of distinct habitat types, communities and assemblages, (ii) conserve large areas of intact habitats and intact biotas that can support viable populations of focal species and focal ecological processes, (iii) conserve keystone species, habitats and community process and (iv) conserve distinct large-scale ecological phenomena and (v) conserve focal species and species of special concern.

Box 47
Candidate Priority Complexes sharing transboundary: a case study of eastern Himalaya
(Source: Sharma, 2001)

Kanchendzonga complex
Consisting of an area of 11,500 km² landscape that forms the watershed of river Tista originating in Sikkim and running through West Bengal. The complex includes the Khangchendzonga conservation area in Nepal, Khangchendzonga Biosphere Reserve in Sikkim, Singalila National park in Darjeeling, Gorkha hill council and many other small PA in Sikkim (Fambonglo, Kyongsla, Macham, Simgbaand Bassey) and Darjeeling (Sechal and Mahananda). This transboundary extends from eastern Nepal into Sikkim and Darjeeling of India. Khangchendzonga conservation area in Nepal is reported to habour 350 species of ferns and allies, 9 species of conifers and 4500 species of flowering plants including 36 species of Rhododendron, 450 species of trees and 430 species of orchids. The landscape provides north south connectivity and includes relatively intact subtropical and temperate forest that have become highly fragmented and cleared throughout most of Nepal. There are also several floral hotspot in this complex especially of *Rhododendron*, Orchids and medicinal plants.

Jaldapara-Buxa-Phibsoo complex

Comprises of 4,560 km² landscape that include three PA such as Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary in India and Phibsoo Wildlife Sanctuary in Bhutan. It has Terai-Duars Savanna, grasslands and small areas of subtropical and temperate broadleaf forests. Within this landscape Phibsoo wildlife Sanctuary in southern Bhutan is connected to Manas protected area complex in Assam and Buxa tiger reserve and Jaldapara wildlife sanctuary is connected with Garumara protected area complex in West Bengal. There are many rare and endemic plant species in this complex.

Jigme Dorjii-Manas- Bumdaling complex
This complex covering a large area of 13,7000 km² forms a link of lowland grassland and savanna to alpine meadows that includes several PAs in Bhutan and Manas Tiger Reserve in Assam, India.

Tawang-Khulong Chu complex
This complex is spread in 8,790 km² landscape amalgamating the Sakteny Sersa corridor linking Sakteng and Khulong Chu wildlife Sanctuary with Eagle's nest and Sessa Orchid reserve in Arunachal Pradesh of India. The Khaling-Eagle's nest corridor extends from Eagle's nest southwestwards, back into Bhutan to link with the Khaling/Neoli PA complex. The corridors between PA are meant to achieve altitudinal habitat connectivity and east-west representation of habitat types and floral assemblages.

Namdapha-Hkakaborazi complex

This complex is the largest with a landscape area of 69,460 km² that has transboundary links in Myanmar, China and India. The landscape has large number of conservation significance pockets such as hukaung Patkoi, Namdapha extnsion and Hukung, Kamlang, Hkakaborazi link, Hkakaborazi-Khaunglanohes, Joypur/upper Diang RF, Hlulaborazi Natonal Park, Kamlang WS and Namdapha NP.

Namcha-Bara-Dibang Walony complex

This complex covering a large area of 27,490 km² along the India-China border includes seven PA such as Dibang valley, MoTuo, Dong Jiu, Namcha Barwa, Mahao, D'Ering Memorial and Mouling. These are several floral pockets in the landscape where plant richness and endemism is high and also contain large areas of threatened eastern Himalayan temperate broadleaf forests.

Action Points	
Database	Building up a database of biodiversity shared by various political entities.
Conservation measures	Need to develop joint ecosystem and species conservation programs, for those ecosystem and species, which overlap among nations. The scope of CITES can be expanded to include species not covered, or such species can be covered by this treaty. Promote international cooperation for conservation of migratory species; establishment of protected areas in transboundary locations. Adjacent country border, rich in endemic diversity need to be identified for establishment of viable trans frontier parks. Political entities need to collaborate to initiate conservation initiatives.

6.2.2. Development of Database

The information which is required to conserve biological diversity, includes human uses, basic taxonomy, distribution, status, trends and ecological relationships exist in the form of systematic monographs, regional checklist, books, research papers etc. For reference, users are required to look at and browse through many voluminous pieces of printed material, which is tiring and time consuming. Therefore, published information should be organized and integrated into a readily accessible comprehensive database. Such a database is an essential part of the whole process of initiating measures on conservation of biological resources at all level, from the local to the global community. Computerization facilities, in this regard, are very useful for simple and efficient retrieval of data in many different forms as demanded by the user. It reduces the monotonous job and also provides facilities for building larger databases. Reproduction and updating can be done in a more simple and efficient manner.

In India, although, some data on biological diversity are available electronically, most are scattered in the literature, herbaria, museum collection and contained in other resources of the biological disciplines. In addition existing data often must be edited critically and periodically updated laboriously before they can be integrated with other data in electronic form. The current state of knowledge about biological diversity is inadequate. Detailed knowledge is still lacking on distribution, population size and other important parameters. Further, there is an urgent need to preserve documents, which deal with any aspect of plant biodiversity of India.

Box 48
Electronic Database: Example from Western Ghats
(Source: Ramesh and Pascal, 1997)

Geographic database for 352 endemic tree species of Western Ghats were prepared which include vegetation and land use maps bio-climate and soil maps, human settlements and communication network. The information on geographic position and data sources for each species records was organized into simple database created with Microsoft Excel, then under ESRI Arc/Info to facilitate the mapping and open up the possibility for further data analysis. This database constitute a powerful tool for analyzing species distribution patterns in relation to ecological gradients and for assessing how species can be conserved in their natural habitats.

At present such documents are housed in public libraries throughtout the country. Preservation of documents of such has beome more important and relevant in view of the existing IPRs and patent laws.

Action points	
	A network of Natural/Regional databases should be created which make specimen based knowledge accessible and guarantee that those data are maintained by Institutions possessing the collections. Taxonomic specialists should be involved to ensure the authenticity of the electronic data. An effort should be made to electronically capture specimen based information in major natural history collections of the world and to make that information freely available to all users for their use and benefits Complete documents on each category (mentioned above) should be published a base line information. Revised flora of India needs to be completed in shortest possible time. Presentation of documents, which deal with any aspect of plant diversity of the country.

6.2.3. Publication on wild plant diversity

Extent of published information reflects the intensity and quality of work being conducted in different fields and areas. Information on wild plant diversity during last 10 years, collected from various journals i.e. Journal of Economic and Taxonomic Botany, Journal of Bombay Natural History Society, Ethnobotany, Indian Journal of Forestry, Van Vigyan, Indian Forester, Bulletin of Botanical Survey of India showed that the maximum studies during this period have been published in aspects of taxonomy followed by ethnobotany. Very few studies have been conducted on ecological status, rarity, endemicity, awareness conservation and management practices of wild plants. State wise information revealed that the Uttaranchal (n=62) was most widely covered state followed by Uttar Pradesh (n=42), Kerala (n=37), Andhra Pradesh and TamilNadu (n=34). Among Union Territories only Andaman and Nicobar Islands are investigated well (n=56). Inspite of the maximum number of plant species per sq km in Sikkim, very few studies (n=18) have been carried out during last 10 years. Likewise, inspite of strong traditional base in west Bengal just one study on ethnobotanical aspect has been published. Bihar, which represents higher number of rare/threatened taxa, remains neglected in the studies on rarity. Similarily high endemic diversity states, Tamil Nadu (n=7), Arunanchal Pradesh (n=0), and Maharastra (n=1) has received lesser attention with regard to endemic studies.

Action Points	
	Considering the biological (wild plants) values available within the states, more emphasis should be given to the studies on specific attributes such as richness, use value, rarity and endemicity. In general, focus on ecological status, studies on endemism, rarity, conservation and management and awareness need to be improved

6.3. Participatory Approach

6.3.1. Community Participation

There has been a growing realization that any initiative concerning conservation and sustainable utilization of biological resources should have community involvement for achieving success. In recognization to this thinking the National Forest Policy, 1988 envisages peoples movement in the development and protection of degraded forests as an essential component. Also, in order to implement the policy prescription, the ministry (MoEF) has issued guidelines in 1990 to involve the village communities in the development and protection of degraded forests on the basis of providing the share of total collected produce. The concept of Joint Forest Management (JFM) was accordingly initiated by developing appropriate mechanism. Till date 26 states have opted/issued resolution for JFM intervention. As a result over 10.25 million ha of forestlands in the country is being managed and protected by 36135 village forests committees.

Box 49
Community conservation: a case study of Chansar village ***(Source: Prasasd, 1997)***

A unique initiative has been undertaken for conservation of degraded forests nearby Chansar village of Panchmahal district of Gujarat. Chansar in the Lunawada taluka is a small village of eighty families. There was a fairly dense forest of about 558 ha consisting of mixed deciduous teak with profuse undergrowth. Due to intense deforestation the area was reduced to bare and eroded hills. The local communities depending on that forest were hard hit and their economy was undermined. The village headmen called a meeting of the villagers and explained to them that they are completely responsible for that deforestation. The villagers resolved that in the name of Hindu religion the village forest should be protected at any cost. The community also decided that anyone felling a tree or damaging it in any way should face social boycott in addition to a heavy fine. A local watchman was appointed on a monthly honorarium raised by equal contribution from each household. The protected patch of forest recorded excellent growth. Enthused by this the local district forester started afforestation work to help the villagers get more income. He helped them solve their drinking water problem too. The news of this success of the Chansar village reached adjoining village, which also adopted this model.

The success of community level JFM in West Bengal and elsewhere through active involvement of women has demonstrated how women can gain both materially as well as in status if they play an effective role in local level forest protection committee.

Box 50
Participatory Forest Management in West Bengal: The Arabari experiment
(Source: MoEF report, 1994)

JFM experiments were being conducted on sal, teak, eucalyptus, and other timber species in Arabari in Midnapore district of West Bengal. Efforts to study the growth and regeneration of trees were failing because local people kept grazing their cattle on the research plots and cutting the saplings for self-consumption or sale. Frustrated by the constant disruptions, the forest officer began to meet with the local people of the surrounding village to explore the possibility of obtaining their co-operation. After extensive discussions, it was concluded that any effort to protect and regenerate forests had to address the linkages between poverty and deforestation. Further consultations with the village people led to a new arrangement guaranteeing their continued access to non-timber forest products (NTFPs), for example, fruit, leaves, mushrooms, twigs and fodder grass for consumption and for sale to generate household income. Also local people would receive a portion of revenue from the harvest of the sal forest they had regenerated.
After these initial discussions, the Arabari experiment (Socio-economic Forestry Project) in the east

Midnapore forest division was initiated in 1972 with the following broad objectives:

- Provide employment to forest fringe dwellers
- Allow them to collect subsistence products from the forest
- Give them the right to a portion of the sale proceeds from the harvest of the forest rehabilitated with their co-operation.

Approximately 1,272 ha of degraded government forests were selected for revival in 11 revenue villages. About 500 families with the total population of 2500 agreed to participate in the programme. In 1987-88, 97 ha of the sal forest were harvested. After the operational expenses were paid to the forest department, a total of Rs. 604,887 was distributed to 618 families (@Rs. 979 per family)

6.3.2. Women participation

In India, women are most closely associated with forests for gathering forest produce such as wood, fodder, grasses, leaves, twigs, wild fruits both for subsistence and sale their participation for conserving biodiversity assume significance. Involving women in selection of plant species and method of harvesting, utilizing their knowledge of uses of different plant species can certainly be helpful in maintaining biodiversity. Reports suggest that women have already proved their innovative practices for conserving natural resources across the country (see Box 51).

Box 51
Women as a Resource Manager

Rajasthan (*Source: GPF and FAO, 1998*).	**Uttaranchal** (*Source: Sinha 1997*)
Women of the Aravalis in Rajasthan have integrated revival of gradational water harvesting system with biodiversity conservation leading to their empowerment. Catalysed by a local NGO, Taeun Bharat Singh, village women from Gopalpura, Gujjaron Ki Losal, Bhaonto-Kolyala and Hamirpur in Alwar district have come out from their isolated, veiled existence into the open-joining hands with their men folk in building Johads, the old water harvesting check-dams. These have led to regeneration of the forest cover in the village. They have organized themselves into informal women Gram Sabhas, undertaken employment generation activities, such as weaving of basket from The indigenous varieties of 'Champuria' grass replenished in abundance in the village forests and revitalized the Ayurvedic health system by regenerating many indigenous species of root and herbs. Women are sustaining as Ayurvedic doctors in their own village.	The originator of Chipko movement in India, which occurred in Garhwal Himalaya in the 1970s, was a woman named Gaura Devi. She led the women folk of the area in a rally to hug the trees and protest against their axing by the officials of the forest department. It was a 'civil disobedience' movement to protect their homeland, the forest.

6.3.3. Farmer's participation

Besides, participation of farmers has also proved useful to conserve biological diversity. A considerable amount of the genetic material, which has been grown or bred by farmers, is of great significance.

A large number of farmers are working with environmentalists and scientists in three agro-ecologically different areas of India viz. the Garhwal Himalaya, the Deccan region and the Western Ghat for conservation of biological diversty.

Box 52
Experience from Garhwal Himalaya

In the Hemal Ghati of the Garhwal Himalaya, though the area has largely taken to Hybrid paddy cultivation many farmers still grow many indigenous crops alongside. 70 indiginous varieties of rice and about 45 varieties of kidney beans are grown *(Sinha, 1997)*

Farmers are documenting available biodiversity, collecting and storing indigenous crop varieties, evaluating and selecting those with good performance, and encouraging their reuse in farmers fields (Navdanya, 1993). The Academy of Development Science and the Indian Society for Rural Gene Banks are working with farmers in Maharashtra to document rice diversity. They have set up community gene banks to propagate selected varieties. Some of these traditional varieties have been reported by these groups to be high yielding and are comfertable to modern hybrids. The association for the propagation of indigenous Genetic Resources, in various parts of India, is helping communities to revive traditional crops. A World Wide Fund for Nature (WWF) supported project in Rajasthan has helped farmers to build a community seed bank which include 30 local varieties of millet (*Pennisetum typhoides*). The Auroville Green Work Resources Centre in Pondicherry is running a seedbank and distribution service for Auroville and the surrounding villages.

Box 53
Beej Bachao Andolan: Farmers participation
(Mahajan et al., 2000)

Realizing well the advantages of traditional seeds, the farmers of the area are active participants in the Beej Bachao Andolan, a movement to save indigenous seeds from the onslaught of new hybrid varieties, in the Garhwal Himalayas. The movement is successfully conserving, 130 varieties of rice, 150 of rajma (Kideny beans) and several varieties of *Amaranthus*, pulses, millets, vegetables, spices and herbs. Forty different crops of indigenous Himalayan cultivars, some with multiple varieties, are grown in this area, every year. Cereals such as red wheat, oats, rice, mandua, *Amaranthus*, buckwheat, corn, millets like jhingora and koni, beans and pulses like various rajma varities, urad, kulat, bhatt, chana, masoor and tor, oilseeds like mustard varieties, sesame seed and tilphara, medicinal varieties, of turmeric and ginger, arbi and red chillies. Vegetables as cucumbers, bitter gourd, a sweet bitter gourd, bottle gourd, jimikand, kadoo, raddish, fenugreek, garlic, tomatoes, peas, potatoes and coriander.

6.3.4. Involving Educational Institution

Students and teachers being the most powerful component of society need to be involved in the biodiversity related initiatives. Considering vastness of the area and prevailing eco-cultural diversity of the country, it is realized that there is an urgent need to develop programmes to address location/region specific biodiversity concerns. Environment education (EE) is found to be an effective mechanism to address biodiversity related problems. In India, EE components to some extent find satisfactory coverage in school curriculum developed by the National Council of Educational Research and Training (NCERT). Likewise, several organizations such as Center for Environmental Education (CEE), Ahmedabad, Environmental Education Centre, Madras; National Museum of Natural History, New Delhi, etc. have contributed in creating environmental awareness among masses and as a component of formal education at school level. However, the EE scenario at college, university level has not been impressive.

The country like India, with vast geographic area, richness and uniqueness of ecosystem and diversity of socio-cultural environment, most of the EE programmes do not address the issue of entire nation. In this context, the education process needs to consider diverse features of this country. Therefore, development and implementation of EE perspectives to cover location/region specific concerns would require specific strategies. One successful initiative by an environmental NGO-Uttarakhand Seva Nidhi (USKN) Almora, deserves mention.

Box 54
Work of Uttara Khand Seva Nidhi (UKSN) on Environment Education
(Source: Bharucha, 2000)

Recognizing the ground realities of the region (i.e. Uttaranchal, west Himalaya), UKSN designed and tested a course on environmental education for rural schools of Uttaranchal. The course content is prepared for students of class 6-8th and involves over 500 schools; 65,000 students, and 1000 teachers. While drawing lessons through experience of this course during the last 12 years, the centre recommends, "the vital relationship between biodiversity and sustainable local livelihood be a major aspect of teaching of biodiversity".

Of the 575 student responders, a rapid statistical survey of the programmes show varying information on biodiversity related environment concerns. Their focus of attention is on agricultural aspects of the environment, as it deals with all their support systems. Though it is difficult to assess to what extent this is directly related to the workbook program, the level of information on these issues is considerably higher than expected.

In order to supplement the above effort and enhance relevance of EE for IHR through non formal means, G.B. Pant Institute of Himalayan Environment and Development, Almora, designed a programme for IHR initially focussing on Uttaranchal in west Himalaya. It was

conceptualized under the umbrella activity "Peoples participation on biodiversity conservation"

Box 55
Peoples participation in biodiverisy conservation
(Source: Dhar, et al., 1999, 2002a)

A series of training workshops (till date eight) i.e. Govt. Inter College, Gangolihat (March 1995), Narayan Nagar (November 1995), Lohaghat (November 1996), Pitthoragarh (October 1997), Narayan Nagar (November 1998)), Inter College Saukiathal (November 1999), Govt. Girls Inter College Dwarahat (March 2001) and Govt Inter College Syalde, Almora (February 2002) has been launched to inculcate awareness among school children and teachers about the importance of biodiversity and possible ways of use and protection of local plant diversity.

Over 680 participants belonging to 319 Institutions have been trained till date in these workshops. Details of the participants are given.

Target Group	Representatives	Institution involved (No.)	Participants (No.)
Resource	Villagers, NGOs, Environmental activist	57	84
Management	College, School teacher	130	174
Workforce	College and school students	132	422
Total		319	680

For training six modules have bee designed: (i) definition and dimensions of biodiversity; (ii) status assessment and monitoring (iii) value and value addition; (iv) maintenance (*in situ*- protected areas, *ex situ* - gene/seed banks, and tissue culture, etc.); (v) methods for re-vegetating degraded lands (nursery preparation, propagation packages, etc.); (vi) linking biodiversity with soil and water components. Each training module included teaching (40-45 min) by the subject experts (Experts identified within the Institute - Researchers and Scientists, and out side Institute- University Professors). Training material included write-ups in Hindi - to provide background information on the relevant subjects - compiled in the form of small booklet. Each participant received a booklet just after pre-training survey. Training on each module was followed by a group discussion (15-20 min) and an on-site training / demonstration (30-35min, mainly through relevant posters and practical demos).

Pre (before initiating the programme) and post (immediately after the programme) questionnaire survey (questions were prepared in Hindi - English translation were conducted to reveal shifts in attitudes, if any, as a result of the process) was conducted. Target groups differed significantly in their understanding and concerns about biodiversity at the beginning of the training programme. At this stage, compared to students, frequency of teachers answering correctly the questions on general understanding/concerns about biodiversity was markedly high. The performance of teachers, however, did not improve significantly at the end of training. On the contrary, training helped in significantly improving student's understanding and concerns about biodiversity. By the end of training, difference in understanding of two groups narrowed considerably and surprisingly the frequency of students with correct answers slightly exceeded those provided by the teachers.

Amongst students, at the start of workshop, more participants realized biodiversity as resource, expressed concern towards biodiversity loss and showed willingness to contribute for the cause of conservation. As compared to responses for general understanding/concerns about biodiversity, the frequency of correct responses on factual knowledge was invariably low at the start of training. At this stage participants showed very poor knowledge on certain specialized subjects like - biodiversity value and value addition, role of Remote Sensing and role of Tissue Culture. In general, in the beginning, larger number of teachers showed knowledge of biodiversity related specific subjects as compared to students. At this stage, frequency of teachers answering correctly the questions related to Protected Areas, biodiversity as a resource for sustenance and importance of conservation and utilization of bioresources was significantly higher than students. Through this exercise factual knowledge of subject in both the cases (teacher and students) improved considerably. Improvement in case of students was significant for all the subjects. However, teachers could not register marked improvement with regard to their knowledge of Protected Areas; agreement with the fact that biodiversity is the resource for sustenance; and biodiversity use is equally important as preservation. Nevertheless, at the end of training, teachers showed markedly higher frequency of correct answers in all cases.

The analysis sggest that the approach is very useful for involving school student and teachers in furthering the cause of biodiversity conservation. The feedback from the student indicated clearly that the location specific problems can be identified and later prioritized for initiating action. It is also a unique participatory approach wherein the student drawn from rural background can disseminate the knowledge in an effective way.

6.3.5. Role of NGOs

The role of NGOs has been increasingly stressed in matters relating to implementation of the (World Conservation Strategy, 1980, Caring for Earth, 1991), strategies and programmes on biodiversity conservation. This fact has been highlighted in Global Biodiversity Strategy (1992) and many other international documents. Of late, this fact has been specifically recognized in preambular paragraph 14 of the Biodiversity Convention (UNCRD 1992) which stresses 'the importance of the non-governmental sector for the conservation of biological diversity and the sustainable use of its components'. The convention adds that, the NGO community includes a large proportion of the World's leading scientists on biodiversity played a major role in advocating the need to conserve biodiversity.

Box 56
NGOs Experience
Source: NBSAP ***contribution***

In situ **conservation**	***Ex situ*** **conservation**
Navdanya is an *in situ* genetic resources conservation initiative of the Research foundation for science, Technology and Natural resources policy, a New Delhi based NGO. It is popular with Marginal farmers and peasants in economically 'back ward' but resource-rich areas of the Garhwal Himalayas and the Western Ghats and some drought-prone areas in Karnataka where women have been primarily responsible for agriculture because of the extensive out-migration of adult males. Conserving agricultural diversity for these women not only secures food for their families but enlarge their options for meeting their non-food-mass-based needs such as fodder, fuel, thatch for the house and raw material for marketable crafts. Navdanya inherently gives importance to women farmers. It recognizes farmers' as breeders of seeds, strengthens farmer-to-farmer, farmer-to-scientist and farmer-to-consumer linkages by locating these in the farmers breeder rights.	Bangalore based NGO, Foundation for Revitalization of Local Health Traditions (FRLHT) coordinating a project which aims at conservation and sustainable use of medicinal plants for Primary Health Care (PHC). The project has set up a network over 55 medicinal plant conservation sites in Kerala, Karnataka and Tamilnadu in collaboration with state forest departments, NGOs, and Research Institutes. The foundation recognised that women are perhaps the biggest single group to possess knowledge about home remedies from medicinal plants. This knowledge is mainly inherited by daughter and is thus pereserved over generations. Womens groups are one of the village level organization targetted by the foundation for conservation and use of medicinal plants. Women are trained in growing medicinal plants extracts of which are used in PHCs. These plants are grow in kitchen garden by the women since women have direct access to, and control over, this patch of land. Kitchen gardens have multiplied through self-help groups and some women groups on marginal lands and field bunds.

Action Points	
Sustainable utilization	In areas where people are to be involved, incentives for their participation in biodiversty must be identified. Eco-tourism and recreation forestry is being tried as income earning operations for local communities. These need to be formalized and included in the relevant policies. In depth studies are needed to determine the feasibility and the cost and benefits of forest based products. Community biodiversity registers must be developed before issue of ownership of resources and equitable sharing of benefits are sorted out clearly and explicitly. These registers will help in organizing relevant information at micro level on patterns of utilization, conservation, status and management that would form the basis of identifying sustainable livelihood patterns. To revive relevant traditional systems of resource conservation, for example; the citizens group "Lok Swasthya Parampara Sambardhan Samithi" of Coimbatore is working to revive interest in medicinal plants used in Ayurvedic and other local healthcare traditions, and attempting to set up medicinal plants conservation units in various parts of India. Channelize benefits of biodiversity conservation back to local communities
Policies/Acts	In protected areas several ways of involving local communities, for example: reserving upto 50% of available posts (e.g. wildlife guards and forest watchers) for inhabitants of local communities. Planning and decision making process should be open, democratic and transparent so that all information related to biodiversity should reach to the local people.
Education and awareness	Encourage mass public awareness and education by conducting people participation action programme in different schools and colleges and also by using folk media and popular science methods.
Research & Development	Special skill and strategies should be developed in order to understand and validate rural women's rich biodiversity knowledge and enable them to become equal participants in biodiversity conservation. Develop effective benefit sharing mechanism, which gives due consideration to women's biodiversity knowledge and expertise in the wake of the IPR regimes. Encouraging women to come forward with solutions to improve the surrounding bio-resources and stake a claim in the benefits.
Conservation	Encourage direct participation of traditional, community level institution particularly women's groups like "mahila mandals", in planning and implementing of conservation activities.

6.4. Policy and legal measures

Global threats to biological diversity have been recognized all over the world and India is not an exception. In recent past, only a small fraction of endangered species were identified for conservation but now varieties of species are protected with the specific aim of promoting the conservation of biological diversity. For the first time, the declaration at the Stockholm Conference, in 1972 highlighted the universal basic legal principles related to the conservation of biological diversity. Subsequently the UN general assembly adopted and solemnly proclaimed the World Charter for Nature, for conservation of the genetic viability of the earth and all life forms and their habitats it support. Furthermore, the United Nations Conference on the Human Environment, 1972, the World Conservation Strategy of 1980, the World Charter of Nature 1982, the Vienna Convention on the Protection of the Ozone Layer, 1985, and its Monitorial Protocol, 1987, Declaration of Brazilia on Environment, 1989, Hague Declaration on the Environment, 1989, Helsinki Declaration on the Protection of the Ozone Layer, 1990, the United Nations Convention on Environmental Impact Assessment in the Transboundary Context, 1991, and several other resolutions of general Assembly of the United Nation were adopted with a view to protect environment which are directly or indirectly helpful in the conservation and protection of biological diversity.

Furthermore, at the national level, India has adopted the Forest Act of 1927, The Wildlife (Protection) Act of 1972, the Forest (Conservation) Act of 1980 and several other laws related to conservation of forests and wildlife in the territory of states throughout the country. These legislation's were passed with a view to prevent deforestation and biological imbalance. This model has been adopted by state legislatures to maintain the abundant Indian tropical forests, in the Western and Eastern Ghats, Silent Valley, mangrove forests at the estuaries seashore of the India and temperate forests of Himalaya, which are the actual abode of biological diversity. Considering that India is a biodiversity rich nation, a number of legislation's were enacted for the species protection or habitat protection.

Box 57
Important Acts Relevant to Biodiversity

1. The Habitat Protection laws

The aim of conservation and protection of biological diversity either species protection or habitat protection in which species are found the law tries to fulfil such aim through protection laws or species protection laws which indirectly protect and conserve the biological diversity or its components.

2. The species Protection Laws

The laws or Acts which protect the species are called the species Protection laws and they are as follows:

2.1. The Indian Forest Act, 1927 was adopted to consolidate the law relating to forests, including reserved forests, village forests, protected forests and non-government forests. It is a colonial legislation enacted mainly to enable the state to acquire ownership over forests and their produce and specifically to facilitate trade and timber. This is mainly for controlling and regulating the timber trade.

2.2. The Wildlife (Protection) Act, 1972 was amended in 1983, 1986, and 1991 provides for the protection of wild plants and animals and regulate hunting, trade and collection of specific forest products. Certain tribes are, however, allowed picking, collecting or possessing specified plants for their bona fide personal use. The revised Act also provides a licensing system to regulate cultivation and trade of specified plants in a pattern similar to the trade in fauna. Licensees are required to declare their stocks and follow prescribed procedures.

2.3. The National Wildlife Action Plan, 1973 identified broad goals of establishing a network of representative protected areas and developing appropriate management systems, which take into account the needs of local people and conservation requirements outside protected areas. The National Forest Policy, as amended in 1989, stressed the sustainable use of forests and the need for greater attention to ecologically rich, mountain and island ecosystems.

3.4. The Forest (Conservation) Act, 1980 amended in 1988 primarily deals with using forestlands for non-forestry purposes, mainly industry and mining. It requires state governments to acquire the approval of the central government before it degazettes a reserved forest, leases forestland to a private person or corporation, or clears it for the purpose of reforestation. Implementation of this act has reduced the annual rate of diversion of forestlands for non-forestry purposes to 16,000 hectares a year, compared with 150,000 hectares per year prior to 1980.

2.5. The Environment (Protection) Act, 1986 empowers the central government to take appropriate measures for the purpose of protecting and improving the environment. It is authorized to lay down standards for controlling emissions and effluent discharges of environmental pollutants, to regulate industrial locations, to prescribe procedures for managing hazardous substances, to establish safeguards for preventing accidents, and to collect and disseminate information regarding environment pollution. In accordance with this act, the central government has issued a number of regulations affecting sectors such as hazardous and chemical wastes, genetically engineered microorganisms, and industrial development of coastal zones.

2.6. The Foreign Trade (Development and Regulation) Act, 1992 is designed to stimulate sustained economic growth and enhance the ecological strength and efficiency of Indian agriculture, industry and services. The central government regulates the import and export of goods by means of a Negative List of Import or a negative List of Export, depending on the situation. Import and export are prohibited/restricted through licensing or routed through specified agencies. Provisions of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are also implemented through this act.

In addition to the above, recently Biodiversity Bill - 2000 has been tabulated in the Parliament with the aim "*to provide for conservation of Biological Diversity, sustainable use of its components and equitable sharing of the benefits arising out of the use of biological resources and for matters connected therewith or incidental thereto*".

Box 58

The Biological Diversity Bill 2000

The Biological diversity bill consist the XII chapters. The chapter I "Preliminary" summarizes the short title, extent and commencement and definition of the bill. The II chapter state that the certain persons not to undertake Biodiversity related activities, results of research not to be transferred to certain persons, not to apply to certain collaborative research projects and application for Intellectual Property Rights not to be made without approval of National Biodiversity Authority (NBA). Also prior information to state biodiversity board is necessary for obtaining biological resources for certain purposes. Chapter III make the provision for establishment of NBA, conditions of service of chairperson and members, chairperson to be Chief Executive of NBA, removal of members, meeting of NBA, committees of NBA, officers and employees of NBA, authentication of orders and decisions of NBA, delegation of powers and expenses of NBA to be defrayed out of the consolidated fund of India. Chapter IV describes the function of NBA. Chapter V consists of approval by NBA for undertaking certain activities, transfer of biological resources or knowledge and determination of equitable benefit sharing by NBA. Chapter VI is for establishment of State Biodiversity Board (SBA), its function and powers for certain activities violating the objectives of conservation. Chapter VII and VIII are related to finance, accounts and audits of NBA and SBA. Chapter IX describes the duties of the Central and State Governments to develop National strategies, plans for conservation of biological diversity, biodiversity heritage sites, notify threatened species, designate repositories and to exempt certain biological resources. Chapter X makes the provision for constitution of Biodiversity Management Committees. Chapter XI is about the local biodiversity fund. Chapter XII gives instructions to NBA and SBA, which consist the NBA to be bound by the directions given by Central Governments, power of State Governments to give direction, settlements to dispute between SBA, members, officers etc. of NBA and SBA deemed to be public servants, protection of action taken in good faith, penalty for contravention of directions or orders of Central, State Governments, NBA and SBA.

Action points	
	Area of high conservation values should be declared as National Heritage and accorded strict protection. A separate Forest cell may need to be created to monitor these areas and prevent fires, poaching, illicit cutting and so on. Medium conservation value areas can be subjected to sustainable forestry operations such as mixed plantations, extraction of dead woods, NTFP collections are carried out in a sustainable manner and not exploited by over-enthusiastic commercial interests. Some low conservation value areas are potentially linked to areas of high and medium conservation. These must be given adequate protection so as to enable their recovery

Gap analysis

At the start of this project an approach for collecting, updating, integrating and analysing the available information was developed. The approach for identification of gaps is based on the available information discussed in the foregoing chapters (1-6). Considering the overall status of plant biodiversity of the country following major gaps have been identified.

7.1. Gaps in Knowledge

7.1.1. General

- Lack of baseline data on the floral diversity, rare, endangered, native, endemic and keystone species makes prioritization of species difficult and unrealistic.
- The base line information on species, varieties and their macro and microhabitat relationships are inadequate.
- Complete floristic inventories are not available for all the regions (biogeographic provinces, state, district) and groups. Those available have limited information on broad distribution range, inadequate status of population size and habitat.
- Indigenous knowledge on the use and conservation of plants by the local communities has not been properly documented and scientifically evaluated.
- Among hierarchical groups, exhaustive inventories on lower plants, such as algae, fungi and bryophytes are not available.
- There is a clear lack of coordination among resources manager, planners, scientist and local communities for initiating any activity related to wild plant diversity.
- Concept of benefit sharing among community groups has not reached the grassroot level, therefore, participatory approach in wild plant diversity conservation is still in infancy.
- Lack of emphasis on location specific wild plant diversity concerns is not addressed in policy documents related to biodiversity maintenance.

7.1.2. Specific

7.1.2.1. Spatial area

- Biogeographic units are not considered for the estimation and analysis of wild plant biodiversity.
- Non-availability of location specific data.
- Lack of resources for publication of finding at state/district level and poor dissemination mechanisms among states and districts.
- Inspite of the recognized unique pattern of wild plant diversity in certain states/district, detailed studies on such botanical hot spots are lacking.
- Information on lower groups is very poor for both States/UTs
- District level floras are not well studied and those studied are largely confined to checklists.

7.1.2.2. Special area

- Incomplete inventory of the plants, little known distribution pattern and population status, insufficient knowledge on propagation technology, lack of information on existence of gene banks are some of the major gaps with regard to special areas of rich and unique plant biodiversity.
- The mangroves despite being an important part of coastal ecosystem have not been studied well in the areas of their occurrence. Following major gaps exist in mangrove studies:
    - In particular there has been no study on the osmo-regulation pattern of mangroves, finding out responsible enzymes for salt control. Inadequate research on detailed chemical analysis of mangroves, which is important for extracting valuable drugs and medicine.
    - Bio-electric potential of mangroves are also necessary for finding out different density and growth pattern.
    - Research on seed germination, viability and vegetative propagation of mangroves is inadequate.

7.1.2.3. Hierarchical group

- Lack of location specific distribution data on status of narrowly distributed taxa (e.g. endemics).
- Lack of ethnobotanical studies of lower groups.
- Existing prevalence of confusion in taxonomic description in different plant groups and general lack of expertise to resolve this issue.
- Lack of information on the number of populations, size and dynamics of majority of rare or threatened plants especially in the lower plants.
- The knowledge about the local liverwort flora in India is still incomplete. For example: Himalaya, Western Ghats and Andaman and Nicobar Islands remain to be bryologically explored. Some of the gap areas in bryological studies are as follows:
    - Economic potentials of the liverworts have yet to be adquatly evaluated inspite of the fact that they possess medicinal, antifungal, antibiotic and antitumor properties.
    - Lack of organized herbarium of liverworts, which could be useful as reference specimen bank for identification and authentication.
- Shortage of experts on the lichens. As a result, major lichen rich sites of the country remain either unexplored or under explored. The gaps in lichen studies are as follows:
    - Lacunae in habitat assessment, population studies, biochemical analysis, nitrogen metabolism and preparation of National Red List and other ecological researches.
    - Lack of proper scientific documentation in the lichen flora.
- Inadequate information on taxonomic and ecological research on mycoflora, which is inadequate to define fungal communities.
- Poor state of teaching of mycology at all levels of education, public awareness and perception of the usefulness of fungi.
- Information on the assessment of the exact number of species/taxa and location of population of pteridopytes is not available.

7.1.2.4. Special group

- The pattern of distribution of rare/threatened species is not known.
- Causative factors of threat to wild plant diversity have not been studied in detail.
- Methodology for the identification of endemic, rare/threatened species has not been developed.
- No specific policy has been formulated on the conservation of endemic species inspite of the fact that they determine uniqueness of the region. For example: India has 24 centres of endemic species. Except three, all other centres are not covered under any regulated protection measures.
- Uniform and systematic inventorisation and documentation of the medicinal plant resources is not available in the country. For example: work on medicinal plants has been conducted by a number of organizations but there is no consolidated compendium on all the aspects available for reference. Methodology adopted for information generation by the organizations varies considerably.
- Non-availability of appropriate technologies for cultivation, conservation and harvesting of important/sensitive plants.
- Problems related to identification, documentation and recognition of the knowledge and practices. The information invariably obtained by the commercial users from the local people is not properly acknowledged.
- Information on exact number of rare species, economically important species and their quantities of collection from the wild is inadequate.
- Information on the reproductive potential, propagation in nature and their populations or representatives under cultivation in farms or experimental gardens is not available.

7.1.2.5. Use value

- Lack of documentation on under exploited and potential economically important plants.
- Inadequate knowledge on documentation of traditional knowledge base on wild plants
- Improper dissemination of technologies for value addition of the wild plants (e.g. wild edibles, medicinal plants, multipurpose trees etc.).
- Lack of proper harvest and post harvest technology.

7.1.2.6. Threats

- No sound methodology on the identification of exotics and native elements.
- Lack of proper methodology for the collection of plant sample/biomass from the wild.
- Lack of self employment schemes in rural areas which cause the major threat to wild plant diversity
- Lack of policy and mechanisms to prevent illegal encroachments.

7.1.2.7. Mechanism

- Poor research inputs for the identification of unique habitats, communities, endemic and threatened species.
- Lack of attempts for monographic revision on individual genera to phyla.
- Inadequate attention on community and population dynamics of the wild plants.
- Documented examples of Sacred Groves and their plant diversity are very less.
- Ecological and biological studies inside the SGs are lacking
- Documentation of peoples view on biodiversity conservation and its benefits and costs, socio-economic compulsion, nature of use and mode of extraction are not studied well.
- Uneven distribution of the current PA networks over state and biogeographic regions. For example: PAs of Northeast and Andaman and Nicobar Islands have not received adequate attention.
- In comparison to the large geographical area of the country, and its rich biodiversity in different biogeographic regions, *ex situ* conservation efforts are very less.
- The efforts of collecting and preserving the genetic resources in *ex-sit*u conservation conditions are inadequate and restricted mainly to improved high yielding varieties. Attention has not been paid for the conservation of traditional varieties/land races.
- Nonavailability of electronic database on the wild plant diversity, which consume maximum time of the researcher for consulting the literature.

7.2. Policy and legal structure

- The Act and Policy related to *ex-situ* conservation is lacking.
- The existing legislation relevant to biodiversity and conservation is pertaining mainly to use/exploitation of biological resources than their conservation.
- Inadequate enforcement of existing laws.
- There are no policies and laws for the process of identification, pre survey, classification and demarcating an area for conservation.
- Most of the states have many schemes for the development of existing National Parks and Wild Life Sanctuaries but very few schemes for *in situ* preservation and regeneration of natural forests have been taken up.
- There are no legislations to ensure that the local people get alternative in case of displacement when a natural forest is declared as reserve and/or as Protected Area.
- A majority of the laws, policies and schemes till recent past have not been able to ensure transparency in administration. There is a need to review the existing legislation, policy statements and institutional structure.
- There are practically no laws making it obligatory for the government to facilitate the development of decentralized institutions for the management of forest. The laws should recognize the existing local institutions like village and forest protection Committees.
- There is no specific law, for the management and conservation of Rangelands, Hills and Mountains ecosystems. These areas declared as forests and PAs, are covered under Indian Forest Act 1927 and Wildlife (Protection) Act, 1992.

7.3. Gaps in Institutional and human capacity

- There is a lack of coordination among various organizations undertaking research on wild plant diversity.
- Since a number of organization/agencies are working in an organized way on various aspects of wild plant diversity, the information on the subject is scattered.
- Although research on wild plant diversity at species level is wide spread but genetic diversity has not been studied adequately.
- The findings of research projects take long time to be integrated into policy-making, which results in delay in implementation.

- India shares a number of components of biodiversity with neighboring countries, but there is a lack of regional cooperation to evolve strategies for effective implementation of the Convention.
- Knowledge on benefit- sharing with the human communities is inadequate, resulting in illegal collection of economically useful plants and other produce from wild.
- Lack of identification, documentation and prioritization of useful plant diversity viz. medicinal, edible, fuel, fodder, fibre and timber species etc.

Interaction

In order to make entire process of Thematic Working Group – Wild Plant Diversity (TWG-WPD) participatory, involvement of various stakeholders was ensured throughout. As such, the approach was discussed and presented in various for a (Figure 2-5). The stakeholders included scientists, research students, plant taxonomist, ecologist, senior forest officers, teachers, students, representatives of community groups and NGOs. The views of each group were considered and relevant inputs incorporated to develop SAP. A number of meetings were conducted at various places i.e. INSA, New Delhi, Govt. Girls Inter College, Dwarahat, G.B. Pant Institute of Himalayan Environment and Development Kosi-Katarmal, Almora, Botanical Survey of India, Dehradun, Forest Research Institute Dehradun, Indian Institute of Remote Sensing, Dehradun, Jiwaji University, Gwalior and Govt. Inter College Syalde in order to ensure the maximum participation in the process (Table 41). Besides on going meetings and workshop, "Call For Action Points" was distributed among stakeholders to obtain inputs from cross section of the society. Two training workshops i.e. Govt. Girls Inter College Dwarahat, Almora (March 3-4 2001) and Govt. Inter College Syalde, Almora (February 2-3, 2002) were organized to inculcate awareness among children and teachers about the importance of NBSAP process and record their experiences on various aspects of local plant diversity.

Table 41. Details of meetings and the level of participation in NBSAP (TWG-WPD) Process

Venue	Date	No. of Participants	Input
INSA, New Delhi	December 27, 2000	Total - 12 6 taxonomist 2 ecologist	Please see proceeding of the meeting (p 169-174)
G.G.I.C. Dwarahat	March 3-4, 2001	Total - 62 46 students 16 teachers	To inculcate awareness among schools students and teachers and record their observations/experiences on various aspects of local wild plant diversity
GBPIHED	June 8, 2001	Total – 14 Scientist	Methodology for NBSAP approach was discussed
GBPIHED	November 5, 2001	Total - 12 4 - Scientist 8 - Student	Inventory, habitat study, utilization pattern of NTFPs, in situ and ex situ conservation techniques, biochemical investigations and transboundaries
BSI, Dehradun	November 7, 2001	Total- 30 Taxonomist	• Computerized data base • Inventory including distribution maps, photographs, description, uses, ecology, habitat/ecosystem, phenology • Species specific action plan • Peoples participation Programme • Encourage to taxonomic studies • Semi- protected area need to protect as Biosphere reserves as they have unique flora • Priorities of research should be fixed
FRI Dehradun	November 20, 2001	Total - 06 Senior Forest Officers	• Develop awareness among the local people for rational use and exploitation of forest resources • Documentation of indigenous knowledge • In-situ and Ex-situ conservation technique • Creation of gene bank of wild plant diversity • Regulation on harvesting and sustainable production
IIRS, Dehradun	November 26, 2001	Total- 14 9 - Botanist 5 - Research student	Please see proceeding of the meeting (p175-177)
Jiwaji University Gwalior	January 14, 2002	Total- 30 10 – representative of community group 2 – NGOs representative 18 – Research students /Botanist	Please see proceeding of the meeting (p 178-180)
G.I.C. Syalde, Almora	February 2-3, 2002	Total- 155 120 students 35 teachers	• To inculcate awareness among schools students and teachers and record their observations/experiences on various aspects of local wild plant diversity

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First consultation meeting

Venue: Indian National Science Academy, New Delhi

Date: December 27, 2000

This Thematic Working Group meeting (TWG) on wild plant biodiversity was conducted at INSA, New Delhi, on December 27, 2000. The meeting was attended by the following: U. Dhar, P. Grard (in place of Dr. B. R. Ramesh), P. K. Hajra, M. P. Nayar, G. M. Oza, G. S. Rawat, N.P.Singh, S.P.Vij, S. R. Yadav, Shruti Devi (NBSAP Representative), S. Ari, I. D. Bhatt and Mitali Joshi (GBPIHED Representatives)

At the outset U. Dhar welcomed the members of TWG and apprised them briefly about the need of convening this very important meeting. Miss Shruti Devi was requested to introduce the NBSAP process to the audience. Shruti gave a brief introduction of all the facets of the activities of NBSAP and also showed the copies of the guidelines prepared by NBSAP for all TWG's.

A background paper and agenda note prepared by U. Dhar (keeping in view NBSAP concept) was the basis of the initial discussion. U. Dhar requested all the members to provide other agenda points if any, before initiating the deliberations. All the members were of the view that other points can come up only after the discussions.

I. Continuous flow of information

This was stressed by the coordinator and was positively responded by all the members. They recommended that relevant communications be circulated among all the members so that they can provide the inputs to the coordinator keeping in view the deadlines of the process.

II. Delineating spatial areas

It was felt necessary to classify spatial areas in a uniform patter so that the inputs of the members are also received in an appropriate way. There was intense discussion at this point. P. K. Hajra was of the opinion that the type of classification mentioned in the Flora of India (Introductory Volume) should be followed. S.P. Vij suggested that it would not be practical to collect and collate the information in this manner, therefore, political boundaries could be

considered. G. S. Rawat reacting to Prof. Vij remarks said that there is a possibility to have it done in a hierarchical fashion starting with ecosystems, biomes, habitats, microhabitats, etc.
P. K. Nayar: It emerges from the discussion that it would be worthwhile to collect information according to political boundaries and then superimpose on biogeographic zones and information thus generated can be useful to consolidate the information. Everybody agreed to this suggestion. It was also felt that the data thus generated could be useful in identifying the gaps.

Another important point that emerged was the paucity of information on sub-specific level, which will adversely affect the preparation of the status paper on plant biodiversity.

III. Identifying members for preparing concept notes

All the members felt that plant biodiversity database of the nation is being worked out by BSI. Therefore BSI can contribute a great deal in preparing these concept notes. This was followed by a suggestion by Dr. Rawat that bibliography of all the experts and their area of specialization should be prepared immediately so that inputs on all the themes and areas can be collected. In this context a format needs to be prepared by the coordinator.

The members thereafter provided the list of a number of specialists who have contributed significantly on specific areas or special groups. The coordinator was advised to be in touch with these experts for their likely contributions. It was at this point that N. P. Singh, Director BSI, agreed and made a commitment that he would ask his identified colleagues to contribute in this endeavor.

Apart from these, P. K. Hajra said that he would be glad to review the extent of plant diversity and the gaps for northeast region. Similarly, M. P. Nayar and B. R. Ramesh would be contributing concept notes on Western Ghats. As far as Maharastra and Karnataka are concerned N. P. Singh said that he would be happy to contribute for these areas with regard to special/peculiar features of plant biodiversity. G. M. Oza and S. R. Yadav will, likewise contribute for Gujarat and Mahrashtra respectively. S. P. Vij informed that while reviewing orchids of the country, he would incorporate the linkages of orchids with livelihood needs. P. K. Hajra and G. S. Rawat jointly agreed to contribute on existing status of knowledge of PA's in India. P. Grard informed the house that he along with B. R. Ramesh would contribute on role of para-taxonomists and capacity building initiatives. M.P. Nayar and Ahmedullah would be happy to compile and collate information on existing knowledge on threatened and endemic elements.

The coordinator was advised to contact Dr. Zutshi for aquatic plant diversity. There was a detailed discussion on underutilized little known uses of some biodiversity elements. The house was told to contact Dr. Natesh (DBT) for inputs.

IV. Type of contributions

It was at this juncture that case studies were taken up for discussion. M.P. Nayar pointed out that TBGRI and RRL Jammu could be contacted for developing concept notes on some success stories wherein plant biodiversity elements have been linked with livelihood needs of the people.

V. Selecting special groups

The group agreed that as far as threats on habitats are concerned some special habitats could be identified on the basis of work generated through remote sensing. IIRS Dehradun could be contacted for details. The group also felt that it would be important to highlight some case studies / rediscoveries on the bases of work done at TBGRI and from the inputs of S. R. Yadav. Such type of information could be put up in the form of boxes in the report. It was also agreed that the report should provide an account of hotspot of the endemic species to be contributed by M. P. Nayar and on legumes perhaps by Dr. Sanjappa.

VI. Collecting information on traditional knowledge

In this context, P. K. Hajra said that some resource persons of Guwahati University and TBGRI could be contacted for giving inputs on use of plant biodiversity elements in traditional practices. M. P. Nayar further elaborated this point and advised the coordinator to contact IIM Ahmadabad for the issues of 'Honey Bee' for sifting such information.

VII. Link forms with livelihood

P. K. Hajra felt that some concept notes could be prepared on bamboos, reeds, brooms, bidi patta, Typha, Aristida, Pandanus, etc. so that these linkages with livelihood needs could be further highlighted.

VIII. Reviewing and prioritizing the points in the concept note

This could be worked out after receiving the inputs from different experts on different groups, areas etc.

IX. Mode and mechanism of organizing meetings

There was a broad consensus that meeting could be held at Pune, Chandigarh, Trivandram and Itanaagar, but the constraints of time would not allow organizing such meetings. Therefore, it was agreed that the coordinator might ask NBSAP to advance the timeframe so that the inputs in such meetings could be incorporated in the draft report.

X. Finalizing a time frame for each identified activity

This was discussed in the context of NBSAP deadlines and all the members agreed that they would make all the efforts to communicate their identified inputs to the coordinator by 15th of March 2001. They also agreed that while the coordinator is expected to contact the identified experts he would also provide the necessary format for preparing such notes.

XI. Communications from NBSAP

The coordinator briefed all the members about the papers that have been received from NBSAP and he assured them that he would pass on relevant information as and when received. U Dhar discussed the type of overlaps, which are expected to emerge among various TWGs.

All this discussion on the agenda points was followed by a brief recap of what emanated so far. U. Dhar thereafter briefed the audience about the guidelines of this TWG and concept notes prepared by NBSAP. This was discussed in detail, pointwise and the brief resume of the discussion is as follows: -

Discussion on Concept notes and Guidelines of NBSAP

The working group agreed to recognize the importance of the points raised in the concept note. The group also felt the need to cover the capacity building mechanisms for plant systematists especially at a time when age of plant taxonomists is skewed to older age.

A number of gaps in knowledge were identified and the group felt that the same could be further elaborated upon after receiving the inputs from identified experts. However, population studies, reproductive biology, breeding mechanisms, plant insect interactions were highlighted.

It was also emphasized that high biodiversity areas, such as, northeastern India, Western Ghats, Andamans and The Himalaya should be given special attention while developing strategies for conservation. Likewise, special habitats need focused attention.

There was a special mention of the role of women in preserving wild plant diversity especially land races of crop plants. In this context it was opined that some case studies could be incorporated in the report, this highlights the role of women in preserving biodiversity.

As far as trans-border issues are concerned, existing initiatives of Government of India could be further strengthened especially with regard to collaboration with Nepal and Bhutan on such issues. Manas was a case in point. It was also felt that MoEF might be consulted to provide the documents published by the Ministry.

While recognizing the importance of consulting such documents in strategies and Action Plan of other countries, Dr. Hajra drew the attention of recently published document of SACEB. He assured that he would provide a copy of the same to U Dhar.

U Dhar thereafter requested each member to review the deliberations and offer comments so that follow up could be streamlined and made action oriented.

Final Discussion and Round up

Dr. Yadav gave a brief resume of the discussions during the deliberations and assured that the responsibilities given to him will be taken up in the right earnest. Dr. Rawat highlighted the importance of incorporating key elements of biodiversity, biodiversity hot-spots etc in the report.

Suggested Table of Contents were also examined by the members and discussed at length. While this was happening, P. K. Nayar came up with an idea of asking each member to contribute specific chapters and then getting them reviewed by identified subject experts. This idea was thought off because of constraints of time frame set by NBSAP. This was discussed and finally the group agreed that both the strategies would be followed. 1. Requesting the identified subject experts to prepare brief concept notes according to the format (to be prepared by U Dhar) and pass on to the coordinator for further processing and 2. Requesting the members to prepare chapters and then pass on to the subject experts to be finally put together and edited by members and the Coordinator. In the context of 1 above Dr. Oza informed the house that he along with Dr. Yadav would be happy to contribute on Chapter 4 and partly Chapter 5. This could not be further discussed because everyone felt that strategy No. 1 could be tried first and responses reviewed.

During the discussions, all the members agreed that resource person for various biogeographic regions could be identified so that we are able to speed up the process. The list reads as follows: North-west Himalaya (U. Dhar, G. S. Rawat), Indo-Gangetic Plains (R. R.

Rao, B. P. Uniyal), Eastern Himalayas (A. S. Chauhan), Assam (P. K. Hajra), Central India (P. C. Kotwal), Arid Zone (V. Singh), Northern Western Ghats and Northern West Coast (S. R. Yadav, G. M. Oza), Southern Western Ghats, southern west Coast and Lakhashadweep (P. K. Nayar, P. Grard, B. R. Ramesh), Deccan (M. P. Nayar), Eastern Ghats and Coromandel Coast (B. R. Ramesh), Andaman and Nicobar Islands (Balakrishnan).

U Dhar presented a draft format for groups and areas. The inputs on the draft are being incorporated in the format.

Thereafter each member reiterated their complete cooperation to see to it that the follow up and deadlines are adequately met. The members thanked U Dhar for conducting the proceedings in a professional and positive way.

The meeting ended with the thanks of the coordinator to all the members for their support, cooperation, expertise and practically feasible inputs. The meeting ended at 6.50 PM.

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Second consultation meeting

Venue: Indian Institute of Remote Sensing, Dehradun, UA

Date: November 26, 2001

This was held on IIRS Dehradun and following member has attended the meeting: U. Dhar, A.N. Purohit, D.K. Singh, Eric Wikramanayake, G. S. Rawat, J.R. Sharma, Meghan Mcknight, P.S. Roy, S.K. Shrivastava, S.P.S. Kushwaha, S.P. Vij, Uma Shankar, I. D. Bhatt, Gayatri Mahar and Mitali Joshi.

An approach for gap analysis and brief action points on the wild plant diversity was presented by Uppeandra Dhar followed by opening remarks of Prof. A.N. Purohit. In his opening remarks he suggested the following points regarding wild plant diversity:

- Link Wild Plant Biodiversity to other TWG's so as there should be no compartmentation.
- Involve educational institutes and make these exercises a part of study schedule program of managers and decision-makers.
- Should include techniques as remote sensing to convince policy makers and bureaucrats.
- Prioritization of action points, which should be location specific for the immediate, impacts (e.g. *Aconitum heterophyllum)*.
- Identification of the working agencies for identification of the implementing agency and the specific area where it should be taken up on priority.

Following Prof. Purohit, detailed discussion was conducted on each group of the wild plant diversity and strategy and action point for each group were suggested by the experts. The following strategies and action points have been emerged during the discussion:

Strategies

(i) Documentation of different groups of wild plant diversity is necessary.

(ii) Conservation of habitat of species of each group is necessary.

(iii) Linking livelihoods with the different group is essential

(iv) Understanding the biology and linkages with other corresponding biodiversity is necessary.

(v) Identification of the groups/ families which have been neglected so far in conservation/ of scientific interest

(vi) Promote the sustainable use of conservation

Action Points

- Inventory including distribution, status and database, interspecific variability and distribution maps of the species
- Restore habitats and rehabilitate species from threatened areas
- Promotion of orchids as cottage industry
- Quantitative analysis and listing of potential economic species
- Development of propagation (*ex-situ*) techniques
- List the species of economic potential
- Research and monitoring
- Establish fungal specialists group for India
- Evolve protocols for monitoring ecosystem health based on lichens
- Promotion of biofertilisers based on algae
- Promote and encourage taxonomic studies on lower groups (more projects)
- Capacity and opportunity building
- Identify microsites, localities, maps, threats, prepare site specific plans
- Declare hotspots of bryophytes
- Autecology of species on biogeochemical aspects
- Ethnobotany of Ppteridophytes (e.g. Vegetables)
- Methods should be developed for sustainable utilization mechanisms (e.g. chilgoza, sago, *Taxus*, *Ephedra*, timber resin). For example: *Juniperus macropoda* for making dhup by Lamas can be cultivated at local level
- Develop criteria for prioritization of species based on use value, availability (e.g. population status, use value / intensity of use and trade) local as well as industrial.
- Identify nodal agencies for coordination for assessment
- Conservation and trade on medicinal plants
- Develop policies to strengthen the state local communities in the use extraction and conservation of medicinal plants

- Review the existing agrotechnology on cultivation of medicinal plants and accordingly carry out further research.
- Evolve mechanism for sustainable utilization of medicinal plants through participation.
- Promote *in situ* conservation of threatened medicinal plants
- Develop species specific conservation plans
- Document of ethnomedicinal and traditional knowledge
- Develop conservation plan for groups such as parasites, saprophytes, insectivorous plants etc.
- Domestication of economic potential species (e.g. Amla, Mahua, Tendupatta, Broomsticks, Tejpatta)
- Develop local self-help groups for value additions as part of ecodevelopment.
- Develop protocol for sustainable harvest, post harvest and market linkages
- Establish more gene bank (*in situ* and *ex situ*)

Besides the above following general points have been discussed at the end of meeting.

- Strategies for various areas (e.g. Seminatural areas) should be separate.
- The inputs, which are provided by the contributors, should be published in a book as chapters.
- PA's reserved forest etc. need to be prioritized for conservation.
- Documentation.
- Action plan need to be changed e.g. Any plan should not only written by DFO's but it should also include scientific and other people before writing and implementing
- While making management / conservation plan there is a need to be a section for plant biodiversity conservation.
- Managers and policy makers should first present their plan content and benefits before taking decisions.
- Some kind of economic benefit should be provided to the local people in the participatory mechanisms.

Proceedings

Third consultation meeting

Venue: School of Studies, Jiwajii University Gwalior, MP

Date: January 14, 2002

This meetng of TWG-WPD was held on Jiwajii University Gwalior, Madhaya Pradesh**.** Prof. Satya Prakash, Vice Chancellor, Jiwajii University, Gwalior inaugurated the Consultation meeting. He dwelt on the need of organizing such meeting wherein academics and community groups can interact freely on biodiversity issues of concern. He called upon NBSAP to promote such activities in future as well to strengthen capacity building and efficient network mechanisms.

Prof. R.K. Chauhan, Head, School of Studies in Botany welcomed the participants and spoke on the importance of maintaining plant biodiversity and thanked NBSAP for reposing faith in this department for holding this consultation meeting.

Dr. U. Dhar presented the genesis and objectives of NBSAP and apprised the participants on the progress made so far in developing SAP for Plant Biodiversity TWG. He informed about the need for strengthening participatory mechanisms for developing SAP. He said that this meeting was organized to identify major issues related to Plant Biodiversity of central India with particular reference to Madhya Pradesh.

Prof. K.K. Koul, Organizer of the meeting stressed that the interaction need to be informal and assured the participants that all relevant key issues on Wild Plant Biodiversity will be projected and incorporated while finalizing SAP.

Dr. Agrawal proposed the vote of thanks and thereafter, Dr. U. Dhar briefed the participants about the approach developed by TWG Wild Plant Biodiversity to ensure that all the components of the subject matter are taken into consideration while developing SAP. There was a brief discussion on how this meeting can elicit opinion of all participants.

Dr. S.K. Singh, SAMBHAW conducted the proceedings.

The major points emanated from the discussion are as follows:

- Inventory on lower groups and microorganisms have not been taken up seriously. This needs to be initiated.
- While collecting, updating and analyzing the status of WPD at various levels, efforts should be made to involve tribal representatives in this process. This could prove a very useful source of information.

- Attention must be focused on the conservation of unique species in the region. For example, occurrence of the species of Gnetum is unique in Bastar.
- In Bastar monoculture of teak initiated by forest department has adversely affected forests of Mahua. This crop is very useful for meeting the livelihood needs of the local communities. As such, mahua plantation should be promoted along with teak.
- In Shivpuri area the population of *Asparagus recemosa* (Satavar) is dwindling at a fast pace, which has affected the livelihood needs and economy f the local communities. The roots of this plant are extracted for medicinal use. Conservation and sustainable use and this resource must be ensured.
- The state government policy on Tendu ka Patta should considered the sustained utilization of this resource.
- Illegal mining in some of the areas is a major threat to the unique biodiversity of Shivpuri and surrounding areas. This needs to be strictly prohibited.
- As result of the commissioning of Guna-Gwaliar rail line, a number of important biodiversity elements have been eliminated or destroyed. Efforts should be made to revegetate the area.
- There is a need to review the policies elated to revegetation and rehabilitating ravines in Madhya Pradesh particularly in and around Gwalior. Some of the initiatives taken up by the state forest department have not yielded the desired results.
- The JFM process area is working with over 70 committees but the results have been very encouraging and the benefits have not reached the grass root level.
- An initiative to develop the biodiversity register should be promoted so that the local inhabitants can take up in-situ mechanisms.
- One of the success stories provided y the participants was from the TEEN Gaun near Gwaliar where the community groups have maintained and managed a water shed efficiently. JFM workers should visit such sites to emulate such mechanism.
- There was a strong feeling of the participants that the school children should be involved in maintaining biodiversity register. They should be imparted training on different aspects of Biodiversity Conservation.
- There is also a need to build up groups in the area of biology, social science, economics in academic/research institutions throughout the state for furthering the cause of biodiversity conservation.
- Although MoEF, New Delhi has a program where small projects are awarded to schools/colleges/ NGOs on environmental awareness, the benefits of this facility has not reached the local communities. As such, there is an urgent need to disseminate the programme objectives.
- A review on the biodiveristy status of Panchmari forest provided by the students of Botany Department indicated that scientific collections have also put pressure on the regeneration of plant populations. Plant collection mechanisms for scientific work must be regulated.
- There is a need to promote local gene banks development by tribal communities at several places.
- Although Biodiversity board has been developed in M.P., the result of this board has yet to reach the stakeholders.
- Promote scientific contributions on assessing the nutritional value of food plants used by the tribal communities of M.P.
- Some measure has been taken, particularly by NGOs, to prepare vernacular names of plants of the region. Such activities need to be promoted.

- Any initiative on rehabilitation Ravines should be based on assessment of soil loss and other social problems of the area.
- Once plantation is undertaken, effective monitoring on survival and growth should be followed. This must be taken up through participatory mechanisms.
- Interaction of village community groups on biodiversity related issues should happen periodically. Subsequently such issues be taken up in village Panchayat meetings.
- Cattle migration form Rajasthan to M.P. is a usual phenomenon. It is during this period M.P. is also short of fodder. The participants were concerned about the depletion of fodder crops due to cattle migration. As such, some regulatory mechanisms could be thought off.
- In majority of the cased policy on the plantation are not based on scientific investigations. Also the distribution of planting material is not adequate; also during distribution of planting material, appropriate time for planting is not considered.
- State level biodiversity committees should be set up look into biodiversity related issues. These committees should include biologists, social scientist, NGO's community group and other stakeholders to develop specific action points.

Suggestions related to the theme on Wild Plant Biodiversity was compiled, analysed and finally incorporated in the respective chapters (1-7) for preparation of the SAP.

Strategies and Action Points

9.1. Introduction

This thematic group covers the status of knowledge base on wild plant biodiversity of the country. It analyses the extent of available information on various aspects and addresses the possible strategies for conservation. Considering the vastness of the area and diversity of bioclimate of the country, sufficient time and adequate manpower would be required to compile, collate and analyze the available information on the subject matter. However, since the present exercise is time bound, efforts have been made to develop action points on the basis of interpretation and analysis of the available data and not on subjective assumptions. We have attempted to present action points with rationale. However, much more thinking is needed before one can hope to achieve the objective of this project.

We have attempted to address the following problems within the gamut of the theme. These are:

- Status of existing information on wild plant with the focus on biodiversity rich, sensitive area and important groups
- Livelihood -plant biodiversity linkages
- Existing status of various conservation mechanisms
- Threats to plant biodiversity
- Gaps in information (General & Specific)

9.2. Approach

At the start of this project we developed an approach for collecting, updating, integrating and analyzing available information. The present report focuses on an approach for identifying strengths and gaps on the basis of available information. Higher and lower groups of wild plants are central in this exercise and are diagrammatically shown (Figure 6). Existing status of each feature is provided in the beginning followed by general and specific action points. The action points are developed on the basis of linkages of various attributes with various life forms of wild plant biodiversity. This methodology ensures that each identified parameter

within an attribute is taken into consideration while developing action points. One can keep on adding other features of an attribute and look at the linkages. This is a process and will take time before we can achieve the desired objectives. The action points will revolve round Areas (Spatial and Special), Special Groups, Mechanisms, Intrinsic Character, Externalities and their linkages with various forms of wild plant diversity.

9.3. GENERAL STRATEGIES

The initial step towards the formation of Strategies and Action Plan should be a thorough compilation of the contact details and area of interest of all the Institutions and individuals (Academics, scientists, NGO's, bureaucrats, community groups, politicians) who have or are at present involved in addressing issue related to plant diversity.

- Involve educational institutes and make these exercises (collection, collation and analysis of existing status of the plant biodiversity) a part of study schedule program of managers and decision-makers.
- The TWG should include the usefulness of remote sensing techniques for characterization of priority biodiversity elements at higher organizational levels. For example, occurrence of patches of endangered plant species could be depicted through remote sensing tools and presented to policy makers for facilitating decision-making processes.
- Prioritization of action points should be location specific for the immediate impacts (eg. Importance of *Aconitum heterophyllum, a high value medicinal plant species, in involving local people for domestication)*.
- Need for identification of the working agencies for implementation and the specific area where it should be taken up on priority.
- Strategies for seminatural areas should be developed separately. Data on the status of plant biodiversity of seminatural areas will help in assessing the impact of anthropogenic disturbance on natural areas with regard to the composition of wild plant biodiversity. Through this exercise factors responsible for exotic species invasion can be identified.
- The inputs, which are provided by the contributors, should be published in a book as chapters.
- Forest managers should consult scientists/academics/experts before preparing Forest Working Plans, Management Plans and other action oriented plans.

Managers and policy makers should first present their plan content before identified experts on plant biodiversity.

- While preparing management/conservation plans of any area there is a need to have a separate section on plant biodiversity.
- Status of indigenous knowledge on wild plant diversity should form one of the major components of any types of policy document related to biodiversity conservation
- Some kind of economic benefit should be provided to the local people for promoting participatory mechanisms.

Specific Action Points

1. Spatial Area

1.1. Biogeographic Region

Status

Of the 10 identified biogeographic regions of the country, adequate information on wild plant biodiversity is available for only a few of them, such as, Himalaya, northeast, Western Ghats and Andaman and Nicobar Islands. This is a major lacunae because, distribution patterns are determined by biogeographic considerations and not by political boundaries. In the present exercise, efforts were made to superimpose the state level information on biogeographical region, but could not be achieved because most of the state boundaries fall in more than one biogeographic region.

It has been observed that the priority setting for conservation has always been a difficult task in our country because of non-availability of location specific data. On the contrary, it has been much easier for some European countries, such as British Isles to undertake this activity. This is largely because of the availability of biodiversity related data in grid formats (in geographical coordinates).

Bioloigical Units

Plant biodiversity research, be it explorations, inventorization, monitoring, assessment or gap analysis, biogeographic regions should be considered as biological units.

Grid System

The information on wild plant biodiversity must be collected, collated and analysed keeping grid units as the baseline. This will help in identifying priority grid units for immediate conservation attention. The number of such sensitive grids will determine the importance of a particular biogeographic region for priority action. If this action point is to be implemented, the prerequisite would be to divide the country into grid units (as is the case with topo-sheets of Survey of India).

The data in grid formats will also help in assessing the endemic rich centres. Elaborate mapping is required for this purpose. Such an attempt has been a very useful in Western Ghats where endemic tree species have been mapped. This has also helped in biodiversity monitoring. Similarly, an attempt in west Himalaya has been successfully made in prioritizing the conservation sites in timberline zone. In this, grid system for 2095 sq km area was developed. The study area was divided into uniform grid units (74.45 sq km) on the basis of intersection of longitudes and latitudes at 5' interval. The uniqueness, richness, naturalness, endemicity and use value of each grid was assessed. Finally clusters of similar grids and unique grids were identified on the basis of available secondary data. However, this process has to be supplemented by primary data to I) authenticate the reported occurrences and ii) monitor change if, any in the composition of biodiversity elements. (Dhar 1998, BCPP-WWF Report).

1.2. State

Status

State and Union Territory floras have been published periodically. It is a useful source of information. However, the type of data available is not in

tune with the contemporary requirements. What is lacking in most cases is the location specific information and detailed ecological data. These gaps are primarily due to the mandate of the organizations responsible for embarking on developing state floras. Nevertheless, these floras do provide wealth of information on species richness, distribution, rarity status and endemism. The analysis of various aspects of plant biodiversity in States and UTs reveals some interesting facts.

An approach was developed to identify priority states. We attempted various level of prioritization as follows:

Ranking of the states on the basis of proportional representation of wild plant richness as against total land area, non-cultivated land and protected area.

Ranking of the states on the basis of use value (documented use of the species), endemicity and rarity status of the available species.

Haryana, Delhi, Tripura and Karnataka were excluded from the prioritization due to non-availability of data on several biological attributes.
On the basis of range of data available for non cultivated land against total land, protected area against total land and protected area against non cultivated land area, states were grouped under 5 classes (1-5), as follows:

i. Available non cultivated land against total land area
   1: <20
   2: 20-40
   3: 40-60
   4: 60-80
   5: >80

ii. Available protected area against total land area
   1: <10
   2: 10-20
   3: 20-30
   4: 30-40
   5: >40

iii. Available protected area against non cultivated land area
   1: <6
   2: 6-12
   3: 12-18
   4: 18-24
   5: >24%

Large number of states (10) have >80% area under uncultivated (wild) land, followed by states with 40-60% (6 No.), 20-40% (3), <20% (3) and 60-80% (2).

Non-cultivated land against total land area was highest in Arunachal Pradesh and lowest in Madhya Pradesh.
Considering the richness per sq km of the species, Sikkim, Himachal Pradesh and Goa rank among the first three (1-3 respectively) and Gujarat, Rajasthan, Madhya Pradesh and Andhra Pradesh rank the least (18-20). Punjab (rank 4) inspite of low non-cultivated land area (<20%) ranked high in species richness per sq km (0.252).

With respect to protected area, maximum states have <6% PA cover Sikkim has the maximum protected area cover (>24%).

Punjab, Nagaland, Meghalaya, Mizoram and Manipur inspite of having <6 % PA cover ranked 4th, 6th, 7th, 8th and 9th respectively as far as richness of the species is concerned.

Considering the use value of species West Bengal, Orissa and Rajasthan ranked 1st, 2nd and 4th, inspite of the low PA cover (<6%). Among states with >80% uncultivated land cover have high species richness and high protected area coverage (12-18%), Uttaranchal ranks high (rank 3) on the basis of species use value.

Representation of rare species was high in Bihar (rank 1) and Tamil Nadu (rank 2) and Maharastra (rank 3). These states represent low species richness (rank above 10) due to the lesser uncultivated area (Bihar and Tamil Nadu, 40-60%), Maharastra (20-40% class) and low coverage under protected areas (<6%; except Maharastra 11-20%). Of these, three states Tamil Nadu (1), Arunanchal Pradesh (2) and Maharastra (3) are also among top ranking states with respect to endemism.

The states which rank no. 2 with regard to PA cover is ranked 20th as far as plant endemics are concerned.

Cumulative score of all the attributes i.e. richness, use value, rarity and endemicity against NCL, PA and TLA ranked Uttaranchal on top priority followed by Tamil Nadu and Kerala.

Considering the cumulative score (richness, use value, rarity and endemicity) following states need special attention

Tamil Nadu (2), Kerala (3) and Orissa (4) with high biological values but relatively less wild land cover (40-60%), protected area (<6%) against total land and <10% protected area against non cultivated land area (except Kerala under class 10-20%) deserve special attention.

Uttaranchal (1) with high cumulative scores of biological values emerges as a unique state with relatively high use value (rank 3), rarity (rank 8), endemicity (rank 5) and richness (rank 11) of wild plants.

The above analysis shows some trends, which are useful in developing action points on what States and Union Territories should do to maintain Wild Plant Biodiversity.

Review of existing status

Before embarking on conservation initiatives, it is recommended to critically analyze the reasons of the state of richness or otherwise of the political units. Among others, the reasons of these trends include poor exploration, lack of resources for publication of findings, scattered information published in obscure journals and overall poor dissemination mechanisms. Notwithstanding these, the above trends do justify recommending following action points:

Indicators-species richness

With the highest PA cover and strong influence of neighboring elements, Sikkim with high species richness per sq. km. of non cultivted land area should be considered a STATE HOT SPOT of Plant biodiversity. Likewise, Tamil Nadu and Maharastra, with rich endemic elements and higher number of rare taxa (Tamil Nadu – rank 2, Maharastra - rank 3) and West Bengal with strong traditional base (with highest number of species of known use value) are considered at par with Sikkim. However, Uttaranchal has highest representation values of various attributes, therefore, deserves special attention.

Uniqueness

Several states (e.g. Rajasthan) may not be species rich but do possess unique desert elements not found anywhere in the country. Therefore it is important to initiate conservation measure in areas with unique plant biodiversity feature.

Identification of Botanical Hot Spot

Within state, Botanical Hot Spots need to be identified for conservation of areas with unique patterns of plant diversity in each state/substate.

Information on species/ population/community performance and distribution and other existing records need to be studied. For example: In Kumaun Himalaya, Uttaranchal, four "Hot Spots" i.e., The Pindari catchment, the Sandev area, Gori- Ganga catchment and Gola catchment were identified on the basis of high community diversity, high plant (species/community) diversity, small population of many rare/endangered orchid species and the ethnobotanical value and human impacts on natural resources (Samant et al., 1993). Likewise in Tripura state 36 sites were prioritized on the basis of biodiversity values (representativeness, vulnerability, ecosystem diversity, conservation threat), taxa based values, socioeconomic values, and conservation feasibility value (Gupta 2000).

Poor information on lower groups

As far as the diversity of lower groups is concerned, the available information is very poor for both States and Union Territories. Except for a few scattered reports of Pteridophytes from Kerala, Karnataka, Jammu and Kashmir, Mizoram, Goa and Orissa, the information is almost lacking.

A major thrust is required to compile state of knowledge on lower groups of plants. This will help in identifying gaps and subsequently in setting targets for adequate inventorization.

Involvement of students and capacity building

School and college students should be involved in future explorations and inventorization. This can happen through capacity building measures. This activity should be incentive driven and not regarded as an academic exercise.

1.3. District

Status

Apart from State floras, several (32) District level floristic investigations have also been undertaken particularly in Madhya Pradesh, Karnataka, Tamil Nadu, Uttar Pradesh, Maharashtra, Rajasthan, Bihar and West Bengal. The usefulness of such studies should not be undermined especially when such units possess some unique features of biodiversity. Besides they provide gap-filling mechanisms for State floras.

Future thrust

Now onwards, any district flora activity should be limited to those areas (Biogeographic region/State/Grids), which are known to support unique features or have not been explored floristically. Relevant line departments at district level need to be involved in this exercise.

Avoid repetitions

The district floras should cover detailed information on various aspects of plant biodiversity. They should not be a repeat of what is included in State floras.

Linking biodiversity with development initiatives

It is high time to consider constituting a Core Committee comprising of representatives of Line Departments, local panchayats, gram sabhas or local village bodies, NGOs, University/College Departments and other stakeholders who could develop mechanisms for need based assessment of state of knowledge of biodiversity and its relevance in the overall development of the administrative unit (district). Such a committee should decide about the future activities on biodiversity related issues. This is possible through periodic interaction among the above mentioned bodies representatives. This is not happening at present because the importance of maintaining local biodiversity for the welfare of the district is not considered a thrust area of activity.

As concurrent action, the state of knowledge at district level can enrich and update database of grid units (biogeographic regions).

2. Special areas

2.1. Himalaya

Status

The Himalaya represents a storehouse of wild plant diversity with the large array of diversity in food, fodder, fruit, vegetable and medicinal plants. The botanical wealth of the Himalaya comprises of more than 8000 angiosperms. About 30% of Himalayan flora is endemic. Besides these, 44 species of gymnosperms, 1159 species of Lichens, 1737 species of pteridophytes and 6900 species of fungi have been recorded from this region. Documented information on useful wild plant diversity reveal that over 1748 species of medicinal plants including 12 species of gymnosperm and 51 species of Pteridophytes, 675 species of wild edible plant 700 spp. of orchids and 63 species of bamboo occur in Himalayan region.

Survey and assessment

Intensification of exploration in under explored/unexplored areas of the region to develop effective baseline data so as to bridge the gap in our knowledge of floristic diversity in the Himalaya

Monitoring

Studies on population dynamics need to be initiated initially on these plant species with restricted geographic range, high economic value, small population size and high habitat specificity.

Permanent plots should be established for monitoring of recruitment behavior of rare, threatened and high value plant species.

Sustainable utilization

Sustainable harvest of non-timber forest resources need to be identified for economic enterprises. For example: Fruits of *Myrica esculenta* can contribute to the cash economy of local rural inhabitants of Kumaun Himalaya if harvested properly. At village level, an average of 60% of households are involved in the harvest and trade of *Myrica* fruits wherever the resource is available. An average collection of 73-297 kg per households/per season fetches a household Rs 913-3713 (US$ 26-106) per season. This income is significant considering the low annual per capita income in the region (Bhatt et al., 2000). And the production of squash and syrup from the fruits of the species can have contributed much more (Dhyani and Dhar 1994). Likewise, systematic harvest of other NTFPs suggest that these plants could play an important role in the development of economic enterprises

Assessment of the current requirement of raw material based on the analysis of market trends of herbal drug formulation need to be carried out so that alternative measures can be planned for sustainable utilization. For example- In the Himalayan region assessment of medicinal plants requirement was carried out on the basis of use value index. Assessment of the stock (175 MPs) revealed that users (industry) rely more on exclusive wild form (64.6%) compared to wild cultivated (20%) and cultivated (15.4%) ones. Among wild forms the UVI (Use Value Index) suggest that some of the plants are the most important to users but their focus is more in non Himalayan plants (except *Aconitum ferox, Picrorhiza kurrooa*) none of high use taxa is Himalayan in origin. Cultivated and wild cultivated forms of users interest, together account for more than 52% of UVI among herbs and contribution of such forms was comparatively low in other life forms (shrubs 28.6%, Trees 17.2%) (Dhar et al., 2000).

Research

Assessing variability of selected species at macro and molecular level will prove useful in identifying traits for better yield.

Research including the documentation of bioresource utilization practices by local communities and their traditional conservation approaches should be carried out.

Field gene banks need to be established for maintenance of diversity in Himalaya.

Participation

Local biodiversity conservation efforts like people's participation programme should be promoted. For example initiatives in this direction have proved very useful in the Himalaya (Dhar 1995-2002). The main aim of these programmes is to involve school children and inculcate awareness through on site training on local biodiversity assessment, documentation, value addition and methods of revegetating degraded lands, development of nurseries and propagation packages. Also the development of preservation models in school/college campuses and on community lands as demonstration plots ensures establishment of area-specific *ex situ* gene bank.

Database Electronic databases on subject experts, NGO's, community groups engaged in biodiversity conservation need to be prepared and periodically updated.

Electronic database on floristic diversity (including localities, habitat, use pattern) need to be developed which should be accessible to all users.

Capacity building Biodiversity assessment conservation techniques should form essential component at school and college curriculum.

2.2 Western Ghat

Status Recognized world over as a Biodiversity Hot Spot, Western Ghats shows an impressive profile of wild plant biodiversity. With over 53.55% forest cover, this region represents 22.6% of total angiosperm diversity of the country. Interestingly, lower groups have also been inventoried to some extent. Most of the endemic plant species are well documented. Over 27% (of the country) each of Rattan and diversity reflects the intimate relationship plant biodiversity with livelihood needs.

Since the area is reasonably well documented floristically, it is imperative to address research and development related issues in this region. Under the research category following Action Points could be considered:

Characterization Current sampling strategies and information storage and handling capabilities should be further strengthened to characterize biodiversity elements and their habitats. This will also help in building the conservation value maps.

Monitoring Effective monitoring of endemic rich plant biodiversity areas must be initiated.

Exotic invasion Measures should be taken to prevent the invasion of exotic species especially in reasonably pristine areas to ensure maintenance of ecosystem health.

Naturalized exotic elements (35 in number) in the region provide opportunities for research in terms of adaptability and suitability in varied climatic conditions.

Prioritization Prioritization of sites and species for people oriented conservation action must be taken up.

Permanent plots Establishment of permanent biodiversity monitoring plots to gauge the state of the forest, to provide baseline data, and to monitor ecosystem changes will help in creating "permanent representative observatory" for developing management practices.

Development initiatives Sustainable utilization of useful plant biodiversity elements could be taken up through appropriate intervention of Self-Help Groups, NGOs and Cooperative Sector after identifying potential sectors of economic activity, such as, medicinal plants cultivation, Orchid development and Marketing of

Rattan and Bamboo products.

Joint Forest Planning and Management (JFPM) experiment in some parts of the region have proved useful to bring paradigm shift in overall approach. Participatory mode of this experiment should be further strengthened and extended. For example: In Karnataka, the Joint Forest Planning and Management Programmes (JFPM) was started in 1993 coincided with the initiation of the Western Ghats Forestry and Environment project. Forest provides different levels of benefits to society, which comprises food medicine, fodder, fuel wood, fibres etc. In order to ensure proper flow of benefits to all groups, the people of Karnataka, under JFPM practice have been differentiated into two groups, based on the dependence on forests i.e. primary stake holders and secondary stake holders. On the basis of Karnataka JFPM policy following fundamental changes are required:

Villagers must be given full (100%) and sole right over all extractable forest produce, including autonomy in marketing.

Village-level bodies must have full autonomy in day-to-day decision-making processes regarding all aspects of forest and public land management.

Village-level institution must govern all public lands that are used for extraction of biomass resources by the village community and which the villagers are willing to manage together including degraded and undegradedlands, other revenue department lands, panchayat and other common lands.

Efforts to promote eco-tourism activity in potential areas of the region must be undertaken.

2.3. Northeast Region

Status

The northeast of India comprising the states of Assam, Manipur, Mizoram, Meghalaya, Nagaland and Tripura covers an area of 171336 sq km representing 5.2% of the country geographical area. Out of 17672 species of flowering plants known in India northeast region harbors nearly 5000 species (29% of the total angiospermic flora). It contains numerous endemic, rare, threatened, economic, medicinal, horticultural, edible fruits, resin, dyes, tannins, fibers, timber yielding and wild relatives of cultivated plant species. The presence of large number of primitive Angiosperms makes this region important and termed as the “cradle of flowering plants”. In this context northeast region has been considered as ‘Sanctuary of ancient angiosperms.’ The region harbors 62.9% gymnosperms, 49.4% pteridophytes, 54% orchids, 68% bamboo, 43.3% rattan (cane). Besides these, 113 aquatic weeds of angiosperms and pteridophytes are reported.

Inventorization

Inventorization of plant resources and assessment of their distribution and status in natural habitats.

Documentation of lower plants should be initiated keeping in view the importance for the human beings.

Documentation of indigenous knowledge about the use of lower group of plants.

Assessment

Intensive exploration of the area/habitats that are reported to be threatened.

Indicator and keystone species should be identified especially in the areas

which show unique dominant biodiversity elements such as endemics and wild relatives.

Indigenous knowledge base can be effective mechanism in identifying indicator/keystone elements.

Education and awareness	Conservation of plant diversity related programme need to be developed for educating the people, so that plant biodiversity of the region can be maintained.
Policies	Prohibition of illegal collection/harvesting of forest resources through legislation. Impact analysis of such legislation should be a part of terms of reference. Policy should be developed for patenting the process/products derived from economically important species and the royalty obtained should reach to the local people where the patented raw material occurs.
Conservation measure	Establishment of botanical gardens for ex situ conservation.
	Adequate recognition to the efforts to conserve biodiversity in Sacred Groves.
Domestication and value addition	Domesticate high value taxa that have small population size (enterprise based conservation). Indigenous technologies need to be used for adequate utilization of dominant weeds of the area. This will provide economic benefits to the local people.

2.4. Mangrove

Status	Mangroves are the salt tolerant ecosystem in tropical and sub tropical regions. The evergreen trees of mangrove forests have the ability to grow in saline tidal zones and are highly adapted to the stresses of flooding and salinity through tube like breathing structures (pneumatophores) specialized root cell membrane and viviparous seedlings. Mangrove ecosystem is source of fodder, fuel wood, tanbarks, edible fish, hides, honey and wax. Besides these, mangroves also play an important role in stabilizing shorelines and harboring many rare and endangered species of both plants and animals. About 6740 sq. km littoral region including deltas, estuaries, backwaters, Bay islands and lagoon in India are protected by extensive cover of mangals (mangrove community) being the third largest formation of the world after Indonesia and Australia. Distribution of 30 families, 43 genera and 68 species excluding salt marshes and some orchids available in mangrove habitat are some interesting feature of Indian mangrove.
Conservation measure	Conservation of small and big islands for speciation and addition of new lands.
	There is a need to develop an effective, ecologically based land use policy in mangrove areas
	Fodder banks need to be established to prevent ruthless ravaging of mangroves

3. Group

3.1 Medicinal plants

Status	In developing countries about 80% of the people rely on medicinal plants for health care needs. In India 2000-3000 plant species are known for their medicinal importance and over 500 species are reported to be used in pharmaceutical industry for preparating over 2000 herbal drugs. About 600-700 species are much in use, however, over 150 species are used

commercially. Some of them are *Rauvolfia, Belladonna, Dioscorea*, *Cinchona* and *Taxus*. Large scale and prolonged exploitation for commercial reasons have resulted in the depletion of such taxa.

General

Develop criteria for prioritization of species based on use value, availability (e.g. status, population dynamics, and intensity of use for domestic consumption and trade) and identify coordinating nodal agencies.

As they are mostly habitat specific, protect, as is possible, natural habitats of the MPs.

Area specific qualities

Specific quantities of secondary metabolites (phytochemicals) are found in specific climatic zones, soil and temperature. Accordingly areas for demonstrating agrotechnological measures and subsequent domestication should be undertaken in identified areas.

Local participation

Local people must be trained periodically for authentic identification and scientific collection of medicinal plants as different parts of the plant need to be collected at various maturity stages. A blend of traditional knowledge and scientific technique would be required for this purpose.

Large size cooperative societies need to be setup in the tribal areas for procurement and marketing of MPs so as to prevent exploitation of middlemen and unethical trading practices. Because there are such cooperatives in many areas e.g. LAMPS, but they have often run into problems because these often remains a bureaucratic control over them and they are not internally democratic. These are challenges to be met. The constitution of cooperative societies should be completely/ wholly democrative for efficient and sustainable utilization of the resources.

Equitable benefits

Pharmaceutical industries based on the local innovative processing and scientific techniques should be established in the proximity of the area of their availability to ensure that the benefits of the resource are accrued equitably.

Conservation measures

In situ as well as ex situ conservation techniques should be developed for fulfilling the ever-increasing demand of MPs. Priority should be given to the threatened/rare, endemic and high value medicinal plants.

Research priority should be given to develop appropriate technology for propagation, cultivation, processing, chemical characterization and marketing of medicinal plants.

Phytochemical and pharmacological investigations should be carried out to find out active principles present in lesser known but potentially high value MPs.

Herbal gardens should be established and local people (particularly women) should be trained how to propagate, preserve and monitor the growth performances of medicinal plants as a part of extension activity.

Technology demonstration Demonstration plots for transfer of technology in rural areas for community welfare should be promoted.

Policies Review the existing agrotechnology on cultivation of medicinal plants and accordingly carry out further research.

Develop species specific plans, which contain documentation of the ethnomedicinal traditional knowledge. e.g. *Angelica glauca* occurs in the forest in Jammu and Kashmir, Himachal Pradesh and Garhwal Himalaya. Its roots are used by local inhabitants for seasoning curry and also in medicine for the treatment of stomach and urinary disorders and rheumatism. This species has become critically endangered in the Himalaya due to its habitat loss, fragmentation and human interference

Regulations for collection and trade Bulk collection of medicinal plants growing in wild need to be regulated/ banned as several pharmaceutical industries and Research/Academic Institutions use bulk collections for screening. In order to ensure monitoring such activities, nodal agency need to be established.

Trade of crude drugs of plant material should be checked. It should be allowed only after thorough monitoring by some competent organization.

Compulsory declaration of where, which and how species are collected and at what cost/benefit to local people. This could be made legally mandatory now under the Biodiversity Bill, when it becomes an act.

3.2. Rarity

Status The rich plant diversity of India is facing many threats such as over extraction/unscientific extraction and habitat destruction resulting in the decline of natural populations. The harvesting of medicinal plants and over collection of ornamental plants from the wild has become a serious threat. Some species are threatened because of their unique nature and restricted occurrence and also because of wasteful collection for herbarium files by students e.g. *Nepenthes khasiana, Balanophora dioica, Drosera peltata, Gnetum* etc.

Documentation Comprehensive mapping, for focused conservation initiatives is required. The pattern of distribution of such species is not available. This will help in prioritizing species for conservation on the basis of status.

Threats There is a need to identify major threats (they are mostly specific), which cause depletion of threatened species.

Conservation measures Species-specific conservation plan needs to be prepared which must include rehabilitation *in-situ*.

Rehabilitation of threatened species should also be undertaken in sacred forests. School/college students on voluntary basis can effectively carry out this activity. A back up mechanism would be required for making it mission oriented.

Gene sanctuaries should be declared where natural population of

rare/threatened plants are growing

3.3. Endemic

Status

By virtue of its varied physiognomy and climate, India harbors a rich flora with a fairly high degree of plant endemism. Being bounded on the north by the Himalayas and with its peninsular part surrounded by the different oceans, the isolation of the Indian flora is sufficient to account for high endemism. About 5725 (33%) species of angiospermic flora are endemic to India, which are distributed over 147 genera and 47 families. Nayar recognized 3 megacentres and 24 microcentres of endemic plants in India. The maximum representation of endemic plants is reported from Himalaya. Out of 620 listed threatened species in the Red Data Book of Indian plants about 550 species are endemic (Nayar and Sastry, 1987,1988,1990). It is estimated that about 1950 narrow endemic plant species will become extinct in India in the foreseeable future. Out of the 5725 endemics, about 2500 fall under threatened category.

Inventorization and documentation

Inventorizing plant endemics is not complete. A complete inventory would be a prerequisite for initiating any conservation related activity.

Comprehensive mapping using Geographic Information System (GIS) of endemic species indicating their habitat, threat perceptions, rarity and rate of decline of populations and the degree of protection need to be developed.

Identifying endemic rich areas and habitats.

Plant taxonomist should develop standard format for collecting detailed information of endemic species.

Causative factors of habitat loss and its consequent effect on endemic taxa need to be studied.

Besides the habitat loss, there is a need to understand autecology, population/reproductive biology of endemic species in order to identify intrinsic causative factors leading to rarity of endemics.

Policy

All policies related to biodiversity conservation should give top priority to promote documentation of indigenous knowledge and hardcore research on reproductive mechanisms of endemic species.

Threats

Human population pressure is one of the cause for the loss or decline of endemic and threatened species, therefore, it is necessary to impart education and inculcate awareness among stakeholders about the importance of such species by formal/informal education programme.

Prioritization

Multiple attributes of conservation value need to be considered for developing a matrix. Using this matrix, priority can be established, indicating where maximum efforts of conservation may be focused. For example- narrow ecological amplitude, high anthropogenic pressure and restricted geographic range of species should be considered a top priority.

4. Hierarchical Groups

4.1. Higher Plants

General Action points

A comprehensive database on the status of existing information must be developed

Characterization of well-documented orders be initiated. Concurrently, focus on population dynamics, reproductive biology and intraspecific variability studies must be initiated for priority species.

Location specific distribution pattern of narrowly distributed taxa must be documented.

4.1.1. Angiosperms

Status

The angiosperms provide maximum direct benefits to mankind such as food, clothing, shelter, medicine etc. They comprise about 17672 taxa under 247 families representing roughly 7% of the described species in the world. The angiospermic flora is divided into dicotyledons and monocotyledons, which contain 203 and 44 families respectively. There are 80 monogeneric families of which 62 belong to dicot and 18 to monocot. Approximately 266 genera of flowering plants are monotypic under 33 families. The largest family, Poaceae, in the angiosperms flora represents 1291 species. Over 5725 species are endemic and constitute nearly 33.50% of the total angiosperm flora of India. Family Poaceae have large number of endemic species. Among the angiosperm plants 600 species are aquatic.

Conservation measures

Establish gene banks (ex situ) for conservation of angiosperms.

Ex situ conservation can be initiated for rehabilitation of rare/threatened, endemic and economically important species.

Methods should be developed for sustainable utilization mechanisms of economically important taxa and domestication of such species.

Research and monitoring of important angiosperms should be carried out.

Promotion of community based regeneration programme for economically useful species must be undertaken.

Status

Orchids are an important group of plants and are very much in demand. The orchids are inherently slow growing and therefore have poor natural regeneration. This is primarily due to their specificity in and requirement for mycorrhizal association. Orchids are saprophytes, terrestrial, lithophytes, and epiphytes. About 1200 species and 166 genera have so far been identified. However, their number is likely to swell further as several areas in the major orchid rich belts in the Himalaya, North East India and Peninsular India are yet to be botanically explored.

Survey, inventorization and research

Extensive survey in orchid rich belt should be conducted and prepare inventories citing extent of intraspecific variation, status, habitat, database and ethnobotanic significance considering the importance of this group.

Quantitative analysis and listing of potential species need to be developed.

Research should be conducted in orchid ecology, reproductive biology, population dynamics, genetic diversity, pollination biology, its linkages

with ferns and mosses keeping in view that orchids are slow grower and regenerate poorly in nature. It will help in understanding the biology and linkages with other corresponding biodiversity elements.

Developing floriculture

Considering the importance of this group in floriculture industry cost effective techniques for propagation of highly valued genera such as *Aerides, Arachnis, Ascocentrum, Calanthe, Coelogyne, Cymbidium, Dendrobium, Paphiopedilum, Phalaenopsis, Renanthera, Rhynchostylis, Vanda* etc. should be developed along with monitoring of wild habitats and population of these taxa.

Habitat restoration

Since some of the species like *Aerides crispa, Bulbophyllum guttulatum, B. rothschilidianum, Calanthe alpina, Cymbidium hookerianum, Dactylorhiza hatagirea* etc. have been endangered due to overexploitation, therefore, proper methods of orchid collection and habitat restoration and reintroduction projects should be initiated along with protection of key sites.

Rural development

Considering the importance in livelihood needs orchids should be promoted as a cottage industry.

Promote orchid propagation in collection centres and encourage local growers to artificially propagate native species for reintroduction and supply for promoting horticultural trade to ensure their sustainable utilization.

Conservation

Properly manage orchid rich habitats and declare/notify orchid sanctuaries for maintaining and conservation of orchid gene pool. Also, rescue orchids from degraded habitats and reintroduce them into orchid rich habitats.

Promote conservation of rare orchids of medicinal value through development of urban terraced home gardens.

4.1.1.2. Rattan

Status

About 70 species of Rattan are known to occur in India. They are popular all over the world and a craze for urban people of India due to their importance as raw material for furniture. Rattan is distributed in three major zones in the country i.e. northeastern India, Western Ghats and Andaman Nicobar and Islands. There are about 2000 small to medium cottage scale units mostly in the unorganized sector, which manufacture cane furniture and other products. Reports suggested that in 1981-82 cane production was 2.91 lakh kg valued at Rs 5.81 lakh. Over 18 species of *Calamus* and two species each of *Daemnorops* and *Plectomia* are commercially important. Besides these several species are used as edible, medicinal and for other traditional importance e.g. *Calamus acanthospathus, C. erectus, C. flagellum, C. gracillus, C. inermis, C. khasiana, C. latifolius, Plectomia assamica, P. bractiaatis and Zalacca secunda*

Inspite of the importance of Rattan in various sectors several species are under threat due to restricted distribution, habitat destruction and overexploitation. Therefore strategies should be developed for proper

management and conservation of this important group.

Research Research should be carried out to understand the causes of habitat destruction and proper methodology developed for management of the habitat considering the restricted distribution and importance of the group.

Conservation measure In situ and ex situ strategies should be developed for the mass multiplication of the commercially important genera such as *Calamus, Daemonorops, Plectomia* and other taxa of traditional importance such as *Calamus acanthospathus, C. erectus, C. flagellum, Plectomia assamica* etc.

4.1.1.3. Bamboo

Status India has the richest diversity of bamboo in the world and is second largest producer of bamboo after China. More than 100 species of bamboo are known in India, of these 50% bamboo are found in the north east region. Bamboo has been utilized for paper industry for a long time. Nearly 80 paper mills are dependent wholly or partially on bamboo in India. Approximately 2 million tonnes of bamboo are utilized for paper and this leads to a production of nearly 600,000 tonnes of paper pulp every year. Out of the 100 species of bamboo 10 are commercially exploited. A few other species are utilized to a limited extent in cottage industry.

Inventorization Inventory of bamboo with regard to taxonomic characters, use value, habitat ecology should be developed

Conservation measures Considering the richness of bamboo in northeast, the region should be developed as bamboo sanctuary.

Considering the importance of bamboo in various industrial sector, conservation techniques using in situ as well as ex situ initiatives should be started for important bamboo species.
Harvest and post harvest technology need to be developed.

4.1.2. Gymnosperms

Status The gymnosperms are important timber yielding plants over 48 species and 10 varieties occur in wild in different habitats of the country. Reports suggest that over seven species are known to be endemic to India. About 26 species have been introduced from other countries of the world, mainly for their usefulness as for timber and medicine, are now naturalized in India. Gymnosprems occupy a major part of forest area including vital water catchments regions of the Himalaya. They produce 25 % of the wood need of the country and yield superior wood pulp, terpenes and resins for oleo-resin and wood based industries. Shifting cultivation, afforestation and ruthless cutting for timber has resulted in depletion of population of several species i.e. *Amentotaxus asssamica, Pinus gerardiana, Cedrus deodara, Gnetum ula, Cephalotaxus mannii, C. griffithi and Picea brachytyla*

Research and Monitoring Methods should be developed for sustainable utilization mechanism of

highly valuable taxa e.g. *Juniperus macropoda, Taxus baccata, Ephedra, Abies, Pinus* etc.

Research and monitoring of important gymnosperms should be carried out

4.2. Lower Groups

General Action Points

Inventory including distribution, status and development of a database of lower groups must be developed. Initially attention should be focused on ethnobotanically and other economically important species. It will help in documentation and prioritizing the species for conservation.

Threats to species need to be identified and accordingly site specific plans should be prepared

4.2.1. Pteridophytes

Status

The pteridophytes grow in a variety of habitats and occur in all climatic zones of the country. About 1135 species (11.35%) and 42 varieties under 204 genera and 64 families occur in India. The diversity of the pteridophytes in the country has been divided into four pteridophytic zones e.g. eastern India, southern India, western India and Andaman & Nicobar. The eastern India showed the highest richness (approx. 810 spp.) as compared to others. About 193 (16.39%) species of pteridophytes are endemic to different parts of India. The maximum endemic species (97) occur in eastern India particularly in Himalayan region. About 254 (21.58%) species of pteridophytes are subject to different categories of threats.

Sustainable use

Considering pteridophytes as ornamental (*Selaginella, Pteris, Adiantum Nephrolepis* and *Asplenium*) and medicinal (*Adiantum capillus–veneris*, *Selaginella bryopteris*, *Lycopodium spp, Actiniopteris spp., Polystichum* etc.), cottage industry could be developed to augment economy and meet livelihood needs.

Research thrust areas

To promote taxonomic studies, viz., autecology and role of gregarious species within PAs/ managed areas need to be studied so that biology of the pteridophytes and its linkages with other corresponding biodiversity components could be understood.

Ex situ conservation can be initiated for rehabilitation of rare/threatened and endemic species.

4.2.2. Bryophytes

Status

The bryophytes is a less known group of plants comprising of about 2850 species and the second largest group of plants in India. About 100 species are rare and nearly 932 (32.9%) are endemic to India.

Explorations in potential sites

Extensive Bryological Explorations in different bryogeographical regions of the country, especially the Himalayas, the Western Ghats and Andaman and Nicobar Islands should be undertaken.

Species-specific surveys to relocate the rare and threatened species with maps.

Conservation measures

Declaring Bryophyte-rich sites as "Bryophyte sites" for in-situ conservation of species.

Establishment of Bryophyte gardens in different altitudinal zones for ex-situ conservation and education.

Ex situ conservation can be initiated for rehabilitation of rare/threatened and endemic species.

Capacity building, both in terms of HRD and institutional infrastructure coupled with more opportunities need to be initiated.

Environmental indicators

Considering the role of bryophytes in habitat modification, nutrient cycling and pollution detection and monitoring, taxonomic research and training should be promoted/encouraged. This will help in capacity building.

Indicators of mineral wealth

Autoecology of species on biogeochemical aspects should be carried out for understanding the biology and linkages with other biodiversity elements and as indicators of mineral deposits.

4.2.3. Fungi

Status

The fungi form one of the largest kingdoms of organisms and constitute a group of heterotrophic organisms subsisting as parasites and saprophytes on other organisms or their residues. In India, over 14500 species are reported, of these 3500 species are endemic. Various species of fungi are edible and medicinally important and support the basic needs of livelihood system.

Comprehensive inventories

Initiate the preparation of Red Data List of large fungi (habitat wise) and assessment of occurrence and general distribution of larger fungi is required.

Conservation initiatives

Conservation of those habitats (grasslands, pastures etc) which may be less worthy for flowering plants but are important for mycoflora.

Ex situ initiatives should be promoted for multiplication of wild edible mushrooms.

Preservation of natural and semi natural habitats by establishing protected areas in different geographical zones. Selected plantation of certain trees (oak, pines etc.), which support a specific groups of ectomycorrhizal/wood-rotting fungi, to facilitate potentially favorable habitats for these fungi.

Legal protection to a few charismatic and popular fungus species needs to be initiated.

Management intervention

Wise management of harvesting wild edible mushrooms for commercial purposes by way of over picking, habitat disturbance, overturning logs and trampling. The preparation of code of conduct for collection issue of license for picking up mushroom will help to some extent. While limited harvest may be allowed in some forest areas but the picking should be strictly regulated in protected areas.

Reduction of environmental pollution (acidification, nitrogen concentration) in densely populated and industrialized regions will help in maintaining and restoring the ectomycorrhizic flora including edible mushrooms.

Enriching knowledge base and capacity building

To develop broad based mycology curiculum in Indian Universites, increase number of workers on taxonomy and ecology of fungi, use of rural adults as parataxonomists – persons trained to collect, sort and prepare material for subsequent examination by taxonomists to be ensured so that the skill and knowledge of retired persons is properly used. Also, rural knowledge on traditional use be blended with this activity.

To sell mycology to younger generation by arranging short courses, delivering lectures and leading fungus foray for general public. The ventures like cryptogamic sanctuary gardens may be used as potential basic tools for educating children and public about the role fungi play in the ecosystems.

Thrust areas

Biochemical analysis of important plants should be conducted to understand its economic importance.

Ultrastructural studies are needed.

4.2.4. Algae

Status

Algae are important source of several natural products, biofertilisers and fine chemicals. About 6,500 species of algae representing 14% of the known Indian flora. Nearly 5820 species are from fresh water bodies and allied habitats and 680 species from marine habitats have been recorded. In India approximately 1928 species are endemic.

Action Points

Promotion of algae as biofertilizers.

Taxonomic research and training should be promoted/encouraged, which will help in capacity and opportunity building.

Indiscriminate collection of marine algae in bulk for their biological screening should be checked and monitored.

4.2.5. Lichens

Status

Lichens represent a symbiotic association between two different groups of plants namely fungi and algae and represent about 2021 species within eight-lichenogeographical region of India. The eastern Himalayan region have the maximum lichen diversity consisting of 843 species however, Eastern Ghats and Deccan Plateau have the minimum (31) species. Lichens have great economic as well as ecological significance. They are used as food, antibiotics, accumulators of radioactivity, antitoxicants, dyestuffs, fodder, perfumes etc. Due to their physiological sensitivity lichens are reliable indicators and useful measuring devices for atmospheric pollution. About 23% of the species are endemic and 20% are rare in Indian flora.

Documentation

National compilation of the lichen flora with special emphasis on protected

areas needs to be started.

Preparation of Red Data List, management of rare and endangered species and definite guidelines for monitoring as well as publication of the available information on the status and trends of these resources.

Institutionalize surveys of lichens to determine the distribution pattern and their screening for discovery of potential biomolecules.

Conservation and awareness

Explore the possibilities of in vitro studies of rare and endangered taxa

Creation of public awareness for lichen conservation.

5. Intrinsic Characters

5.1. Livelihood

Status

Out of the estimated 17672 species of flowering plants in India, nearly 1200 are regularly exploited for food in some way, 3000 species have edible value, 500 species are fibre yielding, 400 species have fodder value, 300 species yield gum and dyes and 100 species yield different types of scent and essential oil. In addition to known plant species several other taxa remain unexploited or underexploited.

Action points

Documentation of under exploited species

Potential of under exploited economically important plants need to be evaluated.

Awareness campaigns on potential values of the important plants.

5.2. Traditional knowledge

Status

Traditional knowledge forms the basis for development of new products. About 550 tribal communities maintain the traditional knowledge in India. These people are the true conservators of wild resources. They have their indigenous ways of protecting and managing the forest resources. For example: in the Himalayan region a number of ethnic groups use nearly 675 wild species as subsidiary food, 35 tree species as multipurpose, socio economically important species, 37 species for fiber and several hundred as medicinal plants. By their long association with nature, they also know the natural history of each species for obtaining sustained yield through managed harvesting. The traditional culture and associated knowledge system which has persisted through several centuries are today at the verge of extinction. In south India Yanadi tribe are experts in snake catching and possess the knowledge of over 22 wild plant species as antidotes for snake bites (Sudarsanam and Prasad, 1995). They often sell the roots/ rhizome of the plants as antidotes along with other medicine herbs in the nearby town and cities. Traditional cultures of tribal communities including their knowledge and uses of wild plants, are rapidly changing through contact with western culture, increased population pressure and the introduction of new food plants by government is forcing these people to abandon or greatly modify their traditional agricultural practices, food and medicine gathering activities.

Issues and Policies

Traditional knowledge must be covered under Intellectual Property Rights.

The Govt. of India should take effective steps to protect the rights of local communities particularly with regard to their knowledge on conservation and sustainable use of plant genetic resources.

Strategies

The traditional knowledge and resource management practice of the rural people should be integrated in modern/scientific developmental strategies.

Steps must be taken to recognize "farmers and traditional healers" knowledge and expertise so that their potential is realized for healthcare needs.

Use of renewable forest resources need to be encouraged.

Education and awareness

The rural communities need to be educated with regard to adequate time of harvesting of resources. Also, they must be imparted education on potential value of little known resources.

5.3. Ethnobotany

Status

Ethnobotany includes the studies of plant wealth used by tribal and other ethnic communities for their food, fodder, medicine (both human and veterinary), clothing, house building, oil seeds, narcotic, beverages, fibre, dye, tannin, agricultural implements, hunting implements, material culture, magico-relegious belief etc. and the impact of such uses on the survival of vegetation and of individual plant species. It also denotes the entire realm of useful relationship of man-nature. The ethnobotanical studies conducted so far on different areas of its sub disciplines and interdesciplines has hardly covered 10-15% of the task involved in India. Except for the listing of the plants used by specific ethnic groups of a particular geographical region, no attempt so far has been made to integrate all the aspects of subject matter as well as interdisciplinary approaches of the subject together. The vast heritage of Vedic literature such as Rigveda, Athravaveda, Kautilyas Arthsastra, Vishnupuran, Agnipuran, Vishnudharmottara Mahapuran, Apstanga Smiriti, Brihat Samihta, Upavanvinoda, etc. and with medieval literature in various regional languages e.g. Sanskrit, Pali, Tamil, Persian etc. possess huge wealth of ethnobotanical information. In India, during last three decades about 450 scientific papers and one and half dozen books on ethnobotany have been published.

Survey and assessment

Field studies should be conducted on the basis of geographic areas and tribal groups.

Studies on folklore and folk taxonomy, palaeo-ethnobotany, folk medicine, veterinary medicine and household remedies need to be conducted and the results integrated.

Uses of the known ethnobotanically important plants need to be investigated.

Study on ancient and medieval literature relevant to ethnobotany should be conducted.

Participation

Role of tribal participation needs to be highlighted in forest management.
Gender differences in plant based knowledge need to be documented.

Issues Intellectual property rights and royalties from marketable plant product need to be suitably regulated.

5.4. Religious

Status The Indian tradition teach us that all forms of plants, animals and human being are closely interlinked and interdependent and that disturbance in any one of them would jeopardize the entire ecological balance of the universe. In the course of living, the ancient people began to see nature with reverence. Their sense of gratitude to nature's bounty is well known. As a part of this process, they began identifying several species of flora with particular personalities of the Hindu pantheon and started worshipping them. For example- the Ficus tree (Ficus religiosa) became symbolic of Lord Krishna, the sacred basil (Osimum sanctum) of Lord Rama. Many plants and their parts are considered sacred in Indian mythology and their destruction is considered sacrilegious. Their leaves, fruits and flowers are used at several religious and cultural functions such as marriage, death, childbirth, various other ceremonies and festivals. This belief and these practices have continued in one form and have helped considerably in the maintenance of the wild plant diversity. For example- traditional Hindu belief that trees can bring peace, prosperity and consolation to mankind if protected and worshipped. Cutting of green tree is considered to be a sin and sacrilege, which can spell disaster for the family and even for the entire village community.

Inventorization An inventory of plants, which are used in several religious ceremonies, should be prepared and popularized not only among rural communities but also in so-called advance urban societies.

Policy A thorough survey of religiously important sites need to be documented and policy should be made to conserve such sites

5.5 Social/Culture

Status There is an inextricable link between indigenous cultural, ethnic diversity and biological diversity. The indigenous culture has provided several "miracle plants" of immense food and medicinal value to the modern civilization. Indigenous culture is now under assault everywhere in the world under the impact of industrialization and they are fast dwindling. The tribals of India are also dwindling under the impact of industrial development and modernization. Larger tribal population have been uprooted and displaced as 'ecological refugees" in central India due to the construction of ambitious Tehri and Narmada Dams. Under the Project Tiger scheme large populations of indigenous people have been displaced from their original homes.

Policy Govt. should recognize that indigenous lands need to be protected from environmentally unsound activities

5.6. Primary healthcare

Status	Over 7500 species of plants are estimated to be used by over 46335 ethnic communities in India, probably has the oldest, richest and most diverse, cultural traditions in the use of medicinal plants. Medicinal plants continue to provide health security to rural people in primary health care. In India the coverage of rural population by the modern health system varies between different regions from 3-30%. Thus, for some 4-5 hundred million people, traditional medicine is the only alternative. For example it has been reported that about 44 medicinal plants are used in traditional physiotherapy in the health care of Gond tribals of U.P.
Conservation measures	Herbal farms should be established for processing and production of herbal medicine as well as generating employment for the benefit of tribal and local population.
Policies	There is a need to develop a comprehensive approach under some form of coordinating mechanism to ensure therapeutic efficacy and safety of herbal medicine through pharmacological and clinical studies and to regulate over-exploitation of plants through cultivation and conservation policies
Documentation	Information on folklore medicine and their utilization patterns from different tribal region should be collected
Assessment	Forest area must be surveyed extensively to assess the potential of medicinal and aromatic plants and their utilization.
Technology development	Multipurpose co-operative societies should be established in tribal areas to perform manifold functions of providing investments, procurement and marketing of medicinal plants Modern technology should be transferred to poor people by using appropriate extension methods. Setting of demonstration farms–cum- nurseries for transfer of technology in rural areas for community welfare should be promoted
Education and awareness	Local people/tribals must be trained for authentic identification and scientific collection of medicinal plants from time to time as the different parts of the plants are to be collected as per their availability and maturity. The active participation and cooperation of local people especially the tribals should be considered for implementation of legislation measures as well as other conservation practices

6. Externalitis

6.1. Anthropogenic

6.1. 1. Agricultural

Status

Agriculture continues to hold an important position in the Indian economy with more than 43% of the country's total geographical area under agriculture. Agriculture and allied activities continue to be the single larger contributor to the Gross Domestic Products (GDP), contributing more than a quarter of the total, employing as much as 65% of the total workforce, and accounting for 18% India's export. The increasing intensification of agriculture puts increasing stress on natural resources in most parts of the country and brings under scrutiny concerns, issues, and initiatives related to irrigation, pesticides and fertilizers, which have a great adverse impact on natural resources.

Promotion of eco-friendly fertilizers

Imbalance and non-integrated fertilizers use can be disastrous, therefore leads to micro nutrient deficiencies.

The efficiency of fertilizers need to be improved.

The integrated uses of organic fertilizers along with chemical fertilizers need to be promoted and optimum doses of farmyard manure need to be determined.

Research

In view of the toxicity of the pesticides there is need to search environment friendly molecules and need-based improvement in integrated pest management modules.

6.1.2. Grazing/Browsing

Status

India's livestock population of 467 million grazes on 11 million ha of pastures. This implies that an average of 42 animals graze on a hectare of land, compared to the threshold level of 5. In the absence of adequate grazing land, nearly one third of fodder requirement is met from forest resources in the form of grazing and cut fodder for stall-feeding. The intensity of grazing is reported over 67% for national Parks and 83% for Wild Life Sanctuaries. Over grazing and over-extraction of fodder lead to forest degradation through decreased vegetative regeneration and, through compaction of soil reducing infiltration and vulnerability to erosion.

Conservation practices

Grazing in forest needs to be regulated, stall-feeding should be encouraged.
Use of crop residue as fodder should be encouraged.

Fodder can be grown on land under agroforestry and Joint Forest Management Programme, where local farming communities are active participants.

Silvicultural practices with respect to forest should be initiated.

6.1.3. Tourism

Status Tourism in India is one of the major threat to wild plant diversity. It is working as a catalyst in habitat destruction on account of development of infrastructure facilities, pollution from vehicles etc. For example; NPs like Kanha, Corbett, Bandipur, Sariska, Kaziranga are now criss-crossed by roads, dotted with tourist complexes and in many other ways disturbed by tourists. Also, the biodiversity of Himalayas, Nilgiri and the Palni Hills, which are abode of several tourist resorts and recreation grounds have become victim of uncontrolled tourism. The original pristine forests are being replaced by exotic ornamental species to attract the tourists. Besides the demand for better facilities like furniture fixtures, and fuelwood further agrevates the problem of biodiversity loss.

Participatory approach Involvement of local people and promotion of ecotourism should be initiated. This can be achieved by awareness programmes on ecotourism related issues.

Tourism and forestry department should develop mechanism for ensuring the management of plant biodiversity especially during peak tourist season.

Capacity building Develop education programs aimed at tourists to explain the importance of maintaining local plant diversity and measures needed to conserve it.

6.1.4. Exotic invasion

Status There are many alien elements in Indian flora, brought mainly by Portuguese, Dutch, French and Englishmen. It is estimated that about 40% of the flowering plants of India are alien/exotic and naturalized in various parts of the country.

Documentation Taxonomic studies should be initiated for identifying the exotic elements and prepare a comprehensive list.

Monitoring and value addition Proper detection and monitoring technology need to be developed.

Evaluate the economic potential of these species for income generation.

6.1.5. Scientific collection

Status Collection of material for scientific purpose from wild is a major threat to plant biodiversity. In India thousands of the researchers are presently collecting the material for their study.

Strategy Sampling strategy should be developed to collect minimum plant samples from the wild

6.1.6. Urbanization

Status In 1997 the urban population of India was 276 million (29% of the total population) which is expected to increase upto 796 million (50% of the total population) in the year 2047. Also it is expected that India will have 5000 cities in 2047 (increasing from 3609 cities in 1991).

Issues Amenities and infrastructure should be created at village level and various self-employment schemes be provided to villagers to overcome out migration.

6.1.7. Socioeconomic

Status	Rural populace of the country is largely dependent on the natural resources to meet their fuel wood needs.
Action point	Distribution mechanism of LPG cylinders and low smoke-high energy chulas among rural inhabitants should be promoted so that dependence on natural resources on fuel wood needs is drastically reduced.

6.1.8. Encroachment

Status	Encroachment by human habitation on natural systems has adversely affected the maintenance of biodiversity. This phenomenon has promoted the replacement of natural systems by man-made agricultural/horticulture systems. While this is happening all across the country, more and more alien/weedy elements are invading into the pristine forests.
Action points	Regulatory mechanisms need to be developed to prevent illegal encroachments in pristine systems.

7. Mechanism

7.1. Research

Database	Assess past and present losses in biodiversity by integrating historical and contemporary information and database into GIS.
Habitat ecology	Identify critical or unique habitats, communities, species and intraspecific taxa that are threatened and need protection.
Threats	Identify social, cultural and economic factors that lead to loss of biodiversity or promote sustained use of biodiversity. Pay particular attention to the issue of inequity in control of the access to biotic resources. Identify research needs on the impact of deforestation, habitat fragmentation and anthropogenic disturbance on natural communities.
Analysis of existing information	Competitive research funds should be made available to support comprehensive comparative revision and monographs that are focused on taxa at all levels from individual genera to phyla.

Participation

Identify practices by local communities as well as public policies that encourage misuse and depletion of biotic resources and generate appropriate methodology to change these practices and policies.

Encourage studies of community and population dynamics for threatened biota with a view to understand how these communities or populations might be effectively conserved

Initiate efforts or develop a program to restore and regenerate degraded forest with the help of local communities.

7.1.1. Database

Status

The information on biological diversity exists in forms ranging from systematic monographs and regional checklist to the data associated with the millions of specimens held in the national collection. This wealth of information should be organized and integrated into a readily accessible comprehensive knowledge base. Such a knowledge base is needed for national land use planning to ensure the long term economic and environmental benefits of these vital biological resources. Although, some data on biological diversity are available electronically, most are scattered in the literature, herbaria, museum collection and contained in other resources of the biological disciplines. In addition existing data often must be edited critically and periodically updated laboriously before they can be integrated with other data in electronic form.

Action points

A network of Natural/Regional databases should be created which make specimen-based knowledge accessible and guarantee that those data are maintained by Institutions possessing the collections. Taxonomic specialists should be involved to ensure the authenticity of the electronic data.

Efforts should be made to electronically capture specimen based information in major natural history collections of the world and to make that information freely available to all users for their use and benefits

Complete documents on each category (mentioned above) should be published a base line information.

Revised flora of India needs to be completed in shortest possible time.

Preservation of documents, which deal with any aspect of plant diversity of the country.

7.1.2. Publication

Status

Extent of published information reflects the intensity and quality of work being conducted in different fields and areas. Information on wild plant diversity during last 10 years, collected from various journals i.e. Journal of Economic and Taxonomic Botany, Journal of Bombay Natural History Society, Ethnobotany, Indian Journal of Forestry, Van Vigyan, Indian Forester, Bulletin of Botanical Survey of India showed that the maximum studies during this period have been published in taxonomical aspect followed by ethnobotany. Very few studies have been conducted on ecological status, rarity, endemicity, awareness conservation and management practices of wild plants. State wise information revealed that the Uttaranchal (n=62) was most widely covered

state followed by Uttar Pradesh (n=42), Kerala (n=37), Andhra Pradesh and Tamil Nadu (n=34). Among Union Territories only Andaman and Nicobar Islands are investigated well (n=56). Inspite of the maximum number of plant species per sq km in Sikkim, very few studies (n=18) have been carried out during last 10 years. Likewise, inspite of strong traditional base in west Bengal just one study on ethnobotanical aspect have been conducted. Bihar, which represents higher number of rare/threatened taxa, remain neglected towards the studies on rarity. Similarily high endemic diversity states, Tamil Nadu (n=7), Arunanchal Pradesh (n=0), and Maharastra (n=1) received lesser attention with regard to endemic studies.

Action Points

Considering the biological (wild plants) values available within the states, more emphasis should be given to the studies on specific attributes such as richness, use value, rarity and endemicity.

In general, focus on ecological status, studies on endemism, rarity, conservation and management and awareness need to be improved

7.2. *In situ*

7.2.1. Protected Areas

Status

Protected Areas (PAs) are regarded as the ultimate repositories of biological diversity. Currently there are 573 PAs in India covering 154040 sq km area (nearly 4.69% of the country's land surface). These include 89 National Parks (NPs) and 484 Wildlife Sanctuaries (WLS). The NPs and WLS cover approximately 1.13% and 3.56% of the land area respectively. Also, there are 11 Biosphere Reserves (BRs) which comprise existing parks, sanctuaries and adjacent reserved forests, essentially to manage the entire landscape according to the principles laid by the Man and Biosphere Programme of the UNESCO. The existing PA network covers varied ecosystems and communities such as a large number of terrestrial habitats. Among the PA coverage within various zones, maximum number of angiosperms have been reported from Himalayan region (5000 species from 67 PAs), however the lowest number of species is recorded from the coast (400 species from 26 PAs).

Policies/Acts

The type localities, areas of special conservation significance and botanical hotspots both in side and out side the PAs should be brought under the umbrella of wildlife protection.

The government's policy on the protection of highly threatened species need to be made stringent. The Wildlife (protection) Act, which is currently under revision, should make special provision for the protection of the threatened type localities and botanical hotspots. The plant conservation strategies for the country need wider publicity

Establish a link between the field managers, ecologist and systematic botanists so as to gear up the plant conservation activities within various PAs. As part of conservation planning and habitat management activities the PA managers should draw a plan for the conservation of rare plants in their area in collaboration with the regional botanists.

Develop guidelines for selection, establishment and management of protected areas.

Priorities for management inputs should be established on the basis of

thorough assessment of biological values.

Education and Awareness

The PA managers should train their field staff in identification and monitoring of critically endangered plant species in their respective areas. The conservation programmes can be more successful by involving the local people and para-taxonomists who possess rich traditional knowledge on species and conservation ethos.

Encourage biodiversity conservation and sustainable use of bioresources on private land.

Assessment and conservation

Prioritize the species for protection and rehabilitation within each botanical hotspot. Identification of habitat for a critically endangered species and protection (of the habitat) would be a better strategy than focusing on the species particularly if it is an inconspicuous herb.

Provision for reintroduction/introduction of rare species within PAs from the surrounding areas in the event of such species being present only outside the PAs, and assessment of human pressure or biotic interferences on various species within PAs for evolving better conservation strategies should be taken up by PA management.

Promote environmentally sound and sustainable development (ecodevelopment) in areas adjacent to protected areas.

Protection of ecosystem/habitats for maintenance of viable population of species.

Prevent introduction of and control or eradicate alien species, threatening ecosystems/habitat/species.

Respect/ uphold relevant knowledge, innovations and practices of local communities to promote wider applications.

7.2.2. Sacred grove

Status

In India, the tradition of maintaining sacred groves is reported from most parts of the country. Approximately 13,750 SGs are reported from the country covering 33,000 ha or 0.01% of the total land area of India. Sacred groves has important role e.g., religious, socio-cultural, economic and political, in the lives of the people. There are several sacred groves in Northeastern India, comprising the state of Assam, Meghalaya and Manipur, many of central India and several in the Western Ghats of south India, comprising the state of Kerala, Karnataka and the Palni and Nilgiri hills of Tamil Nadu, and the Andaman and Nicobars Islands. Some sacred groves also exist in the state of Rajasthan and Gujrat in north Westren India. They have been variously named in different state such as "Mawflong" in Assam and Western Ghats. In Rajasthan such sacred grooves are called "Orans" . The maximum sacred groves are reported from Himachal Pradesh (5000), which are being mantained by various communities.

Documentation

Sacred Groves and their plant biodiversity status in all state need to be documented

Genesis of their sacred identity need to be known and popularized.

Research and Management

Ecological and biological studies need to be initiated
Management options need to be properly monitored and implemented

7.3. *Ex situ*

Status

In India about 10% of the estimated 17672 flowering plants are enlisted as rare and threatened. Conservation of such plant species has become a major concern. The Red Data Book of Indian plants gives an account of 620 species. About 1080 species under threat require enlisting and categorizing in the new IUCN red list. Ex situ conservation techniques can be used for achieving rapid and mass multiplication means of threatened rare and endemic plant species. For the effective conservation of rare/endangered, and economically important plants, Botanical Gardens are the best tool for ex-situ conservation. There are about 150 Botanical Gardens reported form India. Out of them 8 are major Botanical Gardens. In addition, there are 33 Gardens under Govt. control, 77 gardens and parks of public and academic interest and 40 gardens run by the Universities.

Propagation methods

Methodology need to be developed for mass culture of threatened Red Data Book species, through conventional and biotechnological approaches.

Botanic gardens, live gene banks need to be developed, which will act as centres of nature conservation activities

Botanic gardens should take into account the preservation of plants growing in the nearest endemic centres and exchange freely all rare and endangered species.

7.4. Capacity building

Status

Initiate efforts to involve students, from middle schools to college, on biodiversity preservation, first by making them aware of the threats and then by involving them in restoration projects.

Education and

The village communities should be made responsible and capable of

awareness	conserving and protecting Non-Timber Forest Products (NTFPs) and wildlife, which in turn would require empowerment of the villagers as a pre-requisite. Identification of stakeholders in conservation and description of their interests and assumptions Strategies for developing conservation partnership between people and government agencies need to be initiated. There is a need to develop private entrepreneurs from within the village communities by NGOs
Documentation	Peoples view on biodiverstiy conservation and its benefits and costs; socio-economic compulsion; nature of use and mode of extraction need to be documented.

7.5. Participation

Sustainable utilization	In areas where people are to be involved, incentives for their participation in biodiversty must be identified. Eco-tourism and recreation forestry is being tried as income earning operations for local communities. These need to be formalized and included in the relevant policies. In depth studies are needed to determine the feasibility and the cost and benefits of forest based products. Community biodiversity registers must be developed before issue of ownership of resources and equitable sharing of benefits are sorted out clearly and explicitly. These registers will help in organizing relevant information at micro level on patterns of utilization, conservation, status and management that would form the basis of identifying sustainable livelihood patterns. To revive relevant traditional systems of resource conservation, for example; the citizens group "Lok Swasthya Parampara Sambardhan Samithi" of Coimbatore is working to revive interest in medicinal plants used in Ayurvedic and other local healthcare traditions, and attempting to set up medicinal plants conservation units in various parts of India. Channelize benefits of biodiversity conservation back to local communities
Policies/Acts	In protected areas several ways of involving local communities, for example: reserving upto 50% of available posts (e.g. wildlife guards and forest watchers) for inhabitants of local communities. Planning and decision making process should be open, democratic and transparent so that all information related to biodiversity should reach to the local people.
Education and awareness	Encourage mass public awareness and education by conducting people participation action programme in different schools and colleges and also by using folk media and popular science methods.
Research &	Special skill and strategies should be developed in order to understand and

Development

validate rural women's rich biodiversity knowledge and enable them to become equal participants in biodiversity conservation.

Develop effective benefit sharing mechanism, which gives due consideration to women's biodiversity knowledge and expertise in the wake of the IPR regimes.

Encouraging women to come forward with solutions to improve the surrounding bio-resources and stake a claim in the benefits

Conservation

Encourage direct participation of traditional, community level institution particularly women's groups like "mahila mandals", in planning and implementing of conservation activities.

7.6. Policies

Action points

Area of high conservation values should be declared as National Heritage and accorded strict protection. A separate Forest cell may need to be created to monitor these areas and prevent fires, poaching, illicit cutting and so on.

Medium conservation value areas can be subjected to sustainable forestry operations such as mixed plantations, extraction of dead woods, NTFP collections are carried out in a sustainable manner and not exploited by over-enthusiastic commercial interests.

Some low conservation value areas are potentially linked to areas of high and medium conservation. These must be given adequate protection so as to enable their recovery

7.8. Transboundaries

The importance of regional cooperation in conservation has already been recognised in case of continuous habitats and migratory species, though regional agreement on this front are still far from adequate. Virtually no attention has been given to species shared by region. India shares a considerable part of its biodiversity with neighboring countries in south and south east Asia. For example: Natural ecosystem spreading over the boundaries between India and adjoining countries (i) Sundarbans mangroves across India and Bangladesh (ii) Manas forests across India and Bhutan.

Database

Building up a database of biodiversity shared by various political entities.

Conservation measures

Need to develop joint ecosystem and species conservation programs, for those ecosystem and species which overlap among nations.
The scope of CITES can be expanded to include species not covered, or such species can be covered by this treaty.

Promote international cooperation for conservation of migratory species; establishment of protected areas in transboundary locations.

Adjacent country border, rich in endemic diversity need to be identified for establishment of viable trans frontier parks.

Political entities need to collaborate to initiate conservation initiatives.

8. Interaction

Status

In order to ensure participation of different stakeholder in the process of NBSAP, the approach was discussed and presented in various fora. The stakeholders include scientist, research students, plant taxonomist, ecologist, teachers, senior forest officers, students, representatives of community groups and NGOs. The views of each group were considered and relevant inputs incorporated in the process. Besides, Call For Action Points" was distributed among various stakeholders to obtain inputs from cross section of the society. A number of meetings were conducted at various places i.e. INSA, New Delhi, Govt. Girls Inter College, Dwarahat, GBPIHED, Almora, BSI Dehradun, FRI Dehradun, IIRS Dehradun, Jiwaji University, Gwalior and Govt. Inter College Syalde in order to ensure the maximum participation in the NBSAP process. Besides these, two training programs i.e. Govt. Girls Inter College Dwarahat, Almora (March 3-4 2001) and Govt. Inter College Syalde, Almora (February 2-3, 2002) were organized to inculcate awareness among children and teachers about the importance of NBSAP process and record their experiences on local plant diversity. The training was imparted to teacher and students with the help of various modules on wild plant diversity such as (i) Definition and dimension of biodiversity, (ii) Status, Assessment and monitoring (iii) Value and value addition, (iv) maintenance (*in-situ*-protected area, *ex-situ*-gene/seed banks and tissue culture etc. (v) methods for revegetating degraded lands (nursery preparation, propagation packages etc.) (vi) Linking biodiversity with soil and water components. Each training module included teaching (40-45 minute) by the subject experts (with in Institute scientist and from outside). Training material included write up in Hindi to provide background information on the relevant subject, compiled in the form of book. The feed back from the students indicated clearly the location specific problem. By adopting the above approach children can be involved in various process of biodiversity conservation and their participation could be helpful in identification of location specific problems of biodiversity, addressing the identified issue and for strengthening the participatory approach.

Action Points

Biodiversity conservation programme (Training) at school level need to be strengthened all across the country for identification of area specific biodiversity problems. For example: while imparting training to the school children and teachers on Indigenous Knowledge System during February 2-3, 2002 in Govt. Inter College Syalde one of the participants pointed out the disappearance of some Paddy varieties from the region.

Interaction with the various stakeholders must be ensured before preparing and finalizing the biodiversity related Action Plan. For example: during the discussion with various stakeholders in various meetings it was found that some points of special interest emerged during such interactions. The preparation of Biodiversity Granaries is, for example, a case in point.

Follow-up

SN	Strategies/Gaps	Components	Time Frame	Coordinating agency	
				National level	State/district level
1.	**Research**				
	Complete inventory	Hierarchical/ Special group	Medium Term/ Immediate	BSI	Research Organizations, University departments, subject experts, specialized Institution/University
	Population status	Same as above	Long Term/Short Term	MoEF, DST	Same as above
	Distribution pattern	Same as above	Same as above	BSI, National Botanical Research Institute (e.g. NBRI)	Same as above
	Reproductive potential	Same as above	Same as above	DST, MoEF	Same as above
	Economic potential	Same as above	Short Term/ Immediate	CSIR, ISM	Research Organizations, University departments, subject experts, NGOs (specialized), Specialized Institution/University
	Harvest and post harvest Technology	Special group	Immediate	DBT, CSIR	Same as above
	Value addition	Same as above	Same as above	CSIR, DBT, DSIR	Same as above
	Agrotechnology	Same as above	Immediate	Ministry of Agriculture, DBT, ISM (MPB)	Specialized Research Organizations, University departments, subject experts, NGO's, Community group
	***Ex situ* propagation protocols**	Same as above	Same as above	DBT	Same as above
	Biochemical analysis	Same as above	Same as above	ISM, CSIR, DBT	Specialized Research Organizations, University

					departments, subject experts
	Documentation of traditional knowledge	Same as above	Medium Term/Short Term	BSI, DST, CSIR	Research Organizations, University departments, subject experts, NGO's, community groups, Specialized Institution/University
	Electronic database	Same as above	Immediate	NIC	Research Organizations, University departments, subject experts, specialized Institution/University
2.	**Conservation**				
	• ***In situ*** Protected Areas	Same as above	Long Term	MoEF	State Govt., wildlife department, Department of Forest, NGOs, Community groups and relevant Research Organization
	Sacred Groves		Same as above	MoEF	State Govt., NGO's, Community groups
	• ***Ex situ***		Immediate	MoEF, DST, DBT, CSIR, ISM	State Govt., Research Organization, University departments, NGO's, community groups
	Botanical Gardens/Seed Bank		Same as above	MoEF	Same as above
3.	**Capacity Building**				
	People's participation		Short Term	MoEF	State Govt., District administration
	Benefit sharing		Immediate	Same as above	Same as above
	Subject experts		Same as above	Same as above	State Govt.
	Biodiversity education		Same as above	Same as above	Same as above

4. Legislation					
	Conservation of useful plants		Same as above	Govt of India	Same as above
	Area specific		Same as above	Same as above	Same as above
	Equal distribution of PAN		Same as above	Same as above	Same as above
	Biogeographical unit		Same as above	Same as above	Same as above
	Management and conservation of hills and biodiversity rich areas		Same as above	Same as above	Same as above
	IPR regeimes and patent laws		Same as above	Same as above	Same as above
	Involvement of local people in conservation and management		Same as above	Same as above	Same as above
	Benefit sharing		Same as above	Same as above	Same as above

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