ASIA-PACIFIC FORESTRY SECTOR OUTLOOK STUDY II

WORKING PAPER SERIES

Working Paper No. APFSOS II/WP/2009/06

INDIA FORESTRY OUTLOOK STUDY

by

The Ministry of Environment and Forests
Government of India

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
REGIONAL OFFICE FOR ASIA AND THE PACIFIC

Bangkok, 2009

Preface

Rapid socio-economic changes in the Asia-Pacific region are having profound impacts on all sectors including forestry. Societal transformations are changing people's perceptions of forests, while growing and often conflicting demands for forest-derived goods and services have increased the complexity of forest management. Globalization and increasing accessibility to global markets for many, but marginalization and increased asymmetry for others, have presented significantly different opportunities and challenges. Concerns over climate change, escalating energy prices and deepening water deficits have moved forestry into the spotlight of global and national development. Added to these are long-standing challenges, such as poverty and deprivation, which are still to be resolved. Forestry has thus entered the 21st century with a plethora of old and new issues and more to emerge in the future. During the 21st session of the APFC, it was decided to conduct the Asia Pacific Forestry Sector Outlook (APFSOS) Study-II for providing scenarios for the forestry sector in 2020 to combat challenges through appropriate policy interventions at global as well as national levels. FAO is conducting this study and has requested member countries to submit their country reports. FAO is also conducting studies on various thematic elements of the forestry sector. FAO will prepare a final report on the basis of country reports and outcomes of the studies on thematic elements.

Indian forestry revolves around social and environmental elements of Sustainable Forest Management (SFM). The demand for wood and wood products will continue to increase in the future. The present need is met mainly from the agroforestry sector and balance demand through imports. The forests of the country are catering to 16% of the human and 18% of the cattle population needs. India is also maintaining around 20% of the forest area under a protected area network for providing ecological security.

The nation has empowered occupation and habitation rights for forest dependent communities along with the responsibility for conservation of forests. There is a wide gap between "have" and "have not "in the country. The strengthening in the capacity of the rural poor for improving their income is crucial for checking the degradation of forests.

The forestry sector is impacted by other sectors such as energy, agriculture, education, water resources, industry, infrastructure development, biofuels, change in demographic structure and high economic growth. All the policies of the Government of India have to move around the prime objective of the National Forest Policy and mandate of achieving 33% forest and tree cover in the country.

The country report has been prepared after wide consultation with multistakeholders. The main future projection made in this report is a 3-4 time increase in the demand for wood and wood products by 2020. It will facilitate the Government of India and State Governments to make policy interventions for addressing future challenges in the forestry sector.

Contents

INFORMATION NOTE ON THE ASIA-PACIFIC FORESTRY SECTOR OUTLOOK STUDY

The Asia-Pacific Forestry Sector Outlook Study (APFSOS) is a wide-ranging initiative to gather information on, and examine, the evolution of key forestry issues as well as to review important trends in forests and forestry. The main purpose of the study is to provide a better understanding of the changing relationships between society and forests and thus to facilitate timely policy reviews and reforms in national forest sectors. The specific objectives are to:

1. Identify emerging socio-economic changes impacting on forest and forestry
2. Analyze probable scenarios for forestry developments to 2020
3. Identify priorities and strategies to address emerging opportunities and challenges

The first APFSOS was completed in 1998, with an outlook horizon to 2010. During its twenty-first session, held in Dehradun, India, in April 2006, the Asia-Pacific Forestry Commission (APFC) resolved to update the outlook extending the horizon to 2020. The study commenced in October 2006 and is expected to be completed by September 2009.

The study has been coordinated by the Food and Agriculture Organization of the United Nations (FAO), through its regional office in Bangkok and its headquarters in Rome, and implemented in close partnership with APFC member countries with support from a number of international and regional agencies. The Asian Development Bank (ADB), the International Tropical Timber Organization (ITTO), and the United Kingdom's Department for International Development (DFID) provided substantial financial support to implement the study. Partnerships with the Asia-Pacific Association of Forest Research Institutes (APAFRI) and the Secretariat of the Pacific Community (SPC) supported the organizing and implementing of national focal points' workshops and other activities, which have been crucial to the success of this initiative. The contributions of many other individuals and institutions are gratefully acknowledged in the main APFSOS report.

Working papers have been contributed or commissioned on a wide range of topics. These fall under the following categories: country profiles, sub-regional studies and thematic studies. Working papers have been prepared by individual authors or groups of authors and represent their personal views and perspectives; therefore, opinions expressed do not necessarily reflect the views of their employers, the governments of the APFC member countries or of FAO. Material from these working papers has been extracted and combined with information from a wide range of additional sources to produce the main regional outlook report.

Working papers are moderately edited for style and clarity and are formatted to provide a measure of uniformity, but otherwise remain the work of the authors. Copies of these working papers, as well as more information on the Asia-Pacific Forestry Sector Study, can be obtained from:

Mr. Patrick Durst
Senior Forestry Officer
FAO Regional Office for Asia and the Pacific
39 Phra Atit Road
Bangkok 10200
THAILAND
Ph. (66-2) 697 4000
Fax: (66-2) 697 4445
Email: patrick.durst@fao.org

1. INTRODUCTION

Background

The Twenty-first Session of Asia-Pacific Forestry Commission (APFC) held at Dehradun, India in 2006, resolved to undertake the Outlook Study to 2020 as a sequel to the Asia-Pacific Forestry Outlook 2010. Member countries agreed to prepare their respective country reports for developing an abridged outlook study for the Asia-Pacific Region. The present report is the outcome of the work in pursuit of the decision taken.

Objectives

The Forestry Outlook Study 2020 examines the prevailing forestry situation in the country and makes a critical analysis of the trends of development in various socio-economic sectors (agriculture, energy, etc) till 2020 and their influence on the forestry sector in its management, institutional and policy development aspects. The analysis is expected to result in building up scenarios based on the trends and options for forestry to respond to likely developments.

In pursuing the above mentioned objectives the study seeks to

- Identify emerging socio-economic changes which can impact on forests and forestry in the future. These may include elements of economic growth, demographic changes, socio-economic and socio-political developments impacting the forestry sector in India
- Analyze probable scenarios for forestry developments to 2020 in the context of the impact of the identified socio-economic changes and potential of forestry development to cope with the impacts
- Assess the role of the forestry sector to address the Millennium Development Goals (MDGs) by providing sustained sources of livelihood through interface with forest-dependent communities for forest management
- Provide complete thematic coverage of the forestry sector with the exception of wildlife which is referred to in the terms for protected area habitats
- Identify priorities and strategies to address the emerging opportunities and challenges on account of the changing scenarios within and outside the sector
- Assess the type and quantum of investment for policy reorientation and institutional development to affect the identified strategies while maintaining the sustainable status of forest resources

The study besides projecting the picture of the Indian forestry sector in the regional and global context is also likely to provide inputs for national policy reorientation, institutional development and for bilateral and multilateral technical and financial collaborations.

Key elements

The key elements of this study include reports on the present status and future prospects of the following issues:

- State of the biodiversity and related aspects of forests such as productivity, carbon sink status, social interface, environmental services like watersheds, protected areas, conservation, etc
- The interdependence of people and forests and various socio-economic and cultural issues related to forest resources

- Production, consumption and trade of industrial wood products, wood energy and non-wood forest products (NWFPs), including ecotourism, as well as water and their future trends
- Economic development and its impact on the environment and other natural resources (land, water, forests, etc) in terms of future demand on natural resources
- The global change scenario and the role of forests in mitigation and adaptation in the context of genetic resources and utility of the changing biodiversity profiles
- The implications of policy alternatives determining the future course of forestry development in India

Methodology

The Ministry of Environment and Forests (MoEF), Government of India, constituted a National Level Steering Committee under the chairmanship of the Director General of Forests and a Drafting Committee with the Director, Forest Research Institute (FRI), Dehradun, as its chairman for the study.

The National Steering Committee provided the basic framework for identifying the drivers of change within the economic environment and for analyzing the synergy between environment and development issues. Linkages with poverty alleviation were identified as the main emphasis of future forestry development in India. It was decided that the growing importance of NWFPs for poverty reduction is also to be placed in a proper perspective. The recent developments in research and technology and interlinkages between regional economic imbalances and national development leading to many social problems such as extremism have also to be considered in analyzing future forestry development.

Inputs from a number of external resource persons have been used in the report. While the 1998 Forest Policy continues to be the guiding principle for sustainable forestry development in India, the following relevant reports and documents were consulted for preparation of this report:

- National Forestry Action Plan 1999
- Documents related to international conventions
- Millennium Development Goals (2000)
- National Forest Commission Report (2006)
- Acts and policies
- SFM in India report of the Mission 2006 (ITTO)
- International Instruments on Sustainable Development of all Type of Forests
- State Forests Report (2005)

2. CURRENT STATE OF FORESTS AND FORESTRY IN INDIA

The forest resources

Forestland in India is a tract of land that is legally proclaimed to be forest under the forest laws (mainly Indian Forest Acts 1865, 1927). India has a notified forest area of 77.47 million hectares (m ha), comprising 39.99 m ha of Reserved, 23.84 m ha of Protected and 13.64 m ha of Unclassed (unclassified) Forests. The Reserved Forest is an area notified under the Indian Forest Act or a State Forest Act enjoying a higher degree of protection (human activities are prohibited unless expressly permitted); Protected Forests are also notified under the Forest Acts but the restrictions are less stringent (human activities are permitted unless expressly prohibited). Unclassed Forests are forests which have not been included in reserved or protected forest categories. The tenurial status of such forests varies widely.

Trends in forest resources

Forestry as a land use category is the second largest land use category after agriculture in India. Land use categories other than forestry also encompass some forestry activities as important constituents of the respective management domains. In general, the following three categories of the land use classifications contain forest use as a constituent:

1. Forest estate within public (government), community and private domain. While the main category of forestland use is within the public domain, private and community ownership status of many forests exists and is recognized under the law.
2. Common property resources other than the legally recorded community forests also serve the forest definition and provide the goods and services that are normally ascribed to forests. The social forestry resources created and developed during the last three decades of the 20th century are under this category and are constitutionally devolved to the local self-governments (panchayats) for management as common property resources.
3. The agroforestry constituent of agriculture is perhaps the most important land use which, though included in the agriculture sector, is largely in the sown area category; however it caters to the forest products category, providing a valuable quantum of wood-based raw material to industry and is recognized as a part of the strategy for the development of forests and forest industry in the country.

The most dominant component in the first category is government forests, maintained as forest estates and managed by the government. The land use category described as forests in the records includes basically the forest estate and the common property resources maintained as forests irrespective of being within public, community or private (rarely) domain (Table 1). This land use category, indicated by government statistics, has been more or less constant over the last six decades. The trend is shown in Table 1 and Figure 1.

Table 1. Land use in India*

Land use	Area in million hectares	Percentage
Total geographic area	328.73	
Reporting area for land utilization	306.05	100.0
Forests	69.02	22.6
Not available for cultivation	42.41	13.9
Permanent pasture and grazing land	11.04	3.6
Land under miscellaneous tree crops and groves	3.62	1.2
Cultivable wasteland	13.48	4.5
Other fallow land	10.11	3.3
Current fallows	14.80	4.8
Net area sown	141.23	46.1

*Source: Agriculture StatiticsAt A Glance 2003, Ministry of Agriculture.

The existing land use pattern suggests that there is a good possibility to achieve the goal of bringing one-third of the area under forest and tree cover through greening of cultivable wasteland, current fallows and other fallow land in the coming years. Also there is scope for compatible development of agricultural production through increasing irrigated areas which at present are much less than the rainfed areas (Table 2) without extending agriculture in new areas.

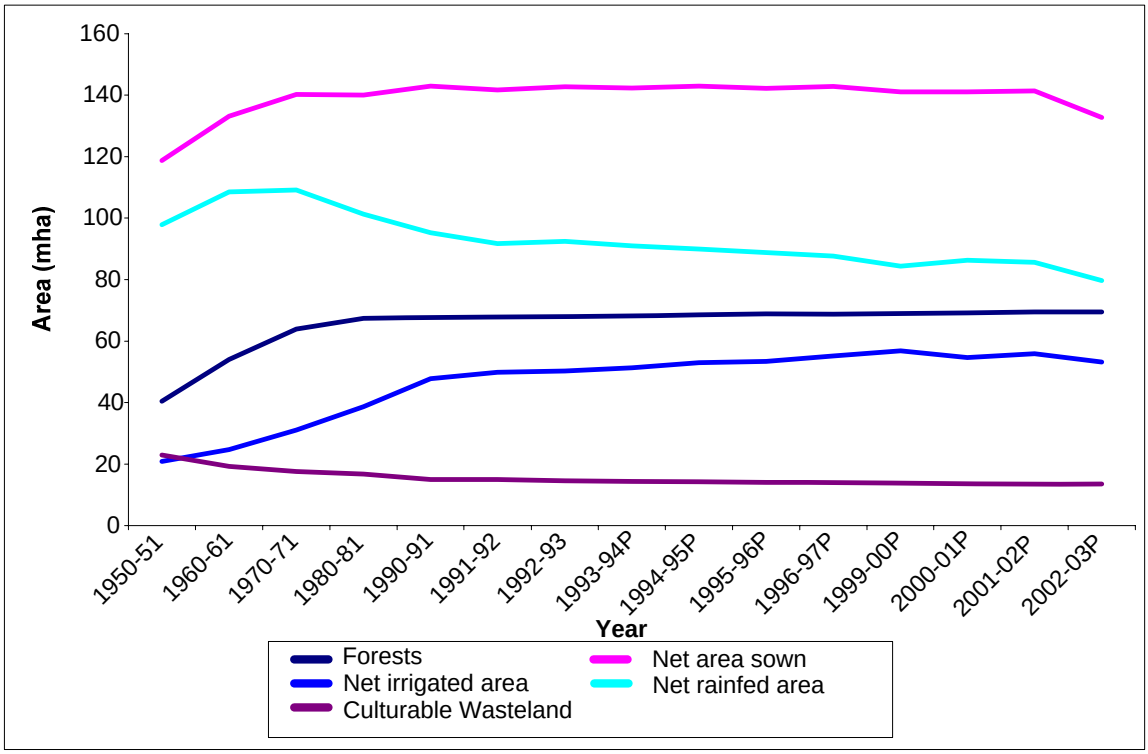

Figure 1. Major land use classification

Table 2. Major land-use categories*

(Area in m ha)

Year	Forests	Net area sown	Net irrigated area	Net rainfed area	Cultivable wasteland
1950-51	40.48	118.75	20.85	97.90	22.94
1960-61	54.05	133.20	24.66	108.54	19.21
1970-71	63.91	140.27	31.10	109.17	17.50
1980-81	67.47	140.00	38.72	101.28	16.74
1990-91	67.80	143.00	47.78	95.22	15.00
1991-92	67.87	141.63	49.87	91.76	14.99
1992-93	67.98	142.72	50.30	92.42	14.57
1993-94P	68.31	142.34	51.34	91.00	14.41
1994-95P	68.60	142.96	53.00	89.96	14.26
1995-96P	68.82	142.20	53.40	88.80	14.10
1996-97P	68.75	142.82	55.14	87.68	13.94
1999-00P	68.97	141.10	56.76	84.34	13.80
2000-01P	69.22	141.08	54.68	86.40	13.64
2001-02P	69.49	141.38	55.85	85.53	13.35
2002-03P	69.47	132.80	53.13	79.67	13.48

*Source: Compendium of Environmental Statistics, 2006.

State of forest resources

Forests include the areas under the forestry land use category and some areas recorded as forests while not under tree cover, like rocky areas, deserts, mountain ranges, etc. The recorded forests inclusive of these categories extend over 76.962 m ha, 23.41% of the geographical area of the country. The forest cover in the country is 67.70 m ha. which is 20.60% of the geographical area of the country*.

The forests of the country have been grouped into 5 major categories and 16 types according to biophysical criteria. The distribution of these groups indicates 38.20% subtropical dry deciduous, 30.30% tropical moist deciduous, 6.7% subtropical thorn and 5.8% tropical wet evergreen forests. Other categories include subtropical pine (5%), tropical semi-evergreen forests (2.5%) and other smaller categories. Temperate and alpine areas cover about 10% of the forest areas in the Himalayan region. The forest area estimate based on types is given in Table 3.

Table 3. Forest area estimate for major forest types*

Forest type**	Area (sq. km)	% of total	Occurrence in states/UTs
Tropical wet evergreen forest	45000	5.8	Arunachal Pradesh, Assam, Karnataka, Kerala, Mizoram, Manipur, Nagaland, Tamil Nadu, Sikkim, Andaman & Nicobar Islands, Goa
Tropical semi-evergreen forest	19000	2.5	Assam, Karnataka, Kerala, Maharashtra, Nagaland, Orissa, Tamil Nadu, Sikkim, Andaman & Nicobar Islands, Goa
Tropical moist deciduous forest	23300	30.3	Andhra Pradesh, Bihar, Gujarat, Assam, Karnataka, Kerala, Maharashtra, Nagaland, Mizoram, Tripura, Meghalaya, Uttar Pradesh, West Bengal, Orissa, Tamil Nadu, Sikkim, Andaman & Nicobar Islands, Goa
Littoral and swamp forest	7000	0.9	Andhra Pradesh, Gujarat, Maharashtra, Orissa, Tamil Nadu, West Bengal, Andaman & Nicobar Islands
Tropical dry deciduous forest	29400	38.2	Andhra Pradesh, Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Jammu & Kashmir, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh
Tropical thorn forest	52000	6.7	Andhra Pradesh, Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh
Tropical dry evergreen forest	3000	0.3	Himachal Pradesh, Jammu & Kashmir, Andhra Pradesh, Tamil Nadu
Subtropical broad leaved hill forest	3000	0.4	Assam, Meghalaya
Subtropical pine forest	37000	5.0	Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Sikkim, Uttar Pradesh, Haryana, Punjab
Subtropical dry evergreen forests	2000	0.2	Himachal Pradesh, Jammu & Kashmir
Montane wet temperate forests	16000	2.0	Arunachal Pradesh, Karnataka, Manipur, Nagaland, Sikkim, Tamil Nadu
Himalayan moist temperate forests	26000	3.4	Himachal Pradesh, Jammu & Kashmir, Uttarakhand
Himalayan dry temperate forests	2000	0.2	Himachal Pradesh, Jammu & Kashmir
Sub-alpine, moist alpine scrub forests and alpine forests	33000	4.3	Jammu & Kashmir, Himachal Pradesh and Uttarakhand

*Forest Survey of India 1995.
** As per the Seth and Champion Classification of Forest Type of India.

Largest areas bear tropical dry deciduous and tropical moist deciduous types. These have been most important in terms of yield of forest products. Accordingly these habitats have been converted into commercial plantations also for industrial raw material.

From the point of view of forest utilization value, the important forest regions include the central southern region with predominantly teak forests, the eastern region with *Shorea robusta* (sal) dominated forests and the western Himalayan region with coniferous species like pine, cedar, spruce and fir. The northern plains and foothills of the Indian Himalayan region support *Shorea, Dalbergia, Terminalias Gmelina, Albizzias*, etc while the northwestern

arid areas bear *Prosopis* and *Anogeissus* dominated vegetation, interspersed with grassy rangelands. The northeastern region is rich in tropical and subtropical moist forests with much diversity of hardwood and softwood species. Similar composition of forests in the Western Ghats and in the Andaman and Nicobar Islands has been an important source of wood and wood products. Other specific ecologically important regions include sandalwood habitats in the southern dry belt, red sanders in Andhra Pradesh, shola forests in Nilgiris, mangroves in the Sundarbans in West Bengal, rain forests in the Andaman and Nicobar Islands and Himalayan alpines.

Forest and tree cover

The Forest Survey of India (FSI) has been undertaking assessment of forest cover in the country since 1981 on a two-year cycle. For the purpose of assessment of tree cover, the country has been divided into 14 physiographic zones by the FSI. The assessment of tree cover includes digital processing of satellite imageries for blocks of more than 1 ha (called 'forest cover') and a stastistically designed inventory-based assessment of the notional tree cover outside forests (TOF), accounting for trees in patches less than 1 ha. Accordingly, the 2005 assessment reported a total tree cover of 23.41% including a forest cover of 20.60% and the rest being TOF.

The total cover consists of 5.45 m ha (1.66%) in very dense, 33.26 m ha (10.12%) in moderately dense and 28.98 m ha (8.82%) in open canopy categories. In addition, nearly 10 m ha have been assessed (notionally based on ground sampling for the patches not captured by remote sensing) as under tree cover outside the forests, totaling up to 76.92 m ha or 23.39% of the land area of the country.

Table 4. Forest cover assessment by FSI from 1987 to 2005

Year of State Forest Report	Data period	Forest/tree cover (sq. km)	% of geographical area**	Dense forest (%)
1987	1981-83	640,819	19.49	59.06
1989	1985-87	638,804	19.43	60.27
1991	1987-89	639,364	19.45	60.31
1993	1989-91	639,386	19.45	60.30
1995	1991-93	638,879	19.43	60.27
1997	1993-95	633,397	19.27	57.98
1999	1996-98	637,293	19.39	59.21
		2001		
Forest	2000	675,538	20.55	61.70
Tree cover@	2000	81,472	02.48	
Total		**757,010**	**23.03**	
		2003		
Forest	2002	677,816	20.62	57.33***
Tree cover	2002	99,896	4.04	
Total		**777,712**	**23.68**	
		2005		
Forest	2003	677,088	20.60	57.19
Tree cover	2003	81,663	2.79	
Total		**768,751**	**23.39**	

** Geographical area (32,87,263 sq km); @ assessment attempted for the first time.

*** Assessed with higher resolution and two density categories (moderate and very dense).

Growing stock

The growing stock (wood biomass indicating growing capital) of Indian forests/trees is estimated at 6,218.282 million m^3 [4,602.038 million m^3 in forest and 1,616,244 million m^3 outside] i.e. 59.79 m^3/hectare (SFR 2005) with only 0.7 m^3/hectare/year productivity against the world average of 2.1 m^3/hectare/year. This is mainly due to non-recycling of biomass in forest soil, forest fire, grazing, over-exploitation, etc.

The mean annual increment (MAI) of India's forests is assessed to be less than 0.5 m^3/hectare/year as against the world average of about 2 m^3/ha/year. The two most important tropical hardwood species, viz. teak and sal in tropical moist deciduous and dry deciduous forests have very dense and moderately dense forest areas and cover about 60% of the forests. In such areas, the MAI is much higher than the average. An assessment of the increment in the natural forests of India was made by the FSI in 1995 which indicated an annual allowable cut (AAC) of over 87 million m^3. The net annual increment of growing stock from all sources (public and private) was assessed to be 127 million m^3 in 1994 and the actual production was estimated to be 294 million m^3 (FAO, 1997).

Table 5. Forest increment in the natural forests of India (1995)*

State	Increment '000 cubic metres
Arunachal Pradesh	15243
Madhya Pradesh (including Chhattisgarh)	14122
Jammu & Kashmir	6402
Assam	6061
Andhra Pradesh	5929
Uttar Pradesh (including Uttarakhand)	5818
Karnataka	5574
Maharashtra	5008
Orissa	4432
Meghalaya	2150
Kerala	1983
Nagaland	1903
Manipur	1889
Bihar (including Jharkhand)	1715
Himachal Pradesh	1603
Andaman & Nicobar Islands	1494
Gujarat	1459
Tamil Nadu	1394
Mizoram	1332
Sikkim	767
West Bengal	433
Tripura	316
Rajasthan	292
Goa, Daman & Diu	231
Haryana	27
Punjab	23
Dadra & Nagar Haveli	22
Total	*87622*

*Source: Forest Survey of India (1995). *Extent, composition, density, growing stock and annual increment of India's forests.*

The MAI for planted species in agroforestry/farm forestry is much higher than in the natural forests. The main species planted in farm forestry are poplars in north India and eucalyptus in all parts of India. The MAI varies between 10 to 60 m^3/ha/year. The case study of ITC Bhadrachalam is given in Box 1.

Box. 1. Growth and Income from Farm Forestry in Andhra Pradesh

The International Tobacco Company (ITC) which has a paper and pulp mill in Andhra Pradesh (Bhadrachalam, district Khamam) has promoted a partnership with farmers to grow clonal eucalyptus plantations in farmers' fields. Results have shown that the MAI of a clonal plantation of eucalyptus species ranges between 20 and 58 m^3/ha/year and the farmers are able to earn a net profit of INR.50,000 to 150,000 per ha, depending on site quality and management inputs, in the first cutting, 3 years after planting. Profits increase in the subsequent cuttings, since the cost involved in maintaining a coppice crop is lower. Further, since the tree farms are raised under a system of agroforestry, additional income will be earned from the harvest of the agricultural crop.

The forest research unit of the company carries out trials on the genetic improvement of the planting stock and silvicultural/agroforestry practices (e.g. spacing of planting rows, type of inter-crop) to be adopted. The company supplies clonal seedlings for planting to the farmers along with continuing extension services. Further, the company guarantees to buy the pulpwood produced by the farmers at a fixed floor price which is revised periodically.

Currently the tree farms within economic distance from the mill are able to supply only about 40% of the pulpwood required by the mill. It is estimated that the company will be able to source its entire pulpwood requirement from the clonal tree farms in the selected districts of Andhra Pradesh.

The MAI of clonal eucalyptus plantations being raised by Tamil Nadu Forest Development Corporation has been giving a mean annual increment of 20-60 m^3/ha/year. Improved technology of plant propagation in fast growing species provides promising potential for agroforestry.

State of forest management

During the early years of scientific management, forests were managed primarily for wood production under the Working Plans prescribing specific management systems based on the growth rates, regeneration, increment patterns and extent of variability of crops. Appropriate silvicultural systems were taken into account for harvesting, regeneration and growth regulation. Development imperatives after independence resulted in large scale diversion of forests for agriculture and other developmental activities. The postindependence development strategies necessitated expansion of the resource base for industrial development in the country. In the early 1960s, imperatives of industrial development prompted governments to boost investment in large-scale industrial plantations for ensuring supply to wood-based industry. Approximately 5.4 million ha (30% of 18 m ha of plantations till 1990*), of the forest area have been under commercial plantations, diverting natural forests into fast growing pulp, matchwood, plywood and other economically important hardwood species. The diversion of the forests was restricted in 1980. However, plantation activity continued in afforestation and enrichment efforts for degraded forests in India. At present, classical forest management systems have been changed to planting with harvesting followed by replanting. Harvesting in natural forests is largely limited to salvaging of dead/fallen material.

Joint forest management

Consequent to heavy human sustenance pressure on forests coupled with some innovative experiments in society's involvement in forest management, models for participatory forest management have been evolving in India since the 1980s. This has been followed by acceptance of the principles of community participation in the management of natural resources and biodiversity. Accordingly, at present about 22.02 m ha (India's Forests, GOI

2007) of largely natural degraded forests are being managed and rehabilitated under the Participatory/Joint Forest Management (JFM) regimes. Being more social than scientific systems, these regimes are rarely supported by an inventory and an assessment of basic parameters for understanding the dynamics of forests.
JFM is one of the thrust areas of the forestry programme with many expectations. The JFM programme has been envisaged as an effective tool for halting further degradation of forests. Communities in about 170,000 forest fringe villages are at present involved in the JFM programme. By February 2007, there were 99,868 JFMCs covering about 125,000 villages on forest fringes. Forest areas amounting to more than 21.4 m ha are covered by the JFM programme.

Diversion of forestland for non-forestry purposes

During the initial years of the postindependence period, forests were considered as surplus land and large areas were diverted for various development purposes including agriculture. On the recommendations of the National Commission on Agriculture in 1976, increasing productivity and the concept of social forestry emerged as major objectives. The National Forest Policy 1988 brought about a major change in the definition of the term 'use' related to government forests meaning 'economic use subordinated to ecological use'.

In 1996, through a landmark judgement on the diversion of forests by the Apex Court, all matters related to diversion of forests, irrespective of ownership, came within the purview of the government and for any land use change from the forest category, prior concurrence of the central government was made mandatory. Further, the stipulated mandatory provision of compensatory afforestation and payment of net present value has made the diversion process more stringent. The trend of diversion of forestlands since 1980 has declined considerably indicating that large scale reduction of forests is not anticipated in the near future.

Conservation status of forests

Indian forests have been under severe pressure for meeting growing demands for alternative land uses, fuel, fodder, grazing, timber, pulpwood and NWFPs from ever growing human and livestock populations and industrial development and infrastructure needs. Some important facts about our forests in this context are provided below.

- The per capita forest area is only 0.064 ha against the world average of 0.64 ha. (FAO) i.e. only one-tenth of the world average.
- The growing stock of Indian forests/trees is estimated at 6414 million m^3 [4782 in forest and 1632 outside] i.e. 61.72 m^3/ha (SFR-2005) with only 0.7 m^3 /hectare/year productivity against the world average of 2.1 m^3 /hectare/year. This is mainly due to non-recycling of biomass in forest soil, forest fire, grazing, over-exploitation, etc.
- Due to rapid industrial development along with an increase in human population from 390 million (1950) to 1 billion in 2001 and domestic animals from 350 million to 520 million, the demand–supply gap for construction and industrial timber, fodder and NWFPs is rapidly increasing leading to over-harvesting and degradation of ecosystems.
- Vast stretches of forest are still diverted for a variety of developmental and infrastructural projects.
- In spite of the recognition of the significance of fulfilling the needs of local communities in the Forest Policy, there are inadequate institutional arrangements to involve them positively in forest conservation and management. As much as 78% of the forest area is subjected to heavy grazing and other unregulated uses, adversely effecting productivity and regeneration. Similarly, nearly 10 m ha of forest area are under shifting cultivation; once a sustainable rotational agroforestry system, it has run into difficulties with population increase and penetration of market forces.

- Land use changes including diversion of community areas for fuel, fodder, etc for non-primary production purposes have redirected nearly all non-farm needs towards forests.

Forestry and livelihoods

Forests and forest produce have been recognized as multipurpose resources with the potential of providing livelihoods to a substantial part of the population. Constitutional provisions empower the local panchayats with rights over NWFPs. The strategy for forest management focuses on empowerment of community institutions in management and deriving livelihoods from forests. The Government of India has promulgated a law recognizing the rights of forest dwellers in forestlands wherein ownership rights are documented and the rights of communities are recognized for common use of forests for their livelihood practices conforming to the principles of sustainability of forests. These provisions are considered to be enhancing the stake of the forest dwellers and fringe populations in the development of forests. The effect of this new law will be clear after a few years.

Similarly, with the realization that the existing forest areas alone cannot cater to all the livelihood needs of the country, sizeable areas of non-forest lands used earlier by rural communities for their daily needs as common property resources need to be revived and regenerated. The Constitution of India puts the responsibility of social forestry on local panchayats. The revival and management of such village common lands are being considered as a promising way for sustainable management of natural resources. Assuming that about 20% of the present forest and tree cover of the country, i.e. 14 m ha, is covered under this category, it can be extended to bring an extent of about 20 m ha under forestland use by 2020.

Expansion of plantation programmes

Since 1980s, the Government of India has promoted plantations under different agroforestry and social forestry plantation schemes as well as investment in industrial plantations. The plantation area in India is 32.57 m ha, which accounts for 17 % of the global forest plantation and is the second largest in the world after China. It also has the largest share in the global plantation of teak (44%). The most prominent plantation species are eucalyptus, poplars, acacias, silver oak and rubber wood. It is estimated that 1.5 million m^3 of rubber wood are available in India and by 2020 the annual output of rubber wood will reach 14 million m^3 of usable logs. Several projects are underway in different research institutes of the country to overcome the processing problem of the species and to develop a cheap technology suitable for India.

Policy and legal framework

The formal Forest Policy and legal framework for protection, conservation and management of forests have been in effect since 1894 and 1865 respectively. Early forest policies tended to consider timber production as the primary function of the forest. In today's context, a multiplicity of interests competes for forest outputs and correspondingly forest policies have become increasingly complex. The Forest Policy 1952 recognized the protective role of forests and discarded the notion that forestry has no intrinsic right to land. It stipulated that the country should aim at having at least one third of its total land area under forests. Wildlife conservation became prominent in 1972 with the promulgation of the Wildlife (Protection) Act. The legal regime for protection of forests is mainly limited to the Indian Forest Act 1927.

Most of the states in the country have promulgated separate legislations to meet the specificities of the respective states. The Constitution of India assigns fundamental duties to the citizens of the country and directs States for conservation and protection of forest, wildlife and the environment. The country shifted forest from the state list to the concurrent list in the Constitution of India due to emerging ecological needs in the mid-1970s. India has shown

political commitment for the conservation of forests with the initiative to enact the Forest (Conservation) Act 1980. It is regulatory Act and maintains balance between development and conservation. It was a milestone step in the direction of forest conservation in the country.

India had taken a revolutionary shift in forest management from a regulatory to a participatory approach with the promulgation of the National Forest Policy 1988. This Forest Policy came four years before the Earth Summit which embodies all elements of SFM and India's forests are treated as social and environmental resources. Ecological security became the prime objective and focus was given for providing livelihoods for forest dependent communities. India initiated the implementation of this policy in a major way to involve local communities in the conservation, protection and management of forests through JFM institutions in 1990 and expanded this programme to more than 22 million hectares of forests with the involvement of approximately 21 million people. India has shown sensitivity towards the recognition of tenurial rights of the tribals on forestland with the issuance of guidelines to state governments in 1990. The Environment Protection Act was enacted in 1986 for improving the environment of the country. India has shown remarkable progress during the last 15 years for enhancing the contribution of forests towards poverty alleviation through empowering people with the ownership of NWFPs. India has provided a legal regime for biodiversity conservation with the promulgation of national level legislation i.e. The Biological Diversity Act 2002. Another milestone was achieved in 2006 with the enactment of a national level legislation for assigning habitation and occupation rights on forests along with the responsibility for conservation of biological resources and maintenance of the ecological balance to communities. Fine tuning of the Indian Forest Act 1927, the State Forest Acts and the Wildlife Protection Act is needed in future.

Forests in India are treated primarily as social and environmental resource and only secondarily as commercial resources. The country largely depends upon the forest for its requirement of wood and wood products from private lands. We are making relevant policy interventions to provide an enabling environment for the private sector to grow more trees. The policy and legal regime has been reviewed by an independent body, i.e. the National Forest Commission which submitted its report in 2006. The view of the National Forest Commission is to continue with the National Forest Policy 1988.The forestry sector is impacted directly by the policies of other sectors such as agriculture, rural development, *panchayti raj*, education, energy, and water resources and indirectly by the policies of petroleum, chemical and fertilizers, and industry and commerce. India needs a separate grazing policy and also to facilitate natural regeneration in forests.

India is looking for certain policy interventions to motivate people to grow more trees in future and also thinking about establish a mechanism to involve the private sector in investing financial resources in degraded forests. Our mandate is to achieve 33% forest and tree cover in the country and also to contribute towards achieving global objectives for the sustainable development of all types of forests. The policy and legal regime in the forestry sector will focus on poverty alleviation through forestry, increasing productivity, enabling the private sector to grow more trees, ecological security, empowerment of communities along with their capacity building and biodiversity conservation in 2020.

The Forest Policy of 1952 was among the notable initiatives taken by the Government in postindependent India. It enunciated a target of maintaining one third of the total land area under forests. In 1976, The National Commission on Agriculture fully acknowledged the role to be played by forestry in the development of the country and recommended large scale plantations on degraded forest areas and social forestry in community and private lands to reduce the growing gap in timber and firewood requirements. It also suggested the formation of Forest Corporations to raise plantations in degraded forestlands. This led to the initiation of large scale social forestry projects from 1980 onwards with international assistance and as part of the rural development programme since the 7th Five Year Plan.

The National Forest Policy 1988 acknowledges the primacy of the requirements of local communities, and advocates a sustainable management approach with maintenance of environmental stability, restoration of ecological balance, and soil and water conservation as the prime objectives of forest management. The conservation of natural heritage and genetic resources is highlighted with indicator targets of maintaining forest/tree cover (33% of the landmass and 66% in hills). The social concerns are addressed through increasing productivity of forests to meet local needs first, and creating a massive people's movement for afforestation to reduce pressure on existing forests. Industries have been specifically advised to network with farmers for the production of industrial raw material instead of depending on subsidized supply from government forests. The economic benefits of forests have been subordinated to the principal aim of environmental stability.

The National Afforestation and Eco-development Board (NAEB) has the mandate to regenerate degraded forests in the country with the active involvement of the public and stakeholders. The National Wasteland Development Board (NWDB) focuses on improving land capabilities.

The subject 'Forest' has been in the concurrent list of the Indian Constitution since 1976. The Forest (Conservation) Act 1980 (amended in 1988, 2003) empowers the central Government (Ministry of Environment and Forests) to guide states in matters related to the diversion of forestland for non-forestry purposes, conversion of natural forests into plantations and even priorities of forest management in line with the National Forest Policy.

The forest laws in India provide for declaration of forests under government management in categories like reserve and protected forests. Other categories include community, local common and private forests, aggregating into unclassed forests. The legal categories of lands indicate the intensity of regulation on the use of these lands as forests. Forests have traditionally been the habitats of tribal communities with a variety of lifestyles ranging from nomads, hunters, wild food gatherers to agrarians. The traditional lifestyles of tribes and their recorded rights have been respected and embedded in forest management practices as well as in subsequent policies. A law was enacted in 2006 recognizing the rights of occupation of forests by tribes and forest dwellers and empowering them for the management of forests (used by them) as common property resources. It is estimated that about 20% of the government controlled and managed forestland will come under the occupational titles recognized under this law. The recognition of the right of common use conforms to the policy prescription of participatory forest management and also accepted principles of biodiversity conservation as well as community involvement in conservation.
Within the ambit of the national policy and legislation, states can promulgate legal instruments and undertake suitable measures to facilitate smooth functioning of the sector. A number of state laws have been passed to regulate forest resource use, including timber and NWFPs.

Box 2. The Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

This is an Act to recognize and vest the forest rights and occupation of forestland in forest dwelling Scheduled Tribes and other traditional forest dwellers to provide for a frame work for recording the forest rights so vested and the nature of evidence required for such recognition and vesting in respect of forestland.

Whereas the recognized rights of the forest dwelling Scheduled Tribes and other traditional forest dwellers include the responsibilities and authority for sustainable use, conservation of biodiversity and maintenance of ecological balance, thereby strengthening the conservation regime of the forests while ensuring livelihood and food security of the forest dwelling Scheduled Tribes and other traditional forest dwellers.

And whereas the forest rights on ancestral lands and their habitat were not adequately recognized in the consolidation of State forest during the colonial period as well as in independent India resulting in historical injustice to the forest dwelling Scheduled Tribes and other traditional forest dwellers who are integral to the very survival and sustainability of the forest ecosystem.

And whereas it has become necessary to address the long standing insecurity of tenurial and occupational rights of forest dwelling Scheduled Tribes and other traditional forest dwellers including those who were forced to relocate their dwelling due to State development interventions.

Biodiversity conservation

The important milestones in independent India on wildlife conservation include provision in the National Forest Policy 1952 for the setting up of sanctuaries and national parks for the preservation of wildlife, enactment of the Wild Life (Protection) Act 1972, launching of Project Tiger in 1973, Project Elephant in 1992 and the Biological Diversity Act 2002. The National Forest Policy 1988 has conservation as its basic objective: "Conserving the natural heritage of the country by preserving the remaining natural forest with vast variety of flora & fauna, which represents the remarkable biological diversity and genetic resources of the country".

Forest and wildlife are inseparable. We have set apart around 4.8 percent of the geographical area of the country for the exclusive conservation of its biodiversity in the form of Protected Areas. Currently the 659 Protected Areas include 100 National Parks, 514 Sanctuaries, 41 Conservation Reserves and 4 Community Reserves. We are also aware that tiger conservation has become a symbol of the status of wildlife conservation in the country and also represents the conservation of whole ecosystems. However, Tiger Reserves and Protected Areas are faced with multifarious challenges these days. Habitat fragmentation, conflicting land uses, presence of heavily used infrastructure and biotic interference are some of them. The All India Tiger Estimation figures using refined methodology is in the public domain. The assessment, for the first time depicts the status of tiger habitat, co-predators and prey across tiger landscapes. The status of tigers has not shown a significant change in the core tiger habitats of Tiger Reserves and Protected Areas; their status in other forest areas is not satisfactory. The approximate figure of tigers in the country is 1411 and may vary between 1165 and 1657 (Wild Life Institute of India 2008). This calls for mainstreaming tiger concerns in the landscape around core areas.

The Wildlife (Protection) Act 1972 provides a basis for conservation forestry with the constitution of a series of National Parks and Wildlife Sanctuaries. These areas, mostly the game reserves of the erstwhile rulers and subsequently the catchments of dams and reservoirs, have become showcases of Indian biodiversity. A network of 659 such protected areas is

spread over the country, covering about 16 million ha of forests. These conservation areas cover all the legal categories of forests and are managed for the conservation of biodiversity with generally flagship animal species as the focus.

The National Board for Wildlife, chaired by the Prime Minister of India, is the apex body to consider wildlife and biodiversity conservation issues at the national level. Establishment of the Directorate of Wild Life Preservation, the ban on Indian ivory and India's membership of CITES indicate national initiatives towards protection of wildlife. On the research and development front, setting up of the Wild Life Institute of India, Central Zoo Authority and now Tiger Conservation Authority and National Wild Life Crime Control Bureau show the increasing national resolve to support the responsibility of states for conservation.

The participatory approach has also been attempted in wildlife management. The India Eco-development Project was implemented during 1995-2005 under GEF sponsorship. The main focus of the programme was village eco-development through the sustainable development of village resources and involvement of local people in the conservation of protected areas. The results have been encouraging at some sites and participation and benefit-sharing are now a recognized aspect of PA management. However, the adoption of this approach as an integral part of PA management is yet to be realized.

Wood and wood products

Viability of forest management for wood production

The plantation activities undertaken (32.6 million ha) after independence are impressive. Forest plantations being a major investment activity, the low level of productivity is a cause of concern. About 50% of the plantations raised since 1980 are in agroforestry systems with varying intensities of management. The National Forest Policy 1988 envisaged that forest industries should meet their raw material requirement from wood grown in collaboration with farmers and local communities. In accordance with the stipulation in the NFP, 1988, subsidies on supply of raw material from government forests to forest-based industries will gradually cease. Several industrial enterprises (particularly the pulp and paper companies) have been working with farmers to encourage farm forestry activities with their active technical and financial assistance. The following approaches are commonly pursued:

- Supply of free or subsidized quality planting stock with or without buy back guarantee
- Bank loan assistance and providing planting stock, technical extension and buy back guarantee
- Leasing or share cropping schemes under which the company raises and maintains plantations on farmers' lands based on appropriate arrangements
- Intensive research and development and commercial sale of clonal planting stock to farmers by companies with or without buy back guarantee

These initiatives have popularized the concept of tree farming and have contributed to the cultivation of commercial trees on private lands. This has also provided farmers with an alternative/complementary source of land use for improving their farm income particularly in the event of crop failure.

Current level of production of wood and wood products

India, an ITTO producer member country, is one of the major consumers of wood in the Asia Pacific region although the country domestically produces several tropical hardwood species. The indigenous production was sufficient to meet most of the domestic timber demand till the

1980s. However, with the enactment of the Forest Conservation Act 1980 and subsequently the formulation of the National Forest Policy 1988 there has been more emphasis on conservation than timber production.

Production from natural forests has shown a declining trend due to continuing forest degradation. Sampling in some of the reserved forests (RF) revealed that 82% had dense forests while the forests were degraded in the remaining 18% and had open crops where production was minimal (SFR, 2003). In protected forests (PF) the percentage of open forest was more than 60% which meant that harvesting in these areas was not feasible. Some good forest areas were also included in wildlife areas further affecting their productivity. The conditions of plantations after 1980 have also not brought the best of results mainly due to lack of proper protection, cleaning and thinning at the desired stage. Thus, production from plantations was not commensurate with the area under plantation.

In order to arrest deforestation and environmental deterioration most of the state forest departments have completely or partially banned logging in natural forests over the past 20 to 25 years. Madhya Pradesh is a case in point where 16 districts/forest divisions completely banned logging with the view that these areas would ultimately recoup.

Wood production

At present, logging operations in natural forests have been minimized and the resulting wood scarcity has provided an impetus for the development of farm forestry, homestead forestry and agroforestry particularly in north and south India. Currently, about 50% of the wood supply in the country comes from non-forest sources, that is, outside government forests. The rest of the industrial wood consumption is accounted for partly by imports and supply from public forests, mainly plantations.

India's round wood production in 2006 was estimated to be about 240 million m^3, of which 75% is the estimated share of fuelwood and 15-20 million m^3 industrial round wood, including poles and small lumber for rural households (NFC Report 2006, p 261). Supply from natural forests (including temperate hardwood and softwood species) is about 12 million m^3 (about half coming from tropical forest areas). The estimated share of industrial round wood for industry coming from farm forestry and other trees outside forests is 31 million m^3. Official imports of timber accounted for just over 3 million m^3 in 2006, mostly in the form of logs. Hence, there is a gap between consumption and supply of timber of about 25 million m^3 (conservatively estimated). It is assumed that a considerable part of this gap is being filled from unregistered sources, such as from home gardens and small timber logs and poles. Recycling and use of modern technologies for structural use of small wood and waste wood are also important contributors. There are varying estimates of production as well as consumption of forest products, particularly timber and processed wood.

In wood production, the concept of annual allowable cut (AAC) has often been given low consideration. India's AAC, based on the net annual increment of growing stock from all sources (public and private) was only 127 million m^3 in 1994, but actual production was estimated to be 294 million m^3. According to FAO (1997), estimated removals were about 50% above net increment. Over-cutting is, however, more serious than these figures imply, considering that nearly 40% of the net annual increment in the region is in young forest plantations and that the proportion of total production from plantations is comparatively low. The failure to use less commercially desirable species and sizes, led to damage to residual trees, inadequate protection and maintenance. The state forest departments (SFDs) admit seizure of 10-20% of the illegally harvested timber. However, even the routine seizure of illegal logs in the country is guesstimated to be about 200,000 m^3. This figure needs to be multiplied by a factor of 10 to get a reasonable account of unrecorded removal.

The Government of India as a major policy initiative has permitted import of wood under the Open General License since 1996 with a view to easing the wood shortage and also to reduce pressure on natural forests

The data on wood production, import and export in ITTO producer member countries of the Asia Pacific region between 1990 and 2000 are given in Table 6.

Table 6. Wood statistics of ITTO producer member countries in the Asia-Pacific region, 1990-2000

Round wood production (000 m^3)

a)	1990	273,687
b)	2000	319,498

Industrial round wood production (000 m^3)

a)	1990	24,406
b)	2000	22,188

Processed products 2000

a)	Sawn wood	7,900
b)	Panel products	421
c)	Wood pulp	1,590

Export 2000

a)	Round wood	-
b)	Sawn wood	6
c)	Panel products	14
d)	Wood pulp`	16

Import 2000

a)	Round wood	2,100
b)	Sawn wood	9
c)	Panel products	86
d)	Wood pulp	166

Most of the production estimates of timber products (round wood logs, sawn wood, veneer and plywood) are generally based on *FAO Year Book of Forest Products 2003* and *ITTO Annual Review and Assessment of World Timber Situation, 2004/05*. Some of the data pertaining to 2001-2005 are given in Tables 7, 8 and 9.

Table 7. Production of timber products ('000 m^3)

Item/year	2001	2002	2003	2004	2005
Round wood/logs	13500	13500	13500	13500	13500
Sawn wood	6800	6000	6000	6000	6000
Veneer	55	235	246	258	258
Plywood	1300	1600	1760	1936	1936

Table 8. Consumption of timber products ('000 m^3)

Item/year	2001	2002	2003	2004*	2005*
Round wood/logs	15914	15051	16293	16535	16535
Sawn wood	6806	6007	6010	5984	5984
Veneer	56	238	249	257	257
Plywood	1253	1551	1704	1911	1911

Table 9. Import of timber products ('000 m^3)

Item/year	2001	2002	2003	2004	2005
Round wood/logs	2421	1561	2798	3036	3036
Sawn wood	7	7	10	11	11
Veneer	2	4	4	6	6
Plywood	17	10	4	9	9

Source: FAO Year Book 2003, ITTO Annual Review and Assessment of World Timber Situation, 2004/05.

Based on the figures given in Tables 9 to 11, an estimate for 2005-2006 is provided in Table 10 (Bhat, 2004).

Table 10. Estimated production, consumption and trade of timber products, 2005-2006

Items	Volume (million m^3)				Value (million US$)	
	Production	Consumption	Imports	Exports	Imports	Exports
Round wood/logs	52.041	56.690	4.689	0.0040	937.8	0.80
Sawn wood	32.961	33.180	0.221	0.0020	55.0	0.70.
Veneer	2.340	2.380	0.068	0.0280	7.5	6.22
Plywood	0.499	0.500	0.003	0.0019	1.8	5.20

The requirement for wood and wood products is bound to witness an unprecedented upward trend due to various economic and policy initiatives recently taken in India. In the education sector the allocation has been hiked from 2% to 6% of the GDP. For this purpose there is going to be a major demand for paper and pulp. The gap between present availability and future demand cannot be met entirely from import. Some new large units will be required to be established apart from enhancing the installed capacity of the existing mills. Since the raw material is not likely to come from natural forests, agroforestry and farm forestry sources are bound to get greater emphasis. The development of the farm sector will have the advantage of recent agricultural policy which emphasizes intensification of agriculture so as to ensure annual growth presently hovering at about 2% to 4%. This would mean more inputs in the form of irrigation, watershed management, improved variety of seeds, organic farming, etc. Agroforestry and farm forestry to supplement the income of the farmers have been identified as the main strategy for achieving the growth in agriculture. The prospective paper and pulp mills and other forest-based industries can develop partnership with farmers to grow timber species presently practiced by the ITC in Andhra Pradesh.

All panels other than plywood barely account for 10% of the total production and the remaining 90% comprises plywood and block board. There are about 62 large and medium size plywood mills and over 2,500 SSI units which mostly operate based on plantation wood like poplar and eucalyptus grown by farmers under agroforestry systems. Technological advances allow more efficient use of raw material for better quality of products. Development of panels of bamboo composites from the mats of woven bamboo slivers is a significant development. Medium density fibreboard (MDF) has a variety of end uses and can replace tropical hardwood timbers for most of the uses. Despite the technological advances relating to efficient use of wood, reduction of wastage, diversity of raw materials and recycling, the gap between demand and supply is widening. Projected demand for panel wood by 2020 as given in table 5.4 of "Forests and Wildlife Statistics, INDIA 2004" is reproduced below (Table 11).

Table 11. Projected demand of panel wood (in million m^3)

Plywood	Veneer	Particle board	MDF board	Total
29.20	0.70	0.35	0.28	30.53

The development of infrastructure and housing will also require substantial wood and wood products. According to the housing policy for the 11th Five Year Plan (2007-2012) there is a backlog of over 22 million housing units. Similarly 26 million housing units are additionally to be constructed during this plan period. It is not possible to achieve this target in the next 5 years; as a result at least 50% spillover will go to the 12th Plan and beyond. It is presumed that each housing unit will require on average 2 m^3 of timber for construction and furniture (presuming that doors and windows will be partly timber and partly steel or aluminum). This would mean about 50 million m^3 of additional timber in the next 5 years or so. Since natural forests and existing plantations are not going to meet any additional demand, the bulk of the supply will have to come from non-forest sources. This may trigger private participation in sustainable forestry.

Wood and wood products for meeting energy requirements are going to be stable in view of the fact that the urban poor are gradually switching to non-wood sources (LPG, kerosene and solar appliances). A number of programmes on women's health in rural areas are in vogue. Many other programmes may evolve in view of the greater emphasis on their health problems connected with the smoke-related problems of burning fuels. Improved smokeless stoves, solar appliances and even LPG in areas close to urban areas may reduce the pressure on forests for fuelwood. There is a continuous rural migration to urban cities. As such, the rural population is not likely to grow unproportionally. Moreover, the rural population has a number of other alternatives for cooking food. In coming years, with the construction of express highways and other roads, road side restaurants (*dhabas)* are also likely to start using LPG and their dependence on fuelwood may decline. With the aforementioned developments the current level of consumption of wood as fuel will more or less stabilize or marginally diminish in the coming decade.

Forest industries

Despite good economic linkages, flexibility (for capital, technology, etc) and diversity of forest resources, forest-based timber processing industries are generally handicapped due to inefficient operations, legal restrictions, low output, non-availability of skilled labour and resultant inertia.

In terms of wood (and increasingly bamboo) utilisation in India, there are some 23,000 sawmills of varying capacities (mostly small and unsophisticated technically). Of these, 950 units are manufacturing wood-based panel products and veneer sheets; 380 units are producing pulp, paper and paperboards; 5 units safety matches (with an unknown number of cottage scale units); plus many units involved in downstream processing and recovery and further processing of residues. Seventy to 90% of the plants are in small-scale sectors. Most of the production units are short of investment capital, hire un-organized and legally unprotected labour, use outdated machinery and are characterized by poor management and technical skills. In sawmills, for example, only 3% of products generated meet Indian grading standards. Processing technologies in small-scale sectors are generally inefficient and cause a high amount of wastage.

Information on wood-based industries and secondary forest-based industries as gathered by the Central Statistical Organization (CSO, Kolkata, 2002) is given in Tables 12 and 13.

Table 12. Wood-based units at a glance

Description/year	2000-2001	2001-2002
Number of factories	3227	3161
Factories in operation	2823	2821
Fixed capital (in million INR)	830,940	84,823
Total output (in million INR)	2,234,060	34,337
Materials consumed (in million INR)	1,445,000	2,006,550
Net value added (in million INR)	297,900	351,400
Income (in million INR)	194,490	237,410
Profit (in million INR)	26,590	26,910

Source: CSO Kolkata, 2002.

Table 13. Secondary forest industries in India

Sub-sector	No. of production units	Capacity share of small scale plants (% of production)
Pulp and paper, paper board	406	66
Wood-based panel	506	80-90
Saw mills	23,000	82
Matches	12,000	82
Doors wood working plants	98	95

Source: CSO Kolkata, 2002.

Timber trade

India is a net importer of forest products. In 2001, the largest share of forest product import was for logs, followed by paper and paperboard and recovered paper. The total recorded value of imports of primary forest-based products in 2001 was US$942 million, compared to US$94 million for exports of those products. On a value base, the import of logs made up about 42% of the total forest product import bill, while the officially recorded volume was only about 2.1 million m^3 in 2004. Ninety-five percent of all wood imports to India are logs, mainly from tropical countries. The main supply countries for tropical logs are Myanmar, Indonesia, Malaysia and several African and South American countries. Log imports are supported by a favourable tariff regime of 5%, compared with 25% for imported sawn wood,

Fuelwood production and trade

Fuelwood accounts for about 50% of the total fuel consumption in rural India (FSI, 2002). It is the mainstay of India's rural population for cooking food and for other household and non-agricultural work such as rural crafts. Annual consumption ranges between 250-300 million m^3. Of this, only about 17 million m^3 of fuelwood are recorded to come from India's forest, leaving a staggering gap of more than 90% of the total consumption. Part of the gap is absorbed by production from forests and trees outside forests but much of it is collected in an unorganized way from the forests. This is an important factor impacting growing stock and ecological imbalances.

Based on per capita fuelwood consumption, the FSI has estimated the annual consumption of fuelwood in rural areas in the vicinity of forests and non-forest areas at 78 million tonnes and 74 million tonnes respectively. Average per capita consumption was 424 kg and 144 kg respectively.

Fuelwood collection ("head loading") from forests is traditionally uncontrolled and unmonitored. About 75% of all forest production is said to be fuelwood, mostly collected from natural forests. Most of the 225 million m^3 of fuelwood is consumed domestically by the

forest-dependent poor including tribals. The sale of fuelwood is also a major source of income. About 30 million m^3 of fuelwood are used for industrial purposes, including charcoal.

Trees outside forests (TOF)

Social forestry was initiated in 1980s to assist rural communities and landless people to meet their livelihood needs for fodder, fuelwood, small timber, fruits, and minor forest produce through community planned and managed nurseries and tree plantations in common lands and non-forest public lands. Social forestry was recognized as a component of 'community development' programmes. However, the focus on this aspect withered with increasing global attention on biodiversity conservation within forests. The revival of social forestry with stronger linkage with communities for better livelihood opportunities is being considered in view of the recognition of the linkage of life support with conservation.

The FSI has made a comprehensive assessment of TOF in rural and urban areas of Punjab using remote sensing techniques followed by a field inventory. TOF provide a viable diversification option and help in making farm management practices competitive, which is desirable in the present era of globalization. TOF also help in achieving ecological security by improving soil and water conservation.

Non-wood forest products

Non-wood forest products (NWFPs) in India play an important role in the social and traditional life of millions of forest dependent populations, particularly the tribal and landless people, women and other rural poor. Today, they contribute over 75% of total forest export revenue in India. Nearly 400 million people living in and around forests in India depend on NWFPs for sustenance and supplemental income. NWFPs contribute significantly to the income of about 30% of rural people. More than 80% of forest dwellers depend on NWFPs for basic necessities. The collection of NWFPs comprises the main source of wage labour for 17% of landless labourers, and 39% more are involved in NWFP collection as a subsidiary occupation.

Traditionally, the collection of NWFPs has been a low intensity activity and generally sustainable. However, as their economic potential has improved, the intensity of collection has increased and better infrastructure for trade and processing has developed. For example, many pharmaceutical enterprises have emerged to meet the market demand for medicines. They pose a threat to many medicinal plants through demand-based overexploitation. This has raised concern about the sustainability of NWFP resources and the equitable distribution of the benefits derived from them. For addressing these concerns and improving the resource base outside forests by promoting cultivation of medicinal plants and germ plasm, the National Medicinal Plants Board was established in 2002. The Board is also expected to develop standards because various plants are used in traditional Ayurvedic medicines and are in the export trade especially to the Middle East and Europe.

In most cases, trading of nationalized NWFPs is controlled through autonomous state-supported institutions such as State Forest Development Corporations and federations of cooperatives and tribal societies.

The production and trade in NWFPs has received attention in successive forest policy statements. The Constitution provides for ownership of NWFPs to Gram sabhas/panchayats (village assemblies) in states with sizable tribal populations.

States in India have different systems for management and trade of NWFPs. The State Minor Forest Produce (Trade and Development) Co-operative Federation Ltd in Madhya Pradesh organises collection of minor forest products through cooperatives and organises good trade

practices for optimising the wages and benefits, eventually ploughing back the benefits to the communities and ensuring that the resources are sustainably managed.

The role of forestry in rural livelihood is indicated by a few studies like Vedeld et al. (2004), who observed that forest products contribute between 20-40% of the total income of households in forest areas. Other estimates in Indian conditions indicate a range between 10-54% (Bhattacharya and Hayat, 2004; Prasad, 2006). There are varying estimates (100 million to 500 million persons) of dependence of communities on NWFPs for cash income and self-consumption (Prasad and Bhatnagar, 1990; Shiva 1993; Saxena, 1999; Bhattacharya and Hayat, 2004).

For the successful implementation of JFM, flow of benefits through production of NWFPs offers the best incentives to the participating communities on a sustained basis. In order to sustain the interest of the participating communities in forest conservation, sustainable NWFP management therefore assumes a key role. However, current NWFP management practices need reforms in order to make them ecologically and socially sustainable.

Among the NWFPs, tendu leaves (leaves of *Diospyros melanoxylon)* used as wrappers for making *bidies* (country cigarettes) are the most important. The cottage industry supports about 10 million people.
Other important NWFPs include seeds of sal (*Shorea robusta)*, Indian gooseberry, amla (*Emblica officinalis),* myrobelan fruits of *Terminalia bellirica* Roxb (baheda) and *T. chebula* (Harra); kernels and seeds of *Buchanania lanzans*; roots like *Asparagus racemosus* (satavar) and *Chlorophytum borivilliana*; gums of *Boswellia serrata* and *Sterculia urens*; flowers and seeds of *Madhuca longifolia,* Taxus, *Agalochha* sp., *Celastrus paniculata, Andrographis paniculata,* and *Helicteres isora*. These are only some of the most prominent NWFPs being traded. In addition, there are a number of other NWFPs specific to a particular ecosystem that are traded.

With the growing preference for use of natural products the market demand for different NWFPs is growing as is evident in Table 14.

Table 14. Growing demand in trade

Species	Demand (in tonnes)		Annual growth rate (%)
	2001-02	2004-05	
Amla (*Emblica officinalis Gaertn)*	22,729.5	41,782.9	22.5
Ashok (*Saraca asoka (Roxb.)De Wilde*)	7,051.3	10,724.2	15.0
Ashwagandha (*Withania somanifera (Linn) Dunal*)	7,028.7	9,127.5	9.1
Atis (*Aconitum heterophyllum Wall. ex Royle)*	270.1	448.4	18.4
Bael (*Aegle marmelos (Linn) Corr)*	5,381.2	7,084.5	9.6
Bhumi amlaki *(Phyllanthus amorus Schum &Thonn)*	2,212.6	2,985.3	10.5
Brahmi (*Bacopa monniteri (L) Pennel*)	3,822.5	6,621.8	20.1
Chandan (*Santalum album Linn*)	635.2	1,073.1	19.1
Chirata (*Swertia chirata Buch-Ham*	965.2	1,284.7	10.0
Daru haridra (*Berberis aristata DC)*	1,187.3	1,829.4	15.5
Giloe (*Tinospora cordifolia Miers*)	2,258.3	2,932.6	9.1
Gudmar (*Gymnenia sylvestre R Br)*	N.A.	N.A.	N.A.
Guggal (*Commiphora wightii (Am.) Bhandari)*	1,505.0	2,548.9	19.2
Isabgol (*Plantago avata Forsk*)	N.A.	N.A.	N.A.
Jatamansi (*Nardostachys jatamansi DC*)	674.9	866.8	8.7
Kalihari (*Gloriosa superba Linn*)	65.4	100.5	15.4
Kalmegh (*Andrographis paniculata Wall ex Nees)*	2,005.0	2,197.3	3.1
Kesar (*Crocus sativus Linn*)	N.A.	N.A.	N.A.
Kokum (*Garcinic indica Chois*)	N.A.	N.A.	N.A.
Kuth (*Saussurea costus C B Clarke (S.lappa*)	1,414.1	1,826.3	8.9
Kutki (*Picrorhiza kurroa Benth ex Royle*)	220.3	317.0	12.9
Makoy (*Solanum nigrum Linn*)	2,077.9	2,192.2	1.8
Mulethi (*Glycyrrhi glabra Linn*)	873.4	1,359.8	15.9
Patharchur *(Coleus barbatus Benth/ C vettiveroides Jacob*)	37.8	60.8	17.2
Pippali *(Piper longum Linn*)	3,992.5	6,280.4	16.3
Safed Musali (*Chlorophylum borivillianumum Sant*)	N.A.	N.A.	N.A.
Sarpgandha (*Rawollfia serpentinaBenth ex Kurz*)	423.6	588.7	11.6
Senna (*Cassia Augustifolia Vahl)*	6,462.5	11,677.3	21.8
Shatavari (*Asparagus racemosus Willd.)*	10,924.7	16,658.5	15.1
Tulsi (*Ocimum sanctum Linn*)	3,296.8	5,402.9	17.9
Vatsnabh (*Aconitum ferox Wall)*	322.3	3,426.8	30.0
Viavidang (*Embelica ribes Burm f.)*	N.A.	N.A.	N.A.

Source*:* National Medicinal Plant Board, New Delhi.

Service functions of forests

In addition to widespread tangible benefits such as timber, fuelwood, pulpwood, fodder and fibre grasses, and non-wood forest produce, forests also provide intangible services such as watershed benefits at the local level, ecotourism, biodiversity conservation at the national level and carbon sequestration at the global level. The major services include:

- Consumptive direct-use value, e.g., timber, fuelwood, fodder and fibre grasses, and a wide range of non-wood products derived from plants and animals.

- Option values, e.g., a natural habitat for biodiversity and a repository of genetic wealth.
- Non-consumptive direct-use values, e.g., recreation and ecotourism.
- Local indirect-use values, e.g., carbon sequestration.

Economic valuation of forests in the Indian context

A few attempts have been made in India recently to estimate the economic value of the intangible benefits of forests. The following annual values indicate general observations on selected benefits on a unit area basis.

Table 15. Annual values of selected benefits of forests in India

Economic benefit	Nature of benefit	Value of annual flow of goods and services per hectare (INR.)	
		Minimum	Maximum
Timber	Tangible	2701	9,270
NWFPs	Tangible	538	2,957
Ecological functions (watershed)	Intangible	624	200,000
Ecotourism	Intangible	676	20,444
Carbon store	Intangible	20,125	1,200,000

Source: Manoharan, 2000.

Forest institutions

There are forestry-trained human resources at the union and state levels with defined functions and responsibilities. While at the Government level, the role of the MoEF is mostly for providing policy, strategy and legislations, at the state level the state forest departments (SFDs) play the main role as custodians of public forest resource, carrying out normative, regulatory, silvicultural and protection functions. Often they also perform an enterprise function, by being involved in forest production, processing and trade. Most of the states in India have set up forest development corporations (FDCs), to be responsible for the production activities of the public forest estate. These corporations are meant to operate as autonomous business entities.

There are specialized institutions directly linked to the MoEF. These include the network of institutions under the Indian Council of Forestry Research and Education (ICFRE) Dehradun; the Indian Institute of Forest Management, Bhopal (IIFM); the Indira Gandhi National Forest Academy, Dehradun; the Wild Life Institute of India, Dehradun; and the FRI University and Forest Survey of India, Dehradun. The major institutions carrying out forestry research in India (ICFRE, the Forest Research Institutes or Research Divisions of SFDs) are core-funded by the Government.

Funding of forestry

Funding in forestry has been a problematic area in most developing countries, and India is no exception. The main reason for low allocation to the sector is the fact that forestry has neither gained the importance it deserves nor does it attract political commitment. Financial resources are limited in the country. There is competing demand from sectors such as Power, Transport, Health Care, Rural Development etc. Undervaluation of the contribution of forests to the GDP, which is presently estimated as 1.2%, is another reason for inadequate financial support which is evident in Table 16 which gives the allocation for the forestry sector in successive plans.

Table 16. Outlay in the forestry sector in successive plans*

Plan	Period	Total public sector (Rs. in crores)	Outlay for forestry and wildlife (Rs. in crores)	% of plan outlay
First	1951-56	2069	7.64	0.37
Second	1956-61	4800	21.21	0.44
Third	1961-66	7500	45.85	0.61
Post-Third	1966-69	6687	41.93	0.63
Fourth	1969-74	15901	89.42	0.56
Fifth	1974-79	38853	208.84	0.53
Annual	1979-80	12550	68.33	0.54
Sixth	1980-85	97500	692.49	0.71
Seventh	1985-90	180000	1859.10	1.03
Post-Seventh	1990-92	139197	1413.00	1.01
Eighth	1992-97	434100	4081.87	0.94
Ninth	1997-02	859200	8189.09	0.95

*India. Planning Commission. Plan Documents.
Note: 1 crore = 10 million rupees.

The MoEF and Forest Departments of various states have been requesting the Finance Ministry and Planning Commission for allocation of 3% of Plan outlay to the Forestry Sector. But this has not been settled so far. However recently there have been two developments, which have resulted in increasing investment in the forestry sector to some extent. In one of the recommendations of the 12th Finance Commission an ad hoc one time grant of INR10000 million was sanctioned to forest-rich states to implement the prescriptions of working plans. India has created an innovative funding mechanism to supplement the efforts of the nation in sustainable forest development and management. A corpus of INR70000 million has been created. It is expected that this amount will soon increase to INR 100000 million.

India is trying to generate financial resources for implementing SFM in the country. In spite of such efforts, India needs more financial resources to implement SFM and also to build the capacity of its human resource living in and around forests. India also advocates the establishment of a Global Forest Fund for providing financial resources to developing countries.

Human resource development

India has more than one hundred years of forest service which is hierarchically structured from the level of uniformed forest guards and foresters with policing functions upwards to Indian Forest Service (IFS) officers recruited by the Union Public Service Commission. Foresters of all levels are well-trained in traditional technical forest-related subjects. The main training is imparted at the Indira Gandhi National Forest Academy (IGNFA) in Dehradun for IFS officers. Each state has training schools for forestry and one state, Andhra Pradesh, has instituted a vocational training facility for village foresters who are not engaged in the forest service.

Role of public and private sectors

Role of NGOs

The National Forest Policy 1988 envisaged a definite but limited role for non-governmental organizations (NGOs) in assisting in the process of rural development. There are thousands of NGOs and NGO groupings in India which are working to support communities in organizing themselves to provide training, deliver extension services, identify income earning activities and to facilitate market access. SFDs often may include NGOs in the rural extension work and the development of micro-plans and other activities in joint forest management schemes.

NGOs can play an important monitoring and communication role between communities and forest services. Equity issues, conflict resolution and development-oriented investments at the community level may be effectively managed by NGOs trusted by forest-dependent communities.

Private forestry initiatives

The Government has been by far the most important player in the Indian forestry sector. While the main forestry activities have remained under Government domain, rural people have also been practising forestry in their farms, homesteads, and community land to meet their primary household requirements for fuel, poles, timber and medicinal plants. Several different combinations of agro-silvi-pastoral systems are practised by rural people. With the advent of social forestry, a promotional drive was launched for tree planting in wastelands, institutional lands and non-forest public and private lands. Many tree farming and agroforestry enterprises have sprung up all over the country and they are performing an important role as suppliers of forest raw material as well as market products (fuelwood, poles, small timber, bamboo, etc).

A new development in this regard has been the involvement of large pulp and paper companies in supporting such small scale efforts though R&D support, technology extension for establishing clonal plantations and a buyback arrangement for the pulpwood produced. Currently the area of private tree planting (including agroforestry/farm forestry) covers an area of over 6 million hectares. In addition, there are also other non-forest sources of wood, namely rubber, coconut, cashew, and mango plantations. The non-forest sources together provide about 50% of the total wood supply in the country and probably an equal or larger share of NWFPs.

A number of private companies, industrial houses, private individuals with large holdings, forest farmers, household with gardens, etc are now getting involved in raising forest plantations for producing timber, wood fuel, NWFPs, medicinal plants etc. Currently the area of private tree planting covers over 6 million hectares.

Private initiatives are not supported commensurately with relevant research, extension, technological packages, input delivery, market information and/or credit facilities. Being private initiatives, these forestry efforts tend to be efficient in terms of growth and yield. But the landowners can also move on to better economic alternatives if and when such opportunities are available. In the interests of sustainable forestry, it is necessary to encourage the small operators to keep up their interest and to ensure that their needs are adequately understood and addressed.

A number of private companies are now getting involved in raising forest plantations for producing wood raw material. There are some 40 plantation companies in operation. It is too early to evaluate their performances. While the Government has dominated the Indian forestry scene for the last 150 years, there is a growing realization now that the private sector should be encouraged to play a greater role than it has hitherto played. It has been widely accepted that there is an urgent need to simplify procedures to allow the private sector to contribute more effectively (Saigal et al. 2002). The timber transit rules and regulations have been relaxed by some states as a means to encourage private tree planting.

Research and development

Research on the multifaceted forestry discipline is an important requirement for SFM. Apart from ICFRE's mandate for research in all fields, there are a number of other public institutions engaged in different thematic research areas (IIFM, for the application of business management principles to forestry, the Wild Life Institute of India, for management research

on protected areas). Besides, SFDs have also established several state forest research institutions and forestry research setups that carry out R&D on local forestry issues. Further, there are several universities and institutions engaged in research on biology and socio-economic studies relating to forestry.

ICFRE with its network of eight institutions forms the backbone of forestry research in India. ICFRE institutes are spread across all the physiographic zones of the country focusing on research relevant to forestry issues of respective zones. The Council not only undertakes research through its institutes, but also has the mandate to encourage and guide forestry education and research in other educational and research institutions. Problem solving task orientation, participation of clients in research planning, demonstration of research results, dissemination and sharing of research information, networking of research institutions, establishment of technology centres to highlight the "how to do" aspect of research are inter alia areas requiring special attention.

Overall state of forests: dynamics of change in forest conditions

Forest resources are affected by a complex web of policies and conditions. A varied set of policies have significant direct and indirect impacts on changes in the level of forest resources. Over the last ten years, policy and decision making have been increasingly moving toward integrated and holistic assessment of economic, social and environmental issues. As such, the multiple aspects and potential benefits of forest resources are being directly considered by a rather large number of inter-governmental processes. The importance of forests as tools to generate economic, social and environmental products and services are highlighted in a number of instruments. The UN Millennium Declaration and the Johannesburg Plan of Implementation (JPOI) agreed during the World Summit on Sustainable Development (WSSD) to explicitly recognize the link between SFM and development. Both were concerned on the rapid rate of deforestation, especially in tropical countries and called for new commitment by both governments and stakeholders for finding ways to address this complex problem. There are a number of international and regional instruments and processes that address the issue of deforestation from different perspectives.

The discussion clearly indicates that with fast economic development, forestry is being redefined. People's participation in India's flagship JFM programme has had a visible impact on forest restoration. According to the SFR (2001 and 2003) there has been a marginal increase in forest cover. Forest diversion appears to be halting. There is greater emphasis on poverty alleviation through forestry programmes. NWFPs have come to the centre stage providing year round employment and supplementing the income of forest-dependent populations. Private participation in forestry is also gradually gaining momentum. It is hoped that with SFDs easing out certain legal and policy disincentives this participation may further grow to meet the bulk of India's requirements for forest goods and services. Forestry statistics have to be organized for gathering reliable and up-to-date statistics on all aspects of forestry.

3. DRIVERS OF CHANGE

Demographic change

India's population of 1.12 billion (July 2007 estimate), approximately one sixth of the world's population, is projected to touch 1.33 billion by 2020. The national demographic growth rate is estimated at 1.38% per annum, the population density is 336 inhabitants per square kilometer, seven times the world average. Seven hundred and forty million people (68%) live in rural areas, (growth rate 1.43% per annum). Six hundred million people are dependent on agriculture for their livelihoods, of which 200 million are to some degree forest dependent whereas 90 million are in scheduled lists of tribes under the Indian Constitution and are particularly forest dependent. Thirty-one percent of the population is less than 14 years of age while another 64% is between 14 and 64.

The population of farmers is aging rapidly, and the next generation is more focused on opportunities for urban employment. Eighty-eight percent of the 89.4 million Indian farmers have land holdings in the range of 0.1 to 2 ha.

The geographic location of India allows for human habitation with near optimum environmental living conditions. Therefore, even with a low per capita energy intensity and carbon emission levels, a high density of the population is living comfortably. However, with increasing population, per capita availability of natural resources is decreasing, resulting in an increase in the cost of living in terms of energy requirement and proportionate use of resources. Based on the above demographic profile energy consumption, particularly the use of firewood, was assessed in 2006 (Table 17).

Table 17. Percentage distribution of households in various income groups using sources other than firewood for heating water

Income group	Firewood	Other sources
Rural low	100	0
Rural middle	70	30
Rural high	60	40
Urban low	60	40
Urban middle	20	80
Urban high	0	100

Source: National Energy Map for India: Technology Vision 2030.

The dependency ratio of the population on forests shows a declining trend (Figure 2). The most likely scenario is also presented in Figure 2. However, as the size of the population depending on forests increases with faster growth of population, the demand for products and services from forests keeps increasing, albeit at a slower rate than the population.

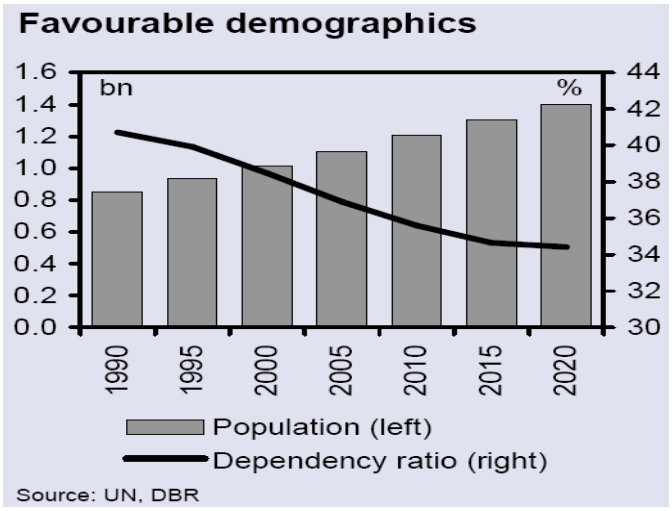

Figure 2. Demographics depicting dependence on forest product use

Factors influencing the state of forests

With the changing demographic situation, corresponding changes in economic, social, and cultural aspects of society also cause changes in the need and utility perceptions of natural resources including forests. The influences of the changes include those which govern the extent of forests, and also those which determine the profile in terms of management concerns related to production, quality, utility and services , etc expected from forests.

Primary production

Agriculture remains the primary occupation of the majority of the population in rural India and is foremost for rural economic growth. An extent of 141 million ha (over 42%) of the total geographic area is under agriculture. While the Agriculture Policy does not prescribe an increase in the extent under agriculture, diversions from agriculture in favour of urbanization are taking place slowly. In the vicinity of larger urban areas, irrigated agricultural lands are being converted. As the government is committed to increasing agricultural growth from the present (less than 2%) to about 4% it is likely that farmers' income will be supplemented by additional avenues of income particularly from dairies, horticulture, vegetable cultivation, etc. This is due to the expanding road network in hitherto uncovered rural areas. Increasing area under irrigation being a priority of the agriculture sector, inclusion of more rainfed areas under irrigation is expected to offset the loss of irrigated farmlands. The corresponding fall in net area is also being offset by increasing use of wastelands, technological advances and increasing investment in suitable production systems in rainfed areas.

With an increasing focus on the development of rainfed areas and diversification of agricultural practices, economic theory about traditional practices is also becoming increasingly prevalent. In these circumstances, the prospects of perennial tree-based crops including agroforestry have a significant future. This is complemented by increasing government efforts and several initiatives by the private sector for networking with farmers on production systems related to pulpwood, plywood, biofuels, bamboo, etc. Thus, while agricultural developments put pressure on forestry in terms of area, they can also reduce pressure on forests for products; the area supporting perennial tree-based systems could only add to green cover.

Infrastructure and industrial growth

Infrastructure development is the main focus for sustaining the economic growth rates projected for the coming years. India has committed to developing state-of-the-art infrastructure for facilitating growth and improving quality of life. Communication, transport, housing, energy, healthcare and knowledge infrastructure are the priorities. Land is the foremost requirement. The safeguards adopted in India in terms of making environmental impact assessments mandatory for development projects and also for decision making on diversion of forests at the highest level ensure objective considerations of balanced growth. The diversion rate of forests for development has been inevitable in recent years.

The present target of industrial growth is 10% while that of the manufacturing sector is 12%. Special economic zones and special economic regions are also expected to have strong influence on the socio-economic profile of people in their catchments, leading to changes in consumption patterns and way of living. Dependence on forests in areas with forests in the vicinity is also expected to be influenced accordingly. Industrial development is expected to have a special focus on the small and medium enterprise sector in the coming years. The agro- and rural industry segment depends upon the farm and non-farm production of raw material, a large proportion of which comes from forest products. Rural social forestry is becoming very important in organizing the sustained supply of wood and non-wood products for craft, artisanal and value addition segments of rural industries.

Urbanization

According to the 2001 census, 285 million people (27.8%) live in 5,161 towns. Out of this figure 285 million urban people, (37%) live in 35 metropolitan cities today, as against 19% in 1951. The projection for the urban population by 2020/2021 indicates a corresponding size of 433 million. Cities harbouring over 100,000 people account for 68.9% of the urban population and about 23% of the population is estimated to be slum dwellers. The estimated requirement for housing in urban areas in 2002 was about 22.44 million dwelling units. This was estimated to be around 24.71 million by 2007 and 26.3 million by 2012. The requirement projections and housing plans are basically for economically weaker sections and low income groups and any housing development in this section essentially finds wood and wood products affordable for housing. Therefore, the trend can be taken as an indicator of the growth in the requirement for structural material and accessories in the housing sector.

The growing use of industrial material with technologies for efficient use of wood and wood composites together is resulting in increasing use of smaller and low quality wood, also for structural purposes, thus bringing wood-based structural material within affordable prices. Similarly, the increasing use of plantation wood from short-rotation species is also improving the returns from agroforestry practices. For example, growing of poplars, acacias, casuarinas and eucalyptus in north and south India is making agricultural practices more remunerative. The development of rural road networks and other rural infrastructure is likely to further improve the economic viability of agriculture and other land-based activities as the farmers will have better access to urban markets. The trend indicates a positive influence on agroforestry development in the coming years.

Economic changes

With a per capita GDP of US$3,4032 (2007 estimate which registered a 14% increase over 2005), India is a middle-income country. There are major and increasing differences between the rich and the poor, the north and the south, and the urban and rural areas of the country. It is estimated that there are between 300 and 500 million Indians who are heavily affected by poverty (living on less than US$1 per day); many of them are living in forest-fringe areas. The most poverty-prone states are in northeast and central India.

The urban-based economy has grown rapidly through investment in industries and services which are increasingly being liberalized from government control. Currently the economy has been growing at about 9% per annum. The projections for the coming years are 9%+. This high rate of economic growth, however, is not commensurate with employment figures. During 2004/2005, almost 58% of the population was unemployed. The impetus on agriculture is considered helpful in reducing rural unemployment. Skill development for value addition and manufacturing in small and medium sectors is also recognized as equally important in this respect.

High economic growth, physical infrastructure and industrial sectors have also put pressure on environmental resources. Increasing education and awareness of civil society have brought the environmental sustainability agenda to the forefront of national awareness. The imperatives of conservation of the environment in general and forests, biodiversity and ecosystem services in particular have been recognized as essential components of sustainable development.

Climate change

With the recognition of climate change as a consequence of anthropogenic carbon emissions, every effort is being made to either mitigate impact by reducing emissions or working on adaptation to the changing situations. As the predictions of the impact of climate change are still full of uncertainties, concepts on possible strategies for adaptations are said to be far from clear and the cost of adaptations is also indicated to be much more than mitigation. Further, in the wake of uncertainties, mitigation or reduction of green house gases (GHG) is the only option available. The united global efforts in this context, which include the UN Framework Convention on Climate Change (UNFCCC) and related protocols, focus on arrangements on limiting carbon emissions to the lowest levels possible. Carbon sequestration is a very important option in this context.

Forests can be used as sinks for carbon dioxide, which is the most prevalent GHG. The role as sinks is presently the most important for immobilizing large quantities of carbon for long periods. Thus, the role of forests in climate change is determined by their state and management. The impact of climate change on forests is also expected to be in line with changes in climatic conditions, to be manifested in species composition, profile, productivity, resilience and biodiversity. In India, with around 70 million tribal and 200 million non-tribal rural people depending on forest resources for their subsistence needs, climate change will have an impact on their livelihoods.

There are varying estimates of carbon stock in the biomass and mineral soils in India. A comprehensive study conducted by Haripriya (2003) takes into account the carbon stored in both above and below ground biomass as well as in the soil. The study estimated the total carbon stock in biomass and mineral soils to be 2,934 million tonnes and 5,109 million tonnes respectively for 1994 and 1995. The average biomass carbon of the forest ecosystem in India for 1994 was reported to be 46 tonnes/hectare, of which 76% is in aboveground biomass and the rest is in fine and coarse root biomass. The average mineral soil carbon was found to be 80 tonnes/hectare.

The forest cover and the growing stock of India have shown a gradual upward trend over the years. However, the growing stock per unit area of Indian forests is substantially lower (and hence the carbon in biomass) when compared to other South Asian countries and the global average. The post-Kyoto Protocol negotiations are sure to have carbon sequestration as an important factor in mitigation strategies and Indian forests will have a key role.

Based on the annual average afforestation of 1.16 million hectares as the default rate of afforestation, the mitigation potential of forestry was analysed by Ravindranath et al. (2006).

The studies indicated that from 2005 to 2025, the mitigation potential of short-rotation forestry options for carbon stock may vary from 63 tonnes/hectare for hot arid regions to 101 tonnes/hectare in the northern and eastern plains. For long rotation forestry, the potential varies from 58 tonnes/hectare for the Eastern/Western Ghats and coastal plains to 118 tonnes/hectare in the northern and eastern plains. The mitigation potential of the natural regeneration option varied from 71 tonnes/hectare to 89 tonnes/hectare.

Political and institutional environment

The forestry institution in India is well organized but needs to gear up to deal with emerging demands and challenges. Meeting expectations of the stakeholders will require significant changes in the roles and responsibilities as well as structure of the forest administration. The increasing decentralization of the democratic processes, community empowerment, participation in decision making, increasing inter-sectoral linkages, and economic aspects governing decision making require urgent development of skills for interpreting conservation and ecosystem services in economic terms and support to conservation on the basis of economic imperatives.

The use of modern technologies and concepts in natural resource management planning and implementation needs suitable and compatible changes in governance and documentation systems. The auditing system could include environmental audit as an integral part of the social audit. A long-term strategy will be needed to deal with the challenges of improving governance, accountability and transparency in all spheres of central and local governments, the corporate sector and community levels.

Impacts on forests

Change in forestland resources

The growing concern for the environment and sustainable development and India's commitments to global environmental concerns have been increasingly influencing the greening movement in the country and bringing more areas under plantations. The steady enhancement of green cover along with reduction in cultivable wastelands indicates the effective policy and programmatic interventions towards optimisation of land use. It is expected that cultivable waste and degraded lands will decrease substantially in favour of green cover.

The pace of economic growth including infrastructure and industrial growth is sure to influence the demand for forest products and it is certain that the business-as-usual scenario is unable to keep pace with demands. An analysis of the demands for wood, which is a major indicator of forest products, is given below.

Growth pattern in demand for wood

The total industrial demand for wood, in terms of round wood equivalent (RWE) is expected to rise from 58 million m^3 in 2000 to 153 million m^3 in 2020.

Table 18 reveals that the average annual rate of growth of demand for timber in RWE from 2000 to 2005 will be 5.52%, which will increase till 2014 and then the rate of growth of demand shows a decreasing trend between 2015 and 2020.

Table 18. Growth pattern of future demand of wood

Year	Demand (million m^3)	Percentage increase (average per annum)
2000	58.00	-
2005	74.00	5.52
2010	95.00	5.68
2015	123.00	5.89
2020	153.00	4.88

This slight decline in the growth rate in the later decade will be due to a plateau in infrastructure growth and a focus on maintenance. The use of wood may not decrease as wood proves to be the best environmentally friendly material for structural purposes and is sought after in energy saving in the sense of being a renewable option.

Alternatives/substitutes from metals, synthetic composites, etc will be on a downward trend because they involve energy and carbon intensive processing, apart from being non-renewable.

Wood demand from short and long rotation tree species

Future demands for wood may be projected in terms of wood from short- and long-rotation tree species. The forest-based industries use wood not only from short-rotation (SR) or long-rotation (LR) species, but also in a varying mix depending upon availability. Based on this assumption, the projected wood demand from short- and long-rotation species is projected in Tables 19 and 20 respectively.

Table 19. Projected demand for RWE from SR species (million m^3)

	Industry	2000	2005	2010	2015	2020
	Paper and paperboard (100%)	4.48	8.96	15.50	26.64	35.84
	Newsprint (100%)	1.78	2.56	3.42	4.63	6.22
	Rayon grade pulp (100%)	2.50	2.80	3.10	3.40	3.80
	Construction industry (20%)	3.18	3.88	4.42	5.26	5.70
	Packaging (50%)	2.31	2.77	3.20	3.78	4.50
	Agricultural implements (50%)	1.06	1.17	1.25	1.25	1.25
	Sports goods (50%)	0.18	0.29	0.49	0.84	1.37
	Plywood (50%)	5.50	7.0	8.98	11.45	14.60
	Veneer (50%)	0.14	0.17	0.22	0.27	0.35
	Matchbox (100%)	2.30	2.60	3.00	3.40	4.00
	Mining (50%)	1.60	1.75	2.00	2.25	2.50
	Miscellaneous industry (50%)	2.85	3.35	4.70	5.60	7.58
Total		**27.87**	**37.30**	**50.18**	**68.76**	**87.70**

Table 20. Projected demand for RWE from LR species (in million m^3)

	Industry	2000	2005	2010	2015	2020
	Construction industry (80%)	12.72	15.52	17.68	21.04	22.80
	Packaging (5%)	2.31	2.77	3.20	3.78	4.50
	Furniture (100%)	2.52	3.36	4.62	5.9	7.53
	Automobile (100%)	0.19	0.28	0.41	0.60	0.87
	Agricultural implements (50%)	1.06	1.17	1.25	1.25	1.25
	Railway sleepers (100%)	0.03	0.03	0.22	0.02	0.02
	Sports goods (50%)	0.18	0.29	0.49	0.84	1.37
	Handicrafts (100%)	0.45	0.54	0.65	0.78	0.95
	Plywood (50%)	5.50	7.00	8.98	11.45	14.60
	Veneer (50%)	0.14	0.17	0.22	0.27	0.35
	Particleboard (100%)	0.14	0.18	0.22	0.28	0.35
	MDF board (100%)	0.14	0.17	0.21	0.24	0.28
	Mining (50%)	1.60	1.75	2.00	2.25	2.50
	Catamaran (100%)	0.03	0.05	0.07	0.11	0.16
	Miscellaneous industry (50%)	2.85	3.35	4.70	5.60	7.58
Total		**29.85**	**36.63**	**44.92**	**54.40**	**65.10**

A summary of demand projection for industrial wood from SR and LR species is shown in Table 21.

Table 21. Summary demand projection of industrial wood from SR & LR species (in million m^3)

Source of wood/year	2000	2005	2010	2015	2020
Wood from SR species	27.87	37.30	50.18	68.76	87.70
Wood from LR Species	29.85	36.62	44.92	54.40	65.10
Total (% growth)	**57.72**	**73.92 (5.52)**	**95.10 (5.68)**	**123.16 (5.89)**	**152.80 (4.88)**

The demand for wood from LR species is almost equal to that from SR species up to 2005. But by 2020, the demand for wood from SR species will be 33% more than that from LR species. It clearly shows that in future, industries will require more wood from SR species i.e. from farmlands and other non-forestlands. Though some of the SR species like bamboo come from forests and similarly some hardwood species like *shisham* come from private land also, most of the SR species are grown in private lands and LR species in forests.

Plywood and panel industry

The wood-using panel industries are plywood, veneer, particleboard, MDF board, etc. The demand projections for these products are summarized in Table 22 and Figure 3.

Table 22. Projected demand for panel wood (million m^3)

Year	Plywood	Veneer	Particleboard	MDF board	Total
1998	10.10	0.25	0.13	0.13	10.61
1999	10.50	0.26	0.13	0.14	11.03
2000	11.00	0.27	0.14	0.14	11.55
2005	14.00	0.34	0.18	0.17	14.69
2010	17.96	0.43	0.22	0.21	18.82
2015	22.90	0.54	0.28	0.24	23.96
2020	29.20	0.70	0.35	0.28	30.53

Source: Table 5.4 of "*Forest and Wildlife Statistics, India 2004*".

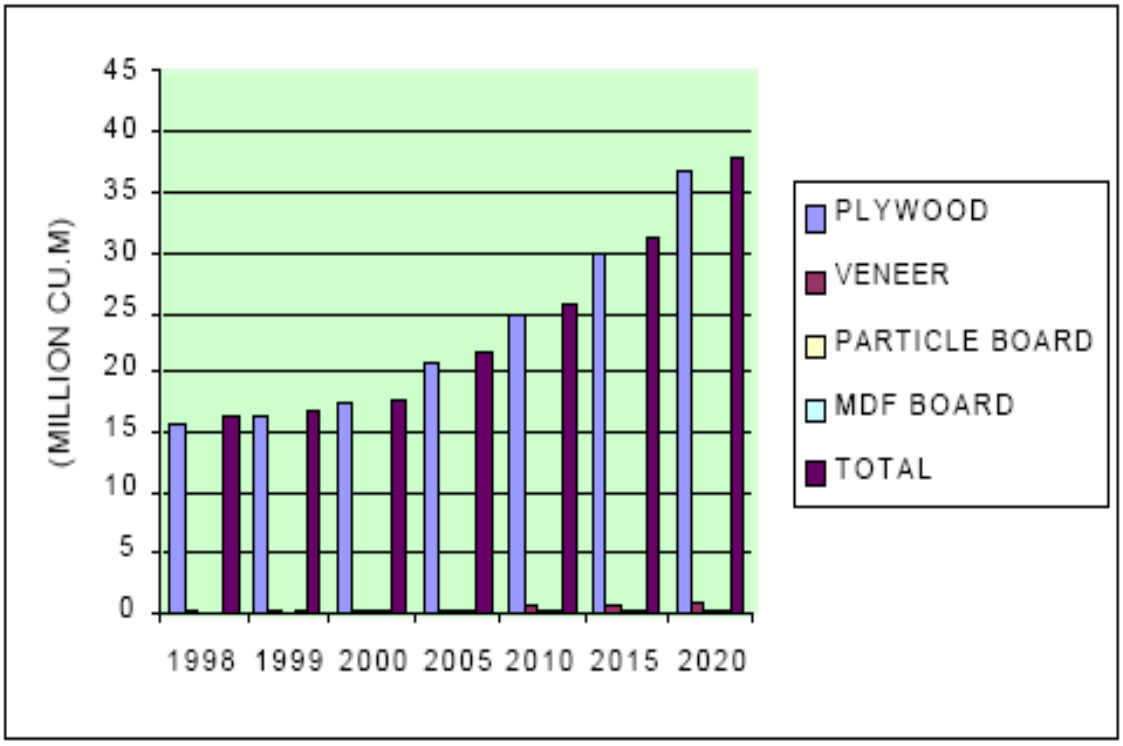

Figure 3. Projected demand for panel wood

Paper and pulp industry

The pulp and paper industry is considered one of the high consumers of forest-based raw materials. However, on average the industry in India uses only 3.5% of the total wood from forests. Nearly 90% of the wood from forest is being used as fuel (Figure 4).

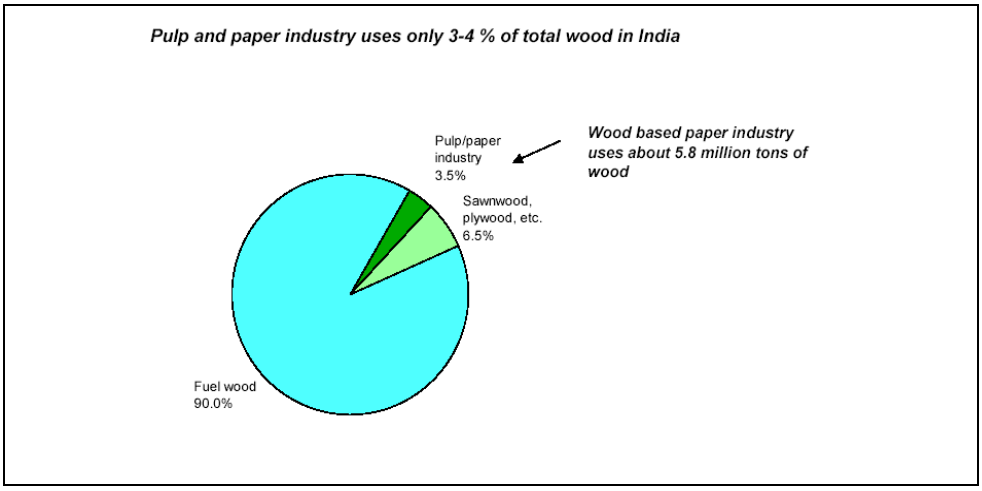

Figure 4. Wood consumption in India

The industries consuming pulpwood are primarily paper and paperboard, newsprint and rayon grade pulp. The demand projection for pulpwood-based industries is given in Table 23.

Table 23. RWE projected demand for pulpwood-based industries (million m^3)

Year	Paper and paperboard	News-print	Rayon grade pulp	Total
2000	4.48	1.78	2.50	8.76
2005	8.96	2.56	2.80	14.32
2010	15.40	3.42	3.10	21.92
2015	26.64	4.63	3.40	34.67
2020	35.84	6.22	3.80	45.86

The pulp and paper industry is the most important cellulose fibre-based industry in India with a turnover exceeding INR.100 million. There are more than 380 mills with installed capacity of nearly 5 million tonnes. Historically, the industry has grown at 5% per annum, but during the 1990s, the growth rate was faster at around 8%. Most of the mills are very small compared to international standards; 315 (83%) of the mills have less than 10,000 tonnes per annum capacity. Only four mills have installed capacity of over 100,000 tonnes per year. The per capita consumption of paper in India is very low — around 5 kg compared to the world average of around 50 kg and 40 kg for the Asia Pacific region.

Each tonne of paper production requires approximately 4 tonnes of freshly harvested pulpwood. The present forest resources are inadequate even to meet fibre demand for existing pulp mills. There is tremendous scope for the farm forestry sector to increase production and bridge the growing gap between demand and availability of pulpwood. For example, 14.4 million tonnes of additional pulpwood will be required annually to bridge the projected gap of 3.6 million tonnes of paper by 2010/2011. The demand for wood in the paper industry is likely to increase to 13.2 million tonnes by 2020. Figure 5 shows the demand for wood in the Indian paper industry.

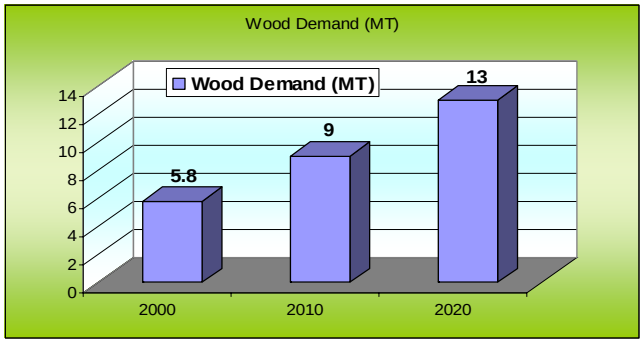

Figure 5. Demand for wood in the Indian paper industry

Plantation and wood production

Several initiatives have been taken by the Indian paper industry for meeting the demand for raw material. The attempts mostly started after the 1988 NFP prescriptions advocating industry–farmer interface. By 2005, nearly 343,000 hectares of farm forestry plantations had been promoted by paper industries over 16 years, which are members of the Indian Paper Manufacturers Association (IPMA). It is estimated that this land mass can produce approximately 20 million tonnes of wood at 60 tonnes/hectare yield (Table 23).

Table 23. Company-wise data on plantations promoted under farm forestry

	Company	Plantations (hectares)	Estimated wood generation (lakh MT)*
	ITC	42000	25.20
	BILT	40000	21.00
	JK	46000	27.60
	APPM	29000	17.40
	SPM	15000	09.00
	TNPL	2000	01.20
	SPB	200	00.12
	Orient	27000	16.20
	Century	17000	10.20
	Star	35220	21.13
	MPM	35000	21.00
	HNL	30000	18.00
	WCPM	25000	15.00
Total		**343420**	**203.05**

*@ 60 MT/hectare yield. 1 lakh = 100,000

The current level of promotion of planting by the industry is 65,000 hectares. To meet the additional annual requirement of 3 million tonnes of pulpwood, an additional planting of 50,000 hectares is required at the prevailing productivity range. Therefore, every year nearly 115,000 hectares of plantation are to be carried out by the industry to meet the pulpwood demand on a continuous and sustainable basis. With increasing focus on R&D and genetic improvement initiated largely by the private sector, a twofold increase in productivity can be projected as feasible.

Table 24. Farm forestry plantations in the last 5 years promoted by industry

Year	Area planted (hectares)	Yield/hectare (MT)	Estimated wood generation (million MT) in the year
2001-02	16,000	60	2006-07 = 0.960
2002-03	25,000	60	2007-08 = 1.500
2003-04	36,000	60	2008-09 = 2.160
2004-05	45,000	60	2009-10 = 2.700
2005-06	65,000	60	2010-11 = 3.900

Apart from the industry's effort, farmers on their own are also raising plantations, be they clonal or seed root, which is adding to the general availability of wood to the industry. Therefore, the industry today is getting almost 5 to 6 million tonnes of wood annually through farm forestry. With improvement of markets, apart from technologies for increasing productivity, this sector is expected to expand manyfold in coming years.

Meeting the demand for raw material by wood-based industry

Efforts have been made to work out strategies for the production of wood required by wood-based industries for meeting raw material requirements.

The total area of tree plantation in the 1999/2000, under different schemes was 31.2 million hectares. This includes part of degraded forests also, but then there is no separate data on plantation on forest and non-forest lands. The majority of plantation was in non-forest lands. Out of 31.2 million hectares, 10.26 million hectares were planted by way of seedling distribution among farmers and the remaining 20.94 million was block plantation. The Forest Department and Forest Corporation have been planting 70% of the fast growing short-rotation species and 30% long-rotation species. Out of this the estimated survival rate according to the FAO study is around 62% and assessment by the NAEB through field survey also comes to an average of 60%.

Assuming the rotation period of plantation timber is 7 to 10 years and that of teak 20 years, the economics of growing plantation timber is compared with that of teak in Table 25.

Table 25. Economics of growing poplar, eucalyptus, teak and *Kadamba* sp.

Species	Poplar	Eucalyptus	*Kadamba**	Teak
Rotation years	7	10	8	20
No. of trees/hectare	500	1,250	320	475
Expenditure/hectare in INR	82,292	113,215	43,776	209,715
Benefit (in INR)	272,533	266,220	68,124	419,961
B:C ratio	3.31	2.33	1.6	2.0
IRR %	68	32	31	30

***** *Anthocephalus kadamba*

The requirement for land (both degraded and agroforestry land) for the plywood industry is projected in Table 26. It is clear that the total land requirement for the plywood industry in 2005 is 0.91 million hectares, 1.8 million hectares in 2010, 2.29 million hectares in 2015 and 2.63 million hectares in 2020. This is assuming that 70% of plantation timber and 30% long-

rotation timber are used for the manufacture of plywood. Further, assuming the cost of plantation for long-rotation hardwood timber as INR.40,000 per hectare and for short-rotation plantation timber as INR.25,000 per hectare, the cost involved to carry out plantation in both degraded and agroforestry land works out to be approximately INR.33,000 million in 2005, INR.63,000 million in 2010, INR.68,000 million in 2015 and INR.79,000 million in 2020. This is five times the budget available at present. It may not be possible for the Government alone, hence corporate sectors and the bulk consumers of wood have to come forward to invest in this cause for their requirements. It is suggested that wood-based industries can fulfill this huge task in two ways. Firstly, they have to make available funds and participate in the management of degraded forests along with the Government as formulated by the MoEF and secondly they have to establish relationships with farmers and individuals by providing them with quality planting materials. Unless this task is taken on a war footing the requirement for raw material by wood-based industries will not be fulfilled.

Table 26. Land requirements for growing plantation timber/hardwood species for the plywood industry

Year	Yield of plantation timber/ hectare/year	Yield of LR hardwood timber/ hectare/year	Projected demand of RWE of plantation timber in million m^3	Projected demand of RWE of hardwood timber in million m^3	Total land requirement in million ha for growing timber for the plywood industry
2005	20 m^3	10 m^3	9.80	4.20	0.91
2010	20 m^3	10 m^3	12.57	5.39	1.80
2015	20 m^3	10 m^3	16.03	6.87	2.29
2020	20 m^3	10 m^3	20.44	8.76	2.63

The shortages of industrial raw material and the increase in its price have forced industries to look for alternative avenues. The import of timber from other countries is on the rise. The industries have also started obtaining a part of their raw material requirement from farmers. It is hoped that in a decade or so, the linkage between forest-based industries and farmers for short-rotation tree species will develop to such an extent that dependence of panel industries on timber grown in natural forests will be reduced considerably. However, for meeting the growing needs of saw milling and the plywood industry, degraded forests will have to be regenerated and planted with long-rotation tree species like teak (*Tectona grandis*), *gurjan* (*Dipterocarpus turbinatus*), makai (*Shorea assamica*), *dhup* (*Canarium* spp.), *Vateria indica*, *pali* (*Palaquium ellipticum*), and *poon* (*Calophyllum inophyllum*).

Table 27. Timber import trend (in '000 m^3) (value in million rupees)

Particulars	2002-03	2003-04	2004-05	2005-06
Logs	16,033.9	30,681.4	37,371.0	36,817.4
Sawn wood	341.8	566.07	608.2	924.0
Plywood	168.8	193.1	233.6	365.1
Veneer	159.9	165.5	226.1	492.4
Particle board, etc.	346.4	608.7	767.3	1,178.6
MDF/hardboard	487.6	600.5	813.2	1,237.8
Wooden furniture	322.5	563.2	787.4	1,368.6
Grand total INR.	17,860.9	33,378.4	40,806.8	42,383.9

Source: Directorate General of Commerce, Intelligence and Statistics, Kolkata.

Trees Outside Forests (TOF)

TOF is the single most important and cost effective strategy for achieving the goal of 33% forest/tree cover envisaged in the NFP 1988. It also helps in achieving the important additional goal of poverty alleviation.

Trees growing outside forests provide a viable diversification option and help in making farm management practices competitive, which is highly desirable in the present era of globalization. TOF help in achieving ecological security by improving soil and water conservation, and have immense potential for socio-economic and cultural development. Therefore, TOF plantation programmes should be fine-tuned to be more responsive to the social, cultural and economic needs of the stakeholders.

We should take into account both the economic and ecological aspects of TOF. The key lessons such as people's empowerment, assessment of rural needs at the village level, involvement of local institutions, civil society, and self-help groups need to be incorporated in all future programmes for planting trees on non-forest lands.

A strong extension network with a responsive research support system is the key issue for the success of such types of forestry projects. The Forest Department should have a strong extension setup, along the lines of the Agricultural Department, to provide timely guidance to the community in making the right choice of species for planting outside forests, tending of plantations to maturity, their value addition and most importantly marketing of the produce at remunerative prices. For increasing tree cover outside the forest area, there is an urgent need to develop synergy among various departments and extension research agencies working in the field.

There should be a nodal apex body/committee comprising representatives of concerned ministries/departments i.e. forest, agriculture, rural development, commerce and industry, etc at the Central level to take the mission of agroforestry to its logical conclusions of ensuring financial prosperity and ecological security for the practicing communities. The Forest Department should be the nodal department for this exercise.

Trends and changes for reflecting the true economic value of forests

Despite making a considerable contribution to India's economic and ecological systems, forest value is not reflected in the national income (GNP) of the country and the current value of forest reflected in the System of National Accounts (SNA) represents less than 10% of the real value (0.7% of GDP in 2005-2006). This is mainly due to lack no methodology for valuation and estimation of the true contribution of forest services to the economic system.

The basis for estimating the economic value of a resource or an environmental amenity is its probable effect on human welfare. There is lack of understanding of the true role of forests in people's well-being. Forestlands have become degraded on account of overuse and mismanagement, the investment in the sector has not kept pace with the removals and the few resources available to the forestry sector are often put to non-productive uses. Whereas the investment in human-induced capital and financial capital is on the rise, the forestry sector due to lack of appreciation of its true and total value has always been less appreciated and thus has received less budgetary allocation and investment. Low investment in the sector is the result of its low annual growth as compared to other sectors of the economy.

Inter-sectoral linkages and economic growth

The rising demand for and pressure on land as well as forest boundaries make inter-sectoral planning and implementation essential. Besides the local pressure exerted by the demographic

increase in the agrarian rural population, there is increasing competition for land for mining, infrastructure, housing, tourist facilities, hydropower generation and water supply. Due to the non-availability of sufficient central or state level codes for integrated land use planning and clear guidance on priorities for selection between incompatible land uses, it is likely that states will prefer the higher financial yields apparently available in the short term from non-forest use. This provides another good reason for using total economic value (TEV) in land use planning and coordination, where TEV includes forest services as well as forest goods.

Three examples indicate why inter-sectoral planning needs higher priority:

a. The Central Government plans to electrify all rural areas by 2009. What effect this electrification is expected to have on fuelwood consumption, which is currently estimated to comprise 85% of woody forest harvest by volume, will require in-depth analysis. The most imminent scenario that emerges is that because of the lack of uninterrupted supply of electricity, it may not be possible to use electricity for cooking by replacing wood fuel. The electricity in rural areas may be used for lighting and irrigation purposes. With the intensification of agriculture and use of agroforestry, there may be an abundant supply of fuelwood at the doorsteps of farmers thus easing pressure on natural forests.

b. Natural regeneration in large areas of notified forests is damaged continually by free-grazing village-owned cattle. Stall-feeding milch cows with high-yielding fodder produced in agroforestry schemes can be seen in some demonstration areas. There remains the problem of large numbers of steers roaming free and with only limited demand for animal traction (pulling carts and ploughs and other agricultural tilling implements). The cultural sentiment is strongly against slaughter of excess steers. The need for understanding of financial losses in foregone forest growth because of cattle browsing and trampling, and optimum options for managing the cattle population will demand better coordination with the Livestock Department on provision of dry-season forage. The reduction in scrub cattle and improved supply of cultivated fodder may improve milk production and may further supplement farmers' income on the one hand and reduce pressure on forests for grazing on the other.

c. In education, a quantum jump in investment is envisaged from 2% to 6% of GDP. India is also developing into a global hub for quality printing at competitive cost. The major paper and pulp mills in India have planned expansion of over 63% in coming years. Currently, the paper mills have been using up to 30% recycled fibre, 31% agro-based raw material and 39% wood. According to the CII study (2006), the projected use of raw material by 2010 is going to be 30% recycled fibre and 28% agro-based material. The wood requirement, as raw material, is pitched at 42% against 84% prevalent in the 1970s. However, this trend may come back with more emphasis on wood resources grown outside forests. A number of paper mills (e.g. ITC) have already demonstrated the usefulness of partnership with farmers. Another compelling reason for India to grow its own raw material is the likely competition from China and other neo-economies who will be competing for raw material from Asia, Africa and Latin America. New Zealand raw material may not be enough to meet the growing demands of paper mills in India and other countries.

It is essential to monitor the development in closely linked sectors and assess the trend of forest growth and productivity.

Trends in the overall development

There are a number of indicators showing all round improvement and they are all likely to have a positive influence on the forestry sector. One of the most important attributes would be

governance indicators. For this purpose three major economies of Asia viz., Singapore, China and India have been compared for control of corruption, role of law, regulatory governance effectiveness, political stability, voice and accountability (Figure 6).

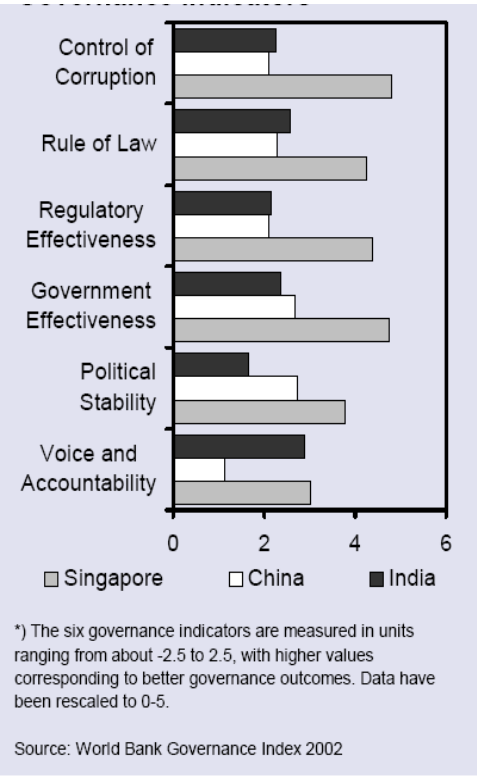

Figure 6. Governance indicators

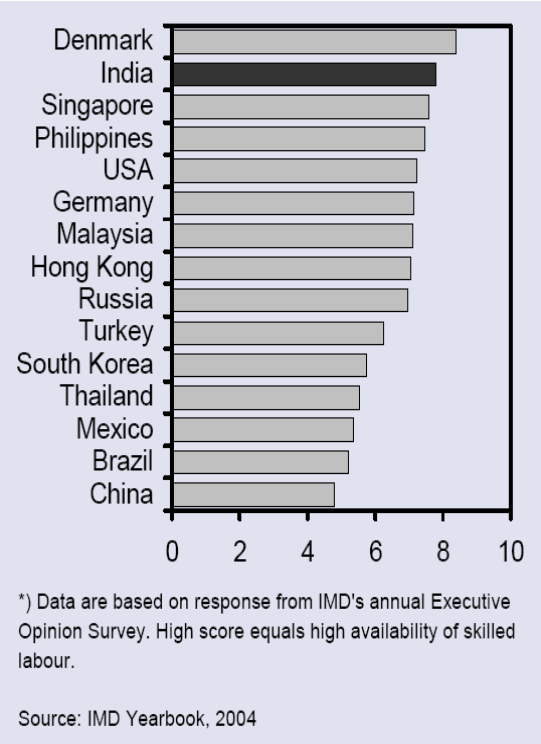

Figure 7. High availability of skilled labour

With respect to the last indicator (voice and accountability) India and Singapore are similar and ahead of China. In many other indicators, India is either better off or equal to China but far behind Singapore. Looking at the socio-economic and demographic mix this is not really surprising. Instead of comparison with Singapore it is better to compare with China due to its huge population. Further, with respect to the high availability of skilled labour, India is only next to Denmark and ahead of many other developed and developing countries (Figure 7).

Another measurable indicator is the household consumption bundle calculated in 2002 and projected for 2020, which shows a favourable economic scenario and corresponding spending on essential items. The reduced depredation of forests and uplifting of the population above the poverty line will have a positive impact on the forest health of India as shown in Figure 8.

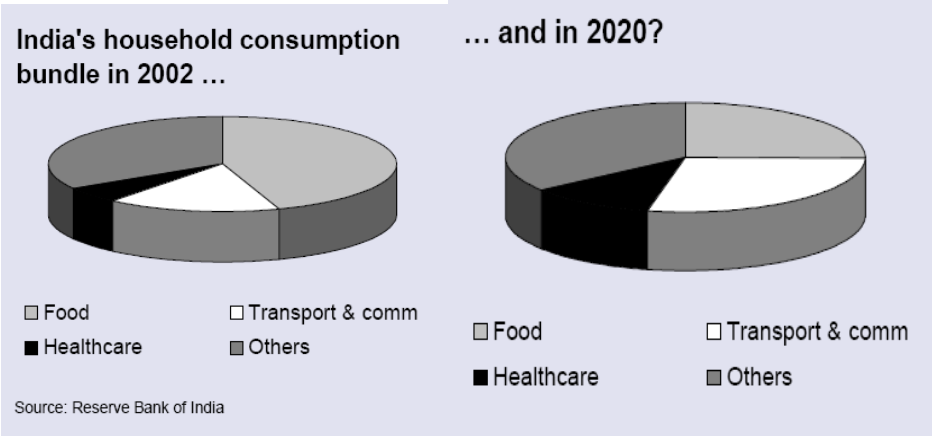

Figure 8. Projected household consumption bundle in 2020
Adopted from Jennifer Asuncion-Mund. *India rising: A medium-term perspective* .Deutsche Bank Research May 19, 2005 India Special, Frankfurt

Future energy demand and its implications on forests

India's requirements for firewood at the close of the century were variously estimated between 225 million and 350 million m^3 (Chakravarti, 1985). Taking conservative estimates of the requirements and an optimistic estimate of per hectare fuelwood production, the country will require a minimum of 25 million hectares of land for intensive fuelwood cultivation. At the country level, it appears that there will be no difficulty in finding adequate land for fuelwood production, but in view of the ecological and socio-economic imbalances in the country, much investigative study will be required at the meso- and micro-levels to arrive at the local targets of production, land requirements and technology. In a subsequent assessment (ITTO, 2003) the current level of fuelwood consumption has been assessed to be 280 million m^3 which is projected to rise to 400 million m^3 in 2020. This is quite reasonable to assume when FAO (1997) projected fuelwood consumption of 262.782 million m^3 in 1993 and 302.387 million m^3 in 2010.

Fuelwood is likely to continue to be the most important fuel for cooking and heating particularly in rural areas in the vicinity of forests. However, the proportion of fuelwood from forest and non-forest sources is likely to remain at 50:50. Presuming the current trend of decadal population growth, there is no likelihood of any perceptible change in the present amount of household fuelwood consumption. This optimism is based on the projected trend for use of LPG for heating water and cooking among rural middle (20%), rural high (20%), urban low (10%) and urban middle (60%) classes. Gradually, LPG supply is reaching the slums and rural areas in the vicinity of medium and small towns as well.

Another cause for optimism is due to likely expansion of agro/farm forestry. Growing of eucalyptus, casuarina, poplars, sissoo, and some other local species has demonstrated their economic potentials in farm income. Besides yielding wood for supply to forest-based industries, they may also meet the demand for small timber and fuelwood. Surplus production of wood may also act as fuel for brick kilns and similar rural industries. The changes in felling and transit rules, which have so far throttled the growth of tree cultivation is becoming evident because of imminent growing pressure on forest-based industries to develop partnerships with farmers and have a committed supply of wood, or resort to uncertain and expensive sustained import of raw material to keep the industries alive. There is visible eagerness on the part of SFDs and the Government of India to create an enabling environment for the above developments.

Economics of wood energy use

The present economic boom is gradually improving the economic conditions of the urban poor. With convenient availability of alternative fuels as well as the added advantages of convenience of use, the reduction of societal risk from smoke, and affordability with improved economic status, preferences for alternative fuels are increasing. These include LPG, kerosene and in some cases, even electricity. All these measures are likely to reduce wood fuel consumption in urban areas. With increasing awareness, procurement of illegally collected forest products including fuelwood in commercial establishments like hotels and brick kilns is also falling. Environmental norms also discourage energy deficient systems in the industry sector, resulting in fall in demand for firewood.

Technological changes with alternative fuels (biofuels)

Growing biofuel crops is becoming a visible cultivation activity in rural areas. While conventional crops like sugarcane have an additional utility for use as a blend in conventional fuels, oilseeds, especially non-edible ones, have emerged as an option for cultivation in rainfed, low capability lands. Biofuel can also be used for domestic purposes such as lighting and cooking. People are gradually switching their preference for use of clean fuel and this may help in reducing fuelwood consumption. These appliances and technologies have been in vogue for some time but due to primitive technologies and lack of maintenance they have barely impacted on the energy consumption pattern. However, modern technological advances in the use of conventional fuels like gasifiers, better biogas systems, use of biodegradable waste for electricity generation, and integration of electronics in propulsion technology will be important aspects of the energy budget in the coming years.

Impact of globalization

India like China is working towards sustained supply of forest raw material for industry. The pressure on forest resources may become intense as forest harvesting in parts of Africa, Latin America and Southeast Asia cannot meet the growing need. Some of countries in Southeast Asia (e.g. Indonesia) have already adopted the pro-conservation approach. Sooner than later, some of these countries may resort to self-regulation and in the absence of commensurate investment in forest plantations, the resources may not last long. These developments are likely to encourage importing countries like India and China to make further investment in production forestry. Private participation in forestry in India is being presently examined. In time to come it may become imminent. What is required is the change in certain rules like easing out the land ceiling act, felling and transit rules. Liberalization has already prompted governments to sanction special economic zones (SEZs). SAARC member countries have sustainable forestry development as an important subject. Some other regional groupings with other Asia-Pacific countries are also in existence. Right now it is not very clear about the trade in forest products amongst the members of these countries but in future it may develop. In addition, India has bilateral cooperation on SFM with China and other countries of the region. These types of bilateral cooperation may expand and develop into a formidable combination for development and generation of forest products.

With WTO requirements coming into play, many trade barriers (tariffs and non-tariffs) will disappear and liberalized import and export of forest products will be ensured. With the economy growing, the general public will have easy access to material that is affordable.

Technological changes within and outside the forest sector

Information technology is gradually emerging as an important tool for assessment and decision making in planning and management of forest resources. The FSI is already using remote sensing in forest assessment on a bi-annual basis. Presently, it is limited to assessing

the changes in forest cover on a snapshot basis. With the refinement of technology, the assessment is likely to provide more useful data for forest planning and management.

Tissue culture and clonal propagation are already being extensively applied by forest-based industries to produce quality planting material and this has revolutionized plantation forestry. Improved technology has also found many applications in processing of secondary tropical species. Material hitherto used as fuelwood is now being converted to produce decorative furniture. Similarly, paper pulp and hardboard technology is making use of all types of forest wood in producing durable material for house building and furniture. This is likely to replace the use of sawn planks and optimize the use of wood. Thus, the same production technology is likely to provide better economic returns to industry and help all classes of consumers to meet their requirements.

The availability of improved technology for processing and value addition of NWFPs, can ensure remunerative returns to gatherers, besides providing opportunities for developing rural enterprises for value addition and trade. Forest certification as a modern management tool has the potential to provide the gatherers and rural entrepreneurs with better access to international markets. Technology application can also boost the income of gatherers. Initially, benefits may not be adequately apportioned to poor gatherers. However, their involvement in self-help groups and access to microfinance and storage facilities is likely to improve their condition.

Environmental issues and their impact on the forest sector

The adverse impact of climate change is becoming more and more visible. The consequences of climate change on the monsoon pattern and concomitant natural calamities (and their impact on crop production), receding glaciers, biodiversity, land degradation, desertification and soil erosion are being debated. Carbon sequestration and storage forestry are being considered as viable and acceptable climate change mitigation strategies. This would require more international understanding so that it is accepted for global funding. Although climate change has started receiving global attention, there are still many uncertainties and murkiness which require considerable time to address.

In future, India's forests will have to be managed holistically, taking into account tangible and intangible benefits and involving forest communities and other stakeholders who will participate directly as shareholders. There are four major forest ecosystem services for which there is a clear demand. Forest communities could be rewarded for conserving biodiversity, providing carbon sinks, protecting watersheds, and maintaining scenic beauty or recreational values. But the only way this can happen is if these services have real values attached to them. Payment for environmental services from forests is a phenomenon gaining ground worldwide, and many countries are already on this road to conservation. However, this money needs to go back to the forest communities through a system of localized payments as incentives to conservation. Thus, a "beneficiary pays" principle may be critical to SFM, where the people who benefit from the services, pay incentives to local forest communities. Putting a true value on forests could transform the way SFM is achieved.

Forestry research

The role of forestry research as an important catalyst in poverty alleviation, providing the most desirable goods, enriching services to society, ensuring environmental security of the country and contributing towards addressing global concerns has assumed much greater importance today than ever before. Now there is growing concern about conservation and the sustainability of resources and the rise in environmental problems, such as global warming, biodiversity loss, pollution of water, depletion of the ozone layer, desertification and carbon

sequestration. In the National Forest Policy document, priority areas for research and development have been identified for achieving the objectives of the Policy.

There is a need, therefore, to lay emphasis on the latest scientific forestry research necessitating adequate strengthening of the existing research base as well as new priorities for action. Some of the important areas where research input is vital are: agroforestry, watershed management, coastal area management and protective afforestation, high yield plantations, technological factors that limit yields, wildlife conservation and management, multipurpose forest management, genetic resource conservation, and forestry interaction with other sectors. Forestry research needs to be strengthened further to make it more compatible with national priorities. It should be a catalyst for rural livelihood support and made more people-focused.

Forestry education

Forestry both as a scientific discipline as well as a profession is fast emerging as a multidisciplinary vocation with multi-sectoral dimensions and applicability. Higher education, therefore, needs to tune in to current requirements. The Forest Research Institute/University, in conjunction with other agricultural universities and institutions, is dedicated to developing forestry education, formulating curricula, and designing courses for imparting education and promoting postgraduate research and professional excellence, keeping in view the human resource needs of the country. There is a need, however, to further strengthen their efforts and provide adequate support. Specialized and orientation courses for developing better management skills of in-service personnel also need to be encouraged taking into account the latest developments in forestry and related disciplines. Forest departments in the country and the Government of India should further encourage universities and organizations to take up higher education and research proactively, particularly applied research.

4. PROBABLE SCENARIOS AND THEIR IMPLICATIONS

Rationale for scenario definition

Forestry development is an outcome of the current policies, institutional development, socio-economic imperatives and international commitments. Both (a) developments within the forestry and allied sectors and (b) the external drivers will govern the future forestry scenario. Patterns of economic growth, developmental priorities, demography, skill development, and employment and migration profiles are among the important external drivers. Over 30% of the population lives below the poverty line, and the sector's role in alleviating rural poverty, particularly in forest fringe villages, is critical for constraining overexploitation of forest resources and mobilizing adequate social and political commitments for its development. Awareness and appreciation for forestry as a critical land use and a key element in sustainable development are vital for the sector. Long-term perspectives and strategic planning are inevitable in effective forest planning and management. Sustainable growth of the sector will ultimately depend on developing competitive advantages through increasing efficiency (improved technology and operation), responsive management, and equitable flow of goods and services through superior resource governance.

Elements used in defining scenarios

Some of the key elements used in visualizing future forest scenario include (a) the large population with a remarkable demographic structure of a substantially large young age class and somewhat higher population growth in rural areas; (b) trends of economic growth, investment in agriculture, watershed and rural development; and (c) rural employment potential in forestry and allied sectors. Increasing import of raw material for meeting the requirements of forest-based industries and various consumer wood products such as furniture is also a significant development. The emergence of local and sub-national issues resulting in strong provincial political parties is likely to affect the consensus-building process pertaining to forests and natural resources, demanding long-term commitments and the concerted efforts of various stakeholders.

Priorities for forest management

The looming environmental crisis made it necessary to emphasise the conservation of forest as expressed in the Forest (Conservation) Act 1980, the National Forest Policy 1988, and the National Environment Policy 2006. The production functions of public forests have lower priority. Logging operations in natural forests are discouraged, and locally banned in several areas. Imports of logs and wood products are liberal. Wood scarcity has provided impetus for farm forestry, homestead forestry, agro-forestry and growing trees outside forests. There have been efforts to develop captive tree plantations by wood industry units. Several industrial units are also promoting the growth of tree farms. Currently private and farmlands have emerged as major sources of wood supply. The public forests, mainly forest plantations, meet a small portion of the remaining demand. There is a need to provide adequate management support and protection to avert further deterioration. Adequate investment in technology, management, conservation and protection are relatively convenient to mobilize for growing trees outside forests, which are likely to become reliable sources for forest-based industries and meeting timber demands. The forest-based industries have already demonstrated the benefits of partnership with farmers. This trend is likely to develop in the interest of both parties.

Forestry as a global issue

The principle of sustained yield management for managing timber production was the hallmark of scientific forest management. Contemporary understanding of ecological and environmental functions requires us to move forward to more comprehensive SFM encompassing multiple use forestry to meet the various ecological, economic and social demands of goods and services from forests.

m^3

a) ITTO Objective 2000

India as a producer member country was committed to achieving ITTO's Objective 2000, which meant all timber and NWFPs in the market would come from sustainably managed forests. However, average wood production fell from 47 m^3/hectare in 1990 to 43 m^3/hectare in 2000. The aboveground biomass in forests diminished from 93 metric tonnes per hectare in 1990 to 73 metric tonnes per hectare in 2000. Further compliance with Objective 2000 under the growing demand–supply gap will be almost unattainable in the near future. Increasing the productivity of natural forests needs large investment as well as strengthening village-level institutions. Further, creating an enabling environment for promoting agroforestry, farm forestry and growing trees outside forests to meet the growing demand for forest products is inevitable.

b) Climate change debate

Global warming may significantly affect agricultural production in India because of large dependence on the monsoon. Climate modeling suggests that some traditional cropping patterns in semi-arid areas may become untenable. They might threaten large proportions of biodiversity and cause increased pressure on forests (IPCC AR4 Climate Change Report 2007). On the other hand, robust agroforestry systems may replace many farm areas. For the short term, mitigation initiatives will be the priority and forests will gain importance as carbon sinks in the long term. Adaptation and reducing the vulnerability of forest ecosystems will become a major management challenge in the near future.

c) Global objectives on forests (2007)

Global concern for SFM has led to the development of a global instrument where the following four global objectives have been agreed upon:

(1) Reverse the loss of forest cover worldwide through SFM, including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest degradation.
(2) Enhance forest-based economic, social and environmental benefits by improving the livelihood of forest-dependent people.
(3) Increase significantly the area of protected forests worldwide and other areas of sustainably managed forests, as well as the proportion of forest products from sustainably managed forests.
(4) Reverse the decline in official development assistance for SFM and mobilize significantly increased, new and additional financial resources from all sources for the implementation of SFM. The forest development strategies of India conform with the global objectives and global efforts will only accentuate the pace of efforts.

(d) Import of forest products

The increasing gap between demand and supply is boosting imports of forest products. Industrial round wood consumption in 2005 was 27.8 million m^3 and this is projected to increase to 38.1 million, 49.8 million and 63.1 million m^3 in 2010, 2015 and 2020

respectively (personal communication from Dr. CTS Nair). Against 58 million m^3 in 2000 and 74 million m^3 in 2005, the FSI projected industrial round wood demand at 95 million m^3 in 2010, 123 million m^3 in 2015 and 153 million m^3 in 2020 (Pandey 2007). The import bill for forest products rose from US$722 million in 1990 to US$1,300 million in 2000 and then to US$3.1 billion in 2005. An adequate enabling environment, such as reasonable provisions regarding land ceiling, tree felling and transit of timber, and institutional restructuring for generating wood and other forest produce may arrest this trend.

Other closely linked sectors

The beneficial impact of the current economic growth on the rural poor can only be seen through higher priority of public investment in the sustainable management of natural resources, which are the mainstay of rural livelihoods. The development in the agriculture sector that supports about 70% of India's population is the major priority for national and state governments, and investment in agriculture and allied sectors should continue to grow. From the current level of less than 2%, targeted agricultural growth is at 4% per annum through intensification of agriculture in which agroforestry, farm forestry and other similar sources are going to play important roles. Forestry, despite its well-known ecological (environmental), economic (production) and socio-cultural dimensions has not received similar attention. Perhaps small individual stakes in forestry often lead to preference for non-forest land use such as subsistence agriculture, grazing, and fisheries in spite of considerable damage to the environment and long-term livelihood potentials. However, forestry development has great potential for creating rural employment through NWFPs and ecotourism as well as wood production. There is an urgent need to boost efforts for enhancing people's participation through the JFM programme with adequate empowerment of local communities having decision-making control over their forests. An appropriate incentive regime must effectively compensate local communities' conservation efforts.

Energy

The growing prosperity of the rural middle class and household income of the urban poor has spread the use of LPG as a replacement for biomass energy. There is greater access to LPG and other forms of non-conventional and conventional energy in many rural areas. The time efficiency of LPG is also attractive considering rising employment opportunities generated by rural and urban infrastructure development. However, newer demands for forest produce are also emerging.

External drivers

Demographic transition

India had a large (61.6%) population between 15-64 years of age in 2005. This is projected to grow to 63.6% (2010), 65.2% (2015), and 66.3% (2020). Further, the birth rate (per 1000) is projected to decline from 26.5 (2000), 24.5 (2005), 23.0 (2010), 21.1 (2015), 19.4 (2020) to 18.1 in 2025. This transition will have an impact on the economy, employability and use of energy and natural resources such as forests, land and water.

Economic changes

The present GDP growth is hovering around 9%, and is expected to remain high in the next decade. The emphasis on urban and rural infrastructure development is generating large employment opportunities even for unskilled and semi-skilled workers. Substantial poverty alleviation efforts have been introduced recently in the form of the National Rural Employment Guarantee Act (NREGA) ensuring 100 days of employment to each needy household in rural areas.

Environmental concerns

The climate change debate has a major bearing on land use options, intensifying production and conservation pressure on land, water and forests. Perhaps, climate change mitigation will bring more investment into the forestry sector.
‘

Changing political and institutional environment

Although the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 (TFRA) has generated much concern for the conservation of forests because of recognition granted for the habitation and livelihood rights of forest dwellers, it also assigns responsibilities of forest conservation and assistance in SFM to local communities.

Technological changes

Emerging scenarios in forestry have necessitated the need for specific R&D support. Various frontline areas requiring R&D inputs include farm forestry/agroforestry; biofuels; forest certification; participatory forest management; forest nano science and technology; quality planting material; eco-friendly products and livelihood support systems.

The pace of sustained forest management will be determined by the economic analysis of the ecological aspects of the human environment, which have been in focus in the context of global climate change and the proven unsustainability of growth based on high input technology alone. The scenarios described here indicate the situation in 2020 based on the intensity of efforts needed for their attainment.

The business-as-usual scenario

Large expansion of trees outside natural forest areas will be feasible because of favourable markets. If the business-as-usual scenario continues, natural forests are going to be under tremendous pressure and this may cause damage to them. The non-forestry use of forest areas under the rights recognized under the provisions of the TFRA may proceed unabated if the documentation of the recognized rights is not taken in a time bound manner. The recognition of occupational rights on forests will achieve the twin goals of sustainable development in forests and enhancing income of the people living in and around the forest areas. The forests of the country will be meeting the socio-economic and ecological needs of the country. The demand for wood and wood products will be met mainly through import and production under agro-forestry/farm forestry.

Probable shifts and alternative scenarios

The promotion of agroforestry and farm forestry is likely to ease the gap between demand and supply. It may not be economically feasible for the urban and rural poor to continue with fuel head loads because alternative employment opportunities may be more remunerative and without much drudgery. This will help in improving the conditions of natural forests. Fuelwood and small timber will come more from trees outside forests than from natural forests. Efficiency in the utilization of biomass for energy purposes is a developing area with potential positive impact on the consumption of woody biomass.

JFM is now a well-recognized strategy for SFM covering about one third of the forest areas. However, the JFM modalities at present need more consolidation by way of an enabling environment for ensuring empowered participation in management to make them more effective in reciprocating for forest protection and sustainable development.

Promoting the cultivation of medicinal and aromatic plants is likely to have a favourable impact on the biodiversity of natural forests. The business model approach for processing, value addition and marketing of NWFPs is likely to reverse degradation and ensure increased returns to gatherers. Emerging systems may lead to higher gains for gatherers, sustainable management and greater availability of NWFPs.

The most likely situation

The future scenario is most likely to address people's emotional attachment to land, heritage and culture. Village institutions (such as JFM committees, community forest management committees and the *gram sabha*) responsible for resource management should be more empowered and directly engaged in programme implementation. The overall production of forest goods mainly from trees outside forests should rise. However, the maintenance of ecological balance and biodiversity conservation may gradually be confined to much smaller pockets of protected areas and other government forests.

Based on approaches with varying intensity of policy, management and programmatic interventions in future, a statement of measurable and monitorable criteria is presented in Table 28 with indications for 2020 in the three probable scenarios.

Table 28. Measurable and monitorable criteria

Criteria	Unit	Remarks		
		Business as usual	**Best case**	
Extent under forests	Million hectares	77.47	70	Diversions offset by compensatory afforestation
Diversion of forests	Growth rate (%)	5	1	Rate of diversion slows down with infrastructure development reaching a plateau
Forests under non-forest rights of forest dwellers	Percent of total	30	20	The forest rights are documented and frozen in the shortest possible timeframe
Forestry use of forests	Percent of total	75	80	Remaining forests under rights or infrastructure and non-cultivable category
Area under commercial plantations	Million hectares	5	5	Conversion of forests into plantations is not resumed
Plantation productivity	Growth rate (%)	0	100	Vast scope for intensive management with technology and investment
PA network	Percent of total forest area	25	30	No scope for expansion due to community pressure and production imperatives, apart from principles of biodiversity conservation across all the forests
Forest under community participation	Percent of total	30	50	Apart from JFM, forest right laws also recognize community control
Tree cover in non-forest common areas	Million hectares	14	20	Presuming that about 20% of the existing green cover is in this category, planted under social forestry
Agroforestry	Million hectares	10	30	Entire TOF is considered part of agroforestry
Green cover	Percent of geo. area	30	35	Depends on agro- and social forestry
Forest productivity	t/ha/y	1.34	2	Figures from NFAP (1998)
Rural livelihood	Share of forestry in HH income	Marginal	Substantial	No quantifiable indicators at present
NWFP production	Growth rate (%)	0	50	NWFPs grow faster with better productivity and management
Wood production (forests)	Growth (%)	0	50	Production from the EAP inputs of 1995-2005 starts yielding by 2020
Wood production (outside forests)	Growth (%)	0	100	Mainly from agroforestry
Import of wood	Percent of consumption	15	5	Imports fall with increasing production

5. VISUALIZING 2020

Forest cover

The forest and tree cover of 23.39% of the geographical area in 2005 is likely to touch 25% by 2008 and 30% by 2012. The goal is to bring 33% under forest and tree cover by 2020. TOFs in the form of farm forestry, agroforestry, homestead forestry, etc will bridge part of the gap. TOFs have immense potential for socio-economic and cultural development. The current trend in the forestry sector favouring promotion of agroforestry is likely to improve the tree-based use of agriculture substantially. The programmes on the cultivation of bamboo, rationalization of regulatory regimes for forest produce to favour cultivation in rainfed areas, realization of environmental preference for use of wood products in structural purposes, and improvement in technologies that boost efficiency in wood utilization have been driving the use and markets for wood-based material. These factors are expected to result in the enhancement of the area under agroforestry from about 10 million hectares (about 5% of the total agriculture area) at present to at least 20 million hectares in the near future. Further, about one third of India's total forests (22 million hectares) has already been covered under the JFM programme. It is likely that the major part of the remaining two thirds of forest area will also be brought under the participatory mode of forest management.

India's economic growth is being propelled by massive infrastructure development which obviously will need land in addition to other items/investment. The technology for efficient utilization of wood and wood composites has influenced remunerative agroforestry practices.

Area under sustainable forest management

Rising import of wood and wood products in India should make India among the influential players in the international market. This status can help India in promoting the agenda of sustainable resource management at the global level and evolve collaborative programmes and activities across the globe.

The major objectives of Agenda 21 of the United Nations Conference on Environment and Development (UNCED) related to forestry are to achieve conservation and rational utilization of forests and tree-based resources, to increase their contribution to overall socio-economic development and environmental protection, and bring improvements in people's quality of life (UNCED, 1993). ITTO's Objective (2003) supports SFM. In India, about 75% of forests are covered by forest working plans and management plans, which are scientific documents based on the principles of sustainable forest managemen, implying harvesting well within the regenerative capacity of the forests without jeopardizing the ecological services. The principles have so far served as an effective proxy for SFM optimising both the tangible and intangible values of forests. Although about 75% of India's forests are covered under systematic forest planning, 53% is reported to be deficient in natural regeneration. The balance between removal and the annual allowable cut (AAC) needs much closer scrutiny from the perspective of multipurpose measurement. The coverage of forest area under working plans is a good indicator for showing the progress towards SFM. India is committed to implementing monitorable measures for SFM.

Biodiversity and wildlife conservation

Various policies, statutes and action plans have been formulated by the Government of India for shaping the conservation of wildlife in the coming decade. These policy imperatives will continue to guide forestry in future.

The NFP has advocated maintaining genetic continuity among the protected areas (PAs). This has been reinforced by the Wildlife Conservation Service (WCS) as well as NWAP, which

call for bringing 10% of the land area of the country under the PA network by applying scientific approaches based on the principles of biogeography. The Wildlife Protection Act (WPA) has included two new categories of PAs, namely conservation and community reserves, in its 2002 amendment. This declaration does not lead to the drastic curtailment of the rights, privileges and concessions of local people. Hence, these categories are likely to play a key role in achieving the aim of 10% area under the PA network. With SFM governing the ecological functions of forests, the objectives and even strategies of forest and wildlife management indicate convergence. Thus, the island approach of wildlife management may see a shift towards conservation with specific approaches for specific biomes. The recently passed TFRA is likely to have a major influence on this process. It will allow only critical habitats within national parks and sanctuaries to be notified as PAs where coexistence with local communities is not possible. Thus, relocation of human settlement may be possible in the intentionally notified PAs only if it is absolutely necessary for long-term biodiversity conservation. The identification of such areas will be based on scientific and objective criteria as in the case of tiger reserves according to the recent 2006 amendment of the WPA. The management approach will need to take into account these realities and look towards 'inclusive protection/management' of habitats.

Conservation of rare and threatened wildlife species

The tiger task force and implementation of its recommendations will hopefully lead to the tiger population rebounding in most of its habitats. The setting up of the National Tiger Conservation Authority through suitable amendment to the WPA in 2006 was the first crucial step in this direction. The establishment of the Wildlife Crime Control Bureau will help curb the poaching and illegal trade of wildlife by organized intelligence gathering, strategic planning and execution of anti-poaching operations in the country. The identification of villages which need to be relocated out of critical tiger habitat is already underway for developing and implementing proper relocation plans. Similar strategies are being formulated and actions being taken for the conservation of other threatened species as and when required.

Another very significant tangible benefit from these reserves is tourism. More and more PAs are now coming into tourism circuits. The demand for eco-tourism is growing much more than what is being met right now. The choice of areas needs to expand out of the PAs to other forest areas. The eco-tourism approach is expected to see a change towards activities that are environmentally friendly, managed by local people and having a high component of conservation education.

By 2020 we may see an India with nearly 10% area under a network consisting of finally notified PAs, including scientifically identified inviolate spaces, landscape level plans and PA specific management plans; all nature-based tourism activities serving as true 'ecotourism'; illegal trade of wildlife and its derivatives under complete check; and human settlements in critical wildlife habitats relocated through appropriate resettlement packages. By 2020 we may see an India where every citizen respects wildlife and its habitat for the various services it provides for humanity and becoming aware of the moral responsibility for its conservation.

Wood and wood products

Production, consumption and trade of forest products

The trend of import of timber may continue so long as Asia-Pacific and African countries find it politically desirable and economically feasible to export. However, in the long run, it may not be a sustainable source of supply. Increase in the productivity of forests and creating a conducive environment for the growth of TOFs under agro- and farm forestry, homestead gardens, etc are expected to be pursued with vigour and will prompt substantial growth in production sector.

With respect to wood energy for cooking and heating, the trend indicates that more and more people among the urban poor and middle classes will gradually switch to LPG and other efficient energy sources. The rural population in peri-urban areas and villages away from forests will also find fuelwood more expensive and inconvenient to use and therefore they will also gradually switch over to other sources (such as LPG and non-conventional energy); however domestic requirements in rural areas will continue to depend on nearby forests. The rural population today has several employment opportunities in development works as well as assured employment through schemes like National Rural Employment Guarantee Act. Fuelwood collection and head load extraction may not remain remunerative.

State of forest industries

India's forest-based secondary industry encompasses a wide range of small, medium and large scale firms that process wood into a variety of products for the domestic market. With the improvement of productivity, net supply of wood products may improve. However, the principles of SFM and fair trade practices including eco-labeling of wood products might limit the wood supply from natural forests. In the circumstances, wood from trees outside forests, mostly agroforestry, will become the main source of raw material for industries. It is also likely that wood processing units will modernize and improve their efficiency to meet the growing demands of the house construction and furniture industry, infrastructure and other industrial requirements.

These developments are likely to support new processing technologies creating demand for small sized, lower quality wood that could be produced in short rotation in farms and on common land.

The existing paper and pulp mills have proposed to undergo substantial expansion in their capacity. With substantial expansion of education and knowledge infrastructure, pulpwood demand will escalate for paper, opening markets for farm forestry.

Country's share in global trade and probable changes in the context of alternative scenarios

Looking at the magnitude of domestic demand, it is less likely that India will have any export-oriented development in a decade or so. The enhanced capacity and new technologies will at the most take care of internal demand. However, there may be specialized export items like antique furniture and wooden toys, wood carvings and other small wooden products which in terms of volume and value will not be substantial.

Future forestry institutions

There have been remarkable changes in the social values and stakeholder expectations from forests in the recent past. Various studies on institutional reform supported by donors in different states highlight the inability of current work practices, structures, and culture to readily address the emerging complex issues of the sector and rapidly changing public demands (Om Consultants 2000). The new paradigms and new institutional arrangements that need to be adopted to guide the change will primarily depend on our understanding of the emerging trends of challenges and opportunities. These trends are sending signals for change, some of which might be even ahead of our knowledge and experience of the outcomes of the change.

The future of forestry institutions will be guided by the new vision, strategic direction, and measurable outcome that will be set for the sector. While maintenance of ecological balance remains the pre-eminent objective of forest management, contributions of forests to the

subsistence and livelihood needs of millions of rural poor, especially the tribal communities, is one of the primary considerations (MoEF 1988).

Reengineering of SFD

It is increasingly challenging for the development agencies working in forested areas to tune into the pace of fast changing socio-economic conditions and assertion of community rights. Generating employment opportunities has always remained a major task in these areas and this will become more challenging with the degradation of natural resources and growing social unrest.

Traditionally, the management of forests has remained exclusively with the state forest departments. The trend suggests that forest management will have to be based on local circumstances. The challenge will be to strike a balance between local and national interests. Many stakeholders of the sector are more prone to taking non-negotiable ideological positions which result in intractable conflicts among them. Power differentials among stakeholders also make it challenging for the SFDs to bring them to the negotiation table for the settlement of conflicting issues. Another challenge will be to significantly improve horizontal integration of forest plans with the plans of other sectors and vertical integration with the plans of the higher levels of governance in a manner that ensures livelihood security and minimizes conflict between economic development and environmental security.

Mobilizing adequate financial resources for SFM in developing countries continues to be one of the major challenges of the sector. India has been trying to bridge the budgetary gap by adopting various policy instruments. The private sector and civil society organizations have shown keen interest in participating in the management of the sector. Such opportunities need to be considered keeping their interest complementary to those of communities.

The recent policies on rural development and natural resource management of the Government of India and some states clearly indicate that the policy makers are promoting multi-level, multi-organizational and multi-sectoral interventions for sustainable natural resource management and livelihood security. There is widespread perception that the policy space for collaboration has expanded with the decentralization of governance. However, a beneficial change in the situation on the ground is not so visible. Three parallel approaches to local development are simultaneously being promoted by the Government, i.e. Panchayati Raj, JFM and cooperatives. However, despite substantial overlap in the principles of these approaches, it has been difficult to integrate them at the local level (Helling et al. 2005).

Meeting expectations of the stakeholders will require significant changes in the roles and responsibilities of the SFDs. They will have to forge different types of alliances and working partnerships with local bodies and other sectors. Each sector has a unique advantage that can be used to overcome the constraints of the SFDs. This will require proper changes in the structure and systems of the SFDs. Building multi-level, multi-organizational, and multi-sectoral relationships for convergent actions requires flexibility in the systems of the SFDs. The systems that require re-invention include planning, budgeting and approval; management information; and human resource development. The auditing system could include environmental audit as an integral part of the social audit. A long-term strategy will need to be compatible with improving governance, accountability and transparency in all spheres of the central and local governments, the corporate sector and community levels.

The introduction of innovative market instruments could help in bridging the budgetary gap of the forestry sector. A ‘Forest Fund’ has been created in some countries to overcome this problem that refers to constellations of approaches through which a portion of the state revenue is set aside for forestry purposes. The percentage of forest funding in the overall budget of the forestry sector in some countries is fairly high. Nearly a third of the United

States Forest Service's budget flows through special accounts and trust funds. The SFDs may be allowed to retain the revenue. India should also advocate on behalf of developing countries for increasing international assistance for the sector.

There is need for improved interactions between people and public servants.

The rising price of forest produce, growing interests in medicinal and nutritional values of NWFPs and the emerging trade scenario under the WTO regime are also creating significant investment opportunities for private organisations. The debate on private participation has remained polarized on account of the appropriate role for the industry and control over public forestland. New approaches need to be defined to create a win-win situation while addressing the concerns and apprehensions of stakeholders.

Effective management of human capital

The country's competitive advantage in a global economy and its ability to reduce poverty, to a large extent, will depend on the quality of research and education as development of the sector will be contingent upon creation of new usable knowledge and the availability of professionally qualified human resources. The appearance of new providers of tertiary education in a "borderless education" environment will provide greater opportunity for collaboration with international centres of excellence. Transformation in the modes of delivery and organizational patterns in tertiary education as a result of the information and communication revolution will go a long way to providing quality education at an affordable price. The rise of market forces in tertiary education and the emergence of a global market for advanced human capital will provide new opportunities for Indian universities.

Institutional response

The problems of the sector are gradually becoming more complex and challenging. The solution to these problems lies in the faster adoption of new technologies, products and processes. Attracting and maintaining competent and motivated human capital will require better human resource planning, a recruitment strategy for filling critical skill gaps and proper alignment with the programmes, orientation and training of employees, promoting specialization among senior employees supported by continuing education, developing the competencies of potential leaders, and strategies to create working environments conducive to creativity. The ICFRE should also synthesize research and aggressively push for its application by providing extension support. This will require changes in the appraisal system of the scientists. Priority should also be given to stimulate investment in forest science and technology. Involvement of the private sector and commercialization of the new technologies will require effective management of intellectual property.

Information and knowledge management

The pace of innovation has intensified markedly forcing rapid human-induced changes. Climate change is cautioning decision makers to consider the environmental implications of development initiatives. There is a growing realization that interdependence could be better understood by looking at the larger picture that requires capacity to analyze large volumes of data drawn from different sectors. The falling prices of computer hardware, the declining costs of data transmission and expanding communication technology will allow updating, retrieval and analysis of large volumes of data collected from even remote villages. It will also be affordable to regularly update spatial data with developments in remote sensing technology.

Institutional response

Forest information needs to be integrated with social, economic and environmental data. A central agency should be identified to integrate data from various states and sectors such that it can provide synthesized and distilled information to guide policies and decisions. The MoEF should identify and adequately resource such an agency. The SFDs should continue expanding electronic government services to their customers. This would facilitate speedy planning, online monitoring, and enhancement of citizens' online transactions.

A central agency may be assigned the task of developing a knowledge index such that the gap between India and other countries that are using relatively new technologies could be measured and strategies developed to bridge this gap. A knowledge management system needs to be developed to add value to information through synthesis and analysis.

Policy and legal framework

Forests and wildlife are in the concurrent list of the Constitution of India which has the provision for conservation of forest and wildlife under article 48A and 51A(g). The main responsibility of the central Government is policy and planning; implementation of activities related to forest and wildlife is with state governments. The National Forest Policy 1988 formulated four years before the Earth Summit embodies all elements of SFM. The National Forest Commission has reviewed the existing Forest Policy and recommended no change. The policies of other sectors such as the National Environment Policy 2006, National Agriculture Policy, National Farmers Policy 2007, Tribal Policy, National Land Use Policy, and National Policy on Biofuels will have an impact on the NFP. The NFP revolves around environmental and social aspects mainly. India has a strong legal regime to implement its forest policy. The protection of forest and wildlife is mainly through the Indian Forest Act 1927, Forest Acts of various states, Wildlife (Protection) Act, 1972 and Biological Diversity Act, 2002. India has enacted the TFRA to address the social aspect of forest policy. The Forest (Conservation) Act 1980 is maintaining a balance between conservation and development, and will also be effective in future for the conservation of forests in the country. The new legal regime in the form of the TFRA will enhance the contribution of forests towards poverty alleviation of the people living in and around forests. The role of communities will be more crucial in the sustainable development of forests in future. The country has to rationalize regulatory and policy constraints for trees grown on private land to motivate the private sector to grow more trees, which will facilitate achieving one third of the land area under forest or trees. A new grazing policy is needed to check the degradation of forests, particularly due to interstate movement of livestock and overgrazing beyond carrying capacity. India, as a member state of the United Nations, has agreed to contribute towards achieving the shared global objectives on the sustainable development of all types of forests through a non-legally binding international instrument. The country has a policy and legal framework to implement SFM and is in the process of developing mechanisms for forest certification.

Long-term shift in increased use of forests for their service functions

Climate change will affect agricultural production and most probably increase the pressure on forests. Climate change adaptation and reducing the vulnerability of forest eco-systems will become a major challenge in the management of the rural landscape in the near future. Climate modeling suggests that some traditional cropping patterns in semi-arid areas may become untenable because of increasing drought and unreliable rainfall and may be replaced by robust agroforestry systems. This would see the expansion of TOF which will offset the loss of crop productivity. Soil and water conservation will also require greater emphasis so there will be greater focus on forests and grasslands due to their known effectiveness.

Energy uses and their likely scenario

More than 55% of India's households belong to the low income group and cannot spend much money on energy. As the price of commercial energy is high the consumer will keep using traditional fuels and thus there is no reason to expect any dramatic energy switch in rural India. However, growing emphasis on biofuel such as biomass-based gasifiers and bio-diesel from *Jatropha, Pongamia* and other tree-based oils is expected to change the usage pattern of biomass for energy for domestic consumption. Further technological improvement may bring efficiency and cost reduction.

More and more people in urban peripheries are now switching over to non-wood-based energy sources. In urban areas during the last 20 years, there has been a substantial switch in energy consumption. The use of traditional fuels has halved in relative terms and been replaced by commercial energy sources.

With the expansion of farm-/agroforestry and other forms of tree growing, an abundant supply of fuelwood is expected in the close vicinity of villages. With the receding forests and self-restrictions imposed by JFMC members on unsustainable removal, the rural middle class population is expected to switch over to LPG and electricity in the coming decades. The new energy policy focusing on the development of biofuel resources may provide an economic energy option available to the rural and urban poor. As employment opportunities for the rural and urban poor are growing due to fast infrastructure development there may be disincentives for the rural poor to continue fuel head load removal as an economic option.

Future of NWFPs

NWFPs account for around 70% of forest-based export earnings. They provide 55% of total employment in the primary forest sector, with considerable multiplier effects in downstream processing and trade of some products.

The Government of India has empowered communities with the ownership of NWFPs for the purpose of collection, trade, value addition and marketing through a national level legislation. This is a milestone for enhancing the contribution of forests towards poverty alleviation of the 350-400 million people living in and around forests. Some of the states such as Madhya Pradesh and Chhattisgarh have adopted strategies for enhancing the income of forest-dependent communities through NWFP management and its value addition, trade, marketing and certification for quality control of the value-added NWFPs. The Government of India is now focusing on forest certification as well as certification for forest-dependent communities for quality control of value-added NWFPs to explore better markets.

The major challenge before the Government of India is to build community capacity with respect to sustainable harvesting of NWFPs, value addition, trade and marketing. More efforts are needed for inventorization of NWFPs and techniques for their cultivation and regeneration. India has national level legislation for ensuring benefits arising out of traditional forest-related knowledge (TFRK). More efforts are needed to document TFRK. The Government of India is looking positively to overcoming these challenges for enhancing the income of forest-dependent communities.

NWFPs account for around 70% of forest-based export earnings (US$500 million) and provide 55% of total employment in the primary forest sector, with considerable multiplier effects in downstream processing and trade of some products.

Management, including harvesting and trade of NWFPs, is at present handled by state agencies in the case of large volume products and the rest is generally available to communities. In some states, well-organized collection and trade systems ensure realization

of optimum value from markets, which is passed on to communities for collective and individual use, while setting apart a portion for regeneration of NWFPs. The new Forest Rights Act empowers forest-dependent community institutions to undertake sustainable management. This will imply that the management planning for NWFPs will be integrated with community institutions. In the event of conflict between SFDs and the *gram sabha*, at present there is no conflict resolution mechanism. However, in due course if the matter becomes serious the Government of India or Supreme Court of India may issue guidelines.

At present there is little R&D on aspects of sustainable harvesting limits. This is to be addressed by researchers who, based on inventorying and viable population research, could prescribe the harvesting time and quantity. Forest certification may also become a tool to provide a price advantage for gatherers as well as to ensure sustainable management. Forest certification regimes within the principles of SFM are expected to be internalized in community-based forest management.

Urban forestry

Rapid urbanization will mean an increased emphasis on urban and recreational forestry. This will include avenues, green belts, parks, gardens and recreational forestry. Urban forestry will play a vital role in the urban renewal programmes of the government.
The management of urban forests will be coordinated with the management of cities. They will be required to maintain natural forests' water and nutrient cycles, support flora and fauna and also provide recreational benefits for the population.
Mixed plantations will need to be revised along roads and avenues thus helping to establish green belts and also add to aesthetic value. Trees will be supplemented with herbs and shrubs.
Urban camp sites will be created in large cities to provide camping sites, other recreational benefits and serve as green belts.
Town planners are already making urban forestry an integral part of their plans. This trend will grow and spread to smaller towns and cities. Massive research and development support will be needed for urban forestry.

Forests and water

The looming environmental crisis was one of the main reasons for the Government of India to lay more emphasis on the environmental protection and conservation roles of forest in the 1988 Policy. Measures need to be continued with much vigour particularly to protect the upland watersheds outside the tropical belt, through forest conservation and afforestation, against increased erosion under degraded forests, sedimentation of water reservoirs, silting of irrigation canals, and flooding due to rapid run-off. Willingness to pay for environmental services, particularly for the quality and amount of water downstream is an important programme being tested in some locations in India. Upstream communities are being gradually oriented to practice organic farming and assist in watershed management. The downstream people benefiting from these interventions upstream have shown willingness to pay and compensate for the efforts of upstream communities. Apart from the Government, international and national NGOs are gradually getting involved in promoting these initiatives. It is hoped that in the next 5-10 years this mode of improving water supply will gradually spread to more areas particularly where urban water supply is based on this kind of situation.

Forests as carbon sequesters

Forestry development becomes crucial because the existing natural forest stands have already fixed a huge amount of carbon from the atmosphere. However, due to alarmingly increasing GHG content in the atmosphere, it is urgently required to trap this carbon increment on a long-term basis and on a massive scale. Considering the fact that the level of GHGs are rising very fast, the growth of carbon trapping should equal this pace or better even, be greater.

India has a potential of 175 million tonnes of carbon to be sequestrated annually through land use, land use change and forestry (LULUCF). The market instruments created under the Kyoto Protocol require cumbersome methodologies compared to the present potential of carbon credits. In India, considering the population and economic pressure, it is not possible to set apart land area for carbon sinks. The existing forests and areas outside forests need to be managed optimally for maintaining the optimum size of carbon sinks. The post-Kyoto commitment period deliberations are expected to provide workable mechanisms for accounting for the performance of countries in mitigation. India will be in a better negotiating position if its forests are in a better shape.

Social functions of forests

Local rights, admitted by SFDs during the settlement procedures for forest reservation, govern the use of forest resources by rural and tribal communities living in and near the forests. The plight of most of these communities is one of great hardship and the situation demands the settling of tenure issues and rationalization of the system of people's participation in forestry. These claims were registered and rights were adjudicated mostly at a time when India's rural population was much smaller than it is today. There should be a thorough review of the ways in which rights are considered and now used, in relation to present and predicted livelihood options. Such a review should be accompanied by a study of trends in rural demography, and the implications of government policies now operating and under consideration.

The tribal communities' way of life is woven around harmony with forests, and preservation of nature. The TFRK has been enacted for recognition of their traditional right of living in the forests.

Forest and employment generation

By the end of 2006, there was an estimated 22 million hectares covered by the JFM programme and out of 173,000 villages about 40% have been associated with the programme. This population has been depending upon employment and income from forests for about 150 days in a year. In terms of economic gain through wage labour, forestry operations (forest protection, nursery, plantation, tending operations, harvesting, post-harvesting and NWFP gathering) provide substantial cash income to the rural poor. In addition to NWFPs for sale, a certain quantity is also consumed locally to supplement food and nutrition. The value of herbs used for local health care has not been estimated but is very large. This trend of employment from forests may grow providing better livelihood opportunity. Markets for natural products in modern lifestyles and value-added NWFPs, crafts and products are increasing, providing more opportunities for generating gainful employment.

An overview of the future of the country's forests and forestry in 2020

Strengths

India has been implementing sustained yield-based forest management practices for the last 140 years and has adopted the principle of SFM since the inception of the National Forest Policy 1988 which embodies all elements of SFM. India has a strong legal, policy and institutional framework for implementing strategies for sustainable development of forests. There is a shift in the policy, legislation and institution for involvement of people in SFM with benefit sharing. The empowerment of people with the enactment of national level legislation for recognizing their rights on forests will definitely impact the institutional and legal regime of the forestry sector. The role of the Forest Department will be marginalized and will be replaced by community-based institutions. The Government of India has to face the challenge of building community capacity to maintain a balance between meeting their needs for sustenance and livelihood and maintaining ecological security of the nation. The

Constitution of India provides specific provisions for wildlife conservation. India is practising in situ conservation of wildlife through the protected area network of more than 600 national parks, sanctuaries, biosphere reserves and community reserves. Special efforts are being made for in situ conservation of the tiger population. India has to explore support at international forums to save the tiger. The role of trees grown on private land will be crucial to meet the demand for wood and wood products in the country. The Government of India is creating an enabling environment for growing more trees on private land. The National Farmers Policy 2007 provides sufficient space for agroforestry and NWFPs to enhance the income of farmers. The forest resources of India will be treated as social and environmental resources in 2020.

Challenges and threats

India's forests are under heavy multiple pressures. The requirements for fuelwood, timber and other forest products are much more than those available sustainably from forests. The deficit in demands and availability of forest products, which is already extremely large, will further increase in future with the increase in population. The fodder situation is also not satisfactory and results in large scale overgrazing and extensive cutting in forest areas. The problems confronting the forestry sector in India are well known. A random listing of these problems is given below:

1. Loss of forests through diversion, encroachment and degradtion (including desertification and soil erosion).
2. Declining forest productivity through overuse beyond sustainable limits.
3. Inadequate investment in afforestation and forest protection, management and development — inability to fully implement full multiple use/protected area management.
4. Inadequate rural energy sources and lack of viable alternative energy for rural communities.
5. High cattle population with low productivity in rural areas and inadequate fodder production resulting in very high grazing pressure on forest areas.
6. Lack of capacity of the people living in and around forests to implement SFM.
7. Forest fire and shifting cultivation.
8. Inadequate regeneration and enrichment planting to restock/rehabilitate degraded forests.
9. Inadequate distribution of protected areas for full representation of biodiversity and ecosystems.
10. Ever-increasing biotic pressures on forest research and extension in bringing knowledge and technology to the field.
11. Inadequate extension support to farmers for agro/farm forestry — lack of appropriate agroforestry production models and other extension service.
12. Over-reliance on rules and procedures of forestry organisations rather than on productivity and efficiency.
13. Inadequate and non-prioritised forest research and extension in bringing knowledge and technology to the field.
14. Inefficient forest industry in terms of scale of operations, equipment, technology, management, shortage of raw material, protection, etc.
15. Inadequate infrastructure and institutional support for marketing and distribution of wood and NWFPs.
16. Insufficient database and information systems for resource utilisation and management planning.
17. Lack of effective national and state land use policy planning and relationalisation of priorities.
18. Breakdown of linkages between technical forestry issues and financial planning.
19. Forestry education is not abreast with the latest developments in the forestry sector.
20. Lack of viable economic/social alternatives for rural poor and tribal people.

21. The vast potential of biodiversity and NWFPs found in forests is not reaped fully.

6. CREATING A BETTER FUTURE

Responding to the changing societal needs

India has undertaken a number of initiatives, adopted diverse strategies, policy and associated instruments to create an enabling environment for the sustainable management of forest resources. However, a number of socio-economic challenges have come to the fore due to rapidly changing societal needs which directly and at times indirectly, impact sustainable forestry development in India.

The population projection for India under the realistic scenario (2000-2025) shows that the population of the age range of 15-64 years will be 66.3% by 2020. The median age will be 27 years. This will mean growth of the manufacturing sector to meet the ever-increasing demands of the population for housing, furniture, paper use, ecotourism, quality water and environment. All these needs will require well-managed forests in rural landscapes and green spaces in urban areas. The growth will also heat up the climate change debate and necessitate emphasis on clean development mechanisms (CDM), including green environments wherever feasible. The recent National Rural Employment Guarantee Act, Bharat Nirman and the Backward Regions Grant Fund are aiming to improve the socio-economic conditions of rural and urban poor by providing gainful employment and at the same time catering to better living conditions through urban and rural infrastructure development. This is likely to improve the income and consequently the purchasing power of the people.

The concept of people's participation in forestry has gained momentum in India, and there have been a number of initiatives to ensure participation, as seen in the different models of JFM. In view of the large dependence of communities on forestry as a source of sustainable livelihood there is a need for higher and well-organized participation. Local organizations such as cooperatives are still at the building stage and are not strong enough in forestry. Strong cooperative movements across the country would lead to better societal involvement.

Shifting cultivation in the Northeast, which so far has affected an estimated 10 million hectares of forestland, is likely to decline as it is gradually becoming more labour- and other input-intensive. Some of the abandoned shifting cultivation areas in one of the northeastern states, Tripura, have been brought under rubber and bamboo plantations. Other models have also been on a small scale. A substantial number of former shifting cultivators are now associated with rubber plantations. It is expected that with government, NGO, and civil society intervention, people will become organized and spend their newfound wealth in the creation of assets. One of the impacts could be intensification of agriculture for the land-owning population and alternative employment avenues for landless people. In agriculture, there may be diversification. Species suited for agro- and farm forestry, horticultural and medicinal use could gradually be planted in increased proportions by the land-owning population. Ultimately, the rural ecosystem may see layered crop sequences providing income throughout the year.

The manufacturing sector related to forestry is likely to further develop in the form of capacity expansion of paper and pulp and other processed woods. With increasing private participation and as an outcome of market forces it is likely that more investment-friendly legal tools will be devised. Already a number of initiatives have been taken at the government level. SFDs will also be required to make certain changes. All these initiatives are likely to contribute to the sustainable development of forest and tree resources.

Policy changes within and outside the forestry sector

India has a number of policies and associated instruments. The objectives of forest policies (and legislation) are now more diversified and comprehensive. Moving from a perspective that focused on wood as a sustainable resource, they now address a wide range of private and public goods and values, and acknowledge the equal importance of production as well as conservation. The policies on natural resources which are to reflect national aspirations with regard to their use and management are likely to involve various stakeholders with the government. They are considered to be more effective if conceived and implemented in conjunction with other public policies and in consultation with stakeholders. Accordingly, there has been growing demand for adapting forest policies (and legislation) to new social and economic developments.

Policy goals envisage the roles of forests as multifunctional resources for economic potential and for importance to the environment. In order to meet the challenges to support higher levels of population and a better standard of living, a rational Land Use Policy was adopted five years ago, and the National Environment Policy in 2006.

The policy-making scenario has also oriented fundamentally towards multilevel policy networks, privatization and increased democratic participation. The distinction between private enterprise and public administration is becoming increasingly permeable. A major challenge for India's forest policy is to develop consistent approaches and adaptive political and legal frameworks consistent with SFM. There is need to redefine the roles of private and public sectors, and to find equitable and effective balances between the benefits and responsibilities of stakeholders. This can also help promote stakeholder synergies and avoid or reduce suspicions and conflicts. International agencies, donors and NGOs are active in the forest policy arena in some tropical countries to provide support in developing policies and laws that are transparent and responsive to people's needs. In the case of India, the National Forest Policy 1988 embodies all the requirements in attaining the goals of SFM.

There are difficulties in some cases in law enforcement in the forestry sector, not due to the lack of policy and legal frameworks, but due to gaps in implementation, inadequate capability and insufficient funds and human resources. The involvement of the private sector in forestry is currently under the active consideration of the government. Once the modalities are finalized it may be possible to attract private investments for ensuring SFM.

According priority to inter-sectoral policies

Although conservation of natural resources, particularly forests and wildlife, has linkages with several key sectors of the society, it has not yet been befittingly *mainstreamed* into the *core business* of other allied sectors for effective management. Mainstreaming is required both for multiple benefits and staggering losses, emanating from forest and wildlife conservation, that affect, influence and impact all sectors and strata of the society. Conservation imperatives enjoin that there is a need to look beyond forest and protected area boundaries into the wider landscapes and seascapes and elicit active cooperation and support from all stakeholders. There is a need to sensitize and garner support from the entire gamut of stakeholders by establishing linkages through joint programmes and projects. Forests and wildlife should be managed by adopting an *inclusive management* strategy so that multiple benefits can be accrued from conservation and sustainable use for a wide array of stakeholders.

The sectors having direct and indirect linkages with the forestry sector are numerous and range from the judiciary to agriculture and animal husbandry. Institutionalizing the linkages is a key issue and needs to be achieved through a variety of ways. Sensitization and capacity

building through focused training programmes of the personnel of these sectors is considered as the most important way to achieve this goal.

There is a need for land use planning to meet the challenges created by rising demand for land, particularly forest land. Besides the local pressure exerted by demographic escalation in the agrarian rural population, there is an increasing competition for land for mining, infrastructure, housing, tourist facilities, hydropower generation and water supply. Without central or state level codes for integrated land use planning, and without clear guidance on priorities for selection between incompatible land uses, it is inevitable that central and state governments will prefer the higher financial yields apparently available in short-term non-forest use. This provides another good reason for using total economic value (TEV) in land use planning and coordination, where TEV includes forest services as well as forest goods.

The 'development sectors' include among others, ministries and departments of agriculture, animal husbandry, veterinary medicine, public health, water resources, tribal welfare, rural development, and tourism. These sectors also have both human and financial resources, which need to be appropriately harnessed for biodiversity conservation. The 'regulatory sectors' include revenue, the judiciary, police, army, paramilitary, customs, excise, etc and have the mandate to prevent crimes and prosecute offenders indulging in poaching of wild animals, plant species and forest products as well as those involved in the destruction and degradation of forest resources. It is important that personnel of both the sectors are appropriately sensitized with the aims, objectives, mandate and vision of forestry and wildlife.

There are developments that indicate attaching high priority to inter-sectoral planning. The Central Government plans to electrify all rural areas by 2009. The likely impact this magnitude of electrification is expected to have on fuelwood consumption, which is currently estimated to comprise 85% of woody forest harvest by volume, will require in-depth study. As discussed earlier, the middle income group may use some of the electricity for water heating and even for cooking. Secondly, there is very little private, communal or revenue land available for intensification of agriculture. The absolute number of the rural poor will continue to rise in spite of urban drift and the pull of construction jobs for unskilled labourers in cities. The provision of rural livelihoods requires intensification of agriculture even in marginal areas and/or more opening of notified forestland for licensed agroforestry schemes. However, relevant studies on the extent and intensity of changing demographic pressure on forest boundaries are lacking and may be necessary to answer the above situation in coming years.

Involvement of civil society and NGOs

The level of civil society involvement in SFM varies, depending on the level of awareness which at present is low. Civil society involvement is often peripheral in nature. There is a need for enhancing people's participation and incorporating multiple groups of interest in policy and programme formulation, including NGOs, ethnic groups, rural communities, ecologists, international organisations and others. This intervention is necessary to generate the interest of society in forest and natural resources and in all the environmental benefits associated with them.

The National Forest Policy 1988 envisaged a limited role for NGOs as catalysts in rural development. There are many NGOs and NGO groupings in India which have the strength and experience to support communities in organizing themselves, to provide training, to deliver extension services, to identify income generating activities, to facilitate market access, to develop microplans and other activities in JFM. NGOs could play an important monitoring and communication role between communities and forest services.

External assistance in forestry

External assistance is sought in the forestry sector for augmenting insufficient resource availability from internal sources.There is a lack of means for implementation of SFM, particularly in developing countries including India. There are two windows namely the National Forest Programme (NFP) and Programme on Forestry (PROFOR) available for getting financial resources to implement SFM. The NFP is being operated by FAO and provides US$300,000 for three years. India does not have an NFP facility. The Japan Bank of International Cooperation (JBIC) is the main funding agency in the country for providing soft loans to the forestry sector in India. The country needs around US$1.5 billion annually to implement SFM. The forestry sector is getting around 30% of this need from the national budget.

There is big gap between need and availability of funds. India is advocating the establishment of a Global Forest Fund dedicated to supplement national efforts in the implementation of SFM, particularly in developing countries. Another key area in the country is to build capacity of local communities living in and around forests for implementing SFM. The communities have been empowered with the ownership of minor forest produce and the right to conserve and protect community forest resources. Communities may not be able to implement SFM without strengthening their capacity. Around 350-400 million people are dependant fully or partially on forests and most of them have been assigned the right to protect and conserve forests through national level legislation. This is a key area to attract the attention of external assistance to supplement the efforts of India to build the capacity of the people for implementing SFM.

Institutional changes

A number of relatively new institutions are gradually becoming prominent to influence forestry development in India. JFM is more than 17 years old. The Gram sabha (an assembly of elected villagers) is emerging as another powerful rural decentralized governance unit. In the wake of the Forest Rights Act 2006 the Gram Sabha is to be vested with SFM and sustainable use of scarce forest resources. This institution has the onerous responsibility of addressing the bona fide ownership and livelihood issues of forest dwellers and other rural poor and at the same time assisting in the conservation of forests and biological diversity for posterity. Historically, forests and people have co-existed in harmony which is reflected by higher per capita forest area in tribal dominated areas. The Forest Department will also have to maintain a balance between conservation and livelihood and for this to transpire it should have a flexible approach to be relevant in conflict resolution and framework development.

Rural youth is attracted towards urban areas resulting in migration. According to an estimate, the present trend of over 70% of the population living in rural areas may decline to 50%. The exact magnitude will depend upon how quickly national development priority addresses the development needs of rural areas providing urban types of facilities. In either case there is going to be more pressure on urban land for housing and other facilities. The availability of green space will become scarce. There may be more trees on road sides and in other public places. The pressure on existing green spaces will increase and people will be seeking alternative sites. The agricultural land in the vicinity of urban areas may be acquired by well-off urbanites to develop farm houses and resorts. This may indirectly create pressure on forest areas as dispossessed farmers may encroach upon forestland. Civic bodies will have a greater role to plan urban growth in this context.

In order to get maximum advantage from NWFPs and medicinal plants, one can see the advent of self-help groups, cooperatives and other institutions. Civil society and NGOs will also have a greater role in providing institutional support to forest-dependent people.

Technological changes

The dynamic dimensions of science and technology ensure that the frontiers of knowledge are continually expanding; answers/solutions are being found for problems and sustainable development is being enabled. This applies also to forestry. The technological base of forestry should be strengthened and modern technologies, which are available, should be put to use. Research and education in agriculture and forestry must give more attention to productive technologies related to appropriate land use. This should also be given a greater emphasis in the programmes for education, extension and training in agriculture and forestry. Land survey and classification should be expedited with the use of modern methods such as satellite and aerial surveys supported by ground surveys. Multiplication of appropriate species can be accelerated by the use of modern technologies relating to tissue culture, clonal propagation, etc.

Technology demands that the adoption of the appropriate land use should be supported by a total treatment of catchments and watersheds. A master plan for the treatment of catchments and watersheds, particularly in those areas where the land resource has been substantially eroded or degraded, should be prepared and implemented within a specified time limit. The prescription of land use may itself not lead to the expected levels of productivity. Enforcement of land use should, therefore, go hand in hand with adequate investments in the protection, shaping and management of the land mass both at the macro as well as the micro level. Urgent action is therefore needed for the preparation and implementation of integrated watershed management projects.

Clonal plantations of eucalyptus and poplar have revolutionized production forestry, while the natural forests of teak and sal (*Shorea robusta*) have been giving an increment of 3-5 m^3/hectare/year. The plantations of eucalyptus and poplars are giving an MAI of 20-60 m^3/ha/year. The use of quality planting material will become the norm for all future forestry plantations and drip irrigation and the watershed management approach will become traditional modes of plantation management.

National R&D institutions in many cases need to be strengthened with more funds, facilities, clear plans and priorities. Available research information and results have to be properly disseminated and converted into technological packages for adoption. The irrelevance of research conducted without appropriate problem analysis or consultation with clients about their needs, is often an issue.

GIS and remote sensing technology are going to be used in greater proportions than presently for forest management decision making. Detection of fire and illicit felling will become easier by equipping frontline foresters with modern tools such as global positioning systems (GPS) and mobile phones.

NWFPs including medicinal, aromatic and dye plants will be in greater focus. Technology upgrading will ensure better use of bamboo resources. There is some technology using bamboo for manufacturing bamboo plywood. More technological applications will improve the economic returns from bamboo. Technology upgrading in paper and pulp mills, and other processed-wood and saw mills will have to be implemented to play a key role in the business of forest-based employment, income generation and export.

Technology will also be used for collection of data and preliminary analysis, preparation of digital maps and other purposes. Judiciaries will demand more technological databases for effective and quick delivery of justice.

The Right to Information Act is another area which is likely to reduce instances of subjective judgment. This will improve public access to the implications of forest management decision making.

7. CONCLUSION

The forestry sector in India has traditionally been one of the most organized sectors with more than 140 years of scientific management. However, of late, like other sectors it has been affected by several factors among which are rapid increase in human and livestock population, insufficient infrastructure, inadequate investment and diversion of forestland for agriculture and developmental activities. In addition, there are several other problems which are unique to the forestry sector. These include inadequate public awareness about multiple functions of forests, undervaluation of forest contribution to GDP, technological weakness, insufficient funds and lack of community capacity.

Sustainability of forest ecosystems is an essential component of environmental conservation efforts and any degradation of forests will have an adverse impact on various systems such as water resources, agriculture, biodiversity, environment, climate change and human health besides the subsistence and livelihood opportunities of forest-dependent communities living in and around forests. Having about 2.5% of the world's geographic area, India is supporting 16% of the planet's human population and 18% of the cattle population. About 41% of forest cover has already been degraded and dense forests are also losing their crown density. A large percentage of India's livestock population grazes in forests causing damage to regeneration and productivity.

The requirements for fuelwood, timber and other forest products are much more than what is available sustainably from forests, although the deficit is being met from agroforestry and imports. The deficit of forest products compared to demand is extremely large, which will further increase in future with increase in population, high economic growth and rise in literacy levels. It is also to be noted that availability of NWFPs and their value-added products are vital for the economy of 350-400 million rural people living in and around forests.

The National Forest Policy was revised in 1988 with the principal aim of environmental stability and ecological balance, including atmospheric equilibrium, which are vital for the sustenance of all life forms. This policy gives priority to the sustenance and livelihood needs of the forest-dependent communities, particularly tribals and also involves them in protection, conservation and management of forests. The present forest policy was formulated four years before the Earth Summit which embodied all elements of SFM. India' forests are primarily considered as social and environmental resources. India at present has assigned more than 22 million hectares of forests to the community under JFM with benefit sharing mechanisms.

India made efforts to recognize the tenurial rights of tribals on forests with the issuance of guidelines to state governments in 1990. India has also taken a milestone step to provide occupation and habitation rights to forest-dependent communities living in and around forests through national level legislation along with the right to protect, conserve and regenerate forests. Community decision making will increase in future. The empowerment of communities with ownership of NWFPs for the purpose of collection, processing, trade and marketing is a key step for improving the economy of forest-dependent communities. The Government of India has to anticipate building their capacity further.

India has strong legal, policy and institutional frameworks for the sustainable development of forests in the country. The institutional framework is shifting from a regulatory to a participatory mode of administration, and it will be more people-oriented in future. The promulgation of the Forest Conservation Act 1980 was a milestone step in the history of forestry for the conservation of forests. The Wildlife Protection Act provides a legal regime for wildlife conservation in the country. India is in the process of amending the Indian Forest Act 1927 with respect to the people-oriented approach of the National Forest Policy 1988. The Schedule Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 assigned rights to protect around 40 million hectares of community forest resources

to village level democratic institutions. The fine tuning of other forest-related legislations is needed with respect to the said Act. India recently reviewed its forest-related policies and legislations through the National Forest Commission. The Commission has also given certain recommendations for the sustainable development of forests without suggesting any amendments in the National Forest Policy, 1988.

The major task before the country is to rehabilitate degraded forests and increase their productivity, augment the contribution of forests towards poverty alleviation of the people living in and around forests, and extend the area under forest and tree cover to 33%. The lack of capacity of the community and inadequate investment are the major challenges for the country to overcome the constraints in the implementation of SFM. The country has taken steps for addressing regulatory and policy constraints for trees grown on private land to achieve 33% forest and tree cover. Another big task for the country is to bridge the demand and supply gap of wood and wood products. The demand and supply gap will be bridged mainly from import and private sectors in the country. India will be a considerable market for wood and wood-based products and its demand will more than treble by 2020. India's forests will be fulfilling the socio-economic needs of the people living in and around forests and ecological security of the nation in the future.

It is very important to understand the multidisciplinary function of forests. Overgrazing is causing degradation to forests. A separate grazing policy is urgently needed. The forestry sector is impacted directly by the policies of other sectors such as agriculture, rural development, panchayati raj, education, energy, and water resources and indirectly by the policies relating to petroleum, chemicals and fertilizers, and industry and commerce.

There is a need to invest more than US$1.5 billion in the forestry sector to implement SFM. The contribution of the national budget is around 30% of this need. There will be more investment by private entrepreneurs to grow more trees in the agroforestry sector. India has developed an innovative funding mechanism at the national level to supplement the efforts of the state governments in the implementation of SFM. India has also enacted the National Rural Employment Guarantee Act, 2005 to provide assured employment of 100 days to the adult members of each family. Afforestation and plantation are activities under this scheme. Huges financial resources are available for plantations and afforestation.

India is looking forward to overcoming the challenges induced by high human and livestock population, change in demographic structure, poverty in forest fringe areas, high economic growth, particularly in urban areas, and climate change, with policy and legislative interventions along with capacity building of community and R&D for high productivity in future. India will be a net importer of wood and wood products but must focus on production forestry to become self-sufficient in wood production. The forest and tree cover will expand but the quality of forest may suffer due to grazing and domestic energy requirements in rural areas. Communities will play a crucial role in the implementation of SFM by 2020. The ecological security of the nation will be maintained through the protected area network.

8. REFERENCES

Asuncion-Mund, J. (2005). *India rising: a medium-term perspective.* Deutsche Bank Research May 19, 2005 - India Special.

Bahuguna, V.K., Mitra, K., Capistrano, D., Saigal, S. (eds.). (2004). *Root to Canopy: Regenerating Forests through Community State Partnerships.* Winrock International India/Commonwealth Forestry Association India Chapter, New Delhi, pp. 309-316.

Bhat. (2003). Production potential and cost benefit analysis of agriculture and agroforestry system in Northeast India. *J. Sustain. Agric.*, **22**, 99-108

Bhattacharya, P., Hayat, F. (2004). Sustainable NTFP management for rural development: a case from Madhya Pradesh, India. *International Forestry Review* **6** (2) 161-168.

Central Statistical Organisation. (2004). *National Accounts Statistics*. CSO, New Delhi.

Chakravarti. (1985). Some observations on fuelwood forestry in India. *Journal of Tropical Forestry* **1** (1): 1-14.

Chopra, K., Kadekodi, G.K. (1997). *Natural Resource Accounting in the Yamuna Basin: Accounting for Forest Resources*. Project Report. Ministry of Environment and Forests, New Delhi.

Conclave of Congress Party Chief Ministers (7th: 23 September 2006: Nainital). *Times of India*, New Delhi.

Food and Agriculture Organization. (1997). Integrating criteria and indicators of sustainable forest management in the national forest programmes. Working document. FAO. Rome

Forest and Wildlife Statistics INDIA-2004, Ministry of Environment and Forests, Government of India, New Delhi.

Forest Survey of India. (1995). *State of Forest Report*. FSI, Dehradun Forest Survey of India (1995). *Extent, composition, density, growing stock and annual increment of India's forests*. FSI, Dehradun.

Forest Survey of India. (1999, 2001, 2003, 2005, 2007) *State of Forest Reports* - 1997, 1999, 2003, 2005. FSI, Dehradun.

Haripriya. (2003). *National Energy Map for India: Technology Vision 2030*, New Delhi.

Helling et al. (2005). Linking community empowerment, decentralized governance, and public service provisions through a local development framework. Social Protection Discussion Paper. The World Bank.

India. Ministry of Environment and Forests (1988). P65 National Forestry Policy (1988). Ministry of Environment and Forests, New Delhi.

India. (1999) *National Forestry Action Plan India*. Ministry of Environment and Forests, New Delhi.

India. Ministry of Environment and Forests (2006). *Study of Alternatives for Meeting the Demand of Raw Materials by Wood-Based Industries*. Ministry of Environment and Forests, New Delhi.

India. Ministry of Environment and Forests (2006): *Compendium of Environmental Statistics*. Ministry of Environment and Forests, New Delhi.

India. Registrar General of Census. *Census of India* 2001, 1991, 1981, 1971, 1961, New Delhi.

India's Forests. (2007). Ministry of Environment and Forests, New Delhi.

International Tropical Timber Organization. (2003). *Achieving the ITTO objective 2000 and sustainable forest management in India.* ITTO.

Inter-governmental Panel on Climate Change. (2007). 4th Assessment Report. WMO, UNEP.

Manoharan, T.R. (2000). Natural resource accounting: economic valuation of intangible benefits of forests, RIS Discussion Paper # 04/2000, Research and Information System for the Non-aligned and other Developing Countries, New Delhi.

National Forest Commission, New Delhi. (2006). *Report on the recommendation of National Forest Commission*. Ministry of Environment and Forests, New Delhi.

Om Consultants. (2000). Forest sector institutional framework study for the World Bank: Paper for the Workshop on Policy & Institutional Study, Om Consultants (I) Pvt. Ltd.

Pandey, D.N. (2007). Multifunctional agroforestry systems in India, *Current Science* **92**(4): 455-463.

Prasad and Bhatnagar. (1990). Socioeconomic potential of minor forest produce in Madhya Pradesh. *SFRI Bulletin* No.26. State Forest Research Institute (Jabalpur, Madhya Pradesh) India.

Prasad. 2006. Strategy for sustainable forest management in India National Status Report for ITTO Mission to India (Sept.2006) Ministry of Environment and Forests, New Delhi.

Ravindranath et al. (2006). Sustainable community forest management systems: a study on community forest management and joint forest management institutions from India. *International Review for Environmental Strategies* **6** (1).

Saigal et al. (2002). The role of private sector enterprises in the Indian private sector. A research report prepared in collaboration with IIED, London.

Saxena. (1999). *NTFP policy and the poor in India*. Planning Commission, New Delhi.

Shiva. (1993). Technology scenario in Asia-Pacific forestry sector. *In:* APFSOS working paper no.25. FAO, Rome.

United Nations Conference on Environmental and Development. (1992), (1993). Proceedings. UNCED, Geneva.

Verma, M. (2000). Economic valuation of forests of Himachal Pradesh (mimeo). Indian Institute of Forest Management, Bhopal.

Wildlife Institute of India. (2008). *Status of tigers, co-predators and prey in India*. WII, Dehradun.