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Forestry Sector Analysis for the State of Kerala

K. Jayaraman
V. Anitha
M. Sivaram

Kerala Forest Research Institute
An Institution of Kerala State Council for Science, Technology and Environment,
Peechi – 680 653, Kerala, India

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(Final Report of the Research Project No: KFRI 489/2005)

K. Jayaraman
Division of Forest Information Management System
V. Anitha
Division of Forestry and Human Dimension
M. Sivaram
Division of Forest Information Management System, KFRI

Kerala Forest Research Institute
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CONTENTS

PROJECT PROPOSAL

1. Project number	:	KFRI 489/2005
2. Title of the project	:	Forestry Sector Analysis for the State of Kerala
3. Objective	:	a) To formulate an econometric model useful for projecting the status of supply, demand and price of various forest products in the State. b) To evaluate the status of forest-based industries like sawmilling, pulpwood, plywood, eco-tourism and drug manufacturing and work out their possible future scenarios to the extent possible, subject to the availability of data. c) To analyze the interrelation between forestry and allied sectors in Kerala.
4. Expected outcome	:	The study will help formulate management strategies and development policies with regard to the forest sector in the State. More specifically, the econometric model will throw light on how the forestry sector operates and indicate trends in supply, demand and price of the forest products considered. The scenario models will indicate the possible future scenario/potential of the forest-based industries under alternative policy regulations. The study will also show the interrelations between forestry and allied sectors in the State.
5. Date of commencement	:	April 2005
6. Scheduled date of completion	:	March 2008
7. Funding agency	:	KFRI Plan Grants
8. Project team		
Principal Investigator	:	Dr. K. Jayaraman
Associate Investigators*	:	Dr. V. Anitha, Dr. M. Sivaram

* Dr. C.N. Krishnankutty was associated with the project for one year during the initial phase of the project.

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We are indebted to Dr. S. Sankar, Dr. Jose Kallarackal, Dr. C.N. Krishnankutty and K.V. Bhat, Scientists, KFRI for their valuable editorial comments and directions for improving this report. Our special thanks go to the Research Fellows Ms. Swapna Francis, Mr. K.V. Santheep and Mr. K.P. Sajayan, for their input in terms of data collection, data processing and related works.

PRELUDE

The project KFRI 489/05 : Forestry sector analysis for the State of Kerala was taken up in April 2005 with funding from KFRI Plan Grants and was continued for a period of three years. Because of the broad coverage of the project and certain internal matters, the project activities could not be accomplished in full within the stipulated time of three years. In the meantime, financial support was obtained from the Ministry of Statistics and Programme Implementation, Government of India to continue the project for another year. The project works were continued under the same title but with a different project code viz., KFRI 544/08. Additional data were gathered during the extended period and some of the analyses are continued. Hence this report although formally a final report can be viewed only as an interim report as far as the original project objectives are considered. For the same reason, the ‘conclusions’ do not include any recommendations.

ABSTRACT

Forest sector analysis was carried out under two frameworks, one purely in economic terms as measured by the Net State Domestic Product (NSDP) and the other based on the concepts of sustainable management of forests. As regards the first approach, data on NSDP relating to various sub-sectors for the State from 1960-61 to 2003-04 were subjected to time series analysis after appropriate preprocessing. The overall context was that of the developing economy of Kerala since 1986-87 in response to the liberalization policies introduced at the national level during 1980's. Although all the sectors exhibited a higher growth rate after 1987, the service sector had the maximum boost. Within the primary sector, the performance of forest sector was comparable to that of allied sectors like agriculture and fisheries in terms of growth rate. The forestry sector in particular has been undergoing distinct stages of transition in the past. During 1960's, wood production was much high due to large scale conversion of natural forests to plantations as part of Five Year Plans. The next period was that of some stabilization or slight decrease but 1980's showed a rapid decline in production due to stoppage of clear-felling and selection felling from natural forests. Production caught up later as plantations raised around four decades earlier were coming to maturity. A more quantitative analysis carried out on NSDP of forest sector using ARIMA model indicated an increasing trend for production from forest sector in the immediate future. Analysis based on partial correlation of NSDP of forestry sector with similar values of all other sub-sectors revealed that production from forests has been proceeding more or less independently of other sectors. It was also revealed that the contribution of forest sector to the State income was to the order of 1 to 2 percent showing the inadequacy of NSDP in evaluating the sector performance.

A much larger frame for the sector analysis was that of sustainable forest management (SFM) as provided by ITTO and finalized as Bhopal India Process 2005 which consists of 8 Criteria and 43 indicators. Based on the available data for the period 1987-2003 the following indications were arrived at. With respect to 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 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 is completely banned since 1993. There has been reduction in the number of forest-related offences as well. Production from forests has been increasing 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. The progress towards SFM during 1987-2003 was also evaluated using sustainability index. The graph obtained showed that 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 percentage contribution of forest sector to NSDP.

The survey on forest-based industries was directed to ecotourism and sawmilling. Ecotourism is not a market to be taken lightly considering the fact that it is the fastest

growing market in the tourism industry. The tourism traffic to Kerala depicts an increasing trend over the years. The domestic tourists constitute on an average 95 percent of the total tourist flow during the period 1980-2002 and the foreign tourists constitute the rest 5 percent. The average number of domestic tourists to Kerala during the period 1980 to 2003 is 2,201,960 per year and the year 2003 records the highest number of domestic tourist flow with 5,871,228 visitors. The marginal change in the number of visitors from one year to another during the period is 285,863, indicating an increasing trend of the domestic tourists. The mean value of the foreign tourists who visited Kerala is 110,257 per year during the period 1980-2003. Annual increase of foreign tourists' arrival to Kerala during the given period is 11,047. The forests of Kerala offer excellent opportunity for ecotourism as they are habitats for wide array of flora and fauna. The visitors' flow to the Wildlife Sanctuaries and National Parks of the State depicts an increasing trend during the period 1998-2006 with an annual average flow of 663,255. The visitor flow to the WLSs and NPs in 2006 registered a growth rate of 148 percent compared to that in 1997. Leisure is the major motivation for the visitors to visit the natural areas.

The sawmilling units are spread over the entire State except those parts having larger area under forest. Of the total number of 2214 registered units, 93 percent of the sawmills are small-sized employing less than 10 workers. Examination of the year of inception of a cross section of the population showed that there has been stagnation in the growth of the industry with little or no addition in the number of units in recent times. This is largely because the Forest Department stopped issuing NOC to new entrepreneurs.

A survey of the sawmilling units in the State based on stratified random sampling indicated that the mean annual outturn of the small sized units is 806 m^3 whereas that of larger units is 1958 m^3. Together a total of nearly 1.95 million m^3 of wood gets processed through these sawmills annually. About 85 percent of the total outturn is claimed by the small units. The capacity utilization of the small units is 65 percent and that of large units is estimated as 86 percent. The major sources of the timber used in furniture- making and timber sales are homesteads (53%) and import (34%). Forest depots account for 12%. Teak (29%) pynkado (26%) and jack (15%) were the most preferred timbers used for direct sales and furniture-making by sawmill owners. The timber brought by customers for sawing mostly comes from homesteads (92%). The most common species that are brought by customers for sawing are mango (28%), jack (23%), coconut (14%), anjily (9%) and teak (6%).

The fact that the outturn is far below the installed capacity is an indication of the additional activity possible in the industry without any major structural changes. Shortage of raw material is the major constraint faced by the industry. Hence technological advancements have not made their way into the industry in a big way. Since homesteads continue to be the major source of wood, tree planting in homesteads needs to be promoted by appropriate legal and policy changes. The major timber species coming from homesteads happen to be teak, jack and mango. Pynkado is one of the preferred timbers that are imported. Since there is shortage of wood in the internal market, import could also be liberalized. The mill owners, in general, complained about the problems in

securing or renewing license, unnecessary harassment from officials of different Departments, etc. Some changes in this front could also be thought of.

The study to evaluate the supply-demand situation of teakwood in Kerala based on econometric modelling revealed the following. The domestic consumption of teakwood in Kerala is largely influenced by the per capita income with a positive coefficient. The current export demand is guided by export values of the previous year in a positive manner. Production from forest plantations is weakly dependent on the area logged. This could be so because the production includes yield from thinning but the corresponding logged area does not include the area subjected to thinning. Production from homesteads seems to follow a stable pattern with an average of 40,751 m^3 per annum but for a weak signal from previous year's production figures. The projections made of the demand and price of teakwood based on the model were on the higher side. The reason for low predictivity of the model was attributable to the weak data and short time period. Since the results of modelling the time-related changes in teak price along with changes in related variables were not very encouraging, similar attempts with price of other timbers were abandoned.

1. INTRODUCTION

Forests and forestry are becoming an increasingly larger issue in the context of the current scenario of global warming and related environmental concerns. It has been repeatedly emphasized that forests play a large role not only in maintaining the environmental stability but also in meeting the several economic and socio-cultural objectives put forth by the increasing population. However, in many developing countries, forests have been a subject of large scale exploitation leading to deforestation and forest degradation. Thanks to many international efforts, such countries across the globe have been gearing up to conserve and manage the remaining tracts of forests in a sustainable manner. India has been no exception to this phenomenon well depicted by its National Forest Policy 1988 which laid emphasis on environmental stability and Joint Forest Management. Forests of the State of Kerala are also currently managed in line with the principles laid down in the National Forest Policy but a detailed analysis in this respect seemed to be in order and hence this project.

This study had some specific objectives like developing an econometric model for forest products, evaluating the status of forest-based industries and analyzing the interrelation between forestry and allied sectors. Although the results are supposed to be presented in that order, some modifications had to be effected in this regard in order to meet the overall objective of making a performance evaluation of the forestry sector of the State and developing a reasonable outlook for future trends in the sector. Therefore the presentation starts with an overall analysis of the past situation, current status and future trends in the forest sector followed by specific issues related to forest-based industries, demand and supply of forest products or related issues. The objectives are thus discussed in the reverse order so as to have a more meaningful and logical sequence for the presentation of the subject matter.

Before embarking upon the details of work done, some general concepts and definitions are reviewed in the following. A sector comprises, for the most part, the producing or operating units in the economy that have a common function or output. Thus sectors are segments in the economy identified in terms of their contributions to the economy and daily quality of life. Policies and regulations from the government institutions contribute to regulating and administering each sector. Sector analysis refers to the process of identifying possibilities for improving sector performance.

Forest sector thus comprises all goods and services related to forests. Like any other sector, forest sector also does not stand in isolation. It has inter-linkages with many other sectors and is subject to government policies and regulations implemented from time to time. Conservation and production have been two major themes operating in the sector which had their implications in the management of this important renewable natural resource. Globally, the major issues that are currently discussed in relation to forest sector are forest degradation, climate change, social and environmental services provided by the forests and sustainable forest management many of which are highly relevant even locally. This report examines some of these issues in the States' context.

2. FOREST SECTOR OF KERALA - AN APPRAISAL

Kerala is a small State in the southwestern corner of India. It represents 1.18 percent of the total area of India but claims around 3.5 percent of the total population of the country with a population density of 819 persons per km^2. Forests occupy 11,265 km^2 (FSI 2005), which is 29 percent of the total geographical area of the State. Management of the forests is vested with the government. Felling from natural forests is completely banned. The Western Ghats, a sizeable portion of which is in Kerala, is one of the 34 global hotspots of biodiversity in the world. There are about 550 species utilized as Non-wood Forest Products (NWFP). The tribal communities in and around forests mostly depend on NWFP for their subsistence. Forest plantations occupy about 10 percent of the area under forests. Teak and eucalypts have been the principal forest plantation species. At present, they account for 57,855 and 24,500 ha respectively. Kerala is a State, which has notified tourism as an industry. There are five national parks, eleven wildlife sanctuaries, two bird sanctuaries and one tiger reserve some of which are highly preferred locations for tourists.

In the past, agriculture was a highly competitive sector affecting the forests leading to its destruction. About 46 percent of the total geographical area is now occupied by homegardens and 16 percent by private estates of rubber, cardamom, coffee and tea. The traditional tree crops grown in homesteads are coconut, jack, mango, cashew, teak, anjily etc. The recent liberalization of rules on restricted felling of trees from homesteads has opened up avenues for more agroforestry options in the State. Homegardens and estates, particularly rubber plantations, form the major source of wood supply in the state. The major wood-based industries are sawmilling, packing case, plywood, splints and veneers, pulp and paper, etc. There are around 4000 wood-based units, which depend not only on forests but also on homegardens and estates, for their wood requirements.

Kerala has the legacy of achieving enviable standards in respect of important areas such as literacy, life expectancy and other material quality of life through progressive policies and public action of the State and other social institutions through democratic means. Although the current per capita income is inadequate to support such achievements, the deficiency is supposedly met by the high inflow of migrants' remittance.

The state of Kerala is thus unique in many respects and an overall assessment of the present status and future prospects in quantitative terms using the modern analytical tools has become the need of the day in order to formulate definitive strategies for the development of the forest sector of the State in relation to the overall socio-economic scenario prevailing in the region.

2.1. Analysis based on net state domestic product (NSDP)

One straightforward indicator that can be used in sector analysis is the gross domestic product (GDP). Quite often, NSDP is used in economic analysis which is GDP less depreciation or consumption of capital. The data on NSDP relating to various sub-sectors

for the State from 1960-61 to 2003-04 were collected from the reports of the Directorate of Economics and Statistics, Government of Kerala. The values were then brought to the base year of 1980-81 using forward and backward splicing. An appreciation of the overall context of the State economy would be helpful before proceeding with analysis of forestry sector. A comparison of the overall trend in the NSDP for the State in relation to that of the country is made in Figure 2.1. For effective scaling, the index values with the base year of 1980-81 are shown, instead of absolute values of the NSDP.

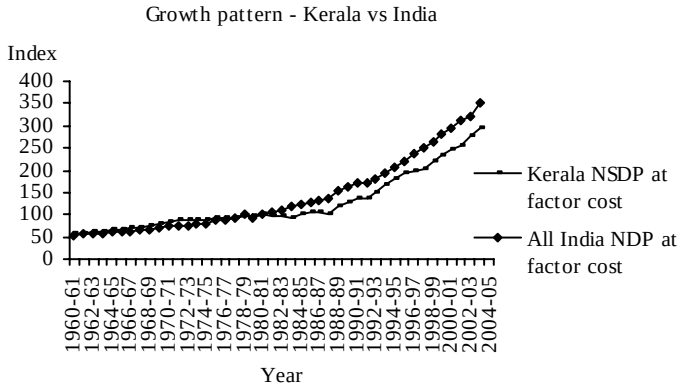


Figure 2.1. Trend in NSDP (index value) for Kerala in comparison to that of India

Figure 2.1 shows that there has been a distinct change in the growth pattern of the State economy since 1986-87. Subrahmanian (2005) had observed that the change is possibly due to the liberalization policies introduced at the national level during 1980's with some lag for the State to respond.

The growth patterns in major sub-sectors of the State, viz., agriculture, industries and service sectors are shown in Figure 2.2. The sub-sectors correspond to the primary, secondary and tertiary sectors of the traditional typology after some modifications. The corresponding growth rates based on exponential function are shown in Table 2.1. Although the primary sector has recorded a higher growth rate after 1986-87, this rate is much low when compared to that of secondary or tertiary sectors.

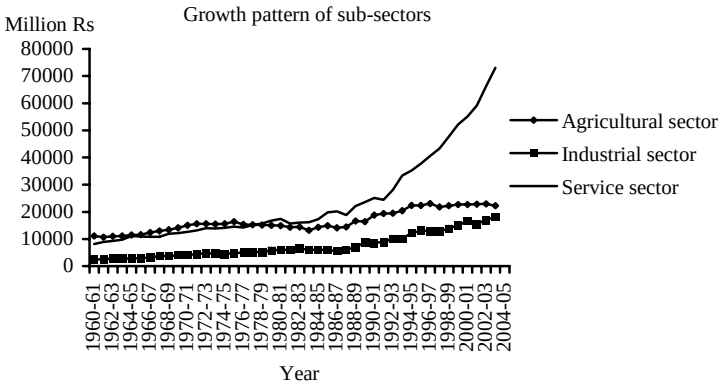


Figure 2.2. Trends in NSDP for major sub-sectors of Kerala

Table 2.1. Growth rates of agriculture, industry and service sectors

Sector	1960-61 to 1986-87	1987-88 to 2003-04
Primary (Agriculture)	1.06	2.89
Secondary (Industry)	3.40	6.32
Tertiary (Service)	3.21	8.17

Within the primary sector comprising agriculture, forestry and fisheries, the growth patterns were much different as shown in Figure 2.3.

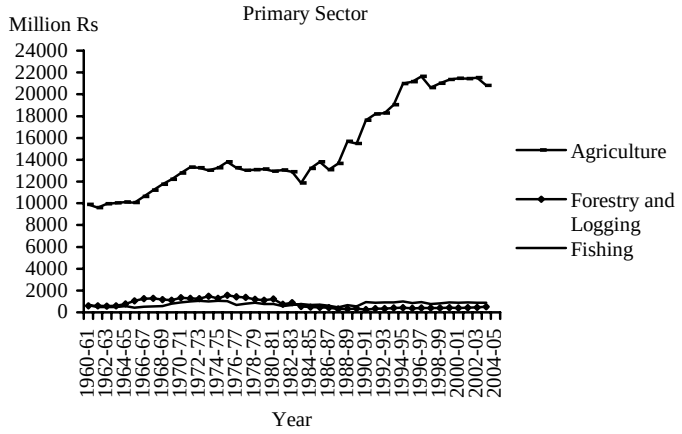


Figure 2.3. Trends in NSDP for agriculture, forestry and fisheries sub-sectors of Kerala

Table 2.2. Growth rates of agriculture, forestry and fisheries sectors

Sector	1960-61 to 1986-87	1987-88 to 2003-04
Agriculture	1.23	2.81
Forestry	0.64	2.98
Fisheries	0.47	2.84

An expanded version of the changes in the forestry sector is depicted in Figure 2.4.

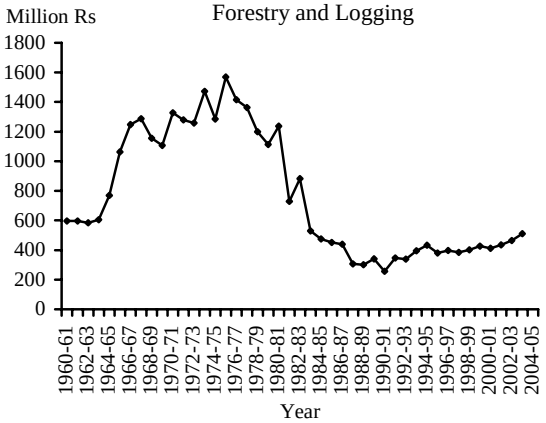


Figure 2.4. Trends in NSDP of forestry sector of Kerala

It can be seen that the forestry sector has been undergoing distinct stages of transition in the past. To make things clear, the decade-wise growth rates worked out are shown in Table 2.3.

Table 2.3. Decade-wise growth rate in forestry sector

Period	Growth rate
1961-62 to 1970-71	9.45
1971-72 to 1980-81	-1.17
1981-82 to 1990-91	-12.34
1991-92 to 2000-01	1.80

During 1960's, the production was much high due to large scale conversion of natural forests to plantations as part of Five Year Plans. The next period was that of some stabilization or slight decrease but 1980's showed a rapid decline in production due to stoppage of clear-felling and selection felling from natural forests. Production caught up later as plantations raised around four decades earlier were coming to maturity.

A more quantitative analysis was carried out on NSDP of forest sector in order to make out future trends. ARIMA model of Box *et al.* (1994) was used to describe the series. A dependent time series that is modeled as a linear combination of its own past values and past values of an error series is known as a (pure) ARIMA model. The order of an ARIMA model is usually denoted by the notation, ARIMA (p,d,q) where p is the order of the autoregressive part, d is the order of differencing, q is the order of the moving average process. Given a dependent time series $\{Y_t = 1 \le t \le n\}$, mathematically, ARIMA model is written as

$$(1-B)^d Y_t = \mu + \frac{\theta(B)}{\phi(B)} a_t$$

Where t indexes time

μ is the mean term

B is the backshift operator; that is, $BX_t=X_{t-1}$

$\phi(B)$ is the autoregressive operator, represented as a polynomial in the back shift operator: $\phi(B) = 1 - \phi_1(B) - ... - \phi_p(B)^p$

$\theta(B)$ is the moving-average operator, represented as a polynomial in the back shift operator: $\theta(B) = 1 - \theta_1(B) - ... - \theta_p(B)^p$

a_t is the independent disturbance, also called the random error.

Results of the time series analysis done using Box-Jenkins model are depicted in Figure 2.5. There is much agreement between the observed and the fitted values during the estimation phase with a total R^2 of 0.90. Second order differencing was required to make the series stationary. The fitted model was ARIMA (1,2,1) after logarithmic transformation. The parameter estimates are reported below.

Intercept : -1.770 (0.596)
Autoregressive parameter : -0.335 (0.158)
Moving average parameter : 0.999 (5.607)

Although some of the parameters were non-significant, they were retained in the model to make the forecasts better. Alternative models tried had larger forecast error. The projections made for the ensuing 7 years after 2003-04 showed further increase in the production from the forests in Kerala as per the present trends.

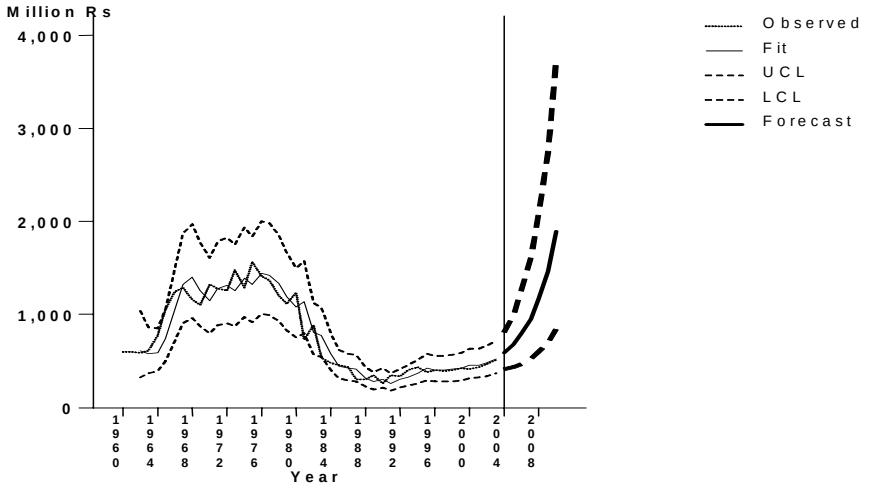


Figure 2.5. Projection of forest sector NSDP based on ARIMA model

One of the objectives specified was to study the interrelation of forestry sector with that of allied sectors. In order to have a glimpse of any such relationships, partial correlations of NSDP of forestry sector with similar values of all other sub-sectors were worked out using the multiple time series data on NSDP. The partial correlations between forestry and other sectors eliminating the influence of total NSDP are reported in Table 2.4.

Table 2.4. Partial correlations of NSDP of forestry sector with other sectors

Sector	Partial correlation with forestry sector NSDP
Agriculture	-0.17
Fishing	0.47
Mining and Quarrying	-0.62
Manufacturing	-0.44
Electricity,Gas and Water supply	0.41
Construction	0.12
Transport, Storage and Communications	0.17
Trade,Hotels and Restaurants	0.54
Banking and Insurance	-0.16
Real estate, Ownership of dwelling etc.	0.40
Public Administration	-0.66
Other services	-0.50

There are no significant correlations to commend upon except those with mining and quarrying and also public administration. We may therefore conclude that production from forests has been proceeding more or less independently of other sectors.

All said and done, one important limitation of the above analysis was that the contribution from the forest sector to the state income was too low (1.6 percent) as can be seen from the

following Table 2.5. This is not to understate the importance of the forest sector but owes mainly to the computation of NSDP which is based on production approach for the primary sector. The NSDP for forest sector is based on the commercial value of the saleable product from forests like timber, firewood and minor forest produce. All the intangible benefits like carbon sequestration, soil and water conservation, biodiversity etc. are presently unaccounted in the computation of GDP and thus the contribution from forestry remains underestimated. Hence, there was a need for going for alternative indicators which is attempted in the next section.

Table 2.5. Contribution of the different sectors to the total State income for 2003-04

Sector	At current price (Million Rs)	Percentage
Agriculture	122093	13.8
Forestry and Logging	14313	1.6
Fishing	12746	1.4
Sub total: Primary	**149152**	**16.9**
Mining and Quarrying	1730	0.2
Manufacturing	68021	7.7
Electricity, Gas and Water supply	118740	13.5
Sub total: Secondary	**188490**	**21.4**
Construction	15336	1.7
Transport, Storage and Communications	73307	8.3
Trade, Hotels and Restaurants	209915	23.8
Banking and Insurance	58754	6.7
Real estate, Ownership of dwelling etc.	77513	8.8
Public Administration	35863	4.1
Other services	73908	8.4
Sub total:Tertiary	**544595**	**61.7**
NSDP at factor cost	**882237**	**100.0**

Source: Economic Review 2006

2.2. Indicators for Sustainable Forest Management (SFM)

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.

Following discussions and commitments at UNCED (India was party to the commitment), about 160 countries participated and developed sets of criteria and indicators (C&I) for SFM, through regionally and internationally recognized 9 processes, that were specific to various forestry scenarios of the world. The Indian initiative to develop a national set of C&I for SFM was in the form of Bhopal-India process,

organized by IIFM, Bhopal. The B-I process developed a national set of 8 Criteria and 43 indicators (Table 2.6). This set of C&I prepared for national level is specifically relevant to the current forestry scenario in India. It has been accepted and validated by the National Task Force appointed by the Government of India, which also recommended it for being adopted and implemented by all the respective state forest departments in the country.

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. By identifying the main prerequisites of Sustainable Forest Management (SFM), the C&I provide a means of assessing the progress towards SFM. The conceptual framework of SFM includes sustainability principle, criteria, indicators and verifiers. The definitions of these terms are as under.

Principle: A fundamental truth or law as the basis of reasoning or action.

Criteria: A criterion is defined as an aspect of forest management that is considered important and by which sustainable forest management may be assessed. A criterion is accompanied by a set of related indicators and describes a state or situation, which should be met to comply with sustainable forest management.

Indicators: An indicator is defined as a quantitative, qualitative or descriptive attribute that when measured or monitored periodically indicates the direction of change within the criterion.

Verifiers: Standard value of the indicators to achieve the level of sustainability.

An attempt has been made here to evaluate the sustainability index for the State of Kerala using the limited data that are available for the State. Due to the paucity of data, several indicators had to be just omitted from the discussion. However, the analysis carried out gives some picture of the situation at hand with respect to the region.

Table 2.6. Refined set of indicators of Bhopal-India Process (2005)

Criteria	Indicators		Applicability	
			FMU	Nation
Criterion 1: Increase in the extent of forest and tree cover	1.1	Area and type of forest cover under (a) Natural forest	+	+
		(b) Man-made forest (tree plantations)	+	+
	1.2	Forest area officially diverted for non-forestry purposes	+	+
	1.3	Forest area under encroachment	+	+
	1.4	Area of dense, open and scrub forests	+	+
	1.5	Trees outside forest area	+	+
Criterion 2: Maintenance conservation and enhancement of biodiversity	2.1	Area of protected eco-systems (Protected Areas)	+	+
	2.2	Number of (a) Animal	+	+
		(b) Plant species	+	+
	2.3	Number and status of threatened species (a) Animal	+	+
		(b) Plant species	+	+
	2.4	Status of locally significant species (a) Animal and	+	✓
		(b) Plant species	+	✓
	2.5	Status of species prone to over-exploitation	+	+
	2.6	Status of non-destructive harvest of wood and non-wood forest produce	+	+
Criterion 3: Maintenance and enhancement of ecosystem function and vitality	3.1	Status of natural regeneration	+	+
	3.2	Incidences of forest fires	+	+
	3.3	Extent of livestock grazing (a) Forest area open for grazing	+	+
		(b) Number of livestock grazing in forest	+	+
	3.4	Occurrence of weeds in forest (a) Area	+	+
		(b) Weed type	+	+
	3.5	Incidences of pest and diseases	+	✓
Criterion 4: Conservation and maintenance of soil and water resources	4.1	Area under watershed treatment	+	+
	4.2	Area prone to soil erosion	+	+
	4.3	Area under ravine, saline, alkaline soils and deserts (hot and cold)	+	+
	4.4	Soil fertility /site quality	+	+
	4.5	(a) Duration of water flow in the selected streams	+	✓
		(b) Ground water in the vicinity of the forest areas	+	✓
Criterion 5: Maintenance and enhancement of forest resource productivity	5.1	Growing stock of wood	+	+
	5.2	Increment in volume of identified species of wood	+	+
	5.3	Efforts towards enhancement of forest productivity: (a) Technological inputs	+	+
		(b) Area under Hi-tech plantations	+	+
		(c) Area under Seed Production Areas, Clonal Seed Orchards etc	+	+
Criterion 6: Optimization of forest resource	6.1	Recorded removal of wood	+	+
	6.2	Recorded collection of non-wood forest produce	+	+
	6.3	Efforts towards reduction of wastages	+	+

utilization	6.4	Aggregate and per capita consumption of wood and non-wood forest produce	+	+
	6.5	Direct employment in forestry and forest-based industries	+	+
	6.6	Contribution of forests to the income of forest-dependent people	+	+
	6.7	Demand and Supply of wood and non-wood forest produce	+	+
	6.8	Import and Export of wood and non-wood forest produce	✓	+
Criterion 7: Maintenance and enhancement of social, cultural and spiritual benefits	7.1	(a) Number of JFM committees and area(s) protected by them	+	+
		(b) Degree of people's participation in management and benefit-sharing	+	+
		(c) Level of participation of women	+	+
	7.2	Use of indigenous technical knowledge: Identification, Documentation and Application	+	✓
	7.3	Quality and extent to which concessions and privileges are provided	+	+
	7.4	Extent of cultural /sacred protected landscapes: forests, trees, ponds, streams, etc. (a) Type and area of landscape	+	+
		(b) Number of visitors	+	+
Criterion 8: Adequacy of Policy, Legal and Institutional framework	8.1	Existence of policy and legal framework	+	+
	8.2	Number of forest-related offences	+	+
	8.3	Level of investment in Research and Development	+	+
	8.4	Human resource capacity building efforts	+	+
	8.5	Forest Resource Accounting (a) Contribution of forestry sector to the GDP	+	+
		(b) Budgetary allocations to the forestry sector	+	+
	8.6	Monitoring and Evaluation mechanisms	+	+
	8.7	Status of information dissemination and utilization	+	+

Criterion 1: Increase in the extent of forest and tree cover

Increase in the extent of forest area could be both qualitative and quantitative. The shift in status of forests from a scrub jungle to dense forest would be qualitative change whereas increase in forest area would be quantitative. Hence, this criterion would include changes in the status of forests in terms of both physical extent and forest cover.

Indicator 1.1: Area and type of forest cover under (a) Natural forest (b) Man-made forest (Forest plantations)

This indicator monitors the total forest area of natural forests and plantations as legally notified by the forest and land survey authorities. The changes in total forest area under natural and man-made forests will indicate the extent of forest protection and afforestation effected which is vital for the sustainable management of forests.

The total recorded forest area of Kerala is 11,265 km^2 (FSI 2005), which is 29 percent of the geographic area of the State. The area legally under forests has been remaining more or less stable in the State. The man-made forest comprises tree plantations in the forest land. These play important role in enhancing the forest products and also improvement in the forest cover. In the State, the area under forest plantations has been around 10 percent of the total forest area which did not undergo much change during the last two decades.

Table 2.7. Area under natural forests and plantations in Kerala

Year	Recorded forest area (km^2)	Recorded forest as percentage of geographic area (%)	Area under plantations (km^2)	Plantations as percentage of forest area (%)
1987-88	11222	28.9	1196	10.7
1988-89	11222	28.9	1175	10.5
1989-90	11222	28.9	1145	10.2
1990-91	11222	28.9	1138	10.1
1991-92	11222	28.9	1125	10.0
1992-93	11222	28.9	1126	10.0
1993-94	11222	28.9	1121	10.0
1994-95	11221	28.9	1123	10.0
1995-96	11221	28.9	1145	10.2
1996-97	11221	28.9	1148	10.2
1997-98	11221	28.9	1123	10.0
1998-99	11221	28.9	1114	9.90
1999-00	11221	28.9	1110	9.90
2000-01	11221	28.9	1199	10.7
2001-02	11245	28.9	1140	10.2
2002-03	11268	29.0	1136	10.1
2003-04	11266	29.0	1187	10.5
2004-05	11265	29.0	1160	10.3

Source: State of Forest Report (various years) of FSI; Forest Administration Report of KFD.

Indicator 1.2: Forest area officially diverted for non-forestry purposes

Diversion of forest land means forest area diverted for non-forestry purposes like agriculture, resettlement, hydel/irrigation projects, mining, laying of transmission lines etc. It is considered to be the most important reason not only for the shrinkage of forest

cover but also its degradation. Forest Conservation Act 1980 ensures diversion of forest land only for genuine purposes with insistence on compensatory plantation in double the area diverted for non-forestry purposes. However, from 1987 to 2006, about 330,725 ha forest area was diverted for non-forestry purposes. In 1995, an extent of 28,588 ha was diverted for regularization of pre- 1.1.1977 encroachments.

Table 2.8. Area diverted for non-forestry purposes in Kerala

Year	Area (ha)	Year	Area (ha)
1987-88	34.52	1997-98	117.95
1988-89	7.83	1998-99	45.26
1989-90	2.71	1999-00	193.11
1990-91	400.63	2000-01	12.96
1991-92	11.53	2001-02	24.00
1992-93	0.98	2002-03	59.81
1993-94	0.47	2003-04	2193.83
1994-95	28608.47	2004-05	2.86
1995-96	0.54	2005-06	134.77
1996-97	9.27	2006-07	1.32

Source: Forest Administration Reports of (various years) KFD

Indicator 1.3: Forest area under encroachment

This indicator explains the illegal occupation of forest land by human settlements. The intended situation is of no encroachment in the forest area. However, owing to the high population pressure on the forestry resources, it has not been practically possible to stop encroachment completely. The present policy of the State Government is that all encroachments after 1.1.1977 will be evicted.

Indicator 1.4: Area of dense, open and scrub forests

As per the State of Forest Report 2001, forest cover comprises all lands more than one hectare in area, with a tree canopy density of more than 10 percent, irrespective of land use and ownership. Thus, all lands with tree crops, such as agroforestry plantations, fruit orchards, tea and coffee estates have been included in forest cover. The recent State Forest Report 2005 has provided a complete picture of forest and tree cover in the country. Forest Survey of India also follows the following classification, viz., Dense forest: All lands with tree cover of canopy density of 40 percent and above; Open forest: All lands with tree cover of canopy density between 10 to 40 percent; Scrub**:** All lands with poor tree growth mainly of small or stunted trees having canopy density less than 10 percent. The corresponding statistics since 1987 are given as Table 2.9.

Table 2.9. Extent of forest cover in Kerala

Year	Dense forest (km^2)	Open forest (km^2)	Total forest cover (km^2)	Forest-cover as percentage of geographic area (%)	Scrub (km^2)
1987	8569	1833	10402	26.8	-
1989	8312	1837	10149	26.1	-
1991	8421	1871	10292	26.5	109
1993	8421	1915	10336	26.6	93

1995	8455	1881	10336	26.6	-
1997	8454	1880	10334	26.6	83
1999	8429	1894	10323	26.6	91
2001	11772	3788	15560	40.0	71
2003	9628	5949	15577	40.1	72
2005	9660	5935	15595	40.1	70

Source: State of Forest Report (various years) of FSI

The increase in the forest cover in the recent years could be due to the change in the definition also. The National Forest Policy (1988) has laid a target of 33 percent of the geographical area to be brought under forest cover and the State has exceeded this target with respect to the new definition of forest cover.

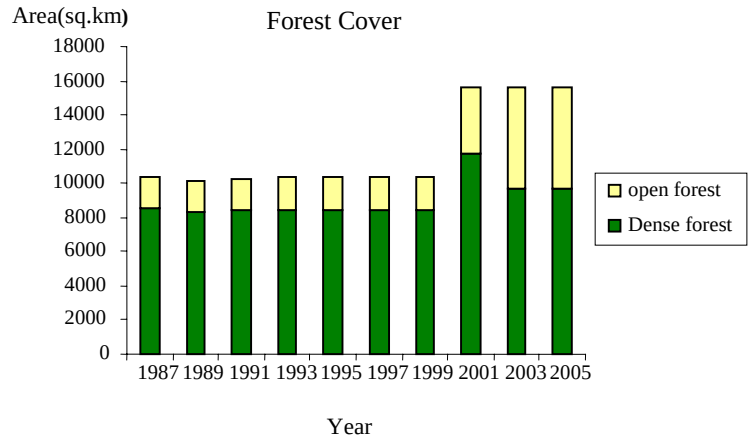


Figure 2.6. Dense and open forest covers in different assessments (Kerala)

Indicator 1.5: Trees outside Forest (ToF)

Trees outside Forest (ToF) play an important role in supporting the rural economy and livelihood as well as environmental amelioration. Assessment of area under trees outside forest has become inevitable for states having low forest cover in order to supplement the goods and services accrued from the natural forests. Trees growing outside the forest land also perform similar ecological, economic and social functions as those growing in the forest. The estimate of area under ToF in the State is to the order of 11 percent by 2003. Trees outside forest (ToF) include trees in cities, on farms, along roads and in many other locations. Trees outside forest are also an important source of non-wood forest products. In Kerala, a study revealed that out of the total annual production of 11.7 million cubic metres of wood in the State, about 78 percent was from homesteads, 11 percent from estates and only 11 percent from forests (Krishnankutty *et al*., 2005).

Criterion 2: Maintenance, conservation and enhancement of biodiversity

Although biodiversity is defined at different levels like habitat, species and genic level, species diversity is the most commonly referred category. Sustainable Forest Management envisages not just maintenance and conservation but also enhancement of biodiversity by providing conducive environments and appropriate interventions.

Indicator 2.1: Area of protected eco-systems (Protected Areas)

Protected areas are repositories of biodiversity which are an important indicator in the national context. Protected areas include National Parks, Wildlife Sanctuaries and also other categories such as Biosphere Reserves, World Heritage Sites, Conservation and Community Reserves. The recommendation is that at least five percent of total geographical area should be under protected class. Over the years, there has been a progressive inclusion of forest area to the Protected Category in the State resulting in a much larger portion under the class when compared to the national standard (Table 2.10).

Table 2.10. Extent of Protected Areas in Kerala 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 (various years); Forest Administration Report (various years) of KFD

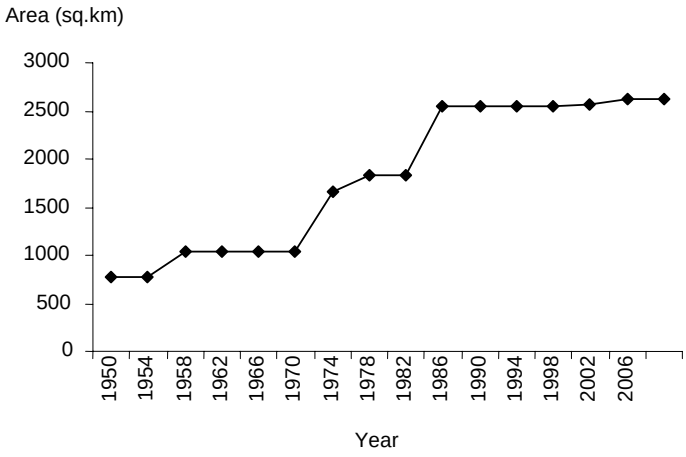


Figure 2.7. Extent of protected areas in Kerala

Indicator 2.2: Number of (a) Animal species (b) Plant species

Species diversity is responsible for the functional diversity of an ecosystem which is thought to be one of the factors that determine the long-term stability of an ecosystem and its ability to recover from major disturbances. Thus periodical enumeration of plant and animal species is considered important in a larger context. It is imperative that the existing species or biotypes are preserved. The biodiversity profiles for the State of Kerala for 2007 are given in the Tables 2.11 and 2.12.

Table 2.11. Plant diversity

Category	*Number of species*
Algae	866
Fungi	4800
Lichens	520
Bryophytes	350
Pteridophytes	332
Gymnosperms	4
Angiosperms	4968
Total	11,840

Source: State of Environment Report-Kerala 2007

Table 2.12. Animal diversity

Category	*Number of 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 Arthropda	600

Echinodermata	8
Freshwater fishes	196
Amphibians	117
Reptiles	159
Birds	508
Mammals	145
Total	8452

Source: State of Environment Report-Kerala (2007

The State has a rich diversity both in terms of plant and animal diversity which needs to be maintained.

Indicator 2.3: Number and status of threatened species.

A taxon is threatened when it is facing an extremely high risk of extinction in the wild in the immediate future. Habitat loss and degradation are major causes of endangerment of a species. Similarly, some plant species are under threat due to overexploitation and introduction of alien species. This indicator provides an assessment of animal and plant species, which comes under threatened category of the IUCN. The recommendation is that the existing threatened animal/plant species should be protected and their status should be enhanced.

Table 2.13. Number of species of flora and fauna in Kerala belonging to different threat categories as per IUCN Red data list (2004)

Threat categories	Flora	Fauna
Critically Rare(CR)	19	9
Endangered(EN)	68	24
Extinct(EX)	3	1
Vulnerable(VU)	48	48
Total	172	82

Source: State of Environment Report – Kerala 2007

Indicator 2.4: Status of locally significant species (a) Animal (b) Plant species

This indicator records the number of animal and plant species of socio-economic/ socio cultural importance for local community at Forest Management Unit (FMU) level. These species can be called as indicator species for the forest or the Division and their ecological status, regeneration and related parameters can be monitored over time. Dependency of people would include dependency of their livestock for grazing, their traditional lifestyle, including hunting and gathering. The existing locally significant animal/ plant species should be protected and their status should be enhanced. The composition of plant and animal species in any habitat ensures the uniqueness of that particular area. Although no quantitative data are available, the forest degradation that has been happening in many parts of the State would indicate the need for more vigil in this regard.

Indicator 2.5: Status of species prone to overexploitation

The species that are significant for commercial purposes are more prone to be exploited. A species that faces overexploitation is one that may become severely endangered or even extinct due to the rate in which the species is being used. A number of plant species become endangered due to its unsustainable and illegal extraction from the wild for use by industries. Similarly, due to the trade in animal parts, many species continue to suffer high rate of exploitation. Therefore, overexploitation is certainly a factor leading to endangerment. The recommendation is that status of such species should be monitored regularly and efforts made to improve their population.

Indicator 2.6: Status of non-destructive harvest of wood and non-wood forest produce

Proper harvesting of forest produce has a direct bearing on the health and vitality of forest ecosystems. Sustainability in extraction of the species requires an approach that examines the effect of various factors apart from the harvesting intensity. But it is quite apparent that harvesting choice and techniques greatly contribute to recognize the effect that humans have had on specific species. Due emphasis should be given to develop non-destructive harvesting regimes with scientific inputs and consultation with local communities as they have developed their own system of managing forest resources. Therefore efforts should be made for non-destructive and limited harvest of wood and non-wood forest products on maturity.

Criterion 3: Maintenance and enhancement of ecosystem function and vitality

Ecosystem can be understood as a community of living organisms interacting with each other and also with the physical environment. Ecosystem vitality is the ability of an ecosystem to withstand and survive the extraneous disturbances and unfavorable conditions. The prerequisite for the maintenance of ecosystem and its vitality is the provision of favorable conditions to check damages from external factors. Thus this criterion envisages monitoring both biotic and abiotic disturbances affecting the forest ecosystem.

Indicator 3.1: Status of natural regeneration

In natural forest ecosystem, regeneration would be a good indicator of sustainable forest management since natural regeneration would raise the possibility of having forest in the area in succeeding generations. Number of established seedlings per unit area of different species is indicative of efficient seed production, seed vitality, seed germination and ability to withstand disturbances. However, time series data on this aspect for the State is scattered.

Indicator 3.2: Incidences of forest fires

Forest fires cause considerable damage to the forest health. The forests may take a long time to recover from the undesirable effects of forest fires. Reporting, documenting and monitoring fires are important for strategic forest fire management. The incidence of forest fires in Kerala since 1987 is given in table 2.14. Ideally, there should not be any instances of fire but the fact is that sporadic fires do occur in the State's forest.

Table 2.14. Details of fire in Kerala forests

Year	No. of incidents	Destroyed area (ha)	Financial loss (Rs)
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	665.22	24325
2001-02	584	6200.013	331100
2002-03	267	3697.34	57317
2003-04	949	15581.364	263365
2004-05	370	2442.449	181082

Source**:** Forest Statistics Report / Forest Administrative Reports of KFD

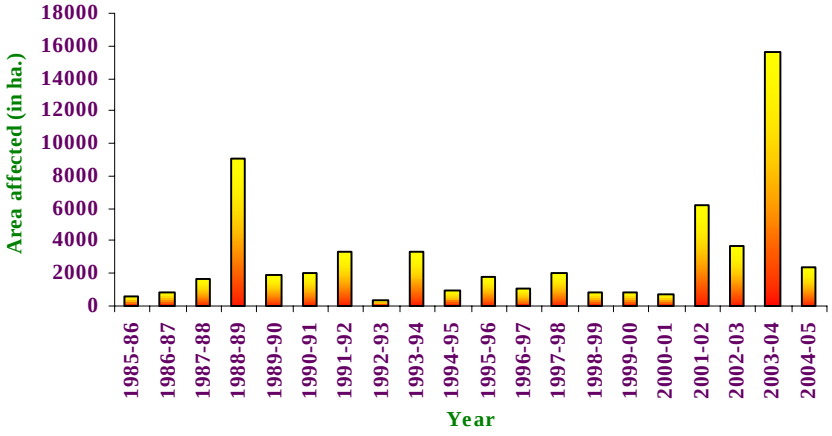


Figure 2.8. Incidence of forest fire

Indicator 3.3: Extent of livestock grazing

Uncontrolled livestock grazing could affect natural regeneration and result in loss of biodiversity. As a regulatory measure, the number of livestock grazing in forest area open for grazing should not exceed the carrying capacity of 2.5 cattle units/ha (FSI 2004). Statistics on forest area open for grazing in the State is reported in the Table 2.15. Cattle-grazing is prohibited in forest since 1993-94.

Table 2.15. 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	810	1996-97	0
1985-86	472.37	1997-98	0
1986-87	427.37	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

Source: Forest Administration Report (various years) of KFD

Indicator 3.4: Occurrence of weeds in forest (a) affected area (b) weed type

Weeds are undesired plants in the cropping system as they flourish at the cost of the desired species, reducing the natural regeneration and affecting the forest composition to a great extent. The weeds may be in various life forms such as herbs, shrubs and vines. The weed species may overtop the natural forest tree species and reduce the forest productivity. The spread of weeds in the forest area needs to be monitored. Control methods such as various tending operations like cleaning, weeding, and release cutting will reduce the weed infestation. There should be proper preventive and control mechanism to check weed infestation.

A survey conducted by Sankaran and Sreenivasan (1999) revealed that in a short period of 20 years, mikania has become a serious threat to forest plantations in Kerala. The frequent cultural practices and the thin canopy especially in young plantations, act as a catalyst in promoting infestation in plantations. Periodic weeding carried out in the plantations has not been very effective in controlling the weed.

Indicator 3.5: Incidences of pests and diseases

Incidence of pests in forest is a natural phenomenon, which occurs regularly in forest areas. Generally these pests are host-specific. Pests and diseases are part of the natural

ecosystem but sometimes they assume epidemic proportions and pose threat to the useful species of plants and animals. Several such cases are reported from forest. Some of these are the teak defoliator and skeletoniser (*Hybalea peura and Eutectona machaeralis)* prevalent throughout teak plantations in Kerala. Similarly the wild animals are also affected by certain diseases such as anthrax, rinderpest and the like.

Criterion 4: Conservation and maintenance of soil and water resources

Efficiency and effectiveness of a forest ecosystem are directly linked to the type of soil and the available water resources and vice versa. Soil is considered to be the mother of all resources because, on this valuable resource, the forests survive. Besides, water is one of the most important life-supporting factors. Therefore, it is necessary that soil and water conservation functions are assessed and the shortcomings identified and appropriately addressed. This criterion helps in assessing the regulatory functions of the forests related to soil and moisture regime. Unfortunately, information is scanty on this aspect for the State's forest.

Indicator 4.1: Area under watershed treatment

This indicator addresses the issue of forest land-use planning whereby areas which need protection of soil and water are delineated and allocated to special protection zones. Budget is usually allotted for the treatment for watershed as per yearly plan of operations.

Indicator 4.2: Area prone to soil erosion

Soil erosion is an important aspect in land management. Soil erosion leads to far- ranging impacts like formation of gullies and floods causing damages to farmlands and villages, decline in water flow in streams during dry season, consequent reduction of crop productivity, siltation of reservoirs and canals.

The rate of soil erosion varies with site-specific parameters such as slope, soil texture, structure and depth, rainfall, vegetation type, cover density and management interventions. Measuring soil erosion is a difficult task usually requiring long-term studies. Areas prone to soil and water loss should be brought under soil and water conservation measures.

Indicator 4.3: Area under ravine, saline, alkaline soils and deserts (hot and cold)

Indicator 4.4: Soil fertility/ Site quality

Soil fertility indicates nutrient status of a soil. The soil characteristics can be measured by a number of parameters addressing the physical, chemical and biological aspects. All these determine the overall quality of soil and accordingly affect the growth of the plants. On the other hand, site is a complex of physical and biological factors of the area that determine what forest and other vegetation it may carry. Site quality is a measure of the relative productive capacity of a site for a particular species. Every site gives a different growth response to the different species. Site quality can be evaluated by measuring either the vegetative, physical or climatic factors of the site. In traditional forestry, site quality is measured through top-height *vs* age curves.

Indicator 4.5(a): Duration of water flow in the selected streams.

This indicator describes the role of forests in converting precipitation into perennial flow of water through infiltration and water retention capacity of the soils of the forest. Forests play an important role in regulating the water flow/ run off in the watershed.

Indicator 4.5(b): Ground water in the vicinity of the forest areas

This indicator deals with the percolation of water into subsurface aquifer and can be gauged by the water level in the wells of the vicinity. The specific climate of Indian subcontinent offers seasonal rainfall and longer dry periods. Maintenance of water table could be a desired situation to which forest management can contribute.

Criterion 5: Maintenance and enhancement of forest resource productivity

This criterion is concerned with management of forest for the production of wood and non-wood forest products. Such production can only be maintained in the long term if it is economically and functionally viable, ecologically sound and socially acceptable.

Indicator 5.1: Growing stock of wood

Growing stock is the total standing volume of the wood of the forest area. Increase in the growing stock of forests is an important indicator of productivity of the forest. Information on growing stock can be derived at FMU-level through Working Plans. It can also be derived from forest cover mapping with field verification. Growing stock of wood also indicates the carbon store in the forest.

Indicator 5.2: Increment in volume of identified species of wood

Increment in the volume of specified tree species can be a good indicator to assess the health of natural as well as planted forest. It can be calculated with the help of yield tables and can be field-tested at the ground level. Attempts are made to utilize remote sensing for this purpose by Forest Survey of India.

Indicator 5.3 Efforts towards enhancement of forest productivity:

(a) Technological inputs
(b) Area under Hi-tech plantations
(c) Area under Seed Production Areas, Clonal Seed Orchards, etc.

This indicator records the efforts undertaken for enhancement of productivity of forests through the use of quality seeds and planting material, 'best' management practices in afforestation and reforestation activities and good harvesting instruments.

Criterion 6: Optimization of forest resource utilization

This criterion deals with optimizing utilization, i.e., meeting the requirements of the people and their condition getting better without affecting the condition of the forests.

Indicator 6.1: Recorded removal of wood

Extraction of wood relates to the official removal of the wood from the forests and mature plantations by the Forest Department. The annual collection should not exceed

average annual increment put by the growing stock. Since the stoppage of all felling operations from natural forest in 1987 in Kerala, the main source of wood from forests has been teak plantations. The available figures in this respect are given in Table 2.16. During the period between 1987 and 2004, the average rate of removal has been around 32,000 m^3 annually. The plantations are worked on a 60 year rotation except in a few Divisions, based on Working Plans.

Table 2.16: Production of teakwood from forest plantations in Kerala

Year	Production (m^3)	Year	Production (m^3)
1987-88	19222	1996-97	32817
1988-89	8099	1997-98	12307
1989-90	24735	1998-99	18338
1990-91	15583	1999-00	33973
1991-92	20927	2000-01	----
1992-93	32429	2001-02	34667
1993-94	23240	2002-03	49927
1994-95	57289	2003-04	107892
1995-96	26766	2004-05	20169

Source: Administration Reports (various years) of the Kerala Forest Dept.

Indicator 6.2: Recorded collection of non-wood forest products (NWFP)

Other than fuelwood, NWFP play a significant role in rural community. The NWFP are not only consumed in the households but sold for earning an alternative income by the people. The practices for extraction of NWFPs greatly decide the condition of the forests and future availability of the desired produce. The premature, over and destructive harvesting of NWFP must be checked. NWFP such as grass and fodder, medicinal plants, food plants, oil yielding seeds and others used by the people and industry are to be recorded.

Indicator 6.3: Efforts towards reduction of wastages

Efficient utilization of forest resources is the key for Sustainable Forest Management. Many actions have been taken by the Forest Department in the past for the efficient harvesting of wood so as to minimize its wastage. Proper training and monitoring mechanism should be developed to measure the effectiveness of the efforts made towards reduction of wastage.

Indicator 6.4: Aggregate and per capita consumption of Wood and Non-Wood Forest Produce

Per capita consumption of wood and non-wood forest products provide some information about the importance of these products for the economy. An increase in the per capita and total consumption may indicate higher pressure on the forests. However, this information does not point to the progress made towards sustainable forest management, unless it can be compared with sustainable harvest levels.

Indicator 6.5: Direct employment in forestry and forest-based industries

Forest management is generally carried out through those persons who are recruited and trained to work in the forest departments to execute the policy mandates, legal and technical works. The system thus provides less opportunity for local people to get involved in the management of forests except where Joint Forest Management is in operation. Local people do get involved in works such as NWFP collection, fire control, thinning and weeding operations etc. Forest-based industries also are found to provide employment. The recommendation is that, the average number of employment generated through forestry should be maintained.

Indicator 6.6: Contribution of forest to the income of forest-dependent people

In addition to the income from employment in the forest sector, this indicator assesses other types of benefits to the forest-dependent people derived from the utilization of forests. Participatory approaches like JFM, which evolved in 1990 allows forest-dependent people to have a stake in forestry resources like NWFP collection. The intended situation is that the contribution of forest to the income of forest dependent people should be maintained.

Indicator 6.7: Demand and supply of wood and non-wood forest produce

Demand and supply of various wood and non-wood forest products largely depend upon the local requirements of people and local market conditions. Regular monitoring of the demand and supply of timber, firewood, fodder and other NWFP is desirable. The recommendation is that efforts should be made to reduce the gap between demand and supply of wood and non-wood forest products.

The study by Krishnankutty *et al*. (2005) revealed that of the total demand of 12.261 million m^3 roundwood equivalent of wood in Kerala during 2000-01, fuelwood accounted for the major share (83%). Household sector was the major consumer of fuelwood accounting for 73 percent 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 percent of the total demand for fuelwood. Of the total demand for timber, industries sector accounted for the major share, household sector ranked next, followed by export. Timber export included 4,96,000 m^3 of packing cases and 78,000 m^3 of other timbers. The total demand for teakwood was 96,000 m^3 of which consumption within the State accounted for 86 percent and export to other States within the country 14 percent. Nearly half of the export was teak poles and the market was in Tamil Nadu.

In the total supply of timber, forests produced only 4 percent. Import accounted for 15 percent of the total supply (Krishnankutty *et al*., 2005). Import from other countries was 1,59,000 m^3 which is 51.2 % of the total timber import. In the teakwood supply, the contribution of forest plantations was substantial (52%); import accounted for 15 percent and homegardens the remaining 33 percent. On the fuelwood supply side, homegardens produced about 82 percent and the contribution of forests came to around 11 percent 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 m^3. When there was a small deficit of 667 m^3 of teakwood, there was a large deficit of 1,91,000 m^3 of other timbers and the deficits were met by import.

There was an overall decline in the demand for timber from 24,93,000 m^3 during 1987-88 to 20,65,000 m^3 during 2000-01. 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 m^3, the demand after 13 years was only 1,01,96,000 m^3. The decline in the demand for fuelwood was mainly due to the shift to LPG. Trees in areas outside forests particularly homegardens were 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 homegardens 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 (Krishnankutty *et al*., 2005).

Indicator 6.8: Import and export of wood and non-wood forest produce

Under this indicator, information on volumes of wood and NWFP exported and imported annually is collected. The recommendation is that the average values of import and export of wood-based products and NWFPs should be maintained.

Table 2.17. Trends in export and import of wood

Year	Export of wood from Kerala (m^3)	Import of wood to Kerala (m^3)
1987-88	844337	231260
1988-89	823188	137581
1989-90	463403	123707
1990-91	457724	133041
1991-92	606252	167158
1992-93	587550	110592
1993-94	947905	141270
1994-95	911397	214565
1995-96	789961	182928
1996-97	746356	207527
1997-98	887366	277862
1998-99	694516	254891
1999-00	941788	228085
2000-01	980871	226473
2001-02	326465	226687

Source : Updated data from check posts of Kerala Forest Department

Table 2.17 shows the trends in export and import of wood in Kerala for the period 1987-2002. Although the export of wood showed an irregular trend over the years, the quantum dropped dramatically in the recent past. The import figures showed a slight increase over the years.

Criterion 7: Maintenance and enhancement of social, cultural and spiritual benefits

Besides the economic values, there are social, religious and cultural values attached to the forests. These values are reflected in the form of protected patches of forests and tree species in the forests. The value systems have been protecting the trees and thus, have to be maintained.

Indicators 7.1 (a): Number of JFM committees and area(s) protected by them, 7.1(b): Degree of people's participation in management and benefit-sharing, 7.1(c): Level of participation of women

Joint Forest Management was introduced in India with the proclamation of National Forest Policy 1988. However, through a resolution in 1990, the scheme was actually introduced in all the states in India. In Kerala, it is known as Participatory Forest Management. Under the scheme, the forest-dependent communities are given rights to collect lops and branches and non-timber forest products.

The total area under joint forest management provides some indication about the level of participation of local people in the management of forest resources. The recommendation is that the entire forest area should be under participatory management regime. All the members of the JFMC should participate in JFMC meetings. There should be adequate representation of women as per the JFM guidelines.

In Kerala, 598 PFM Committees have been formed and 1,73,235 ha forest area have been brought under PFM. About 66,022 members including 7365 SC's and 21952 ST's are involved in PFM programme in various forest divisions of Kerala.

Table 2.18. Status of PFM as on 2006

No. of fringe VSSs	No. of tribal VSSs	No. of ULOs	No. of EDCs	Total	Area covered under PFM (ha)
304	68	33	193	598	1,73,235

Table 2.19. Details of membership in JFMCs as on 2006

Total JFMCs (Nos)	Total membership	SC	ST	Others
598	66022	7365	21952	36705

Table 2.20. Year-wise constitution of VSS under implementation

Period	Number of VSS	Period	Number of VSS
1998-99	0	2002-03	89
1999-00	13	2004-05	179
2000-01	8	2005-06	46
2001-02	37	Total	372

Source: Correspondence with Kerala Forest Department Headquarters / Divisonal Forest Offices.

Indicator 7.2: Use of indigenous technical knowledge: Identification, documentation and application

Indigenous knowledge is applied by many communities in the use of forest produce. In the present scenario, local knowledge as well as the associated biodiversity are declining. In this regard, primary initiatives have been taken by the Government of India in the form of Acts viz., the Protection of Plant Varieties of Farmers' Right Act (2001) and Biological Diversity Act (2002). The forest-based communities have developed traditional systems and knowledge based on their direct interaction and inter-relationship with the forest resources. These indigenous practices and the associated knowledge should be acknowledged and incorporated into the forestry management systems for improved management of the forests.

Indicator 7.3: Quality and extent to which concessions and privileges are provided

Besides getting indirect and intangible benefits from the forest, the communities also enjoy certain direct and tangible benefits from the forest resources in the form of their rights on the forests and forestry resources. Awareness about these rights and privileges is to be created among the people but the proper applicability of these rights and concessions should be monitored.

The National Forest Policy of India has mentioned that the rights and privileges on the use of forests would be enjoyed by the communities living in and around the forest areas. The Government of India has passed several rules and regulations to develop adequate benefit-sharing mechanisms. These privileges are often termed as *Nistar* rights (for the villages staying within the area of 5 km from the forests). The forest dwelling communities have the right to collect NWFPs and fuelwood (fallen, dead and dry, as headloads) for their self-consumption, from the forests. However, they do not have the access to harvest timber or poaching wild animals from the forests.

Indicator 7.4: Extent of cultural/sacred-protected landscapes: forests, trees, ponds, streams, etc.

This indicator assesses the forest areas used for recreational/tourism purposes and those that play an important role in the cultural and religious life of people. The focus of assessment of recreational needs is on number of visitors and facilities available for recreational activities. For cultural and religious sites, the number of visitors and level of protection of these sites should be assessed. So the existing system of traditional protection to the cultural/sacred–protected landscapes, forest, animals, trees, ponds, streams, etc. is to be continued.

Criterion 8: Adequacy of policy, legal and institutional framework

An enabling environment and strengthened institutional structure are prerequisites for sustainable forest management (SFM). The policies and legal framework should promote and support SFM through various institutional frameworks. This criterion deals with the institutional set-up, human resource and related other resources, capacity and community participation.

Indicator 8.1: Existence of policy and legal framework

This indicator deals with policies and laws related to forests and their proper implementation. In India, the Indian Forest Act 1927, has been effective and is being followed for controlling the forest offences. National Forest Policy (1988) has been formulated to provide basis for management of forests in India. The Forest Conservation Act (1980) has been a milestone in significantly reducing the diversion of forest land for non-forestry purposes. The Biological Diversity Act (2002) provided for establishing a legal body in the name of National Biodiversity Authority, which has powers and responsibilities for all the biodiversity-related aspects of the country. All these regulations are quite effective in providing legal protection to the forests and wildlife of the country, despite a heavy biotic pressure. In brief, this indicator focuses on the existence of legal framework and the frequency of updating specific policies and laws for sustainable management of the forests. Intended situation is that all the provisions of policy and legal framework should be effectively implemented.
A list of Acts relevant to forest management in Kerala is given below;

- Kerala Forest Act and Amendments 1961.
- 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.

Indicator 8.2: Number of forest-related offences

The forest-related offences arise as violation of forest laws in the forms of cattle grazing, illicit felling, trespassing, encroachment and conflicts leading to forest fires. Information about the number of registered forest offences and area affected can provide some indication of whether the control measures and conflict management tools are effective. The recommendation is that there should be no forest-related offences and the existing number of offences should decline.

Table 2.21. Number of forest offences booked under Kerala Forest Act 1961

Year	Clearing of forest land	Illicit collection of forest produces	Section 61 A	Miscellaneous	Total
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: Administration Report of Kerala Forest Dept (various years).

Indicator 8.3: Level of investment in Research and Development

This indicator measures the level of investments in forestry research and development. Both, investments by the government and private sector need to be assessed. State forest departments are going to establish research and extension division for meeting the current management requirements. The recommendation is that a proper financial allocation should be provided to promote research in forestry sector.

Indicator 8.4: Human resource capacity building efforts

For sustainable forest management, it is imperative to have competent human resource. The urgent need is to make the people aware and train them according to the need. The

recommendation is that the training programmes should be regularly organized and all the stakeholders should participate in the training programmes.

Indicator 8.5: Forest Resources Accounting

This indicator refers to natural resource accounting, an approach increasingly used by Governments to maintain national accounts about their natural resource such as fish, forests, minerals and the like. The assessment of this indicator is only possible if proper national natural resource accounting system is applied with special reference to forest-related parameters. There are some distortions in the existing system of accounting of the forestry resources due to which the contribution of forestry sector in the GDP is much less. This needs to be rectified. Contribution of forestry sector should increase in the national GDP and accordingly the budget allocation to the sector should also increase.

(a) Contribution of forestry sector to the NSDP

The state accounts include the monetary value of only a small fraction of total economic values of forests. This is because of the conventional economic accounts, which take into account only the revenue received from sale of timber, bamboo, fuelwood and few NWFPs. There is no accounting of the free collection of fuelwood, grass and other NWFPs, benefits from free grazing of livestock in forests and a whole set of intangible benefits such as soil and water conservation, maintenance of productivity of adjoining lands, bio-diversity conservation, moderation of micro-climates, carbon sequestration, release of oxygen, recreation, etc. In addition, there are cultural and religious uses of forests that serve to enhance human welfare but value of which is not included in the conventional economic accounts.

Table 2.22 shows the percentage contribution of forest sector to state economy in terms of direct economic benefits which most often remains below 2 percent.

Table 2.22. Contribution of forestry sector to the NSDP

Year	NSDP of Forestry and Logging (Lakh Rs)	Percent contribution of forestry sector to the NSDP
1987-88	7170	0.9
1988-89	6287	0.7
1989-90	9996	0.9
1990-91	8376	0.7
1991-92	12446	0.8
1992-93	14477	0.8
1993-94	74422	2.9
1994-95	94665	3.0
1995-96	95273	2.5
1996-97	101593	2.3
1997-98	98002	2.0
1998-99	103727	1.9
1999-00	121613	2.0
2000-01	123277	1.9
2001-02	134919	2.0
2002-03	128441	1.7
2003-04	143133	1.6

Source: Economic Review various years

Indicator 8.6: Monitoring and evaluation mechanisms

This indicator deals with the procedures in place to monitor and evaluate forest management activities. Appropriate system of monitoring and evaluation using the Criteria & Indicators should be followed.

Indicator 8.7: Status of information dissemination and utilization

Dissemination of information about forests and forest utilization is considered an important ingredient in today's multi-stakeholders approaches in forest management. A wide range of mechanisms is needed for dissemination of forest-related information by governmental organizations, NGO's and the private sector. Intended situation is that there should be adequate mechanism for information dissemination.

In order to summarize the situation about progress towards Sustainable Forest Management (SFM) in the State using available data, a simple tricolour chart was prepared based on the guidelines of FAO (2005). 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 percent per year, green showing positive change exceeding 0.5 percent and yellow showing changes within ±0.5 percent, all in respect of sustainability. The results for the period 1987 to 2003 are presented in Table 2.23.

Table 2.23. Chart summarizing the progress towards SFM based on available data

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 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 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 is 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 (Venny *et al*., 2007).

$$SI = \left(\sum_i WC_i \times C_i \right) / \sum_i WC_i \ , \quad C_i = \left(\sum_j WI_{ij} \times I_{ij} \right) / \sum_j WI_{ij} \qquad (2)$$

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.* (2007). The graph obtained is shown in Figure 2.9. 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 fire and reduction in the percentage contribution of forest sector to NSDP.

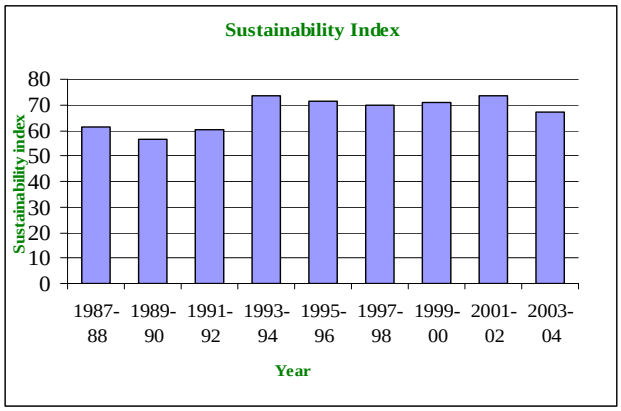


Figure 2.9. The progress towards sustainability of forests in Kerala

3. FOREST-BASED INDUSTRIES

3.1. Ecotourism in Kerala

Tourism is a steadily growing sector all over the world, moreover the developing countries are endowed with greater potential for tourism, especially nature tourism. The importance of ecotourism with its high employment potential is increasing year after year. According to the World Tourism Organization (WTO) with an annual growth rate of 5 percent worldwide, tourism represents 6 percent of the world Gross Domestic Product and 11.4 percent of all consumers spending. Ecotourism is the fastest growing market in the tourism industry. Ecotourism Society (1991) defines ecotourism as *responsible travel that conserves natural environments and sustains the well being of local people*. Ecotourism is a direct consumptive benefit, which is highly under-priced. This sector has certain crucial environmental implications because it depends upon natural endowments for its existence. The Central Government with the introduction of ecotourism policy and guidelines as part of the new tourism policy (2002) paid special attention on traditional picnic spots of natural forests. Ecotourism is one of the key sectors for India in the service sector negotiations under General Agreement on Trade in Services (GATS) in the WTO. The Government of Kerala is committed to develop strategies for utilizing the ecotourism potential in the State. In Kerala, major tourism destinations are broadly classified as beaches, backwaters, water bodies, waterfalls, hill stations, Wildlife Sanctuaries (WLSs) & National Parks (NPs) and culture including festivals. State forests provide a range of opportunities for recreational pursuits that add to those available on other public lands, such as picnicking, camping, trekking, bird watching, nature walk, among others. The water bodies formed within the forest area due to construction of dams/ hydel projects and natural waterfalls provide ample scope for recreational facilities.

3.1.1. General tourism profile

Tourism status in Kerala in the era of new economic policy of 1991

The domestic tourist flow in Kerala showed an increasing trend during 1981-2002; the domestic visitor flow during 2002 was 28.6 times higher than that during 1981. The domestic visitor flow during 1990 was 3.4 times higher than that in 1981, while the growth rate during 1991-2002 was 494 percent. The domestic tourists constituted on an average, 95 percent of the total tourist flow during the period 1980-2002 and the foreign tourists constituted the rest 5 percent.

A comparative analysis of pre-reform period and post-reform period was conducted in order to identify how the domestic tourism sector of the State reacted to the national initiative of the new economic policy in 1991. Figure 3.1 shows the three-year moving averages of domestic tourist flow during the pre-reform and post-reform periods. There has been a significant increase in the domestic tourist flow since the inception of new economic policy in 1991. It is evident from figure 3.1 that year 1996 registered 3.7 times higher amount of domestic visitor flow as compared to that in 1991. While in the second part of the policy period (1997 to 2002) the rate of growth was only 21 percent. Thus the

year 2002 registered only a meager (0.2 times) increases as compared to 1997. Evidently, in the second part of the post-policy period, the domestic tourist flow showed a relatively stagnant trend at a higher level. In the pre-reform period, the growth rate was higher during the period just preceding the new economic policy. During 1986 to 1990, the growth rate was 92 percent, while it was only 70 percent during the period 1980 to 1985 of the pre-reform period. The new economic reform of 1991 based on the globalization, liberalization and privatization has increased the growth rate of domestic tourists' flow in Kerala.

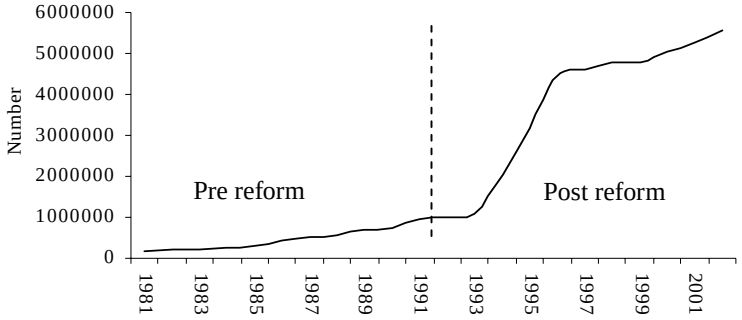


Figure 3.1. Three year moving average of domestic tourists in Kerala

Foreign tourist arrival to Kerala in the era of globalization

The foreign tourist arrival to Kerala shows an increasing trend during the period from 1981 to 2002, indicating a 9.5 times increase in 2002 than that in 1981. The growth rate of foreign tourist arrival during 1981 to 1991 was 221 percent, while it decreased slightly to 188.5 percent during the period 1992-2002. The foreign tourists constituted 11 percent of the total tourist flow in 1980, 7 percent in 1990 and 4 percent in 2000.

The average annual visitor flow during the pre-reform (1980-1990) and post-reform (1991-2003) was 40,556 and 169,234 respectively. Figure 3.2 depicts an impressive difference in the foreign tourist arrival to Kerala since the inception of the new economic policy of 1991. The increase in the foreign tourist arrival during the initial years (1991 to 1996) was higher than that of the second part of the post-reform period (1997 to 2003). During the former period, the foreign tourist arrival increased by 155 percent, while during the later period it was only 62 percent. The analysis of the pre-reform period indicated that the growth rate of foreign tourist arrival was higher during the 5-year period just preceding the reform period (1985 to 1990) compared to the earlier 5-year period 1980 to 1984. The growth rate during the 1985 to 1990 and 1980 to 1984 were 56 and 12 respectively. The new economic policy process has thus had certain positive impact on the foreign tourist arrival to the State and the growth rate of the foreign tourists was normalized at a higher level of visitation during the second part of the post-reform period.

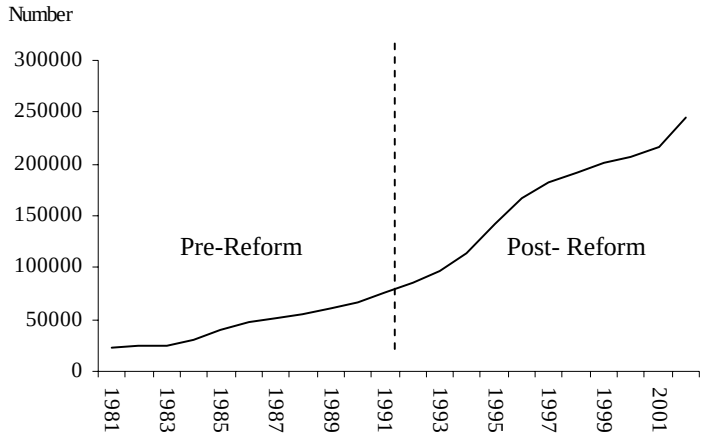


Figure 3.2. Three year moving average of foreign tourist arrival to Kerala

Kerala tourism and travel

The transportation and tourism sectors are interdependent in a tourism-based economy. In Kerala, the foreign tourists adopt different modes of travel such as air, ship, road and rail. During the period 1996 to 2003, on an average, 65 percent of the foreign tourists used the road and rail transportation facilities, while 31 and 4 percent used air and ship respectively. The mean values of foreign tourists who used road and rail, air and ship are 138,886, 66,144 and 7,138 respectively. Figure 3.3 depicts the mode of travel of foreign tourists to Kerala and it is noted that there is a positive growth rate in the number of foreign tourists availing road and rail and airways while the number of foreign tourists using the ship mode of travel remain almost constant.

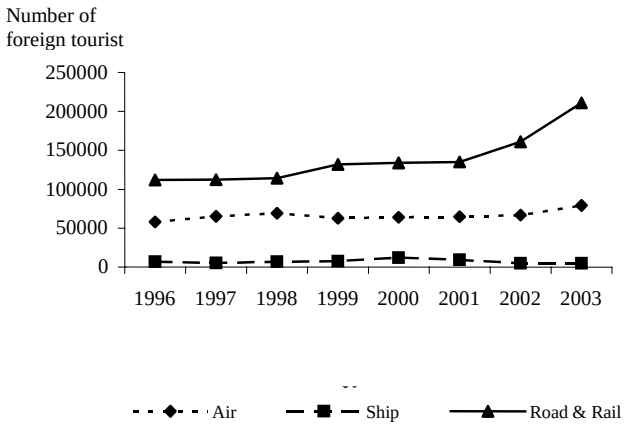


Figure 3.3. Mode of travel of foreign tourists to Kerala

District-wise tourism development in Kerala

In Kerala, southern districts attract more foreign tourists compared to the northern districts. In the district-wise foreign tourist arrival during 2000-04, six districts, namely, Thiruvananthapuram, Idukki, Ernakulam, Alappuzha, Kottayam and Kollam together constituted 95 percent of the foreign tourist arrival moreover Thiruvananthapuram and Idukki together accounted for more than half of the total foreign tourists that arrived during the period. Wayanad, Thrissur, Kozhikode, Kannur and Malappuram districts together registered 5 percent of the foreign tourist arrival to the State during the period 2000-04. There is high regional disparity in the foreign tourists arrival in the state (Figure 3.4).

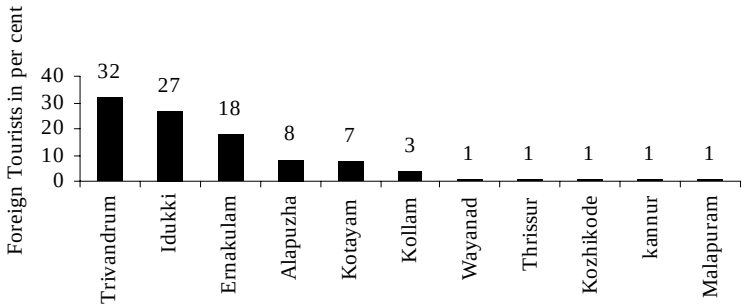


Figure 3.4. District wise foreign tourist arrival in Kerala during 2000-04

In the domestic tourism of the State (Figure 3.5), Thrissur district occupied the first place with 24 percent of the domestic tourists during the period 2000-04 followed by Idukki (15%) and Thiruvananthapuram (14%). Here also, the northern districts lagged behind in the distribution of tourism benefits. The lowest share of tourism development goes to Pathanamthitta with 1 percent of domestic tourist flow during the period 2000-04.

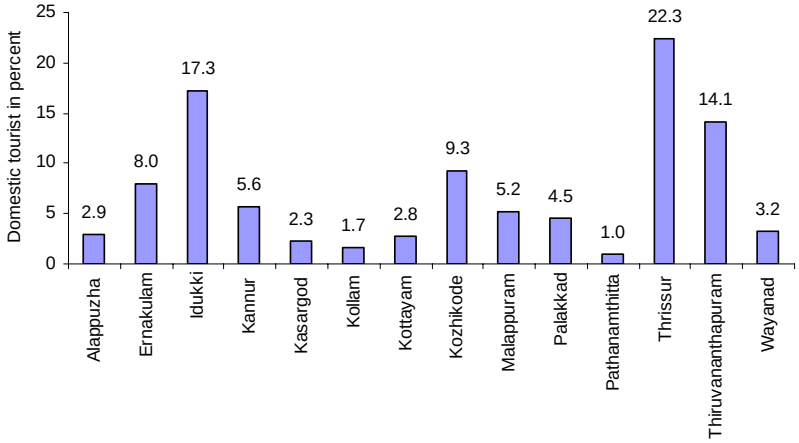


Figure 3.5. District wise classification of domestic tourism in Kerala (2000 -04)

Seasonality of tourism in Kerala

Tourism in the State is seasonal in nature and is classified as lean season (monthly visitation is less than 5 percent), moderate season (5 to 10 percent of visitation) and peak season (above 10 percent monthly visitation). The seasonality of domestic and foreign tourism in the state is estimated based on the monthly averages of visitors flow during the period 2000-04. Based on this classification, June and July constitute the lean season of foreign tourist arrival to Kerala, the moderate season include March, April, May, August, September, and October while the peak season includes November, December, January and February (Figure 3.6).

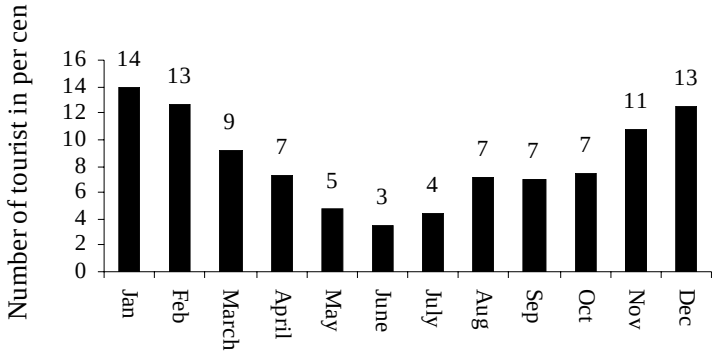


Figure 3.6. Seasonality of foreign tourist arrival to Kerala

As far as domestic tourism is concerned (Figure 3.7), the period from January to March depicted a decreasing trend, then an increase was noted during the period March to May after which a sudden decrease was noted from May to June period. From June onwards the data projects an increasing trend up to December.

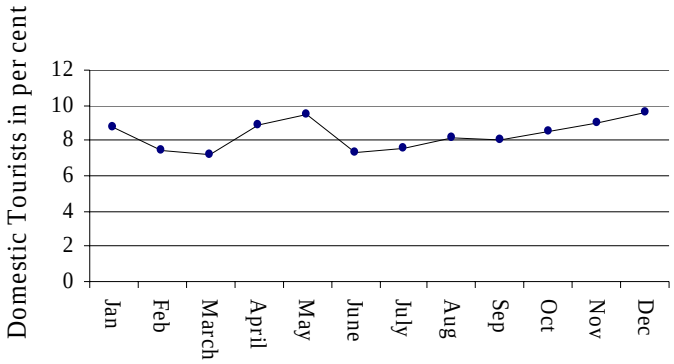


Figure 3.7. Seasonality of domestic tourism in Kerala during the period 2000-04

3.1.2. Ecotourism in Sanctuaries and National Parks of Kerala

The forests of Kerala offer excellent opportunity for ecotourism with a wide array of flora and fauna. Besides, wildlife tourism, they may also provide immense scope for nature and adventure tourism. Development of ecotourism also offers opportunities for development of local economy and developing stakes of local people in preservation of natural resources.

Figure 3.8 illustrates the number of Protected Areas (PAs) in the State by their year of formation. It is interesting to note that larger area is being brought under the PA category and this will positively impact conservation and protection of natural resources. Added to this is the strong conservation bias of the National Forest Policy whereby foresters are adopting a very cautious approach towards development of ecotourism. Conservation of the nature and natural habitats are given over-riding preference over development of tourism but many of the National Parks and Sanctuaries are already on international tourist maps. Although tourism activities are going on in most of the WLSs/NPs, the concept of ecotourism is given emphasis only lately.

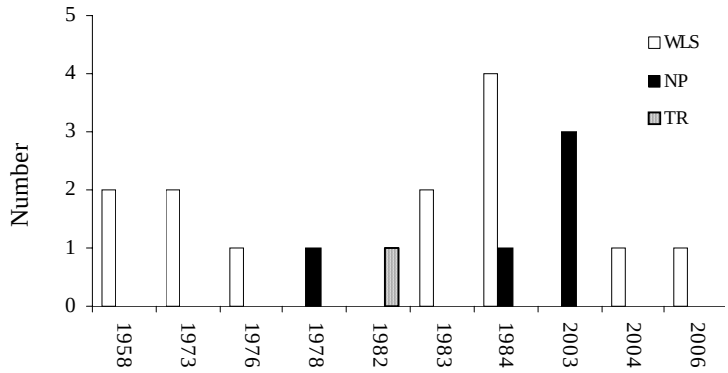


Figure 3.8 Formation of wildlife sanctuaries, national park and tiger reserve.

For the purpose of the proposed assessment of the status of ecotourism in the State, only the Protected Areas, i.e., the WLSs and NPs in Kerala have been considered. The study area covers 14 WLSs, 1 Tiger Reserve and 5 NPs in Kerala (Fig 3.9) with a total tourism zone of 158.85 km^2 (Figure 3.10).

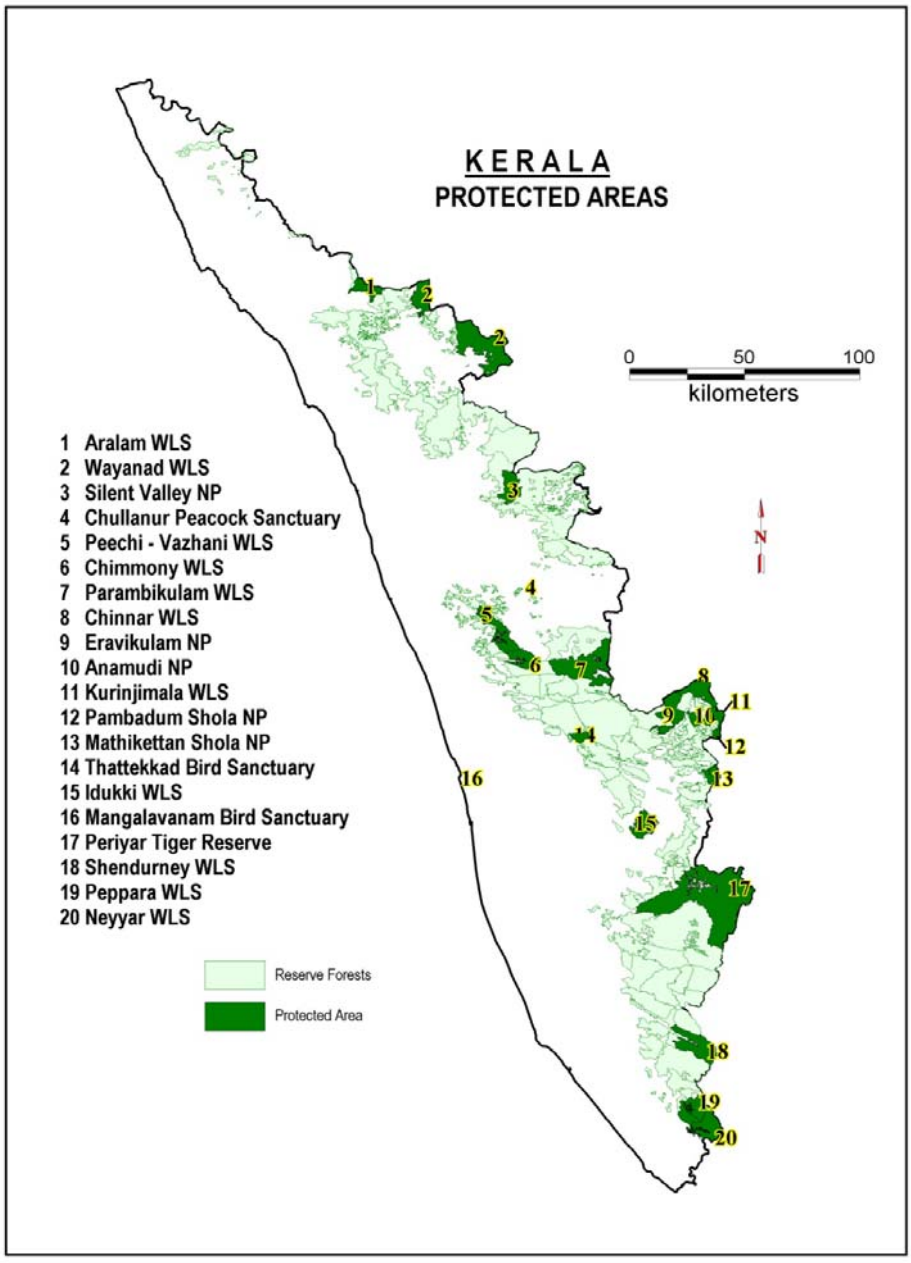


Figure3.9. map of Kerala showing protected areas

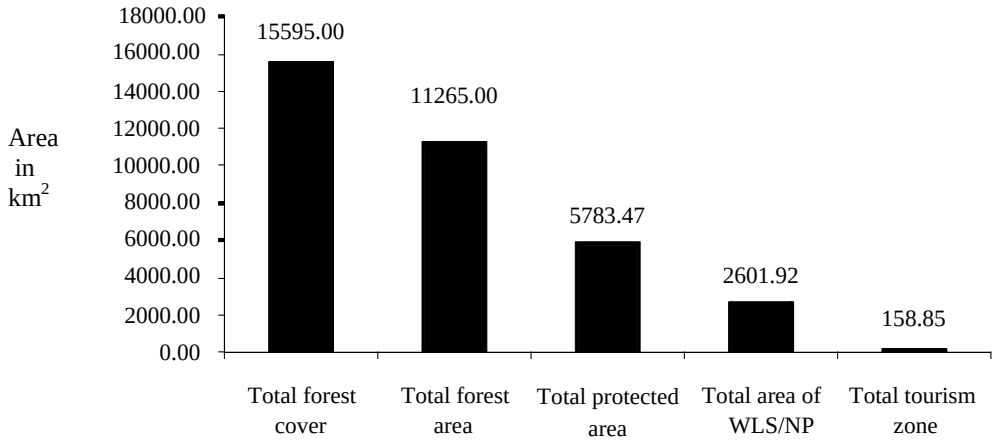


Figure 3.10 Area of forest and ecotourism zone in Kerala

The study is based on both secondary information such as visitors arrival, government revenue generated, employment created, zonation of protected area, etc. and primary information like social and economic aspects of the tourist, income and willingness to pay, tourist's preference, mode of travel, etc; collected by questionnaire method. In the primary data collection the sample size was fixed at 1000 visitors. The study area covered 14 wildlife sanctuaries and 5 national parks. In the first stage of sampling 7 wildlife sanctuaries and 2 national parks were selected by unrestricted random sampling method. In the second stage, the selected wildlife sanctuaries and national parks were divided into high tourism potential area and low potential area based on the past visitor flow and the total sample distributed between the high potential and low potential areas (Table 3.1) in the ratio of 3:1.

Table 3.1 Stratified proportional random sampling

High Tourism Potential Area			Low Tourism Potential Area		
Area	Population	Sample	Area	Population	Sample
PTR	440929(41)	311 (41)	Silent valley	9583 (61)	153 (61)
Eravikulam	304341 (29)	215 (29)	Chinnar	3108 (20)	50 (20)
Wayanad	65953 (6)	47 (6)	Aralam	2932 (19)	47 (19)
Parambikulam	40107 (4)	28 (4)	Total	15623 (100)	250(100)
Thattekkad	40093 (4)	28 (4)			
Neyyar	171920 (16)	121 (16)			
Total	1063343 (100)	750 (100)			

Figures in brackets represent respective percentages

Visitor flow

The visitor flow to the WLSs and NPs depicted an increasing trend during the period 1998 to 2006 and the annual average visitors flow during the period was 663,255. The

visitors' flow to the WLSs and NPs in 2006 registered a growth rate of 148 percent compared to the visitors flow in 1997 (Figure 3.11).

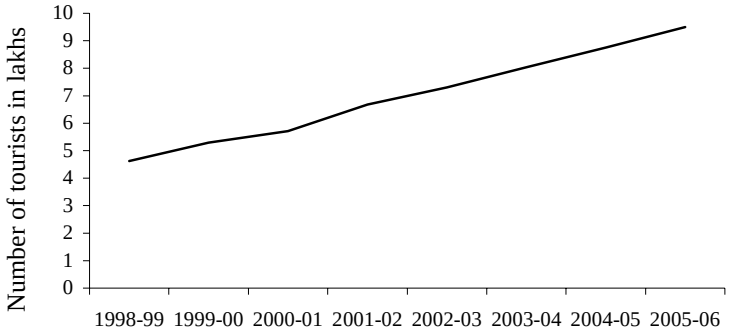


Figure. 3.11. Three-year moving average of tourist flow to WLS and NP

Visitor profile and motivation

In the gender-wise classification of the sample, males constituted the major share with 71.5 percent and the females constituted only 28.5 percent of the total sample. The age of the sample respondents varied between 16 and 80 with an average value of 30. Graduates constituted 38 percent and post graduates 21 percent of the sample. In the occupational structure of the sample, private sector occupied a prominent place with 33 percent, the government, business and agriculture sectors occupied 15, 8, 6 percent respectively. An appreciable 17 percent of the sample were unemployed and 19 percent came under the category of others, which included housewives and students. The senior citizens constituted 2 percent of the sample. Leisure was the major motivation (68 percent) followed by the study and business purposes (Figure 3.12). Nearly 53 percent of the sample arranged their tour themselves and 9 percent depended on the formal tour operators. In the visitors group, 41 percent constituted friends group followed by study group (30 %)and family (27 %) and individuals (2 %). The average travel time of the sample tourists ranged between 1 hour and 6 days with an average 7.3 hours.

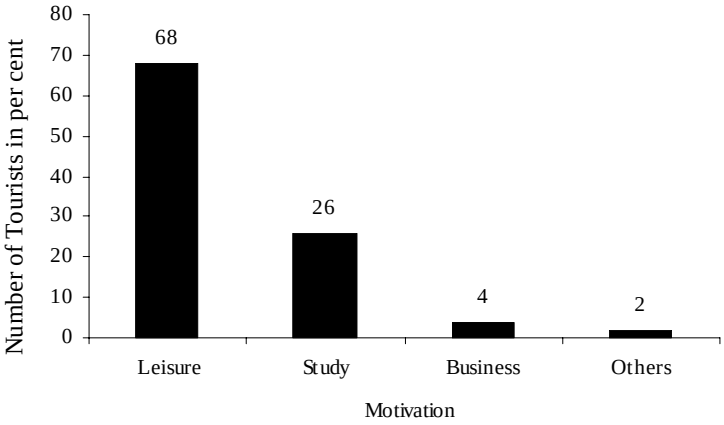


Figure 3.12. Motivation of the tourists in the sample

In the mode of travel, 46 percent depended on private tour coaches, 31 and 13 percent used rented taxi and own vehicles respectively, the public transport was used by only 9 percent of the sample. Around 31 percent of the sample made some kind of shopping as part of their tour and the items in the shopping list included handicrafts, dress, ayurvedic products and spices like cashewnuts, among others.

On the expenditure side of the tourism development, an individual tourist incurred expenditure on various heads such as food and accommodation, travel, shopping and recreation fee. Although the average expenditure was highest in the shopping category (Rs 1023) the number of tourists who incurred the shopping expenditure was low (321) (Figure 3.13). The average travel and accommodation expenditure was Rs 876 and large numbers of tourists incurred food and accommodation expenditure. In the expenditure pattern average expenditure on the recreation was comparatively low with Rs 781. Of the total, 720 tourists in the sample enjoyed various recreation facilities offered at different rates.

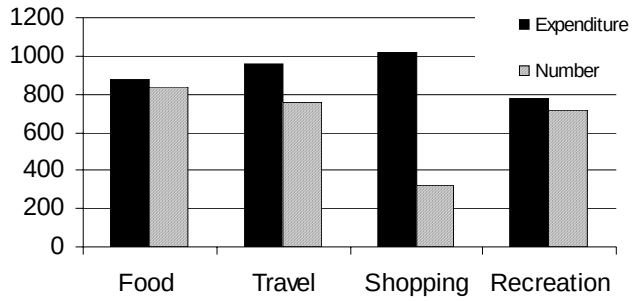


Figure 3.13. Average expenditure and number of tourists

Total conservation value of ecotourism

The demand for the conservation of natural resources depends on various factors such as people's awareness about the importance of the resources, intensity of environmental problem due to the deterioration of the resources, standard of living of the people, etc. The conservation value is the amount the people are willing to sacrifice for having the benefit in the future. The demand theory shows the inverse relationship between the quantity demanded and the price. The price represents the amount the people are willing to sacrifice for having a particular benefit. The contingent valuation method is popularly used for the economic valuation of non marketable environmental goods or quality. In this method, people are directly asked what they are willing to pay for having particular benefits. Different people are willing to pay different amount and the CVM shows the relationship between the amount the people are willing to pay and the number of people willing to pay different amount. Symbolically, $Y = f(X)$ where Y is the demand for the conservation of ecotourism spot, f and X represent the functional relation and amount the

tourist is willing to pay respectively. In order to estimate the conservation value from the conservation demand curve (Figure 3.14) the integration method was adopted.

The real value of a natural resource / Protected Area is infinity. Here, we estimate the conservation value of ecotourism benefits which is the value people are willing to sacrifice for conserving the PA but this does not reflect the actual value. It is based on the assumption that demand for conservation (*Number of people willing to sacrifice*) is positively reflected by the amount that people are willing to pay for conservation. In the contingent valuation questionnaire survey, 302 tourists responded to the question related to the willingness to pay for the conservation of the tourist spot and the estimated aggregated conservation value of the sample was Rs. 6,882,216. The willingness to pay ranged between Rs 10 and Rs 250 and the mean value was Rs 28.

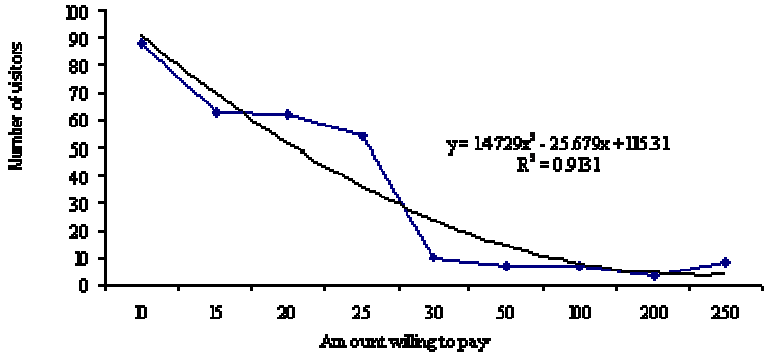


Figure 3. 14. The Conservation Demand Curve of Ecotourism

Economic impact of ecotourism in study area

Nature tourism has multiple social and economic benefits. In the study, the economic impact of the tourism development is enumerated based on the revenue generated and the employment created at site. The marginal contribution of an individual tourist by way of amount spent is different in the different Wildlife Sanctuaries and National Parks of the State. The analysis of this economic impact of ecotourism is restricted to a few WLSs and NPs where sufficient data were available.

In Neyyar WLS the average spending of a tourist during the period 1997-2006 was only Rs 13. The commercial development in the ecotourism areas of Neyyar was relatively poor and it was estimated that the tourism sector generated an aggregate demand equal to Rs 950 per day in the area. This aggregate demand was derived based on the interaction with the shopkeepers, vendors and by analyzing the spending habits of the tourists.

The average revenue generated in the Shendurney WLS was Rs 980,571 and it was mainly from the boating and the average fee of an individual tourist including the foreigners was Rs 36. The Thenmala ecotourism area, which was the first planned ecotourism development project in India, is in the peripheral areas of the Sanctuary. Thus, the commercial sector was well developed in these areas and aggregate demand

created by the ecotourism development in the area was Rs 21,000 per day in the medium season and the average employment generated in the ecotourism area of the Shendurney WLS was 95 labour days per day excluding the employment offered by the EDCs and the Thenmala Ecotourism project.

The total revenue generated in the Periyar Tiger Reserve was Rs. 83,285,972 during the period 1997 to 2006 and the average revenue generated during the period was Rs. 8,328,597. During the period 1964-65 to 2005-06, 6,181,434 tourists visited the PTR and foreign tourists constituted only 7 percent of the total tourist flow. The average annual visitor flow to PTR was 280,974 and the average annual numbers of domestic and foreign tourists were 261,451 and 19,523 respectively. The growth rate of visitors flow and revenue generation in PTR showed an increasing trend, compared to the visitor flow of 1986-87. The growth rate of visitors flow in 2005-06 was 115 percent which implies that the visitors flow in 2005-06 was 1.15 times higher than that of 1986-87. In the case of the revenue generation, the growth rate was 2444 percent, i.e., 24 times increase of the revenue generation in the reference period.

The visitor flow to the Eravikulam NP depicted an increasing trend. During 2000-04, the aggregate visitors flow to the NP was 1,110,972 with an average annual visitor flow of 222,194. The total revenue of the NP from the ecotourism activities was Rs. 12,193,910 and the average annual revenue was Rs. 2,438,782 during the same period. When the annual revenue was regressed to annual visitors flow, it was revealed that one unit increase in the annual visitor flow to the NP createed 7.2 units of increase in the annual revenue collected.

Tourist flow to Chinnar WLS also showed an increasing trend and the average annual tourist flow to the Sanctuary was 2,848 during the period 2004-06. A total of 8,545 visitors made it to the sanctuary and the foreigners constituted 31 percent (2613) of the total visitor flow. The increase in the visitor flow to the sanctuary was relatively small and the estimated growth rate to the sanctuary was only 6.6 percent during the period 2004-06. The aggregate revenue generated in the sanctuary during the period was Rs. 1,088,190 with an annual average of Rs 362,730. The growth of tourism in the sanctuary was more employment elastic in nature thus 53 percent of the aggregate revenue was distributed among the laborers as wages and salary. During the period 2004-06, Rs. 577,950 was distributed with an annual average of Rs. 192,950.

The three-year moving average of the annual visitors flow to the Thattekkad Bird sanctuary showed an increasing trend of annual visitor flow during the period 1994-95 to 2005-06. The total number of visitors to the sanctuary during the period 1993-94 to 2006-07 was 273,116 and the average annual visitors flow was 19,508 in the same period. During the period, foreigners constituted only 1 percent of the total and the average annual visitor flow of foreigners to the Sanctuary was 208. The growth rate of foreign tourists to the sanctuary showed an increasing trend of 5,308 percent during the above-mentioned period, which implies that the arrival of foreign tourists in 2006-07 was 53 times higher than that in 1993-94. The growth rate of total tourists to the Sanctuary was 3,974, implying an increase of 40 times.

The Silent Valley NP offers new opportunities for the ecotourism development in Kerala. During 2006-07, 3,16,690 tourists visited the NP and the average monthly visitation to the park was 26,391 during the year. During the year 2005-06, students and foreigners constituted respectively 26 and 1 percent of the total visitor flow. The total visitors to the NP recorded an increasing trend of 3.8 percent during 2004-05 to 2005-06 which implies that the total visitor flow to the NP in 2005-06 was 0.03 times higher than that in 2004-05.

The outdoor recreation system with its economic parallels identifies certain comparisons between the recreation economy and market economy. Ecotourism development has the potential to make an economic impact via income generation, increase in foreign reserve of the State, development of basic infrastructures and creation of new avenues for employment. It also provides avenues for the sustainable development of the remote rural areas. Tourism employment multipliers summarize either the direct, indirect and induced employment generated by an additional sum of tourism expenditure in the economy. Ecotourism as a sector in the WLSs and NPs of the State can thus be linked to economic development by identifying and assessing its advantages in the development of local economies.

3.2. Sawmilling industry in Kerala

The major wood-based industries in the State are sawmilling and manufacture of packing cases, plywood, splints and veneers, pulp and paper, wooden furniture and fixtures. There are around 4000 wood-based industrial units, which depend not only on forests but also on homegardens and estates, for their wood requirements. The sawmilling industry is one of the most important forest-based industries in Kerala. Bulk of the sawn wood originating from either domestic or imported timber passes through these units and thus the sawmills have a key role as an intermediary between the producers and the consumers. Whether the industry is viable, what is the size of the industry, whether the units are well equipped to meet the sawmilling requirements of the customers, what constraints are faced by the industry, what is the extent of employment generation and what technological standards are kept by the industry are important questions one could ask on the subject. This study was thus aimed at evaluating the current status of this industry and gauging its future potential.

Survey design

A survey was planned to generate information about the industry. The list of sawmilling units in the State was obtained from the office of the Director of Factories and Boilers at Thiruvananthapuram. Some of the population characteristics like spatial distribution and distribution in different size categories were worked out from the data.

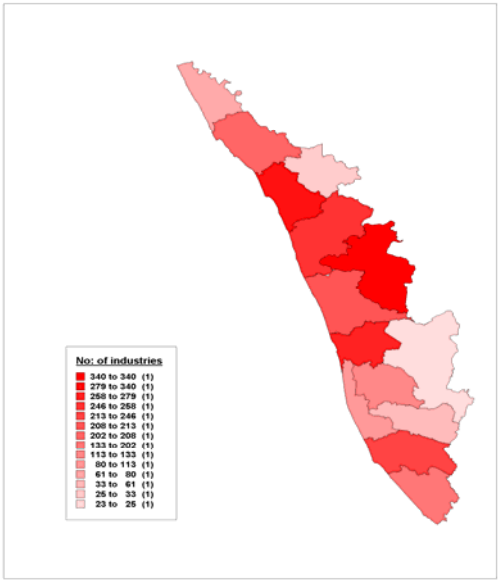
For the sample survey, a total of 216 sawmilling units, i.e., about 10 percent were selected through stratified sampling scheme taking small units (employing less than 10 workers) and large units (employing 10 or more workers) as strata. Out of the 216 units

selected, 185 were small units and 31 were large units. The data were collected by visiting each selected sampling unit. The questionnaire contained questions about the type of operations, year of inception, annual production capacity and outturn, details about the employees, type of timbers used and their sources, fuel consumption and problems faced by the units. Data were collected by direct interview of the owners and employees of the units.

Distribution over Districts and size categories

As on 2006, there were totally 2214 sawmilling units registered under the Factories and Boilers Department of the Kerala State. It would be interesting to examine the structure and distribution of these units in the State. The District-wise distribution of the units is given in Figure 3.15.

Highest number of the sawmilling units were located in Palakkad District (340). Other districts in this respect were Kozhikode (279), Ernakulam (258), Malappuram (246), Kollam (213), Thrissur (208) and Kannur (202). In total, 69% of sawmilling units were concentrated in these Districts. In the other seven Districts, Thiruvananthapuram (133), Kottayam (113), Alappuzha (80), Kasaragod (61), Pathanamthitta (33), Wayanad (25) and Idukki (23), the number of sawmilling units were less than 150. The restriction that prevailed regarding to the location of sawmills (no saw milling units must be located within 5 km distance from the boundary of the forest) limited number of sawmills in Pathanamthitta, Wayanad, and Idukki.

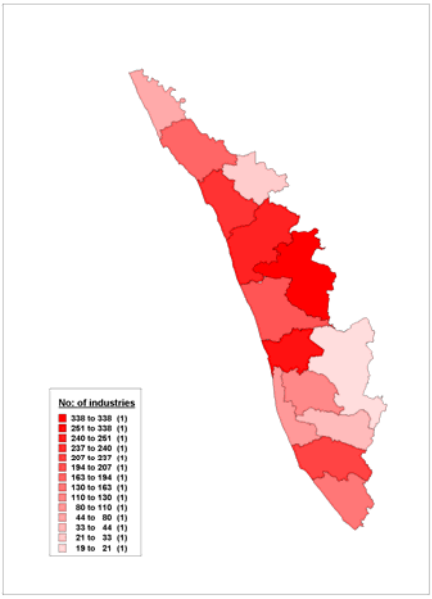


District	Number of units
Palakkad	340
Kozhikode	279
Ernakulam	258
Malappuram	246
Kollam	213
Thrissur	208
Kannur	202
Thiruvananthapuram	133
Kottayam	113
Alappuzha	80
Kasargod	61
Pathanamthitta	33
Wayanad	25
Idukki	23
Total	2214

Figure 3.15. Map showing the distribution of saw milling units in different Districts

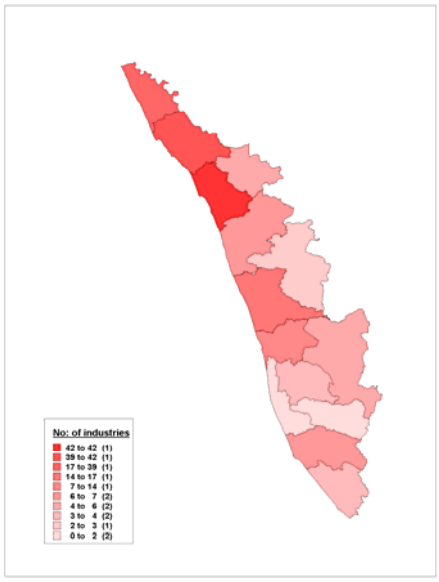
As per the officially accepted norms, the sawmilling units could be classed as small with less than 10 workers and large with 10 or more workers. According to this classification, 2067 units came under the first category (small units) and 147 units under the second category (large units). The distribution of these differently sized units is shown in Figures

3.16a and 3.16b. The small units were concentrated mainly in Palakkad, Eranakulam, Malappuram, Kozhikode, Kollam, Thrissur and Kannur Districts. Out of the 2067 small units, about 80 percent were located in the above districts. The large units were mainly concentrated in Kozhikode, Kannur, Kasaragod and Thrissur Districts. About 75 percent of large sawmilling units were concentrated in these Districts. In short, small units were more or less evenly distributed in different parts of the State; whereas the large units are situated mostly in the northern Districts.



District	Number of units
Palakkad	338
Kozhikode	237
Ernakulam	251
Malappuram	246
Kollam	207
Thrissur	194
Kannur	163
Thiruvananthapuram	130
Kottayam	110
Alappuzha	80
Kasargod	44
Pathanamthitta	33
Wayanad	21
Idukki	19
Total	2067

Figure 3.15a. Map showing the distribution of small sized units in different Districts



District	Number of units
Kozhikode	42
Kannur	39
Kasargod	17
Thrissur	14
Ernakulam	7
Kollam	6
Malappuram	6
Idukki	4
Wayanad	4
Thiruvananthapuram	3
Kottayam	3
Palakkad	2
Alappuzha	0
Pathanamthitta	0
Total	147

Figure 3.16b. Map showing the distribution of large sized units in different Districts

Distribution by year of inception

The distribution of the sample set of sawmilling units by the year inception is shown in Figure 3.17. This figure could not be worked out for the whole population because no such information was available in the records for all the units. As such, the year of inception had to be ascertained from the owners during the survey. It can be seen that the sawmilling industry had its beginning as early as in 1935 but caught up only in later years. There has been a steady increase in the number of registered units over the years but not after 1990. The ban on clear-felling in 1985 and that on selection felling in 1987 contributed to the decrease to some extent. Since a major portion of timber came from households, probably the ban on felling trees from forests did not have much impact. However, the recent restrictions on the issue of no objection certificate (NOC) by the Forest Department have made the industry almost stagnant.

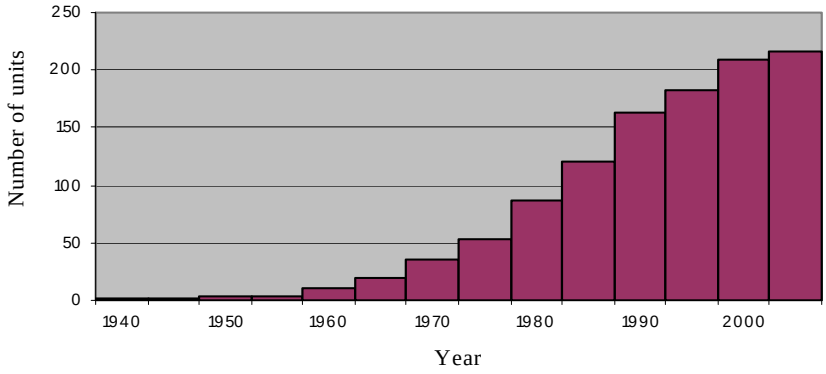


Figure 3.17. Histogram of sample set of sawmills based on year of establishment

Production

The State level mean annual outturn per unit was estimated as 882 (±37) m^3. The mean annual capacity worked out to 1305 (±35) m^3. In effect the capacity utilization was only 68 percent implying that the sawmilling units could process much more wood than that is presently done. The status of the two strata is shown below.

Table 3.2. Outturn and capacity utilization in Kerala

	Mean outturn (m^3)	Capacity (m^3)	Utilization (%)	Total outturn(m^3)
Small sized units	806	1238	65	1666294
Large sized units	1958	2254	86	287860
Overall	882	1305	68	1954154

The large-sized units have been able to utilize their installed strength much more effectively when compared to small-sized units. The total outturn of timber of the saw-milling units in the State worked out to 1,954,154 m^3 for the year 2005-06. This figure has an importance by its nature. With the wide availability of sawmilling facilities in the State, any wood that is processed invariably goes through a sawmill. Hence the outturn of the sawmills should be indicative of the total supply of saw timber from different sources such as forests, homesteads, estates and through import. Of total outturn, the contribution of the small-sized units was 85 percent although by number, the small-sized units comprise 93 percent of the total strength.

Source of timber

The next question is from where the wood is coming to the sawmills. The mill owners either purchased the round wood to sell it after sawing or used it for making furniture. Timber was also brought by customers for sawing. The proportion under these three classes worked out to sawn timber sold (21%), used for furniture and fixtures (5%) and brought by customers (74%).

Mainly four sources could be identified for timber purchased by mill owners, viz., homesteads, import, forest depots and estates. The respective contributions from these sources are presented in Figure 3.18. The major sources of the timber used in furniture making and timber sales were homesteads (53%), import (34%), forest depots (12%) and estates (1%).

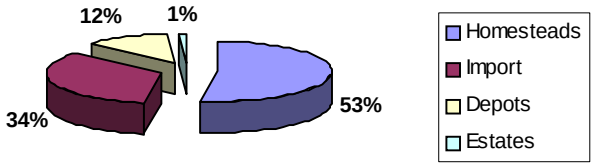


Figure 3.18. Source of timber used for direct sale and furniture making

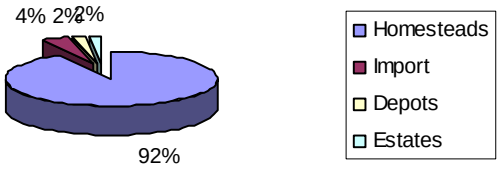


Figure 3.19. Source of timber brought by customers to sawmills

Other than direct purchase, customers also brought wood for sawing. The sources of timber brought by customers for sawing were homesteads (92%), imports (4%), forests (2%) and estates (2%) (Figure 3.19). The overall source-wise partitioning of the wood processed through the saw mills was homesteads (81%), imports (12%), forests (5%) and

estates (2%). In short, wood from homesteads formed the major source of timber for the sawmills. Other than that from homesteads, the industry thrives on imported wood and wood from the forest depots.

Type of timber processed

Analysis revealed that wood of about 42 species was processed by timber mills for direct sale and for making furniture. The major timber species used in timber sales and used for making furniture were teak (29%), pynkado (26%), jack (15%), anjily (6%) and mango (5%) (Figure 3.20). Out of the total timber species used in timber mills, about 80 percent were of these five species. The most preferred species for house construction and furniture were definitely teak and pynkado.

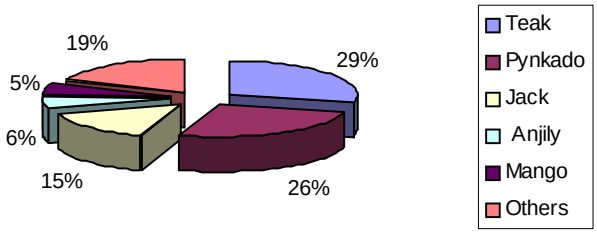


Figure 3.20. Species used in timber sale and furniture making

Customers brought about 53 species to sawmills for sawing. Out of these, the most commonly used timbers were of mango (28%), jack (23%), coconut (14%), anjily (9%) and teak (6%)(Figure 3.21). These five species constituted about 80% of the total timbers used for custom sawing.

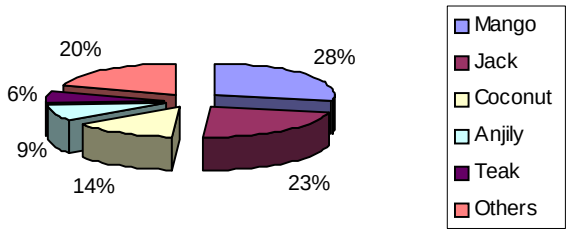


Figure 3.21. Species brought by customers to sawmilling units

Number of workers employed

The average number of full time employees per sawmill was estimated as 6.25 and the average number of part time employees was 0.73 per unit. In the case of small-sized units, the average number of full time employees per sawmill was 5.84 and the average number of part time employees was 0.62 per unit. In large mills the average number of full time employees per sawmill was 12 and the average number of part time employees was 2.18 per unit. An estimate of the total number of people employed in the sawmills was 15,460 including both full time and part time workers.

Constraints in saw milling industry

Interviews with the sawmill owners revealed some of the problems faced by them in running the mills (Table 3.3). On the whole, about 56 percent of the owners indicated shortage of timber. This is consistent with the low capacity utilization (68%) that was realized. Problem with supply of electricity and high electricity charges were also major constraints. Many owners admitted of having problems in meeting the government formalities connected with different departments like the Department of Factories and Boilers which is the licensing authority and Forest Department which issues NOC. They also had frequent troubles with labour unions. Table 3.3 shows that large units had higher incidence of shortage of timber and more cases of labour issues but were able to afford the high fuel cost.

Table 3.3. Strata-wise percentage of sawmills under different constraints

Constraints	Percentage of small units	Percentage of large units	Overall percentage
Shortage of timber	56	62	56
Problem with electricity supply	48	45	48
High electricity charges	67	71	67
Problems with government formalities	42	48	43
High cost of diesel and lubricants	26	11	25
Problems with labour	10	24	11

Future prospects

The survey has revealed that the industry is more than equipped to handle the timber processing requirements of the State. In fact, shortage of timber is one of the problems experienced by the sawmill owners. Since there are limits to the availability of timber from domestic sources, liberalized import policy is the only means to improve the current situation in the industry.

Of late, there has been slack in the industry due to restrictions on issue of NOC to new entrepreneurs. Also, the mill owners faced problem in getting the license renewed annually approaching different offices. A single window processing of the renewal applications is suggested for the purpose.

Band saw, resaw, saw bench, cross cutter and grinder are some of the essential equipments used in the industry. Lathe and planer are required for making furniture and fixtures. Although more advanced and efficient models of these equipments are available presently, the industry has not been very enthusiastic about using them because of the presently faced shortage of raw material.

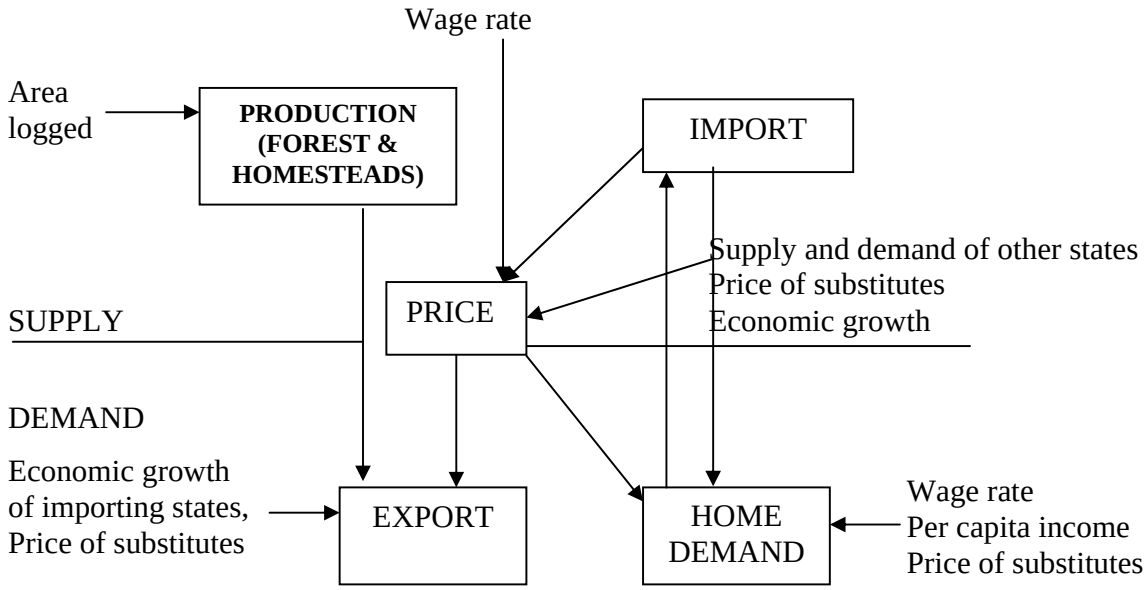
The sawmills require specialized and skilled labour. Organized labour force is quite demanding in their dealing with the management. Although per day rates are in force presently, rate per m^3 is preferable from the management side due to frequent power failures. The high labour charge including that for loading/unloading contributes to the high cost for processed wood. Unless the labour issues are settled effectively, the burden will ultimately fall on the consumers.

4. SUPPLY AND DEMAND FOR FOREST PRODUCTS

Krishnankutty (1990) and Krishnanakutty *et al*. (2005) had assessed the wood balance situation in Kerala for the respective years and made some projections. However, the methods employed had not been based on a thorough econometric approach. Hence, attempts were made to develop an econometric model and make projections of demand and price of some forest products based on such a model. As a first case, teak wood was considered. After some reflection, the following model was proposed for describing the supply-demand situation for teakwood in Kerala.

Supply-Demand Model for teakwood in Kerala

Flow Chart



Model- functional form

$$H_t = \mathrm{f}(P_t, W_t, I_t, Yk_t, Sk_t, H_{t-\theta}) \quad (3)$$

$$X_t = \mathrm{f}(P_t, Yw_t, X_{t-\theta}) \quad (4)$$

$$Qf_t = \mathrm{f}(P_t, P_{t-\theta}, A_t, Qf_{t-\theta}) \quad (5)$$

$$Qh_t = \mathrm{f}(P_t, W_t, Qh_{t-\theta}) \quad (6)$$

$$Qf_t + Qh_t = X_t + H_t - I_t \quad (7)$$

Definition of variables

H_t = Domestic consumption of teakwood (m^3) or its proxy at time t
X_t = Quantity of teakwood exported from Kerala at time t (m^3)
Qf_t = Quantity of teakwood supplied from forests at time t (m^3)

Qh_t = Quantity of teakwood supplied from homesteads and estates at time t (m^3)
I_t = Quantity of teakwood imported to Kerala at time t (m^3)
P_t = Price of teakwood in Kerala at time t (Rs/m^3)
$P_{t-\theta}$ = Price of teakwood in Kerala at time t-θ (Rs/m^3)
A_t = Teak plantation area logged in Kerala at time t (ha)
Sk_t = Price of substitutes of teakwood in Kerala at time t (Rs/unit)
W_t = Government approved wage rate in Kerala at time t (Rs/day)
Yw_t = Per capita income of wood importing states at time t (Rs)
Yk_t = Per capita income of Kerala at time t (Rs)

Time series data were gathered on the relevant variables from various sources such as Kerala Forest Department and Directorate of Economics and Statistics for the period 1980-81 to 2004-05. Quantity of teakwood supplied from homesteads and estates was found out from the cutting permits and transit passes issued by the Forest Department. However, there were doubts regarding whether this could be an underestimate of the true production from homesteads and estates. Comparison with a more realistic value from Krishnankutty *et al*. (2005) for the year 2000-01 indicated that the true value could be 4 times than the recorded. Hence, the whole series was multiplied by four to match with the true values. Moreover, data on production from homesteads were missing for the first 12 years from 1980-81. Graphs of data for the remaining 13 years against time did not show any trend and so the first 12 figures were replaced by the average of the remaining figures in the series.

Data on import and export were obtained from check posts of the Kerala Forest Department. A few terminal missing values were replaced by their predicted values through time series analysis. Domestic consumption of teakwood was obtained indirectly as follows.

$$H_t = Qf_t + Qh_t + I_t - X_t \qquad (8)$$

Wage rate was taken as that of carpenter engaged for construction works in urban areas. Missing values in between the series were replaced through interpolation of the neighboring values. A few terminal missing values in the time series for wage rate and per capita income were substituted by the last available value for the particular variable. Each equation in the overall model was refined based on a preliminary regression using stepwise method for elimination of unwanted variables but the results were modified by causative arguments when applicable. For example, production from forests was found not affected by any variable in the candidate set. However, the area logged was forced in because production from forests is largely a function of the area logged every year. The refined set of equations were brought to the framework of a simultaneous equations model and the parameters were estimated through three stage least squares. PROC SYSLIN of SAS was used for the estimation of parameters. The variables H_t, X_t, Qf_t, Qh_t and P_t were taken as endogenous variables and the remaining variables in the model were declared as instrumental variables. The results of the model fitting exercise are presented in table 4.1.

Table 4.1. The SYSLIN Procedure Three-Stage Least Squares Estimation Parameter Estimates

Dependent variable	Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
H_t	Intercept	1	-14238.9	13505.14	-1.05	0.3037
	Ykt	1	45.98078	11.67478	3.94	0.0008
	Pt	1	-1.60885	0.963156	-1.67	0.1097
X_t	Intercept	1	1614.686	1439.872	1.12	0.2742
	Xt-1	1	0.808769	0.131678	6.14	<.0001
Qf_t	Intercept	1	18256.61	6714.537	2.72	0.0125
	At	1	24.28382	12.35326	1.97	0.0621
Qh_t	Intercept	1	40751.08	8225.783	4.95	<.0001
	Qht-1	1	-0.09970	0.221582	-0.45	0.6571

The system weighted coefficient of determination came to 0.44. Domestic consumption of teakwood in Kerala is largely influenced by the per capita income with a positive coefficient. Current export demand is guided by export values of the previous year in a positive manner. Production from forest plantations is weakly dependent on the area logged. This could be so because the production includes yield from thinning but the corresponding logged area does not include the area subjected to thinning. Production from homesteads seems to follow a stable pattern with an average of 40,751 m^3 per annum but for a weak signal from previous year's production figures. The reduced form parameter estimates are given in table 4.2.

Table 4.2. The reduced form parameter estimates

	Intercept	Ykt	Xt1	At	Qht1	It
H_t	61829.79	-142E-17	-0.78137	11.25274	-0.07033	1
X_t	1861.493	0	0.781365	0	0	0
Qf_t	24020.96	0	0	11.25274	0	0
Qh_t	39670.32	0	0	0	-0.07033	0
P_t	-81872.1	44.22846	1.323056	-19.0538	0.119085	-1.69326

The reduced form coefficients can be utilized for predicting the domestic demand, export demand or future prices subject to restrictive assumption on the values of the exogenous variables. The predicted values for both future domestic demand and teak price were more than expected indicating the low predictivity of the model.

	Predicted for 2004-05	Actual for 2004-05
Teak price (Rs/m^3)	61824	25036
Teak Demand (m^3)	67393	63956

The reason for low predictivity is mainly attributable to the weak data and short time period. Hence, attempts are to be made to gather more refined data for a longer period. For instance, data on production of teakwood from homesteads were missing for 12 years. Data on plantation area thinned were not available.

5. **CONCLUSIONS**

The forest sector analysis conducted for the State of Kerala led to the following conclusions/indications. These are subject to certain limitations in data availability and related deficiencies as indicated in the report.

1. A quantitative analysis carried out with data on Net State Domestic Product of forest sector using ARIMA model indicated an increasing trend for production from the forest sector for the immediate future. Production from forests has been proceeding more or less independently of other sectors. It was also revealed that the contribution of forest sector to the state income was to the order of 1 to 2 percent showing the inadequacy of NSDP in evaluating the sector performance.
2. Analysis using the more comprehensive framework of criteria and indicators for sustainable forest management based on the available data indicated that the management of forests in Kerala is progressing towards sustainability.
3. The overall ecotourism development in the Protected Areas depicts an increasing trend and the new economic policy of 1991 has accelerated the pace of ecotourism development. With increasing urbanization and focus on wildlife and natural ecosystems, ecotourism could be a viable alternative for the sustainable management of the forests. Ecotourism development and the economic development of the ecotourism areas (WLSs & NPs) are positively related. The labour-intensive methods of ecotourism management by incorporating the local community will enhance the distribution of income to the lower sections of the society on the one hand and ensure environmental sustainability on the other. Ecotourism development poses various threats to the conservation of natural resources and developing efficient *site-specific* management strategies is the need of the hour.
4. Sawmilling industry in the State has been in the path of stagnation due to many legal restrictions and shortage of raw material leading to gross underutilization of the installed strength. Only liberal import policies could save the industry. Since homesteads continue to be the major source of wood, tree planting in homesteads needs to be promoted by appropriate legal and policy changes.
5. Developing econometric model for forest products was beset with many difficulties especially due to lack of appropriate data. The models developed based on available data were good enough for predicting the future demand for teak wood but not the price. Efforts are to be made to collect more extensive data in order to utilize the strength of the sophisticated methodology available.

6. REFERENCES

Box, G. E. P., Jenkins, G. M. and Reinsel, G. C. 1994. Time Series Analysis: Forecasting and Control. Third Edition. Englewood Cliffs, NJ: Prentice Hall, Inc.

Bureau of Economics and Statistics (1970 to 2005). Statistics for Planning, Government of Kerala, Thiruvananthapuram.

FAO. 2006. Global Forest Resources Assessment 2005: Progress towards Sustainable Forest Management. FAO Forestry paper 147. Food and Agriculture Organization of the United Nations, Rome. 320 p.

FAO. 2007. State of the World's Forests 2007. Food and Agriculture Organization of the United Nations, Rome. 144 p.

FSI (1987 to 2005). The State of Forest Report. Forest Survey of India, Ministry of Environment and Forests, Dehra Dun, India.

Kerala Forest and Wildlife Department (2000 and 2005). Forest Statistics. Government of Kerala, Thiruvananthapuram.

Kotwal, P.C., Omprakash, M.D., Dugaya, D., Gairola, S., Verma, R., Bhatt, A., Kandari, L.S. and Rawat, T.S. 2006. Bhopal-India Process: Operational Strategy and Reporting Formats on Criteria and Indicators for Sustainable Forest Management in India (Training Manual). Indian Institute of Forest Management, Bhopal. 74 p.

Kotwal, P.C. and Omprakash, M.D. 2007. Fostering Sustainable Forest Management in India through Criteria and Indicators. The Country Report 2007. Indian Institute of Forest Management, Bhopal. 124 p.

Krishnankutty, C.N. 1990. Demand and supply of wood in Kerala and their future trends. KFRI Research Report 67, Kerala Forest Research Institute. 66 p.

Krishnankutty, C.N. 1997. Demand, Supply and Price of Teak Wood in Kerala. Ph.D. Thesis. Department of Economics, University of Calicut, Dr. John Matthai Centre, Thrissur. 206 p.

Krishnankutty, C.N. 2005. Wood-balance Study in Kerala and Market Survey. KFRI Research Report 268, Kerala Forest Research Institute, Peechi, Kerala. 54 p.

KSCSTE. 2007. State of Environment Report- Kerala 2007. Environmental Indicators (Biodiversity, Water and Coastal & Marine). Kerala State Council for Science, Technology and Environment, Thiruvananthapuram.

Mammen Chundamannil. 1993. History of Forest Management in Kerala. KFRI Research Report No.89. Kerala Forest Research Institute, Peechi, Kerala. 114 p.

Muraleedharan, P.K. Sasidharan, N. and Seethalakshmi, K.K. 1997. Biodiversity in Tropical Moist Forests: A Study of Sustainable Use of Non-Wood Forest Products in the Western Ghats, Kerala. KFRI Research Report No. 133. Kerala Forest Research Institute, Peechi. 128p.

Muraleedharan, P.K. Renuka, C. Seethalakshmi, K.K. and Sasidharan, N. 2003. Developing a Model Participatory Management Programme for Conservation of Biodiversity and Sustainable Use of non-wood Forest Products in Kerala, KFRI Research Report No. 251, Kerala Forest Research Institute, Peechi. 117 p.

Sankaran, K.V. and Sreenivasan, M.A. 1999. Status of Mikania infestation in the Western Ghats. *In* : Sankaran, K.V, Murphy, S.T, Evans, H.C. (eds.), Proceedings of the Workshop on Alien Weeds in Moist Tropical Zones: Banes and Benefits, 2-4 Nov. 1999, KFRI, Peechi.

Sivaram, M. 2008. Computerized Database on Kerala Forest Resources and Retrieval System. KFRI Research Report (under finalization). Kerala Forest Research Institute, Peechi.

State Planning Board (1960 to 2006). Economic Review (1960 to 2006). Government of Kerala, Thiruvananthapuram.

Subrahmanian, K.K. Growth Performance. *In* : Rajasenan, D. and Gerard de Groot (eds). Kerala Economy Trajectories: Challenges and Implications. Directorate of Publications and Public Relations, CUSAT for SEPTRA project of the Dept. of Applied Economics, CUSAT. pp 25-48.

Venny, S., Omprakash, M.D. and Kotwal, P.C. 2007. Forest Management and Control System in India : Application of Criteria and Indicators Approach. FORMACS Software Manual. Indian Institute of Forest Management, Bhopal. 83 p.

APPENDIX

Key data used for estimating parameters of the supply-demand model for teakwood

Year	Production from forests (m^3)	Production from homesteads (m^3)	Export (m^3)	Import (m^3)	Teak-wood price (Rs/m^3)	Area logged (ha)	Wage of carpenter (Urban) Rs/day	PCI of Kerala* (Rs)
1980-81	27528		50596	198	3092	298.80	19.33	1508
1981-82	17901		69198	677	3670	161.70	22.87	1406
1982-83	27700		60317	1609	5180	249.00	30.68	1414
1983-84	25411		59182	313	4527	256.20	35	1324
1984-85	21865		73652	495	5107	214.50	37.97	1387
1985-86	14091		91780	604	5873	138.00	40.67	1505
1986-87	16300		80032	1122	7508	370.30	45.39	1450
1987-88	19222		50043	1817	7476	183.90	50.08	1401
1988-89	8099		49352	476	7251	122.50	51.92	1610
1989-90	24735		64356	1384	9432	107.50	53.98	1697
1990-91	15583		58847	765	9299	116.30	56.67	1813
1991-92	20927		57684	863	11352	251.40	61.25	1792
1992-93	32429	35750	50196	1804	13326	402.70	70.92	1943
1993-94	23240	47103	61509	2587	15859	402.70	76.5	2136
1994-95	57289	43591	35648	1602	14197	786.94	91.47	2315
1995-96	26766	29378	36618	3837	23472	284.20	113.85	2410
1996-97	32817	29269	23194	5451	27567	1253.60	134.87	2496
1997-98	12307	41068	19074	10891	27049	384.20	150	2518
1998-99	18338	28533	16138	17183	25445	874.22	159.17	2687
1999-00	33973	32983	15835	15613	21838	379.61	172.21	2861
2000-01	34320	30225	18780	14668	22754	965.35	184	2981
2001-02	34667	49199	6200	7490	24944	1020.06	187	3051
2002-03	49927	40586	7930	7490	24872	653.62	187	3277
2003-04	107892	31973	7930	7490	25660	579.21	187	3462
2004-05	20169	44227	7930	7490	25036	458.82	187	3462

*Per capita income of Kerala