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Information Compendium on Kerala Forestry Sector
(Final Report of the Project No. KFRI 511/2006)

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PROJECT PROPOSAL

1. Project number : KFRI 511/2006
2. Title of the project : Information Compendium on Kerala Forestry Sector
3. Objective :
 - a) To bring out information bulletins on selected themes of public interest related to forests in Kerala based on relevant facts and figures.
 - b) To consolidate the information bulletins into an information compendium on Kerala forestry sector.
4. Expected outcome : Information of public interest on the forestry sector of Kerala to the people concerned in an easily accessible form.
5. Date of commencement : April 2006
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7. Funding agency : KFRI Plan Grants
8. Project team
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EXECUTIVE SUMMARY (Highlights from the bulletins)

Forests have important ecological, environmental and economic roles to play and are essential for survival of human species at the current level of technological development and hence its preservation is of utmost importance.

Forests in Kerala mostly confined to upland occupy about 23 per cent (as officially declared) of the land area of Kerala. Because of the large population, the per capita forestland in the State is 0.04 ha which is much low compared to the national (0.08 ha) or global figures (0.62 ha). However, the total forest cover as defined by the Forest Survey of India extends over 40 per cent in the State including trees outside forests.

According to the remote sensing based stratification, moist deciduous type covers the maximum area of forests (43.62%) followed by evergreen and semi-evergreen (35.1%). Dry deciduous type shows least coverage under the phenological classes (1.06%).

During the last three and a half decades, the percentage area under evergreen forests came down to 34 per cent from 49 per cent in 1972. Primary moist deciduous forests which constituted 30 per cent of the total area in 1972 is now confined to just 2 percent, the rest being transformed to secondary moist deciduous forest. Subsequently, there were changes in species composition with dominance of light demanding species.

The State forests have a rich diversity of flora and fauna comprising as many as 11,840 plant species and 8,452 animal species. Biodiversity must be protected not only for purely ecological reasons but also because it sustains livelihoods.

Wildlife is an integral part of forests in Kerala, as elsewhere. A total area of 2630.49 km² has been brought under Protected Category in Kerala which is 23.3 per cent of the total forest area. Crop damage by wild animals in agricultural fields adjoining the forest areas is very heavy. Against certain animals, deep trenches seem to be more practical compared to electric fences, which are presently being promoted under various government schemes.

On a rough estimate, Kerala has about 2000 sacred groves, which are distinct and unique in biological diversity. Sacred groves which were once part of the culture are fast disappearing due to anthropogenic pressure. Sacred groves are important not only with respect to biodiversity conservation but also by the many beneficial effects they provide to the local environment.

Myristica swamps are a special case of swampy vegetation largely confined to certain pockets in southern Kerala occupying not more than 0.014 per cent of the total forest area of Kerala. The enormous biodiversity of the *Myristica* swamp forests is noteworthy. Conservation of these small and scattered swamp patches needs immediate attention.

Mangroves are salt-tolerant forest ecosystems found mainly inter-tidal regions. Presently, the extent of undisturbed mangroves in Kerala is reduced to just 150 ha mostly distributed in Ernakulam, Kannur and Kozhikode Districts but the potential area comes to around 1670 ha. Destruction of mangroves increases the vulnerability to the calamities and disasters arising out of losing a natural barrier to the fury of the seas.

Forest plantations occupy about 14 per cent of the area under forests in Kerala. Teak and eucalypts have been the principal forest plantation species. Enhancement of productivity of the plantations has been a major issue in the past, which calls for much research effort.

Home gardens in Kerala carry a significant stock of trees which also contribute towards the environmental benefits accrued through tree vegetation and can be taken as a form of agroforestry.

Social forestry is the practice of growing trees in non-conventional forest areas for the benefit of the society. Under the World Bank aided Social Forestry Programme implemented in 1980's in Kerala, around 20,000 ha were brought to plantations of *Acacia auriculiformis*, *Eucalyptus tereticornis* and *Casuarina equisetifolia*.

Non-wood Forest Products (NWFPs) play an important role in the rural economy of Kerala. There are about 550 species utilized as NWFP which includes medicine and narcotic, gum and resin, tan and dye, oil and fat, spices and condiments, food and fodder, fibre and floss, bamboo and cane, insecticides and leaves. One of the major problems for management of NWFP is the absence of suitable marketing channels for these products. However, overexploitation has led to rarity of certain species.

Of the many bamboo species available, 22 species and two varieties belonging to six genera are recorded as native to Kerala. Natural forests and home gardens are the sources of bamboo in Kerala. *Bambusa bambos* is the most common commercially important bamboo species in the home gardens. Palakkad is a major outlet for export of bamboo to neighboring states but the quantity traded has been coming down over years due to depleting growing stock in homesteads. At present, the Kerala State Bamboo Corporation is the main agency concerned with collection of reeds from forests, distribution of reeds to the registered mat weavers and sale to other traditional workers.

Around 14 species of cane are found growing in Kerala. The range of indigenous uses of rattan is vast, from bridges to baskets, from fish trap to furniture, from crossbow strings to handicraft items. The resource depletion of cane in natural forests has led to large scale import of the same to Kerala from north eastern states particularly Assam and Arunachal Pradesh.

Eco-tourism has taken off in a big way in Kerala resulting in phenomenal increase in both the tourist arrivals and earnings from tourism. With increasing urbanization and focus on wildlife and natural ecosystems, Sanctuaries and National Parks are favorite destinations for tourists. Though this eagerness is encouraging, unrestricted tourism in the protected areas may pose a serious threat to the wildlife and their habitats.

Kerala Forest Department has a well developed marketing system including a network of sales depots. Timber mainly from plantations is sold through forest depots whereas industrial raw materials like bamboos, reeds, eucalyptus, etc are being allotted yearly to the industries like HNL. NWFP collected from forests through tribals are marketed by the Federation of SC/ST Societies. Over the years, prices of all timbers have been on the increase, import has been going up and exports coming down except in the case of rubber wood.

Comparison of demand for wood in respective years shows that there has been an overall decline from 2,493,000 m³ during 1987-88 to 2,065,000 m³ during 2000-01. The decline was primarily due to the use of substitutes for wood in construction and due to increased use of LPG. Trees in areas outside forests particularly home gardens are extremely important not only for producing timber and fuelwood, but also for social and environmental benefits.

Fuelwood, non-wood biomass, LPG, kerosene and electricity are the cooking media used in the household sector, which is the largest fuelwood using sector (73%) in Kerala. To reduce the dependence on fuelwood, which is a cause of environmental degradation, it is important to make LPG available throughout the rural areas in the State, particularly in areas adjoining forests.

The major wood-based industries in Kerala are sawmilling, manufacturing of packing cases, match splints and veneers, plywood, pulp and paper, wooden furniture and fixtures. The raw material demand for these industries is met more by production from homesteads and imports rather than from forests.

In spite of many governmental programmes, tribal populations residing in forests are living under deprived conditions. Some of the major problems associated with tribals are their acute poverty, malnutrition, consumption of intoxicants and exploitation by way of land grabbing by non-tribals which have led to unrest in various tribal pockets.

Fire, grazing by cattle, illicit felling, poaching, encroachment, sand mining and to some extent ecotourism pose threats to forests in Kerala although the strict regulations have brought down the number of forest offences committed.

Forests in the State are managed in consonance with the National Forest Policy which lays stress on environmental stability and joint forest management. Over the years, the State has introduced several rules and regulations aimed at the protection of forest resources. Certain restrictions made on felling of trees from areas outside forests have also been effective in preserving the growing stock of trees outside forests.

Analysis based on available data, criteria and indicators shows that management of forests in Kerala is moving towards achieving sustainability.

Research on forestry and related aspects in the State has brought out much valuable information useful for scientific management of forests. Kerala Forest Research Institute over the last three decades could make significant contributions in this respect.

Information compendium on forestry sector of Kerala

Prelude

As part of its mission, the Division of Forest Information Management System of the Kerala Forest Research Institute had undertaken to bring out a series of information bulletins useful to the stakeholders of the forestry sector of Kerala. These bulletins, although intended as a medium to provide statistical information, were modified to the extent of providing a narration of the current forest scenario in all its manifestations and a discussion on the major issues in the forestry sector rather than a simple repetition of statistics regarding the forests of the State. The bulletins have an ingrained message pointing to the importance of the invaluable 'forest' treasure, and the need to protect, conserve and transmit the same to our future generations. These bulletins are expected to have much educative value that could bring awareness not only in the minds of the policy makers but also amongst the general public prompting them to act appropriately.

Technically, the forest can be defined as an area set aside or maintained under vegetation for any indirect benefits, namely climatic, protective or environmental and/or for production of wood and non-wood products. Forests represent the largest, most complex and most self-generating of all terrestrial ecosystems. They cover about one-third of all land area of the world and constitute one-half of the total biomass. Forests have a direct beneficial influence on all parts of the biosphere as a result of their heat absorption capacity and conductivity, influence on the water cycle and emissivity of the infrared band. They act as buffer zones between man-made ecosystems and represent half of the world's photosynthetic fixation of carbon from the atmosphere, with its concurrent release of oxygen.

Forests play multifarious functions and form an important component of the life support system. There are both tangible and intangible benefits arising from the forests. Supply of industrial products, such as sawn timber, panels and paper, and then fuelwood and non-wood forest products comes under direct benefits. The intangible benefits are mostly environmental services that forests provide, such as watershed control, protection of farmland and livestock from the effects of weather, or the sequestration of carbon, and the social and cultural benefits that accrue from the production of goods and services. Functions of the forests can also be grouped as protective, productive and social. Conservation of soil and moisture, preservation of genetic diversity including flora and fauna, amelioration of climate, among others are included under the protective functions, while production of wood for construction, fiber and energy, supply of fodder, green manure and minor forest products, among others are included under the productive function. Social functions include provision of benefits like recreation and often this is broadly defined to include enhancement of employment and income opportunities.

In view of the diverse roles the forests play in our lives, it is all the more important to conserve this nature's invaluable gift to humanity. Some important aspects of forests and forestry in Kerala are included in this compendium.

Forest area

The geographic area recorded as forest in government records is known as forest area. It is also referred to as 'recorded forest area'. Recorded forest area largely comprises Reserved Forests (RF) and Protected Forests (PF), which have been constituted under the provisions of Indian Forest Act, 1927, while forest cover means all lands, more than one hectare in area, with a tree canopy density of more than 10 per cent irrespective of ownership and legal status (FSI, 2005).

India is the second most populous and the seventh largest country in the world with a total geographical area of 3.288 million km². The officially recorded forest area (legally declared) in the country is about 76.96 million hectares, which is 23.41 per cent of the total geographical area (FSI, 2005). Kerala is a small state in the southwestern corner of India. It represents 1.18 per cent of the total area of India but claims around 3.1 per cent of the total population of the country resulting in a population density of 819 persons per km². As per official records of the Forest Department, 11,265 km² of the land are classed as forests, which is about 29 per cent of the total geographical area of the State (Figure 1). However, because of the large population, the per capita forestland in the State is 0.04 ha which is much low compared to the national (0.08 ha) or global standards (0.62 ha) (FSI, 2005 and FAO, 2007). The total forest cover of the country as per 2005 assessment is 677,088 km² and this constitutes 20.6 per cent of the geographic area of the country. The effective forest cover in the State as estimated through remote sensing is 15,595 km² out of which 62 per cent is dense or moderately so and the rest is classed as open forest (FSI, 2005). This is inclusive of plantations outside forest area. The State thus has 40 per cent tree cover, which is more than the target of 33 per cent forest cover as per the National Forest Policy, 1988. The increase shown in forest cover in later years (Figure 2) could be due to the change in the definition of forest cover made by the Forest Survey of India in 2001.



Figure 1. Forest map of Kerala.

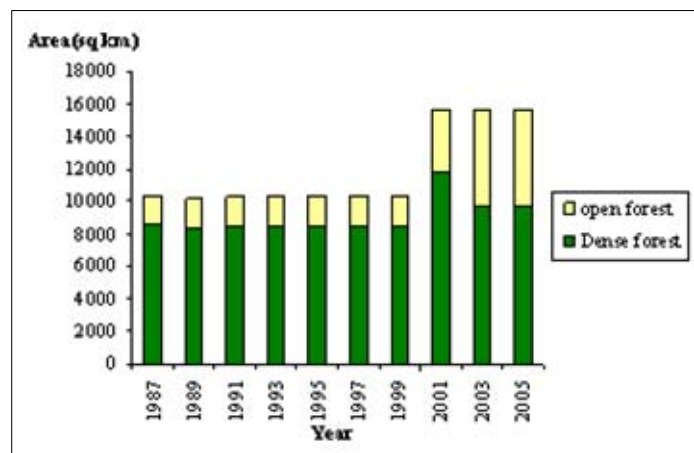


Figure 2. Change in the forest of Kerala since 1987.

Type of forests

Rainfall and altitudinal variations have contributed to floristically rich and diverse forest types in the State. According to the remote sensing based stratification, moist deciduous type covers the maximum area of forests (43.62%) followed by evergreen and semi-evergreen (35.1%). Dry deciduous type shows least coverage under the phenological classes (1.06%) (Figures 3 and 4). Table 1 indicates the different species found in these forest types.

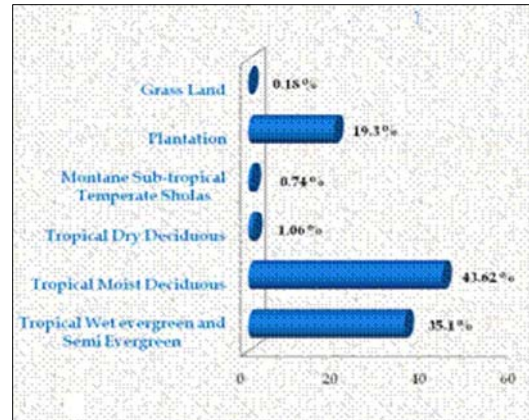
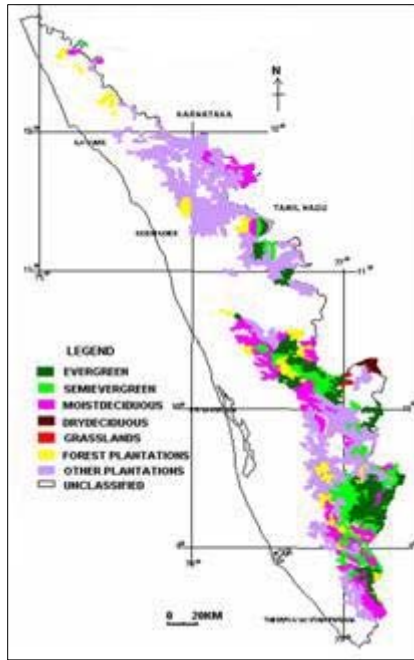


Figure 3. Map of forest types of Kerala

Figure 4. Percent distribution of forest types of Kerala

Table 1: Major plant species found in different types of forests in Kerala

<p>Evergreen forest</p>	<p><i>Artocarpus heterophyllus</i>, <i>Bischofia javanica</i>, <i>Calophyllum elatum</i>, <i>Canarium strictum</i>, <i>Cullenia exarillata</i>, <i>Drypetes elata</i>, <i>Dysoxylum malabaricum</i>, <i>Elaeocarpus tuberculatus</i>, <i>Holigarna arnottiana</i>, <i>H. grahamii</i>, <i>Mesua ferrea</i>, <i>Palaquium ellipticum</i>, <i>Persea macrantha</i>, <i>Poeciloneuron indicum</i>, <i>Polyalthia coffeoides</i>, <i>Vateria Indica</i>.</p>
<p>Semi-evergreen forest</p>	<p><i>Artocarpus heterophyllus</i>, <i>Bischofia javanica</i>, <i>Calophyllum elatum</i>, <i>Euvodia lunuankenda</i>, <i>Hopea ponga</i>, <i>Mangifera indica</i>, <i>Mesua ferrea</i> and <i>Myristica dactyloides</i>. The deciduous floral elements include <i>Acrocarpus fraxinifolius</i>, <i>Bombax ceiba</i>, <i>Chukrasia tabularis</i>, <i>Dalbergia latifolia</i>, <i>Grewia tiliifolia</i>, <i>Lagerstroemia microcarpa</i>, <i>Pterospermum sp.</i>, <i>Terminalia bellirica</i>, <i>Toona ciliata</i>.</p>

 <p>Moist deciduous forest</p>	<p><i>Dillenia pentagyna, Tabernaemontana alternifolia, Lagerstroemia microcarpa, Tectona grandis, Anogeissus latifolia, Dalbergia paniculata, Pterocarpus marsupium, Terminalia paniculata, Hymenodictyon excelsum, Haldina cordifolia, Strychnos nuxvomica, Xylia xylocarpa, Ixora brachiata, Olea dioica, Persea macrantha, Dimocarpus longan, Flacourtia Montana.</i></p>
 <p>Dry deciduous forest</p>	<p><i>Tectona grandis, Terminalia sp., Lagerstroemia lanceolata, Cassia fistula.</i></p>
 <p>Montane subtropical and temperate forest</p>	<p><i>Bischofia javanica, Calophyllum tomentosum, Cedrela toona, Dodonia viscosa, Eugenia arnottiana, E. wightiana, Ficus glomerata, Mallotus philippensis, Persea macarantha, Rhododendron sp., Trewia nudiflora.</i></p>
 <p>Grasslands</p>	<p><i>Gualtheria fragratissima, Toddalia asiatica, Hypericum mysurense, Butea frondosa, Andropogon sp., Ischaemum sp., Themeda sp.</i></p>
 <p>Mangroves</p>	<p><i>Acanthus illicifolius, Acrostichum aurem, Aegiceras corniculatum, Avicennia officinalis, A. marina, Azima tetracantha, Bruguiera gymnorrhiza, B. cylindrica, B sexangula, Excoecaria agallocha, E. indica, Kandelia candel, Rhizophora apiculata, R. mucronata, Sonneratia caseolaris, Calophyllum, Flagellaria indica, Calamus rotang, Syzygium travancoricum</i></p>

One feature of interest regarding the type of forests in Kerala is with respect to the changes that have occurred in their composition during the last three decades. The changes in component vegetation types as given by Chandrasekharan (1973) and the recent assessment by Menon (2006) are shown in Table 2.

Table 2: The distribution of Reserved Forests by vegetation types

Forest type	Area (km ²) (Estimated in 1973)
Evergreen	1937
Semi-evergreen	1711
Moist deciduous	2337
Dry deciduous	136
Pure reeds	185
Montane temperate Shola	14
Grasslands	98
Plantations	1102
Total	7520

Forest type	Area (km ²) (Estimated in 2006)
Evergreen and semi-evergreen	4437
Secondary moist deciduous	4097
Primary moist deciduous	244
Dry deciduous	469
Grasslands	194
Plantations	4044
Total	13485

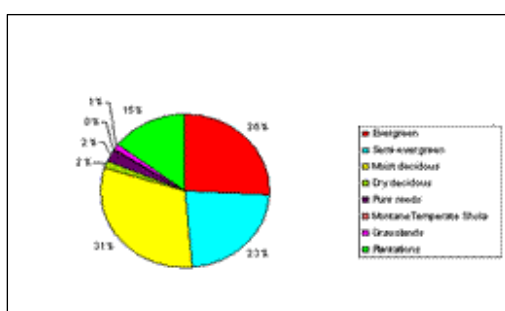


Figure 5. Status of forest types in 1972

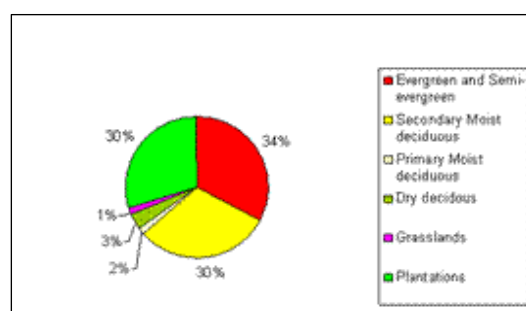


Figure 6. Status of forest types in 2007

The changes in the area distribution of major forest types over the period of 34 years (period 1972 to 2006) are as follows (Figures 5 and 6). The evergreen forests (evergreen and semi-evergreen forests together) was reduced to 34 per cent in 2006 from 49 per cent in 1972. There is very slight difference in the area per cent of moist-deciduous forests (1 per cent increase). Primary moist deciduous forests which constituted 30 per cent of the total area in 1972 is now confined to just 2 per cent, the rest being transformed to secondary moist deciduous forest. Subsequently, there were changes in species composition with dominance of light demanding species. The status of dry deciduous forests was enhanced from 2 per cent to 3 per cent during the period. The plantation area increased to 30 per cent from 15 per cent during the period 1972 to 2006.

The characteristic species associations of different forest types of Kerala were well documented by Chandraekharan (1962). Accordingly, the most widely distributed genera in the top canopy of evergreen forests of Kerala were, *Palaquium* and *Hopea*. Other typical genera in this type were *Vateria*, *Calophyllum*, *Kingiodendron*, *Mesua*, *Cullenia*, *Poeciloneuron*, *Artocarpus* and *Tetramelus*. *Dipterocarpus* species are characteristic, but not an essential component in all the locations. Leguminous species were relatively uncommon. Anacardiaceae, Meliaceae, Lauraceae, Euphorbiaceae and Myrtaceae members were well represented. The families represented in the middle canopy were, Myrtaceae, Lauraceae, Meliaceae and Euphorbiaceae. Undergrowths of palms like *Pinanga dicksonii*, *Arenga wightii* and *Caryota urens*, were also met with.

Studies conducted by KFRI more recently (2000-2006) also affirms the findings of Chandrasekharan (1962) and it was noticed that there is not of much compositional change in the basic structure of tropical evergreen forests, other than that of the selection felled areas, where secondary formations were coming in. The dominant/sub-dominant species were slightly changing as per the localized environmental “niche” or edaphic conditions. There was no marked change in the species composition and structural status of tree vegetation. The regeneration status of characteristic species is highly influenced by the microclimatic conditions and the changing trend of vegetation from homogeneous to heterogeneous nature was notable.

The semi-evergreen forests is an intermediate form between tropical evergreen and tropical moist deciduous types and is considered to represent a stage influenced by man and environment. The “seral” (secondary) forms are under various stages of retrogression from the evergreen climax type. In some cases, the secondary stages are ‘bio-edaphic’ in nature, changing with soil condition. The following forest types are considered as the major secondary edaphic types in Kerala (Table 3).

Table 3: Major secondary edaphic forest types of Kerala

C1- Low land evergreen forest	S5- (b) Moist bamboo brakes
C2- High land evergreen forest	S6- Low level grassland
C3- “Low” tropical Ghat evergreen forest	E1- Myristica swamps
S1- Semi-evergreen (secondary) forest	E2- Tropical valley freshwater swamps
S2- Secondary evergreen forest	E3- Tropical riverine forest
S3- Moist deciduous (secondary) forest	E4- Cane brakes
S4- Open deciduous forest	E5- Xylia mixed forest
S5- (a) Wet bamboo brakes	E6- Laterite scrubs

Biodiversity

Biodiversity refers to the variety and variability (including genetic) of all living organisms and their habitats on earth. The Western Ghats, a sizeable portion of which is in Kerala, is one of the 34 global hotspots of biodiversity in the world. Biodiversity is an essential component of nature and it ensures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind. The loss of biological diversity occurs mainly from habitat destruction, over-harvesting, pollution and inappropriate introduction of exotic plants and animals. Table 4 gives available quantitative figures on the biodiversity in Kerala.

Table 4: Number of plant and animal species in different groups recorded from Kerala

Animal Diversity	
Animal groups	Number of genera / species
Protozoa	63 (genera)
Porifera	22 (genera)
Cnidaria	90 (genera)
Chaetognatha	18

Platyhelminthes	117 (genera)
Aschelminthes	265
Acanthocephala	27
Annelida	91
Mollusca(Fresh water)	26
Insects	6000
Non-insect Arthropoda	600
Echinodermata	8
Freshwater fishes	196
Amphibians	117
Reptiles	159
Birds	508
Mammals	145
Total	8452
Plant Diversity	
Plant groups	Number of species
Algae	866
Fungi	4800
Lichens	520
Bryophytes	350
Pteridophytes	332
Gymnosperms	4
Angiosperms	4968
Total	11,840

Source: KSCSTE (2005, 2007)

Compilations based on floristic studies carried out so far shows that there are 4801 taxa of flowering plants in Kerala (Sasidharan, 2007). They belong to 1431 genera of 211 families. Poaceae is the dominant family with 419 species under 119 genera followed Leguminosae (406/98), Orchidaceae (260/81), Rubiaceae (239/57), Cyperaceae (206/21), Asteraceae (195/70), Acanthaceae (189/36), Euphorbiaceae (182/51), Lamiaceae (114/20) and Balsaminaceae (81/2). Table 5 gives the analysis of flora of Kerala.

Table 5: Representation of different plant groups in the flora of Kerala

	Species	Genera	Family	Peninsular endemics
Dicotyledons	3534	1081	168	1211
Monocotyledons	1257	345	38	415
Gymnosperms	10	5	5	2
Total	4801	1431	211	1628

Source: Sasidharan (2007)

Biodiversity must be protected not only for ecological reasons but also because it sustains livelihoods. Biodiversity in agriculture helps millions eke out a living. It helps people get food, jobs, nutrition, bio-pesticides, traditional medicine, housing material, fodder and

fuel. It also helps to stabilize the climate, improve rainfall and enrich the soil and water table.

Conservation of wildlife

Wildlife is an integral part of forests in Kerala, as elsewhere in the world. The conservation of animal kingdom, particularly of rare species was ensured by special laws and preserved by setting up Sanctuaries and National Parks/Biosphere Reserves. A total area of 2630.49 km² has been brought under Protected Category in Kerala. This is 23.35 per cent of the total forest area and 6.8 per cent of the geographical area of the State, which is higher than the 4 per cent suggested by Government of India. The Sanctuaries and National Parks of Kerala are listed in Table 6 by year of formation. Change in the extent of Protected Area in the State over the years is depicted in Figure 7.

Table 6: Extent of Protected Area under Kerala Forest Department by year of formation

Protected Area	Area (km ²)	Year of formation
Periyar Tiger Reserve	777	1950
Neyyar WLS	128	1958
Peechi- Vazhani WLS	125	1958
Parambikulam WLS	285	1973
Wayanad WLS	344.44	1973
Idukki WLS	70	1976
Eravikulam NP	97	1978
Thattekkad BS	25	1983
Peppara WLS	53	1983
Chimmony WLS	85	1984
Chinnar WLS	90.44	1984
Shendurney WLS	171	1984
Aralam WLS	55	1984
Silent Valley NP	237.52	1984
Agasthyavanam Biological Park	30	1992
Anamudi Shola NP	7.5	2003
Mathikettan Shola NP	12.82	2003
Pampadum Shola NP	1.32	2003
Mangalavanam Bird Sanctuary	0.0274	2004
Kurinjimala WLS	32	2006
Choolannur Pea Fowl Sanctuary	3.42	2007
Total	2630.49	

Source: Economic Review 2006 & Correspondence with KFD Head Quarters.

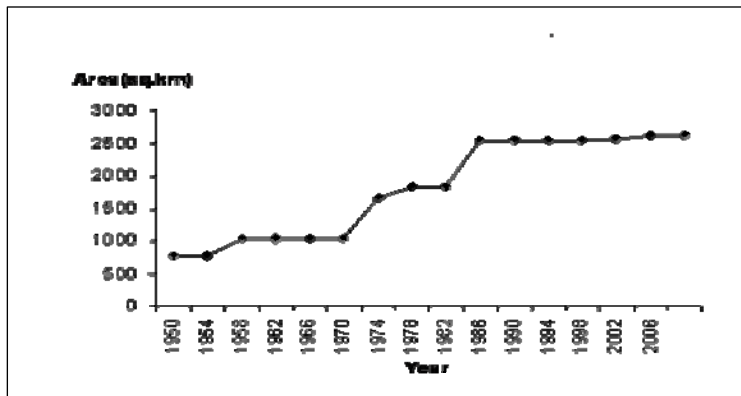






Figure 7. Change in the extent of Protected Area in Kerala over years

Table 7: Major wild animals found in forests of Kerala by classes

<p>Mammals</p> 	<p>Elephant, gaur, sambar, wild dog, jungle cat, tiger, wild boar, sloth bear, leopard, lion tailed macaque, Nilgiri tahr, Nilgiri langur, Malabar giant squirrel, flying squirrel, tiger, spotted deer, grizzled giant squirrel, Hanuman langur, civet cat, Bonnet macaque, Loris, mongoose, barking deer, etc.</p>
<p>Birds</p> 	<p>Water fowl, cuckoo, owl, egret, heron, water duck, jungle fowl, myna, laughing thrush, black bulbul, woodpecker, kingfisher, hornbill, stork, raptor, darter, cormorant, Indian roller, common snipe, crow pheasant, jungle nightjar, kite, grey drongo, Malabar trogon, large pied wagtail, baya sparrow, robin, jungle babbler, sunbird, peacock, crimson-throated barbet, bee-eater, shrike, fairy bluebird, grey-headed fishing eagle, black winged kite, night heron, grey hornbill, etc</p>
<p>Reptiles</p> 	<p>Cobra, viper, krait, crocodile, varanus, pond terrapin, cane turtle, star tortoise, gecko, skink, chameleon, python, green keel back, rat snake, vine snake, etc.</p>
<p>Amphibians</p> 	<p>Ranids, Microhylids, tree frogs (Rhacophorids), toads, Nasikabatrachus, etc.</p>



Elephant herd

Elephants are of major concern in the State Forests. Estimates from a recent census on elephants in the State are given in Table 8.

Table 8: Results from Elephant Census conducted in 2007 in the forests of Kerala

Elephant Reserve	Estimated number of elephants based on direct sightings in sample blocks	Estimated number of elephants based on line transect dung survey
Wayanad Elephant Reserve	490	1240
Nilambur Elephant Reserve	87	663
Anamudi Elephant Reserve	1289	2505
Periyar Elephant Reserve	1136	1660
Total	3002	6068

Source: Sivaram *et al.* (2007)

Density values of few other major species are indicated in Table 9.

Table 9: State level density estimates for selected species using line transect (direct sighting) technique in the year 2002

Animal	Density (number of animals per km ²)	Percentage coefficient of variation
Gaur	1.6	18.1
Sambar deer	3.3	10.7
Spotted deer	4.1	26.5
Nilgiri langur	5.5	12.0
Malabar gaint squirrel	9.5	7.7
Wild boar	6.5	15.2

Source: Easa *et al.* (2002)



Malabar spiny dormouse



Little cormorant



Black whiskered tern

The forest in Kerala is highly fragmented due to settlements and agriculture. Crop damage by wild animals in agricultural fields adjoining the forest areas is very heavy. This is mainly due to the straying of wild animals such as wild boar, elephant, Indian porcupine and deer from the forest to the homesteads and plantations. As a consequence, conflicts between wild animals and farmers in the fringe areas of the forests and protected areas have been increasing.

A survey revealed that wild animals in Kerala destroy around forty five species of crops and major among them are paddy (*Oryza sativa*), coconut palm (*Cocos nucifera*), plantains (*Musa* sp.), cassava (*Manihot esculenta*), arecanut (*Areca catechu*), coffee (*Coffea arabica*), oil palm (*Elaeis guineensis*), pepper (*Piper nigrum*), jack tree (*Artocarpus heterophyllus*), mulberry (*Morus alba*) and mango (*Mangifera indica*). The main animals involved in crop damage are elephant (*Elephas maximus*), gaur (*Bos gaurus*), sambar (*Cervus unicolor*), wild boar (*Sus scrofa*), bonnet macaque (*Macaca radiata*), common langur (*Presbytis entellus*), blacknaped hare (*Lepus nigricollis*) and pea fowl (*Pavo cristatus*). Among these, elephants and wild boars do the maximum damage. Crop damage was highest in the northern part of the State, especially the Wayanad area.



Plantain, coconut palm, arecanut damaged by wild elephants

Wild animals in these tracts are protected against poaching. Past activities like, large-scale conversion of forests into monoculture plantations of teak and eucalyptus, shifting cultivation, hydroelectric projects and organized encroachments reduced the available habitat of wild animals in Kerala. This scenario is leading to man-wildlife conflict in many places. In order to ameliorate the deteriorating situation, Forest Department pays compensation for crop damage and human casualties. However, of the total compensation claimed by the farmers, only 8.2 per cent was sanctioned by the Kerala Forest Department (Jayson, 1998).

Habitations inside deep forests with easily accessible crops around were found to attract wild animals to these settlements. Rehabilitation of tribal settlements proved ineffective because the people involved were more habituated with forest rather than civilized environments. Electric fences around crop fields were suggested as a solution to intrusion by wild animals but they were not very effective for many practical reasons. Deep trenches seem to be more practical compared to electrical fences, which are presently being promoted under various government schemes.

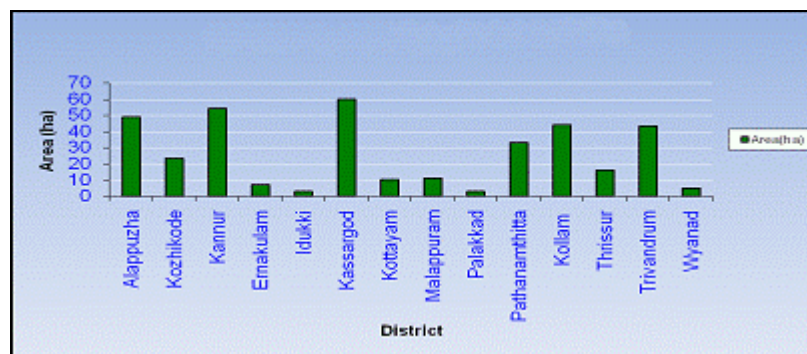
Sacred groves

Sacred groves represent the major effort to recognize and conserve biodiversity (ethnic diversity) traditionally. The age-old system of every village having a temple, a tank and an associated sacred grove supported a method of water harvesting and sharing and may be considered as the backbone of village economy and ecology. People refrained from felling trees and even removing a twig from such areas. Sacred groves have preserved many rare and endemic wild plant species, many of which hold potential benefit to man in medicine, agriculture and industry. They even help in soil and water conservation besides preserving its rich biological wealth. The ponds and streams adjoining the groves are perennial water sources. These are the last resorts to many of the animals and birds for their water requirements, especially during summer. Sacred groves also enrich the soil through its rich litter composition. The nutrients generated thus are not only recycled within the sacred grove ecosystem but also find their way into the adjoining agro-ecosystems. Hence, preservation and sustainable management of these sacred groves are of immense importance.

On a rough estimate, Kerala has about 2000 sacred groves, which are distinct and unique in biological diversity. The size of the sacred groves in Kerala varies as small as one cent to 20 or more hectares. The available inventory on sacred groves indicates that maximum number of such areas is distributed in the northern districts of the State (Figure 8). The vegetation in the undisturbed groves is luxuriant and with multi-layered trees mixed with shrubs, lianas and herbs. The ground is humus laden and abundant with fungus and ferns. The floristic composition is highly influenced by exposure to anthropogenic pressures, cattle grazing, edaphic and climatic variations.



Scenes from sacred groves



Source: Induchoodan (1996)

Figure 8. Area under sacred groves in different Districts of Kerala

The common tree species found in the sacred groves are *Artocarpus hirsutus*, *Mesua ferrea*, *Vateria indica*, *Hopea parviflora*, *H. ponga*, *Alstonia scholaris*, *Mimusops elengi*, *Hydnocarpus pentandra*, *Holigarna arnottiana* etc. The lianas include *Strychnos colubrina*, *Anamirta cocculus*, *Tetracera akara* and *Acacia caesia*. Shrubs are represented by *Ixora nigricans*, *Ixora bracteata*, *Chassalia curviflora*, etc. The seasonal plants such as *Geophila repens*, *Borreria* sp., *Naregamia alata*, *Centella asiatica*, *Aerva lanata*, *Adrographis paniculata* and *Biophytum sensitivum* form the ground vegetation. In southern region of the State, members of the mangroves swamps like *Myristica fatua* var. *magnifica*, *M. malabarica*, *Hydnocarpus* sp. and *Eugenia* sp. are found in the poorly drained sacred groves. The animals found in the sacred groves are of two types, those which inhabit the groves like snakes, frogs, lizards and other group of lower organisms and higher group of fauna that nest and den there and those that visit the grove temporarily for food, shelter among others.

The major threats to the existence of sacred groves in Kerala are the disappearance of the old joint family system and partition of family properties along with changing socio-economic scenario. The second major threat is the anthropogenic activities and cattle grazing. As the demand for land is always high in Kerala, the shrinkage of groves was one of the inevitable consequences. Other important reasons are the loss of faith and traditional beliefs, extraction of timber by the Management (Devaswam) or local people, shifting of deity, biomass removal, poaching and encroachment.

Myristica swamps

The *Myristica* swamps are swampy areas inside evergreen forests of low elevation. They need special non-biotic conditions to develop and hence these ecosystems have become highly restricted and fragmented. In Kerala, these swamps are present in Anchal and Kulathupuzha Forest Ranges and Shendurney Wildlife Sanctuary, below 200 m msl. A recent project by KFRI mapped 60 individual swamp patches which constitute 1.5 km² which hardly make up 0.014 per cent of the total forest area of Kerala.

Each swamp has a central stream, which causes inundation of the swamps. Each swamp has different inundation characteristics- such as time period of inundation, depth of inundation and area under inundation. Many of the swamps dry up during the months of December to March. Water table beneath the ground recedes below 50 cm during summer. The soils of these swamps vary in texture from sandy soils to sandy loams to silt loams and rarely clay loams depending on location factors including geology and physiography of the land, gradational variations within the swamps being not uncommon. There is remarkable variation in other properties also, but in general, most of the swamp soils are acidic (pH 3.0-6.0), non-saline and with low organic carbon content. Eighty two trees and ninety four species of herbs/shrubs constituted the vegetation in the swamps. Forty nine lianas have been recorded. Twelve of these plants have been Red-listed and up to 28 plants are endemic to Western Ghats. Out of the 19 sample plots inside the swamps, *Gymnacranthera farquhariana* was dominant in 10 plots. *Myristica fatua* var. *magnifica* was the dominant tree in 6 swamps. In the remaining plots, *Vateria indica*, *Holigarna arnottiana* and *Lophopetalum wightianum* are dominant species respectively.

Faunal diversity of the *Myristica* swamps consisted of Platyhelminthes - (Bipalium-2, tapeworm-1) 3 species, Nematelminthes - 1 species, Annelida (Oligochaeta -2 and Hirudinea-2) 4 species, Mollusca - 10 species, unidentified Crustacean-1 species, Insecta - 281 species belonging to 83 identified families, Myriapoda - 6 species, Arachnidae-54 species, Pisces-14 species, Amphibia-56 species, Reptilia-55 species, Aves 129 species and Mammalia - 27 species. Quantitative analysis revealed that the differences in the environmental characteristics inside the swamp and outside the swamp play an important role in regulating the species diversity and abundances of both amphibians and reptiles. Amphibians were more susceptible to environmental changes. Patterns of diversity and abundance changes during day and night, across swamps and different months. There was no significant difference in patterns of diversity and abundance recorded during the two years. Many of the animals documented belong to Red-listed and endemic categories.

The enormous biodiversity of the *Myristica* swamp forests is noteworthy. A pertinent question is whether all human entry should be banned into the best and least disturbed patches of swamps, leaving only the disturbed patches for human visits (tourism and academic study). In any case, conservation of these small and scattered swamp patches needs immediate attention.

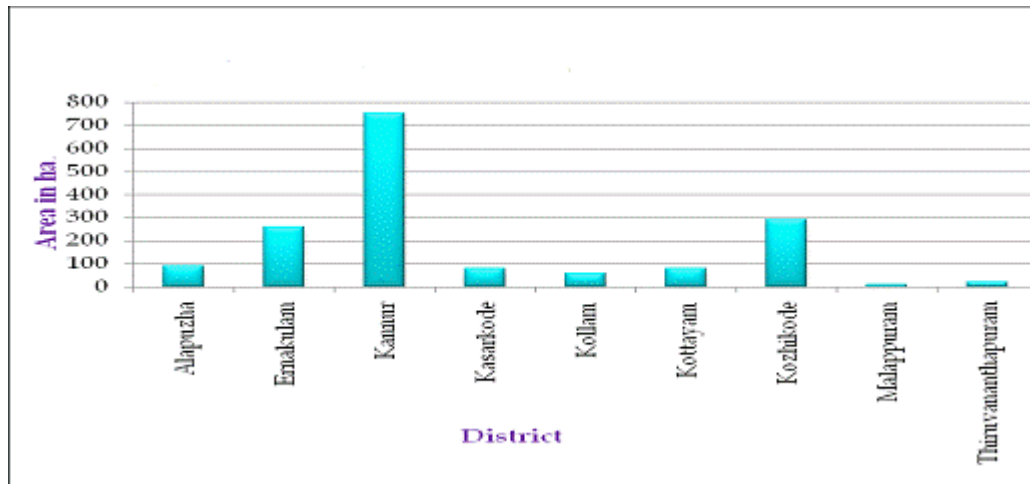


Pictures from *Myristica* swamps

Mangroves

Mangroves are salt-tolerant forest ecosystems found mainly in tropical and sub-tropical inter-tidal regions of the world. These are trees or shrubs that have the common trait of growing in shallow and muddy salt water or brackish waters, especially along quiet shorelines and in estuaries. Typically they produce tangled masses of arching roots that are exposed during low tides. Mangroves do not appear on sandy beaches and rocky shores. A muddy substratum of varying depth and consistency is necessary for their growth. Mangrove forests are considered as the most productive and species-rich wetlands on earth. These provide critical habitat for a diverse marine and terrestrial flora and fauna. A healthy mangrove forest is the key to a healthy marine ecology. In fact, mangrove forests fix more carbon dioxide per unit area than phytoplankton in tropical oceans. Mangroves maintain the temperatures around the water bodies with their thick green growth. This enables the water organisms like planktons, prawns and crabs to breed around the mangroves. Hence, the mangroves act as an ecotone between land and water. Yet, these unique coastal tropical forests are among the most threatened habitats in the world. They may be disappearing more quickly than inland tropical rainforests and with little public notice (FSI, 2003).

Kerala has a coastal line of about 590 km with a number of estuaries and backwaters. Indications are that highly developed mangrove forests existed decades back, along the coastal tract of the State, in suitable areas covered by salt or brackish water at high tides, such as mud flats along the lower reaches of tidal streams and borders of lakes and estuaries more or less protected against heavy wave action. Spread of civilization to the coastal areas wiped out the mangroves through conversion to single use option such as agriculture. Reclamation by means of embankments also might have rendered large areas unfit for the growth of mangroves. Presently, the extent of undisturbed mangroves in Kerala is reduced to just 150 ha mostly distributed in Ernakulam, Kannur and Kozhikode Districts but the potential area comes to around 1670 ha (Figure 9).



Source: Nair and Basha (1997)

Figure 9. Area under mangrove vegetation in different Districts of Kerala



Pictures of mangroves

Source : <http://www.tsunamiresponsewatch.org/trw/category/people/>

A list of major mangrove species found in Kerala and their associates (Nair and Basha, 1997) is given below (Table 10).

Table 10: List of major mangrove species in Kerala

<i>Aegiceras corniculatum</i> L. Blanco	<i>Excoecaria agallocha</i> L.
<i>Avicennia marina</i> (Forsk.) Vierh.	<i>E.indica</i> (Wild) Muell.-Arg.
<i>A.officinalis</i> L.	<i>Kandelia candel</i> (L.) Druce
<i>Bruguiera cylindrica</i> W.&A.	<i>Lumnitzera racemosa</i> Willd.
<i>B. sexangula</i> (Lour.) Poir.	<i>Rhizophora apiculata</i> Blume
<i>B. parviflora</i> (L) Lamk.	<i>R.mucronata</i> Lamk.
<i>B. parviflora</i> Roxb.	<i>Sonneratia caseolaris</i> (L.) Engl.
<i>Ceriops tagal</i> (Perr.) C.B.Rob	

The major problems faced by the mangroves in Kerala are indiscriminate destruction of mangrove species and the resultant loss of flora and fauna, conversion of mangrove areas for different land uses like coconut plantations, paddy cultivation and development of prawn farms and over-exploitation of mangrove resources. Destruction of mangroves increases the vulnerability to the calamities and disasters arising out of losing a natural barrier to the fury of the seas. The destruction caused by the recent tsunami is a good indication. In the conservation efforts, it is to be remembered that mangroves grow under certain climatic situations. A mixture of saline and pure water is needed to sustain them. Hence, coastal outlets and estuaries and riverbanks with muddy and dark soils are suitable places for the mangroves to grow.



Pictures of mangroves in Kannur

Forest plantations

Forest plantations occupy about 14 per cent of the area under forests in Kerala. Teak and eucalypts have been the principal forest plantation species. Acacia, casuarina, albizia, ailanthus and gmelina are some other important forest plantations in Kerala. Teak plantations form a major source of timber from forests. These are grown over a rotation age of 50 to 60 years with several thinnings in between. Eucalypts provide pulpwood for paper industry. Eucalypts are harvested in a period of 7 to 10 years with one or two coppice crops after a seedling crop. Acacia, originally intended as firewood crop, is increasingly used for pulping. They are fast growing and highly adaptable species harvestable in around 8 years. Casuarinas are used as shelterbelts in coastal areas and also used as poles and firewood. Albizia is one of the fast growing multipurpose tree species used as shade tree, and as a source of green leaf manure, firewood, charcoal and pulpwood. Ailanthus gives softwood used in match industry. Gmelina yields good timber in 15 to 20 years. Table 11 gives the productivity of some of the common forest plantation species in Kerala.

Table 11: Major forest plantation species in Kerala

Species	Extent (ha) in Kerala as of 2005	Productivity (m ³ /ha/year)
Teak (<i>Tectona grandis</i>)	75536	3.11 at 60 years
Eucalypts	15968	
<i>Eucalyptus tereticornis</i>	-	7.6 at 8 years
<i>Eucalyptus grandis</i>	-	9.8 at 10 years
Acacia		
<i>Acacia auriculiformis</i>	5,936	23 at 7 years
<i>Acacia mangium</i>	3,401	-
Casuarina (<i>Casuarina equisetifolia</i>)	121	16.6 at 6 years

Silver oak (<i>Grevillea robusta</i>)	1168	-
Albizia (<i>Paraserianthes falcataria</i>)	461	-
Ailanthus (<i>Ailanthus triphysa</i>)	417	-
Gmelina (<i>Gmelina arborea</i>)	-	-

Enhancement of productivity of the plantations has been a major issue in the past, which calls for much research effort. Productivity enhancement could be accomplished through tree improvement programmes and appropriate management practices.



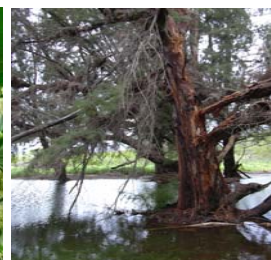
Teak



Eucalypts



Acacia



Casuarina



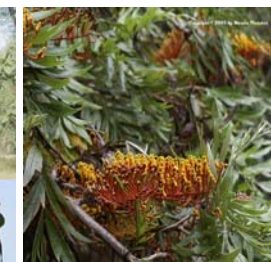
Ailanthus



Albizia



Gmelina



Grevillea

Home gardens

Home gardens (including farm lands) occupy 17,870 km², about 46 per cent of the geographical area of the State (Government of Kerala 2001). Mixed cropping agroforestry is the characteristic feature of land use in the home gardens. It integrates agricultural crops with several trees. Agricultural crops are seasonal and annual crops like pulses, gram, tubers, vegetables; perennial crops like coconut (*Cocos nucifera* Linn.), arecanut (*Areca catechu* Linn.), cocoa (*Theobroma cacao* Linn.), clove (*Syzygium aromaticum* Linn.), etc. The home gardens are often dominated by coconut palms which are a perennial source of non-wood fuels for cooking in rural households. The area under coconut palms alone is 8,800 km². Trees are grown mainly along the boundaries or in intimate mixtures with agricultural crops. Jack (*Artocarpus heterophyllus* Lamk.), mango (*Mangifera indica* Linn.), cashew, tamarind (*Tamarindus indica* Linn.) are more prominent. Other important trees commonly found are teak, anjily (*Artocarpus hirsutus* Lamk.), matty (*Ailanthus triphysa* Dennst.), vatta (*Macaranga peltata* Roxb.), murikku (*Erithrina stricta* Roxb.) etc. Very valuable trees such as rosewood (*Dalbergia latifolia* Roxb.) and sandal (*Santalum album* Linn.) are also sporadically found in home gardens. Trees are an important component of the home garden system which contribute to a high level of wood production.

The home gardens also contribute towards the environmental benefits accrued through tree vegetation. The salient features of the mixed cropping agroforestry is to raise fuelwood, timber and fodder, increase production of food crops and legumes, promote production of fruits, vegetables and pulses, conserve soil and moisture, check soil erosion and enhance soil nutrient status, improve microclimate and increase the levels of farm income through improved and sustained productivity and thus to raise the standard of living of people. Diversity of crop cultivation reduces the economic impact of price fluctuations of any single crop and may also bring down the risk of total crop loss. Optimum utilization of available resources of land, solar energy and technological inputs and an efficient recycling of farm wastes are important features of the system.



Agroforestry in Kerala

Social forestry

Social forestry is the practice of growing trees in non-conventional forest areas for the benefit of the society. Several social forestry schemes have been launched in Kerala in order to increase the supply of fuelwood and small timber. The schemes were National Rural Employment Programme, Rural Fuelwood Programme, Rural Landless Employment Guarantee Programme, Drought Relief Scheme and World Bank Scheme. Under these schemes, plantations have been raised through block, strip and avenue planting in forest areas, waste lands, Panchayath lands, land on the sides of roads, canals and railway lines, etc. A large number of seedlings were also raised in nurseries under these schemes and distributed to farmers and social organizations, for raising them in homesteads and around the public buildings respectively. The species planted and distributed were mainly *Acacia auriculiformis*, *Eucalyptus tereticornis* and *Casuarina equisetifolia*. Some statistics available are reported in Table 12.

Table 12: Area under different social forestry plantations raised during 1983-90 under the World Bank Scheme*

Year of planting	Area (ha)			
	Large block	Small block	Strip	Total
1983	0.00	0.09	0.00	0.09
1984	88.20	56.58	0.00	144.78
1985	1427.53	136.80	75.86	1640.19
1986	2422.55	208.31	54.61	2685.47
1987	2138.55	310.24	40.88	2489.92
1988	2889.80	278.08	85.22	3253.10
1989	1949.14	391.95	249.25	2950.34

1990	2160.25	194.99	27.49	2382.73
Total	13076.27	1577.04	533.31	15186.62

*Plantations raised by the Territorial Divisions availing funds from World Bank Scheme have not been included. The total area of plantations including the ones raised by Territorial Divisions works out to 20,408 ha. (Source: Jayaraman *et al.*, 1992)

Social forestry was suggested as a solution to the problem of deforestation. The objective of the social forestry was to meet the fuelwood and small timber needs of the rural areas, to increase fodder supply and protect agricultural lands from wind and soil erosion, and to increase rural employment potential and give support to tribal economy. While the question whether the plantations raised under the World Bank Schemes helped in meeting the above objectives or not is still under debate, the plantations raised surely augmented the wood supply in the State in one way or other. Social forestry still holds some relevance in Kerala.

Non-wood forest products (NWFP)

Forests provide not only timber and fuelwood but also innumerable other materials. Non-wood forest products are of both plant and animal origin, occurring naturally and sometimes in cultivation in forest areas. The major habitat of the NWFP plants of the state is the natural forests, occurring mainly in the hilly uplands and the high lands. There are about 550 species utilized as NWFP.

The NWFP include mainly medicine and narcotic, gum and resin, tan and dye, oil and fat, spices and condiments, food and fodder, fibre and floss, bamboo and cane, insecticides and leaves. NWFP also provide raw materials for large scale industrial processing units including that for internationally traded commodities such as foods, beverages, confectionery, flavors, perfumes, medicines, paints and polishes. It gives employment and household income in areas near the forest. One of the major problems for management of NWFP in the State is the absence of suitable marketing channels for these products. Most of these products are either utilized locally by tribals or sold in the market for which no suitable marketing infrastructure is available.

There are 145 NWFP items as per the list of the Kerala Forest Department, which is classified as Minor Forest Produce (MFP) as of 2007. Analysis of the status of NWFP in Kerala, projects an ever increasing demand as the sales value of NWFP and its collection charges depict an overall increasing trend during the period 1985-2004. The average quantity of NWFP collected during the period 2001 to 2006 has been 3,015 t. The average sales value and collection charges per year are Rs 31.5 millions and Rs 25.2 millions respectively. The major reason for the rarity of medicinal plants is over-exploitation and habitat loss. Among the 123 NWFPs enumerated from Northern Kerala, 25 species were RET listed, of which *Coscinium fenestratum* is critically endangered (Sasidharan *et al.*, 2008).



Non-wood forest products

Bamboo

Although not grown extensively in plantation scale, bamboo forms an important non-timber forest product and is considered as ‘poor man’s timber’. As of 2004-05, the Kerala Forest Department had 4158 ha under bamboo plantation. Bamboo is the most important raw material for the paper industry in India, and has multiple commercial and household uses. It is extensively used as a substitute for timber in construction, scaffolding, ladders, bridges, fences etc. Numerous articles of daily uses such as tool handles, beds, sticks, tent poles, brushes, pipes, fans, umbrellas, toys, musical instruments, containers, drinking vessels and fishing traps are made of different bamboo species. Bamboo supports cottage industry through out the country and the products like bamboo mats are exported and used for dunnage in ships.

Globally, there are 1575 species of bamboos belonging to 111 genera. In India, 128 species of bamboos belonging to 18 genera are known to occur out of which 99 species belonging to 15 genera are recorded as native to India. Among these, 22 species and two varieties belonging to six genera are recorded as native to Kerala. The species found occurring in Kerala are tabulated below (Table 13).

Table 13: Bamboo species found in Kerala

Species	Uses
<i>Bambusa bambos</i> var.bambos	Raw material for pulp and paper, panel products, thatching, roofing, basket making and furniture making.
<i>Bambusa bambos</i> var.gigantea	Used in thatching, roofing, basket and furniture making.
<i>Dendrocalamus strictus</i>	Extensively used as raw material for paper industry, agricultural implements, musical instruments and, furniture.
<i>Ochlandra beddomei</i>	Used for basket and mat making, construction of hut.
<i>Ochlandra ebracteata</i>	Widely used in paper industry. Also used for making baskets and mats.

<i>Ochlandra keralensis</i>	Culms are used for basketry.
<i>Ochlandra scriptoria</i>	Raw material for paper industry, also used for making, mats, baskets, floats and rafts.
<i>Ochlandra setigera</i>	Used in basket making, mats and house walls.
<i>Ochlandra soderstromiana</i>	Used for mat making and basketry.
<i>Ochlandra spirostylis</i>	Used for making baskets and for mat making.
<i>Ochlandra travancorica</i> var. <i>hirsuta</i>	This species yield superior quality pulp; hence it is used in the paper pulp industry.
<i>Ochlandra travancorica</i> var. <i>travancorica</i>	An ideal raw material for paper manufacture.
<i>Ochlandra wightii</i>	Used for basket and mat making. Also found suitable for paper pulp.
<i>Oxytenanthera bourdillonii</i>	Culms are ideal for the manufacture of high quality toothpicks and combs.
<i>Oxytenanthera monadelphica</i>	Useful for fencing and basket making.
<i>Oxytenanthera ritchiei</i>	Culms are used for fencing, making walking sticks, umbrella handles and baskets.
<i>Dendrocalamus stocksii</i>	Culms are used for constructing purposes, making umbrella handles and baskets.
<i>Schizostachyum beddomei</i>	Culms of this species are used for making mats, baskets and for fencing.
<i>Arundinaria densifolia</i>	Used for making roofs basket and fencing by the tribals.
<i>Arundinaria floribunda</i>	Culms of this species are used for making roofs, fencing and agricultural implements.
<i>Arundinaria microphylla</i>	Leaves are used as fodder.
<i>Arundinaria walkeriana</i>	Culms are used for fencing and roofing.
<i>Arundinaria wightiana</i>	Used for making baskets, mats roofs and fencing.

Source: Dr. Muktesh Kumar, KFRI, Peechi.

Forests and home gardens are the sources of bamboo in Kerala. While bamboo from forest is exclusively utilized by the newsprint factory within the State, bamboo from home gardens goes for industrial and non-industrial uses within and outside the State. Of the total supply of bamboo during 1993-94, home-gardens contributed 63 per cent and forest the remaining 37 per cent (Krishnankutty, 1998). *Bambusa bambos* is the most common commercially important bamboo species in the home gardens. Most of the bamboo is being marketed as poles through the primary and wholesale bamboo depots. There are about 100 primary depots which purchase bamboo in small lots from nearby villages. The primary depots are distributed in all the districts in the State. There are around 40 wholesale depots at different places such as Pathirippala, Mundur, Kalladikode, Ottappalam and Alathur in Palakkad District. No such wholesale depots exist in any other districts. In the wholesale depots, bamboo is purchased in large lots mostly from the home gardens in Palakkad, Thrissur and Malappuram Districts and sold in bulk (truck loads) mainly to retailers, banana farmers and other users outside the State particularly the neighbouring State of Tamil Nadu. The bamboo depots are well established and have been operating as a unique wholesale market since 1960. Figure 10 shows the flow of bamboo from the wholesale market.



Figure 10. Marketing channels of bamboo

The retail markets of bamboo are mainly in different places in Tamil Nadu. Kerala bamboo is preferred by Tamil Nadu farmers and other users, even when lower priced casuarina poles are abundantly available there. Excellent strength and durability are the reasons for preferring bamboo poles over casuarina poles. Over the years, more than 80 per cent of the annual quantities traded through the depots have been moving out of the State (Table 14). Bamboo becomes an important economic crop in home gardens, mainly due to the existence of such a wholesale

market (Krishnankutty, 2004). This marketing advantage needs to be exploited by the bamboo growers through sustainable supply of bamboo to the depots by developing the required resource base in home-gardens.

Movement of bamboo from Palakkad market to the neighbouring States is declining over time (Table 14). The reduction in the sale is due to the shortage in bamboo supply to the depots. It is reported by bamboo traders and growers that the growing stock in home gardens in and around the Palakkad region is being depleted resulting in reduction in the supply to the depots. Bamboo clumps in home gardens are poorly managed and not considered as a crop by most farmers. This happens due to the grower's ignorance on clump management and harvesting practices. In inappropriately harvested clumps, regeneration is adversely affected resulting in the depletion of the resource. There is considerable opportunity to develop the resources through scientific clump management and harvesting techniques (Krishnankutty, 2005). For this, a package of practices needs to be popularized among farmers for sustainable availability of bamboo to the depots.

Table 14: Trends in bamboo trade through the wholesale depots

Year	Quantity sold (metric tonne)			
	Kerala	Tamil Nadu	Karnataka	Total
1989–90	8,586 (16.4)*	33,340 (63.7)	10,383 (19.9)	52,309 (100.0)
1993–94	5,896 (13.6)	28,718 (66.2)	8,771 (20.2)	43,385 (100.0)
2004–05	7,540 (19.8)	30,394 (79.8)	144 (0.4)	38,078 (100.0)

*The figures in the brackets are per centage to annual total

Sources: Krishnankutty (2004) and Muraleedharan *et al.* (2007).

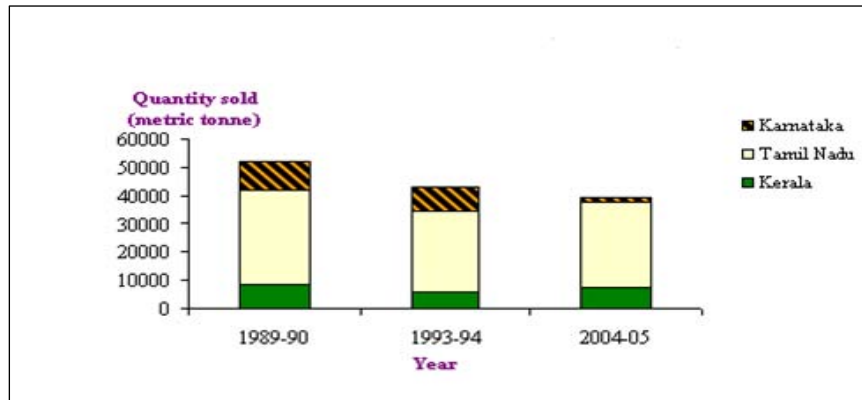


Figure 11. Trend in bamboo trade through wholesale depots

The bamboo industry in Kerala provides livelihood to about 0.1 million workers mostly belonging to the tribes and other weaker sections of the society, majority of which are women. The Kerala State Bamboo Corporation was established in 1971 by the Government to ensure availability of raw materials to about 0.3 million workers belonging to socially and economically backward sector depending on traditional reed based industries without the interference of intermediaries. At present, the major activities of the Corporation include collection of reeds from forests, distribution of reeds to the registered mat weavers and sale to other traditional workers, procurement of bamboo mats and production and sale of bambooply.

The formation of a multidisciplinary and multi departmental State Bamboo Mission in November 2003 was a major initiative for the development of bamboo sector in Kerala. The mission was concerned with popularizing bamboo through supply of seedlings for planting, providing training for skill upgradation for artisans and craftsmen and conducting the Bamboo Fest annually.



Bambusa bambos var. bambos



Bambusa nutans



Bambusa balcooa



Dendrocalamus stocksii



Dendrocalamus strictus



Oxytenanthera ritchiei

Cane

Canes (rattans) are a group of climbing palms that provides raw material for furniture and handicrafts industries. It is one of the main Non-Wood Forest Produces and provides livelihood for millions of tribal and rural people across the world. There are 12 genera of rattans with 555 reported species. In India, rattans are represented by four genera *Calamus*, *Daemonorops*, *Korthalsia* and *Plectocomia* with about 56 species. In Peninsular India, only one genus, *Calamus* is present with 23 reported species. Depending on the species, they are distributed in evergreen, semi evergreen and moist deciduous forests. More numbers of species are seen towards the southern part of Western Ghats whereas from the northern part (Maharashtra and Goa), only two species have been reported so far. *Calamus* is also seen in the Nilgiris and in the Eastern Ghat forests. This species is distributed from almost sea level to 2000 m elevation, most showing altitudinal preferences. The species found occurring in Kerala are tabulated below (Table 15).

Table 15. Cane species found in Kerala

Species	Uses
<i>Calamus brandisii</i>	Excellent small diameter cane, extensively used in furniture industry.
<i>Calamus delessertianus</i>	A good, large diameter rattan, used in furniture industry.
<i>Calamus dransfieldii</i>	A good, large diameter cane, but available only in limited quantities.
<i>Calamus gamblei</i>	A moderately good quality cane, used in furniture industry and for basket making.
<i>Calamus hookerianus</i>	A medium diameter rattan, extensively used in furniture industry and basket-making.
<i>Calamus wightii</i>	A good quality cane but not available in sufficient quantities.
<i>Calamus metzianus</i>	This cane is not used for any purpose because of its easily breakable nature.
<i>Calamus nagbettaii</i>	This cane is considered to be very sacred and is worshiped in many households in Karnataka. This is a very robust cane, but not available in sufficient quantities.
<i>Calamus neelagiricus</i>	A good quality cane but not available in sufficient quantities.
<i>Calamus pseudotenuis</i>	Used in furniture industry and for basket making.
<i>Calamus shendurinii</i>	A good quality medium diameter cane
<i>Calamus thwaitesii</i>	One of the best quality canes used extensively in furniture industry.
<i>Calamus travancoricus</i>	A best quality small diameter cane used extensively in handicraft and furniture industries, but not available in sufficient quantities.
<i>Calamus vattayila</i>	A good quality cane used in furniture industry, but not available in required quantities.

Source: Renuka (2000)

The most important product from cane is the stem. The stem is solid, strong and uniform, yet highly flexible. Because of the remarkable pliability, strength and length, canes are used as substitutes for ropes and cables in suspension bridges in some remote areas. The stem is used either in round form especially for furniture frames, or split, peeled or cored

for matting and basketry. The range of indigenous uses of rattan is vast, from bridges to baskets, from fish trap to furniture, from crossbow strings to handicraft items. Large quantities of canes are also used in tea gardens, colliers and by railways.

In India, all the harvested rattans come from the natural forests. Depending upon the species, soil and climate, rattan reaches harvestable size in 6-12 years. This may even be as long as 15-20 years. Harvesting is usually done during dry months. Deglazing, fumigation, bleaching, oil curing among others are some of the methods used for the value addition of the raw material. Rattan marketing in Kerala is carried out in two ways: (i) collection and marketing of rattan within the State and (ii) purchase of rattan from North-eastern regions and Andaman Islands and sales within the State. The finished products of rattan are sold locally, within the State and exported to other States in the country or abroad. Before 1991, 80 per cent of the units marketed their products within the State and the remaining units both within and out side the State, where as these were 45 and 55 per cent respectively during 2004-05. Of the exported material, 20 per cent go to other countries also, aiming to get a higher price for the products.

Kerala State Scheduled Caste/Scheduled Tribe Development Co-operative Federation (Federation) is the authorized agency for collection of rattan from forests. The Federation is an apex body of Scheduled Caste and Scheduled Tribe Service Co-operative Societies in the State. Generally, the Federation leases out the right of collection to selected tribal societies due to two reasons; first, the federation has no facilities to organize harvesting operation at different places simultaneously, secondly, direct collection by the societies may help enhance the income and employment opportunities of the tribes. In reality, some of the selected societies have no facilities for undertaking this work. Consequently, they engage contractors and subcontractors for the same, leading to increased collection charges (Muraleedharan *et al.* 2000).

Due to over-extraction and unauthorized collection, availability of mature cane during early 1980's was very low. In order to arrest the depletion further, the State Forest Department, put a ban on felling of rattan in 1983. This continued till 1990-91. In general, rattan is collected from the forests in the State only in certain years owing to poor growing stock. For instance, during 1991-92 and 1992-93, there was extraction in some Forest Ranges in the State but the next extraction took place only in 1997-98 and 2000-2001. Further, total number of rattan extracted also showed variation; for instance, they were 203,690 and 249,992 numbers in 1991-92 and 1992-93 which came down to 29,078 numbers in 1997-98 and further to 105,48 in 2000-2001 respectively. Afterwards, there was no rattan extraction from the forests by the Forest Department. Generally, the Federation supplies collected rattan from the forests to the rattan societies at a subsidized price.

The sacred groves are another source of raw materials from where artisans collect rattan for their use. However, supply from this source is minimal. Import, particularly from Assam and Arunachal Pradesh, two north eastern states in the country, is the main source of raw material to the manufacturing units in the State. In addition, rattan is also imported from Andaman in some years. There are about 10 rattan traders in Kerala of whom six

import the rattan regularly. Totally, they import nearly 160-200 truck loads of rattan in a year. Each truck load contains about 400 bundles of rattan, consisting of 20 numbers each in a bundle (12 feet length). The import price of one truck load of rattan during 1988-89 was estimated as Rs.150,000 which increased to Rs 250,000 in 2000-01 and Rs.350,000 in 2004-05 (Muraleedharan *et al.* 2006)

A rattan furniture unit generally requires four varieties of rattan with different thickness. They are thick rattan (above one inch thickness) for frames, medium size (0.5 to 1 inch) for support, thin rattan (0.25 to 0.5 inch) and split rattan for weaving. A look at the average prices of different grades of rattan (standard length of 12 feet length) charged by rattan traders in Kerala in different periods (Table 16) indicates a manifold increase in the price of rattan during the period 1989-90 to 2004-05. This increase is probably due to low availability of rattan from Kerala, high demand, increased tax at collection centers and transportation charges among others.

Table 16: Average prices of four grades of rattans in Kerala (Rs)

Item	1989-90	1993-94	2000-01	2004-05
Thick rattan (1Bundle-20 nos)	142.00	460.00	700.00	900.00
Medium size (1Bundle-20 nos)	117.00	280.00	600.00	700.00
Thin size (1 bundle-100 nos)	172.00	350.00	1200.00	1400.00
Split rattans (1Bundles-200 nos)	122.00	290.00	700.00	800.00

Source: Muraleedharan *et al.* (2006)



C. brandisii



C. delessertianus



C. dransfieldii



C. gamblei



C. metzianus



C. nagabathai

Ecotourism

The International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people". Ecotourism is a fast developing sector in the area of tourism in Kerala. Ecotourism means development of tourism sector without causing harm to the natural resources and saving the non-renewable resources for the posterity. It is purposeful travel to natural areas to understand the cultural and natural history of environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make conservation of natural resources beneficial to local people. Any tourism program, which is: nature-based, ecologically sustainable, where education and interpretation is a major concept and where local people are benefited can be called ecotourism.

Eco-tourism has taken off in a big way in Kerala, as there are several destinations in Kerala known for their natural beauty. The Western Ghats with its tropical ecosystem is an ideal region for ecotourism in Kerala. There is vast biological diversity. Ecotourism in Kerala also gives scope to mountaineering, trekking, bird watching, nature-walks among others. The Western Ghats of Kerala can be projected as an ecotourism zone which can attract great number of foreign customers who comes in to see the famous hill stations, wildlife, beaches and backwaters (Figures 12 and 13).



Tourist destinations in Kerala

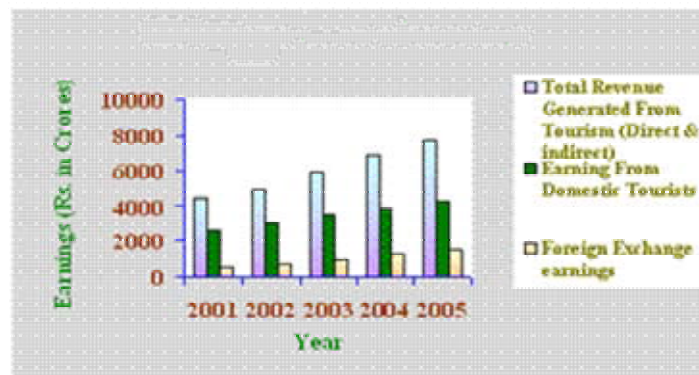


Figure 12. Earnings from tourism over the past years in Kerala

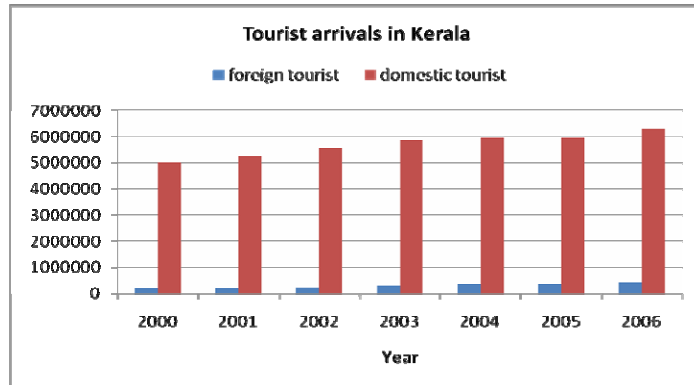


Figure 13. Tourist arrivals over the past years in Kerala

In Kerala, travel to wildlife destinations in the name of “ecotourism” is already a popular concept. Many of the National Parks and Sanctuaries are already on international tourist maps. The visitors’ flow to the Sanctuaries and National Parks shows an increasing trend during the period 1998 to 2006 and the annual average visitors flow during the period was 6,63,255. The visitors flow to the Wildlife Sanctuaries and National Parks in 2006 registered a growth rate of 148 per cent., i.e., 1.5 higher than that of 1997. This increase can often be detrimental to the cause of biodiversity conservation. In practice, the term “eco” is used as a marketing tool. Wildlife tourism is carried out in an unsystematic manner with no clearly laid out policies. Without a proper regulatory mechanism in place, ecotourism generates more negative impacts on environmental conservation and social well-being of local communities. In many areas, it has led to conflicts between local communities and investors, and also increased living costs for locals.

Though this eagerness is encouraging, certain issues have to be taken note of. Loose tourism in the protected areas may pose a serious threat to our wildlife and their habitats. When tourism increases, inappropriate waste disposal and litter thrown by visitors invite scavengers, and they become a threat to new born babies of animals and birds. Vehicle emissions inside or nearby key sites as well as burning of non-biodegradable litter such as plastic wastes pollutes the fresh air of the protected area. Construction of roads and lodges, vehicle safari, campsite as well as trekking could also affect animal corridors adversely.

Marketing of forest produce

KFD sells about 60,000 m³ of timber annually. Major portion of the sale is of teak. KFD undertakes marketing of various types of forest produces worth crores of rupees every year through different disposal methods. Industrial raw materials like bamboos, reeds, eucalyptus, etc are being allotted yearly to the industries like HNL, under mutually agreed conditions and sale prices. Softwood species like elavu are being sold as standing trees, by outright sale through tender-cum-auction. In the case of Non-Wood Forest Produces (NWFP), tribal people are allowed to collect them from the forests, through their co-operatives, which are finally disposed by the Federation of SC/ST Societies. All other forest produces including timber, firewood, poles etc. collected from forest

plantations and dead trees from natural forests are sold by tender-cum auction method, through departmental depots or, in certain cases, through the concerned territorial Divisions.

At present, there are 32 depots including annexe depots functioning, under six Timber Sales Divisions. In Government Timber Depots, sale is normally conducted by the Divisional Forest Officers of Timber Sales Divisions. In other cases, it is done by the Territorial DFOs concerned. Conservator of Forests (CF) of the Forest Circle having control over the sale Divisions confirms the sale. CF himself conducts sale of rosewood.



Timber logs, firewood and bamboo

Table 17 gives average price of teakwood of various categories of teakwood sold through timber depots.

Table 17: Average current price of teakwood (Rs/ m³)

Year	Export Class (185 cm and above)	Girth Class I (150-184 cm)	Girth Class II (100-149 cm)	Girth Class III (75-99 cm)	Girth Class IV (60-74 cm)
2001	40680	37643	30270	21735	15891
2002	40457	38627	30496	22088	17129
2003	45896	42349	31261	21598	15350
2004	44746	42237	30962	21903	16480
2005	65263	57533	42636	28998	19795

Source : Sivaram (2008)

Trends in timber trade in Kerala can be seen from Tables 18, 19 and 20, where the average volume per annum during successive 5-year periods is shown. Teakwood import has grown spectacularly from the period 1981-86 to the period 1995-2001 (Table 18). *Pynkado, gurjan, kussia, padauk, keruing, billinga* and Malaysian *sal* are the other major imported timbers. Annual export of teakwood which was around 33,000 m³ during 1981-1986 period has fallen sharply to just 4,000 m³ during 1996-2001 period (Figure 14). Kerala, which was once a supplier of teakwood, has now become a net importer (Table 19). The phenomenal growth of rubber wood export to other States in the country during the last 20 years is commendable and perhaps an unanticipated outcome. This is due to the increasing availability of rubber wood. In fact, Kerala accounts for nearly 85 per cent of India's total rubber wood production. The export of other timbers shows a continuous decline during the 20-year period while the total import has increased. When the international export is considered, rosewood export from Kerala of the order of 17,200 m³ annually during the early 1970's has declined to 1,400 m³ annually during 1996-2001 and the decline in teakwood export is more profound (Table 20).

Table 18: Trends in import of timber from places outside Kerala*

Five-year Periods	Average volume (m ³) per annum			
	Teakwood	Rose wood	Others	Total timber
1981-1986	594	709	36,910	38,213
1986-1991	935	1147	78,245	80,327
1991-1996	1,873	833	77,397	80,103
1996-2001	11,583	382	1,23,185	1,35,150

*Data from six major inter-State border forest check-posts at Manjeswaram, Muthanga, Noolpuzha, Walayar, Aryankavu and Parassala.

Source: Krishnankutty *et al.* (2005)

Table 19: Trends in export of timber to rest of India*

Five-Year periods	Average volume (m ³) per annum				
	Teak wood	Rose wood	Rubber wood	others	Total timber
1981-1986	33109	189	60983	363473	457754
1986-1991	24298	179	108290	135522	268289
1991-1996	18507	370	216890	103071	338838
1996-2001	1392	103	304727	90034	399256

*Data from six major inter-State border forest check-posts at Manjeswaram, Muthanga, Noolpuzha, Walayar, Aryankavu and Parassala.. Source: Krishnankutty *et al.* (2005)

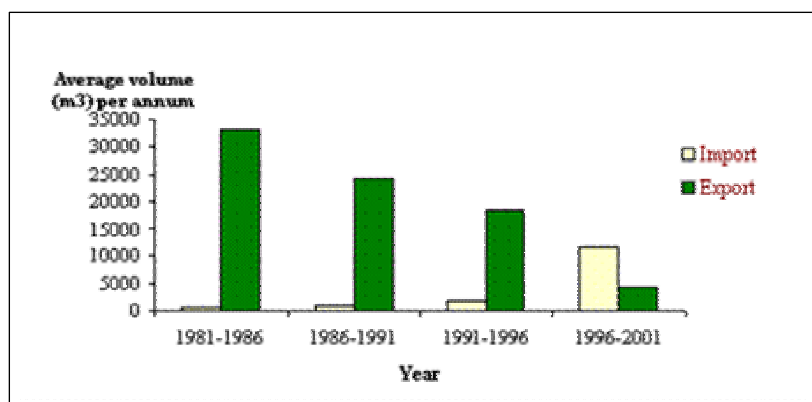


Figure 14. Trends in import and export of teakwood pertaining to Kerala

There is hardly any international market for Kerala teakwood. Non-availability of logs in larger girth classes is the primary reason for the low demand in the international market. The shortening of rotation of teak plantations to 50 years has reduced the production of high value larger girth logs. A policy favouring the growing of large girth timber must be adopted by the Kerala Forest Department and the rotation age of forest teak plantations must be increased (Krishnankutty *et al.*, 2005).

Table 20: Trends in international export of timber from Kerala

Five-year periods	Average volume (m ³) per annum			
	Teak wood	Rose wood	Others	Total timber
1971-1976	899	17,197	603	18,699
1976-1981	517	7,730	955	9,202
1981-1986	112	1,641	453	2,206
1986-1991	39	1,396	277	1,712
1991-1996	21	1,128	94	1,243
1996-2001	93	1,408	1	1,502

Source: Krishnankutty *et al.* (2005)

Demand and supply of wood

Wood is defined to include both timber (construction timber and industrial wood) and fuelwood (including charcoal). Studies conducted in Kerala (Krishnankutty *et al.*, 2005) revealed that of the total demand of 12.261 million m³ roundwood equivalent of wood during 2000-01, fuelwood accounted for the major share (83%). Of the total demand for timber, industries sector accounted for the major share, household sector ranked next, followed by export (Table 21). Timber export includes 4,96,000 m³ of packing cases and 78,000 m³ of other timbers. Timber consumption in the institutions sector for constructions was negligible mainly due to substitution with metal and glass. Most public buildings now have very little timber component. Teakwood is the most valuable timber among the timbers used in Kerala. The total demand for teakwood was 96,000 m³ of which consumption within the State accounted for 86 per cent and export to other States within the country 14 per cent. Nearly half of the export was teak poles and the market was in Tamil Nadu. Households were the major consumer of fuelwood accounting for 73 per cent of the total demand for fuelwood. In the service sector, fuelwood was used for cooking, mostly in restaurants, schools and hostels. Industrial demand was 12 per cent of the total demand for fuelwood.

Table 21: Demand for wood in Kerala (Volume '000 m³)

Sector	Timber		Teakwood		Fuelwood	
	Volume	%	Volume	%	Volume	%
Households	616	29.8	74	76.7	7,438	73.0
Industries	865	41.9	6	6.7	1,247	12.2
Institutions*	10	0.5	2	2.1	1,511	14.8
Export	574	27.8	14	14.5	0	0.0
Total demand	2,065	100.0	96	100.0	10,196	100.0

*All other wood-using sectors

Source: Krishnankutty *et al.* (2005).

In the total supply of timber, the contribution of home gardens is matched with that of rubber estates (Table 22). Forests produced only four per cent. Import accounted for 15 per cent of the total supply. Import from other countries was 1,59,000 m³ which is 51.2 per cent of the total timber import. In the teakwood supply, the contribution of forest plantations was substantial (52 per cent), import accounted for 15 per cent and home gardens the remaining 33 per cent. On the fuelwood supply side, home gardens produced about 82 per cent and the contribution of forests came to around 11 per cent of the total fuelwood supply. Fuelwood import was in the form of charcoal from Tamil Nadu. The demand-supply position during 2000-01 was comfortable with both an export surplus for timber and also for total wood. The source of this surplus was rubberwood which contributed to an export of 4,55,000 m³. When there was a small deficit of 667 m³ of teakwood, there was a large deficit of 1,91,000 m³ of other timbers and the deficits were met by import.

Table 22: Supply of wood in Kerala (Volume '000 m³)

Source	Timber		Teakwood		Fuelwood	
	Volume	%	Volume	%	Volume	%
Home gardens*	850	41.2	31	32.6	8,340	81.8
Rubber estates	817	39.6	--	--	545	5.4
Forests	87	4.2	50	52.2	1,075	10.5
Import	311	15.0	15	15.2	236	2.3
Total supply	2,065	100.0	96	100.0	10,196	100.0

*Includes negligible quantities from estates of cardamom, coffee and tea

Table 23: Change in demand for wood during 1988 to 2001

Wood	Volume in '000 m ³ roundwood equivalent				Compound rate per annum
	1987-88		2000-01		
	Volume	%	Volume	%	
Timber	2,493	17.1	2,065	16.8	(-) 1.44
Fuelwood*	12,152	82.9	10,196	83.2	(-) 1.34
Total wood	14,645	100.0	12,261	100.0	(-) 1.36

Sources: Krishnankutty (1990) and Krishnankutty *et al.* (2005).

Comparison of demand for wood in respective years shows that there has been an overall decline from 2,493,000 m³ during 1987-88 to 2,065,000 m³ during 2000-01 (Table 23). The decline was primarily due to the shift from tiled roof to concrete roof houses in the construction sector, substitution with aluminium and concrete frames for doors and windows, and availability of a variety of substitutes for furniture and fixtures. Compared to the situation in 1987-88 when the total fuelwood demand was 1,21,52,000 m³, the demand after 13 years was only 1,01,96,000 m³. The decline in the demand for fuelwood is mainly due to the shift to LPG. Trees in areas outside forests particularly home gardens are extremely important not only for producing timber and fuelwood, but also for social and environmental benefits. It is, therefore, essential to improve the survival of the young seedlings which are already established and to promote tree planting in home gardens for enhancing the stock of wood resource for the future. As the contribution of forests in the total wood supply is very negligible, the existing forests can be reserved exclusively for conservation.

Consumption of fuelwood

Fuelwood, non-wood biomass, LPG, kerosene and electricity are the cooking media used in the household sector which is the largest fuelwood using sector (73%) in Kerala (Krishnankutty *et al.*, 2005). Non-wood biomass includes coconut/palmyra leaf, sheath, husk, shell and other crop residues. In the rural as well as urban households, different fuels are used with various fuel combinations. The per capita annual consumption of non-wood biomass was 433 kg for the whole of Kerala. Even in the urban areas, the per capita consumption of non-wood biomass was 210 kg per annum. Fuelwood consumption including that of non-wood biomass is predominantly in the rural areas. Per capita annual fuelwood consumption in rural households was 226 kg whereas it was just 43 kg in urban households (Table 24).

Table 24: Household fuel consumption during 2001-02

Fuel type	Per capita annual consumption		
	Rural	Urban	Kerala
Fuelwood (kg)*	226	43	178
Non-wood biomass (kg)	501	210	433
LPG (kg)	9	30	14
Kerosene (litre)	2	5	3
Electricity (kWh)	0	5	1
Other materials (kg)	1	0	0

Source: Krishnankutty *et al.* (2005)

The per capita fuel consumption pattern in a more comparable useful heat terms in kilocalories (kcal) per day can be seen in Table 25. *Useful heat* is obtained by multiplying primary energy quantities with their appliance efficiencies (Krishnankutty *et al.*, 2005). Among different fuels, non-wood biomass fuels are dominant. In rural areas, about 45 per cent of the useful heat was obtained from non-wood biomass. In urban areas, LPG accounted for 67 per cent of all the fuels used. This is the second largest component among different fuels consumed in the households. Fuelwood occupies only the third place accounting for 25 per cent of the fuels and most of this was in rural households. In urban households, it was only six per cent.

Table 25: Household fuel consumption pattern in energy units

Fuel type	Rural		Urban		Kerala	
	Quantity	%	Quantity	%	Quantity	%
Fuelwood	235	31.4	44	5.8	186	24.7
Non-wood biomass	333	44.5	135	17.7	287	38.1
LPG	152	20.3	507	66.6	237	31.5
Kerosene	28	3.7	70	9.2	42	5.6
Electricity	0	0.0	5	0.7	1	0.1
Other materials	0	0.1	0	0.0	0	0.0
Total	748	100.0	761	100.0	753	100.0

**Useful heat* consumed per capita per day in kilocalories. Source: Krishnankutty *et al.* (2005).

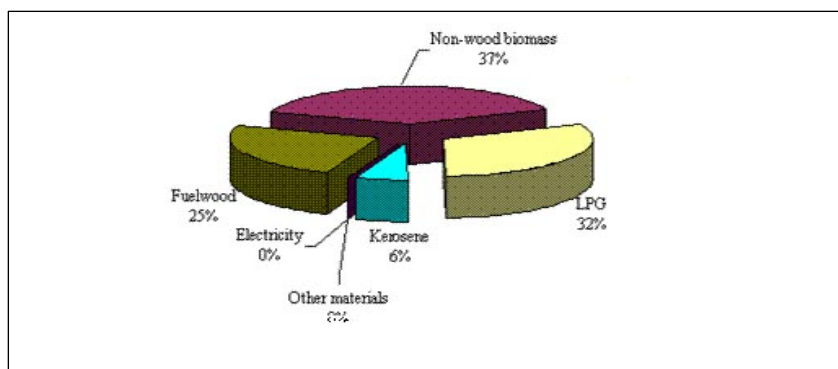


Figure 15. Household fuel consumption in Kerala by type of fuel used

Households having all combinations of fuels without LPG accounted for 51 per cent of the total number of households in Kerala (Table 26). In urban areas, households having LPG and using a combination of LPG and other fuels accounted for 82 per cent while it was only 38 per cent in rural areas. Households depending on LPG alone were 34 per cent in urban areas while it was only two per cent in rural areas. Lack of access to LPG supplies may be the reason for the low LPG use in rural areas. To reduce the dependence on fuelwood, which is a cause of environmental degradation, it is important to make LPG available throughout the rural areas in the State, particularly in areas adjoining forests.

Table 26: Distribution of households according to access to LPG during 2001-02

Households	Rural		Urban		Kerala	
	Number ('000)	% to total	Number ('000)	% to total	Number ('000)	% to total
With LPG	2,056	38.0	1,435	82.0	3,491	48.7
Without LPG	3,352	61.9	314	17.9	3,666	51.2
Kerosene alone	3	0.1	2	0.1	5	0.1
Total	5,411	100.0	1,751	100.0	7,162	100.0

Source: Krishnankutty *et al.* (2005).

Wood-based industries

The major wood-based industries in Kerala are sawmilling, manufacturing of packing cases, match splints and veneers, plywood, pulp and paper, wooden furniture and fixtures. The total industrial demand for timber in Kerala during 2000-01 was 20,65,000 m³ (Table 27). Sawn timber from sawmills is mostly used in the construction sector and a small portion is exported to other States in the country. Timber of jack, anjily, coconut, mango and teak account for a major share of the timber processed in sawmills (Table 28). Timber of many of these species comes entirely from home gardens. Although teak wood comes mostly from forest teak plantations, it is also produced from home gardens. Jack, anjily, mango and teak are the traditionally important trees grown in most of the home gardens in Kerala. The output from the packing case industry is entirely exported to other States. Industrial units of match splints, veneers and furniture mostly depend on timber from home gardens, whereas packing case units use rubber wood from private estates. Most of the plywood units, which were traditionally dependent on forest timber, have

switched over to rubber wood. There are a few units, manufacturing high value plywood, which depend on imported timber. In the match splints and veneer industry, matty (*Ailanthus triphysa*) and ezhilampala (*Alstonia scholaris*) obtained exclusively from home gardens is the preferred species. Vatta (*Macaranga peltata*) timber from home gardens and rubber wood are used for match box veneer. Pulp industry uses eucalypt wood from forest plantations. Teak and jack wood from home gardens are the main timbers used in the furniture units in the rural areas. An interesting fact is the growing importance of trees outside forests, particularly home gardens, in the industrial wood supply in the State.

Table 27: Industry-wise demand for timber during 2000-01 and supply sources

Industries	No. of units	Demand ('000 m ³)	Source of timber supply
Sawmilling	2,366	704	Home gardens, forests, import
Packing cases	366	496	Rubber estates, home gardens
Match splints, veneers	651	473	Home gardens, rubber estates
Plywood	245	244	Home gardens, rubber estates, import
Pulp and paper	1	99	Forest plantations
Furniture	371*	44	Home gardens, forests, import
Others industries	142*	5	Home gardens
Total	4,142	2,065	

*Represents only the units in the organized sector. Although the total quantity of timber consumed includes the quantity used by the units in the unorganized sector, the number of units in the unorganized sector was not estimated and therefore not included. Source: Krishnankutty *et al.* (forthcoming).

Table 28 : Timber processed in sawmills during 2000-01 and their sources

Timber species	Volume ('000 m ³)			Source of supply
	Construction*	Export	Total	
Jack	195	0	195	Home gardens
Anjily	113	1	114	Home gardens
Teak	76	14	90	Home gardens, forests and import
Coconut	76	0	76	Home gardens
Mango	8	0	8	Home gardens
Rosewood	5	2	7	Home gardens and forests
Other timbers	95	61	156	Home gardens, estates and import
Imported timbers	58	0	58	Import from abroad
Total	626	78	704	

*Timber consumed by households sector (6,16,000 m³) and institutions sector (10,000 m³).

Source: Krishnankutty *et al.* (forthcoming).

Industries such as tile-manufacturing, brick-making, tea-processing, metal industries, automobile workshops, textile-mills and rubber goods, consume wood and or charcoal as fuel. The total quantity of fuelwood including charcoal consumed in all the industries in Kerala during 2000-01 was 12,47,000 m³ roundwood equivalent. Industries such as brick and tile manufacturing depend exclusively on coconut wood and rubber wood. Charcoal using industries depend mostly on imported charcoal from the State of Tamil Nadu. There is hardly any dependence on forests for industrial fuelwood.

Forest inhabitants

Forests around the world are inhabited by not just plants and animals but also by humans (aborigines) although their number is much limited now. In the forests of Kerala also, one can find tribal settlements in many places. The tribes who once lived in isolation, deep in the forests and away from the mainstream, had their own traditional social fabric and culture. Historically, the economy of most tribes was subsistence agriculture or hunting and gathering. The process of dispossession of the tribal people started when colonization, in its quest for resources, began penetrating the forest areas. The early 20th century, however saw large areas in the hands of non-tribals, on account of improved transportation and communications. By the time, tribals understood the necessity of obtaining formal land titles, they had lost the opportunity to lay claim to lands that might rightfully have been considered theirs. As of now, they are fighting a losing battle against the more powerful groups in spite of constitutional safeguards.

The Government has special concern and commitment for the well-being of the Scheduled Tribes who are socially and economically backward. Tribal people constitute 8.3 per cent of the Nation's total population, over 84 million people according to the 2001 census. By the same census, the Scheduled Tribe (ST) population of Kerala State was 364,189 constituting only 1.14 per cent of the total population of the State. With a total of 35 STs, the decadal growth has been 13.5 per cent, which was 4.1 per cent higher than the growth of the total population during 1991-2001. District wise distribution of ST population is shown in Table 29. Primitive tribes are the most vulnerable tribal communities in the State, categorized by low population, poor agricultural development and low literacy. Five groups in Kerala, namely, the Kaders, Koragas, Kurumbas, Kattunaickans and the Kanis, belong to this category. As per the survey done by the ST Development Department in 1996-97, there were 19 per cent houseless and 42 per cent with dilapidated houses among the primitive tribes, the total families of primitive tribes being 4406.

Out of 35 Scheduled Tribes notified for the State, Paniyan is the most populous tribe with a population of 81,940 forming 22.5 per cent of the total tribal population. Kurichchan is the second largest tribe having a number of 32,746 constituting 9 per cent of the total ST population. Six other STs, namely, Muthuvan, Kanikaran, Irular, Kurumans, Marati and Malai Arayan having a population ranging from 21,000 to 32,000 along with Paniyan and Kurichchan constitute 73.6 per cent of the total tribal population. Seven tribes, namely, Malayan, Malai Vedan, Mannan etc. having 5,000-16,000 members account for another 20 per cent and the remaining 20 tribes along with the generic tribes constitute the residual 6.4 per cent of the State's tribal population. Tribes having below 500 members are eleven in number. Out of them, Kota, Kammara, Kochu Velan and Konda Kapus are the smallest groups each having less than 50 members.

Table 29: District wise Population of Scheduled Tribes as on 2001

District	Scheduled Tribe			Per centage of State's ST population
	Total	Male	Female	
Thiruvananthapuram	20,893	9,890	11,003	0.65
Kollam	5,190	2,447	2,743	0.20
Pathanamthitta	6,549	3,184	3,365	0.53
Alapuzha	3,131	1,565	1,566	0.15
Kottayam	18,340	8,972	9,368	0.94
Idukky	50,973	25,510	25,463	4.51
Ernakulam	10,046	5,079	4,967	0.32
Thrissur	4,826	2,293	2,533	0.16
Palakkad	39,665	19,990	19,675	1.52
Malappuram	12,267	5,996	6,271	0.34
Kozhikode	5,940	2,924	3,016	0.21
Wayanad	136,062	67,394	68,668	17.43
Kannur	19,969	9,793	10,176	0.83
Kasaragod	30,338	15,132	15,206	2.52
State Total	364,189	180,169	184,020	1.14



Scenes from tribal settlements in forests

Some of the major problems associated with tribals are their acute poverty, malnutrition, consumption of intoxicants and exploitation by way of land grabbing by non-tribals which have led to unrest in various tribal pockets.

Threats to the forests of Kerala

In spite of the best efforts to protect the forests, this invaluable resource is under threat of destruction due to the high population pressure. Quite often, more than reasonable needs, it is the insatiable greed that is operative. It is important that we respect nature and avoid doing any deliberate harm to the same. Some indications are given here as to the destructive elements operational on forests so as to bring them to public attention.

Fire is one of the major threats to the forests of Kerala. People who are engaged in raising livestock often burn the area to get fresh shoots for their cattle, during lean season. Those involved in illicit activities such as ganja cultivation, poaching, tree felling, NWFP collection and very often ignorant tourists and pilgrims are also responsible for big forest fires. The effect of fire depends on the type of vegetation, frequency and intensity of fire and season of burning. Fire causes extensive damage in deciduous forests and grasslands due to heavy fuel load. Only some weeds manage to establish a strong foothold even after

severe fire with the help of fire resistant adaptations. The direct impacts of fire are change in vegetation composition and physical properties of soil, soil erosion and loss of habitat. Table 30 and Figure 16 show the reported incidence of forest fire in Kerala for the last several years.

Table 30: Details of forest fire in Kerala Forests

Year	No. of incidents reported	Area destroyed (ha)	Financial loss (Rs)
1985-86	34	544.54	32730
1986-87	79	889.07	728899
1987-88	61	1695.36	89731
1988-89	229	9049.12	1366902
1989-90	169	1950.99	388780
1990-91	237	2080.62	139198
1991-92	316	3388.15	235392
1992-93	90	398.79	100150
1993-94	147	3337.11	267377
1994-95	127	994.02	134800
1995-96	192	1804.58	798404
1996-97	129	1075.22	96840
1997-98	159	2068.76	205495
1998-99	139	788.39	927154
1999-00	130	842.04	258894
2000-01	107	665	24325
2001-02	584	6200	331100
2002-03	267	3697	57317
2003-04	949	15581	263365
2004-05	370	2442.449	181082

Source: Forest Statistics Reports/Forest Administrative Reports, KFD

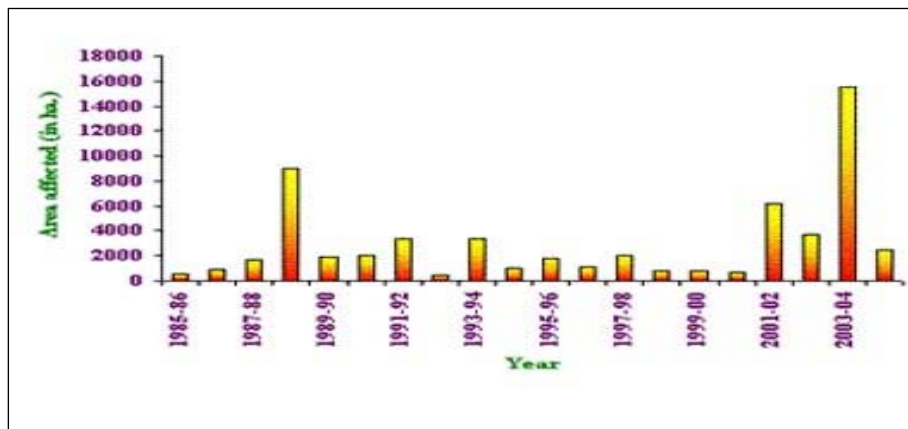


Figure 16. Incidence of forest fire in Kerala over the past years

Grazing by cattle in forest, although not rampant as elsewhere in the country, is identified as a threat to biodiversity in Kerala. Cattle grazing in forests not only remove the biomass and compete with wild herbivores but also spread contagious diseases to wild animals.

The trampling leads to soil erosion and changes in the physical properties of soil. Intensive grazing will lead to domination of a single or a few species, changing the species composition of natural vegetation. Cattle-grazing speeds up the invasion of weeds. Table 31 reports the status of recorded incidence of grazing in Kerala.

Table 31: Extent of forest area open for grazing in Kerala

Year	Area (km ²)	Year	Area (km ²)
1980-81	2436.7	1992-93	1
1981-82	2175.33	1993-94	0
1982-83	3212.23	1994-95	0
1983-84	2514.43	1995-96	0
1984-85	820	1996-97	0
1985-86	472.37	1997-98	0
1986-87	427.369	1998-99	0
1987-88	1	1999-00	0
1988-89	1	2000-01	0
1989-90	1	2001-02	0
1990-91	1	2002-03	0
1991-92	1	2003-04	0

Note. Cattle grazing is prohibited from 1993-94

Source: Forest Administration Report (various years) of KFD

Tree felling, although banned in forests, still poses a threat to biodiversity conservation in the State. The primary effect of tree felling on biodiversity is the removal of biomass and loss of habitat for many epiphytic and arboreal species. Tree felling leads to soil erosion and change of the soil properties. The opening-up of canopy due to felling changes the microclimate and invites weeds to colonize and in turn changes the structure of vegetation. Apart from the direct impact of loss in terms of money to the State, the indirect impact of felling is the constant conflict between the administrative staff and the people involved in this illegal activity.

Firewood collection directly poses threat in the form of removal of biomass, which affects microhabitat of flora and fauna, and indirectly leads to incidence of fire and encourages other illegal activities. The proximity of settlements to the forests is the main factor, which determines the intensity of firewood collection. The firewood collection leads to degradation of habitats which subsequently alters the species composition and vegetation types. It is roughly estimated that 0.8 million cubic meters of firewood is illegally removed from the forest annually. Along with dead and wind fallen trees, standing trees and poles are also removed as firewood.

Kerala is one of the most land hungry States in India with lowest per capita land holding. Organized encroachment of forestland might have started as early as 1950s. Initially the policy of government was to allot forestland for schemes, like 'grow more food', 'arable land' etc. The direct impact of encroachment is habitat loss besides the existence of constant threat on the forests by unauthorized people at fringes of forests. In addition to their involvement directly in the illegal activities they provide shelter for the unscrupulous offenders of the plains who are engaged in all kinds of illegal

activities. The policy of the State Government is that all unauthorized encroachments after January 1, 1977 will be evicted.

A major problem associated with the conservation of wild animals especially the herbivores like elephants in India is that of crop damage. Animals such as elephants, gaur, sambar, wild boar and birds like peafowl, cause extensive damage to crops. This phenomenon has registered significant increase in recent years due to habitat fragmentation and degradation of natural forests and corridors. Almost all the Protected Areas and Non-Protected Areas of Kerala contain a large number of settlements either inside or on the periphery. This leads to degradation of surrounding habitats. The traditional tolerance among the people who live inside the forests or its adjacent areas are fast disappearing and people have become increasingly antagonistic. As a result, the people tend to kill the animals either by poisoning or by other means, like using explosives. This problem is very severe in northern Kerala where cultivation of paddy is extensive. At present, Kerala Forest Department provides compensation for the crop and property damage, human casualties and cattle loss caused by the scheduled animals like elephant, tiger, leopard, gaur, etc. Providing compensation is not a long-term solution. In some areas where conflict is rampant, physical barriers like trenches to prevent the animals entering crop fields are being set up. However, these efforts are found to be effective for only a certain period and become ineffective in due course.

The abundance of wild animals and high demand for their products in the clandestine market pose threat to wild animals. Herbivores like gaur, sambar, chital among others are being poached for their meat. A lot of other not so spectacular species of animals ranging from reptiles to birds as well as plants and medicinal herbs are all part of the unauthorized wildlife trade. The major impact of poaching is species loss and change in their demography apart from extensive fire and other illicit activities.

Collection of Non-Timber Forest Produce (NTFP) is one of the major livelihoods of the local people. The NTFP consist of a variety of products, which are sources of food, fibre, manure, construction materials, cosmetics and cultural products. The users of NTFP range from local individuals to multinational companies. With the development of modern techniques, the number of products and uses based on NTFP has increased by many folds. This market-driven utilization became instrumental in their unsustainable exploitation and resulted in degradation of the natural vegetation. Studies indicate that NTFP collectors are amongst the lowest-income groups in India, often receiving a mere 5-20 per cent of the value for their products. The status of forest offences in Kerala is indicated in Table 32.



Fire

Illicit felling

Grazing

Table 32: Forest offences booked under Kerala Forest Act (1961)

Year	Clearing of Forest land	Illicit collection of Forest Produces	Section 61 A Offences	Miscellaneous	Total
1985-86	88	4815	439	1388	6730
1986-87	-	-	-	-	-
1987-88	123	5200	738	277	6338
1988-89	125	4513	-	-	5450
1989-90	233	4209	231	934	5607
1990-91	86	3545	238	1443	5312
1991-92	117	3362	202	1413	5094
1992-93	73	3770	196	622	4661
1993-94	86	2390	270	1454	4200
1994-95	110	2876	214	1030	4230
1995-96	127	2951	174	445	3697
1996-97	85	2228	282	781	3376
1997-98	89	2175	246	667	3177
1998-99	93	2276	185	581	3135
1999-00	78	1868	165	461	2572
2000-01	86	1641	161	675	2563
2001-02	126	1887	221	608	2842
2002-03	115	2028	231	627	3001
2003-04	83	1321	172	493	2069
2004-05	70	1114	174	224	1582

Source: Forest Statistics Reports/Forest Administrative Reports, KFD.

Sand mining is prevalent in the central and southern parts of Kerala. It is a threat to the stability of a landscape, which results in land slides and lowering of water table. The removal of habitat will endanger the survival of riparian species since most of them occupy a very narrow habitat niche. At the same time, regulated sand mining would help in keeping the health of the streams and reservoirs. Indiscriminate sand mining in some river systems in the state is posing a severe threat to the stability of bridges and banks. Transportation of sand through the forests and other related activities pose severe threat to the ecosystem.

Mass tourism and pilgrimage are considered to be one of the major and increasing threats to biodiversity conservation. Approximately 13 million people visit forest areas annually either as pilgrims or visitors. Among all the Protected Areas in India, the Periyar Tiger Reserve receives the maximum number of tourists. The large influx of people into the forests in short duration makes severe changes to habitat. The major impact of tourism and pilgrimage is littering and over-utilization of resources causing soil erosion, fire, disturbance to wild animals for feeding, ranging etc.

Forest policy and regulations

Management of the forests in the State is vested with the Government. Forest management in general in the State is consonant with the National Forest Policy. The 1988 Forest Policy states that forests are not to be commercially exploited for industries, but are meant to conserve soil and environment, and to meet the subsistence requirements of local people. The policy gives higher priority to environmental stability than to earning revenue. It lays stress on Joint Forest Management with peoples' participation especially women, which is a radical shift from the earlier revenue orientation. The forests in the State in general are managed under the following legislations.

- Kerala Forest Act (1961) and Amendments
- The Kerala Cattle Trespass Act, 1961
- The Kerala Cattle Trespass Rules, 1962.
- Kerala Land Reforms Act, 1963
- The Kerala Forest (Collection of Drift and Stranded Timber) Rules, 1965
- The Forest Settlement Rules, 1965
- The Kerala Private Forests (Vesting and Assignment) Act, 1971
- The Kerala Private Forests (Tribunal) Rules, 1972
- The Kerala Preservation Of Private Forest Act, 1972.
- The Wildlife (Protection) Act, 1972
- The Kerala Private Forests (Vesting and Assignment) Rules, 1974
- The Kerala Private Forests (Exemption from Vesting) Rules, 1974
- The Kerala Restriction On Cutting And Destruction Of Valuable Trees Act, 1974.
- The Kerala Restriction On Cutting And Destruction Of Valuable Trees Rules, 1974.
- The Kerala Forest Produce Transit Rules, 1975
- Kerala Private Forests (Vesting and Assignment) Appeal Rules, 1977.
- The Kerala Forest Produce (Fixation of Selling Price) Act, 1978
- The Kerala Forest Produce (Fixation of Selling Price) Rules, 1978.
- The Forest (Conservation) Act, 1980.
- The Kerala Vested Forests (Management of Reserved Areas) Rules, 1980.
- The Kerala Rules For Payment Of Compensation To Victims Of Attack By Wild Animals, 1980.
- The Forest (Conservation) Rules, 1981.
- The Kerala Preservation of Trees And Regulation Of Cultivation In Hill Areas Ordinance, 1983.
- The Wildlife (Protection) Licensing (Additional Matters For Consideration) Rules, 1983.
- The Kerala Forest (Grazing) Rules, 1985.
- The Kerala Preservation of Trees Act, 1986.
- The Kerala Forest Development Fund Rules, 1989.
- The Recognition of Zoo Rules, 1992.
- The Wildlife (Protection) Rules, 1995.

- The Wildlife (Specified Plants Conditions For Possession By Licensee) Rules, 1995.
- The Kerala Captive Elephants (Management and Maintenance) Rules, 2003.
- The Forest (Conservation) Rules, 2003.
- Declaration of Wild Life Stock Rules, 2003.
- The National Board For Wildlife Rules, 2003.

Source: Thomas and George (2004)

In order to preserve the trees outside forest area, the Government have made certain regulations under The Kerala Promotion of Tree Growth in Non-forest Areas (Amendment) Ordinance, 2006. Under the Ordinance, there is severe restriction on cutting of sandal trees which can be effected only directly by the Forest Department. Other than sandal, cutting of trees of the following species from homesteads (<0.5 ha) is regulated by issuance of felling permits by the Forest Department. The species are teak (*Tectona grandis*), rosewood (*Dalbergia latifolia*), irul (*Xylia xylocarpa*), thempavu (*Terminalia tomentosa*), kampakam (*Hopea parviflora*), chempakam (*Michelia chempaca*), chadachi (*Grewia tiliifolia*), chandana vempu (*Toona ciliata*), cheeni (*Tetrameles nudiflora*), vellakil (*Dysoxylum malabaricum*) and ebony (*Diospyrus* sp.). The above provision is not extended to ‘notified area’ which includes areas close to forest land and land declared as ‘ecologically fragile’. The species for which no permission is required for cutting and removal are coconut, rubber, cashew, tamarind, mango, jack, kodampuli, matti, arecanut, konna, seema konna, nelli, neem, murukku, jathi, albizia, silk cotton, acacia, mangium, and anjili.

Sustainable forest management

Sustainable forest management (SFM) is considered as one of the most important contributions which the forestry sector can make to the sustainable development objectives of not just any nation but the entire globe. In its broadest sense, forest management encompasses the administrative, legal, technical, economic, social and environmental aspects of the conservation and use of forests. International Tropical Timber Organization (ITTO) defined SFM as, *the process of managing permanent forest land to achieve one or more clearly specified objectives of forest management with regard to the production of a continuous flow of desirable forest products and services without undue reduction of its inherent values and future productivity and without undue undesirable effects on the physical and social environment*. Practically, the concept is akin to seeing forest as ‘the goose that lays the golden eggs’. In some corners, the concept has even been stretched to forest certification to the effect that producers shall be able to sell any forest produce only after getting certification that such produce comes from forests managed in a sustainable manner.

There have been efforts globally, to frame certain criteria and indicators (C&I) for SFM. The purpose of C & I is to provide a tool for monitoring, assessing and reporting changes and trends in forest conditions and management systems at the National and also at forest management unit level. The major thematic elements proposed by the Food and Agriculture Organization of the United Nations in this regard are briefly described below.

Thematic elements of Sustainable Forest Management (FAO, 2007)

1. **Extent of forest resources:** This theme reflects the importance of adequate forest cover and stocking, including trees outside forests, to support the social, economic and environmental dimensions of forestry; to reduce deforestation; and to restore and rehabilitate degraded forest landscapes.
2. **Biological diversity:** This theme concerns the conservation and management of biological diversity at ecosystem (landscape), species and genetic levels. Such conservation, including the protection of areas with fragile ecosystems, ensures that diversity of life is maintained, and provides opportunities to develop new products in the future, including medicines.
3. **Forest health and vitality:** Forests need to be managed so that the risks and impacts of unwanted disturbances are minimized, including wildfires, airborne pollution, storm felling, invasive species, pests and diseases.
4. **Productive functions of forest resources:** Forests and trees outside forests provide a wide range of wood and non-wood forest products. This theme reflects the importance of maintaining an ample and valuable supply of primary forest products while ensuring that production and harvesting are sustainable and do not compromise the management options of future generations.
5. **Protective functions of forest resources:** Forests and trees outside forests contribute to moderating soil, hydrological and aquatic systems, maintaining clean water (including healthy fish populations) and reducing the risks and impacts of floods, avalanches, erosion and drought. Protective functions of forest resources also contribute to ecosystem conservation efforts and provide benefits to agriculture and rural livelihoods.
6. **Socio-economic functions:** Forest resources contribute to the overall economy in many ways such as through employment, values generated through processing and marketing of forest products, and energy, trade and investment in the forest sector. They also host and protect sites and landscapes of high cultural, spiritual and recreational value. This theme thus includes aspects of land tenure, indigenous and community management systems, and traditional knowledge.
7. **Legal, policy and institutional frame work:** Legal, policy and institutional arguments—including participatory decision making, governance and law enforcement, and monitoring and assessment of progress—are necessary to support the above six themes. This theme also encompasses broader societal aspects; including fair and equitable use of forest resources, scientific research and education, infrastructure arrangements to support the forest sector, transfer of technology, capacity - building, and public information and communication.

An attempt was made to evaluate the progress of SFM in Kerala for the period 1987 to 2003. The situation in the State based on the available data is depicted as a simple tricolour chart prepared as per the guidelines of FAO (2006). The chart depicts the changes in three colours viz., red, green and yellow depending upon the compound growth rate of each variable, red showing negative change exceeding -0.5 per cent per year, green showing positive change exceeding 0.5 per cent and yellow showing changes within ± 0.5 per cent, all in respect of sustainability.

Chart summarizing the progress towards SFM based on available data for 1987-2003

Criterion		Indicator	Growth rate
Increase in the extent of forest and tree cover	●	Area under forest	0.007
	●	Area under plantations	-0.081
	●	Forest area officially diverted for non-forestry purposes	61.218
	●	Area of dense, open and scrub forests	2.436*
Maintenance, conservation and enhancement of biodiversity	●	Area of protected eco-systems (Protected Areas)	1.603
Maintenance and enhancement of ecosystem function and vitality	●	Incidences of forest fire	-3.752
	●	Extent of livestock grazing	0
Adequacy of policy, legal and institutional framework	●	Number of forest related offences	-6.519
	●	Percentage contribution of forestry sector to the NSDP	5.015

● Positive change with respect to sustainability

● No major change

● Negative change with respect to sustainability

*Positive change in forest cover is partly due to the change in the definition of forest cover made by FSI in 2001.

With respect to the forest area, the only thing of concern was the large area diverted for non-forestry purposes so as to regularize the encroachments. There have been efforts towards forest conservation from the side of the government by bringing more area under the protected class. Although there have been sporadic fires in several years, the general trend has been that of reduction in the incidence. Cattle grazing in forests are completely banned since 1993. There has been reduction in the number of forest related offences as well. Production from forests has been on the increase during the period but still within allowable limits. The only criterion which remains largely unmonitored is soil and water resources. It may be noted that although changes have been happening, they have not been uniform over the period.

To the extent possible, progress towards SFM during 1987 to 2003 was also evaluated using sustainability index proposed by ITTO.

$$SI = \left(\sum_i WC_i \times C_i \right) / \sum_i WC_i, \quad C_i = \left(\sum_j WI_{ij} \times I_{ij} \right) / \sum_j WI_{ij}$$

Where SI = Sustainability index

WC_i = Weight for the i th criterion

C_i = Score of the i th criterion

WI_{ij} = Weight for the j th indicator of the i th criterion

I_{ij} = Score for the j th indicator of the i th criterion

The analysis proceeded following the norms detailed by Kotwal *et al.* (2006). The graph obtained is shown in the following figure.

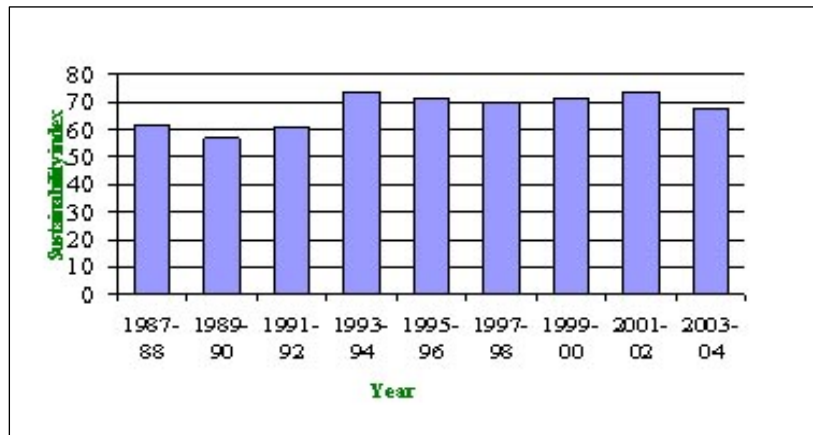


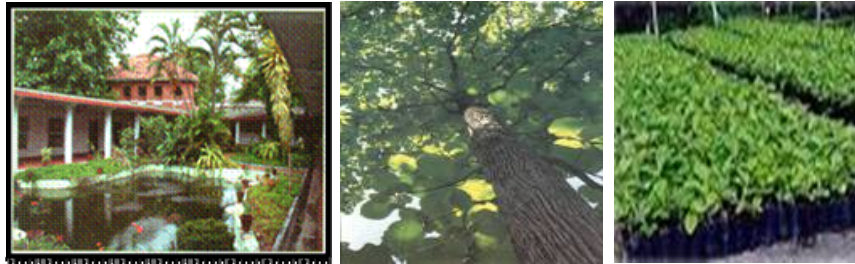
Figure 17. Progress towards sustainability of forests in Kerala

After an initial dip, the index has been moving up except for the year 2003-04 during which time, there was large diversion of forest land for non-forestry purposes and also increased occurrence of fire and reduction in the per centage contribution of forest sector to NSDP. The above analysis was based mostly on officially available information and it is possible that the ground truth is different from what is officially depicted at least with respect to certain indicators.

Forest research

Research is an essential ingredient of any natural resource development effort. Forestry research in India is undertaken by the Indian Council of Forestry Research and Education (ICFRE) at its several regional centers in different parts of the country and also by the respective State Forest Departments and Universities. The main objectives of research in forestry and forest biology should be to discover the intricacies of ecosystem dynamics and biodiversity and utilize such information to improve production from all types of forest lands as far, as possible, and to obtain maximum produce both from natural and man made forests, consistent with the needs of environmental conservation.

In Kerala, the bulk of forest research happens at the Kerala Forest Research Institute (KFRI) at Peechi, Thrissur. The major accomplishments by the Institute during the three decades of its existence have been with respect to the extensive biodiversity documentation and mapping of forest resources, release of disease resistant and fast growing eucalypt and teak clones, protection against the teak defoliator pest through biological control, studies on wood properties of many timber species, optimal stand management practices using growth simulation models for teak, extensive studies on cultivation and utilization of bamboo and cane, many studies made on wildlife, and also socioeconomic & livelihood improvement programmes for backward communities. KFRI was also associated with several wildlife related studies. KFRI (2005) has given a detailed exposition of the research that was undertaken by the Institute and the innovations and technologies that have come forth as a result during the last three decades.



Scenes from Kerala Forest Research Institute

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