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DEMAND AND SUPPLY OF WOOD IN KERALA AND THEIR FUTURE TRENDS

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ABSTRACT

This study is an attempt to estimate the demand for wood by various sectors and supply from different sources in Kerala during the year 1987-88. Wood includes timber, industrial wood poles, fuelwood and charcoal. Demand for wood is defined as the effective demand which is domestic consumption plus exports. Production of wood and imports constitute supply. Inventory of wood is not estimated but is considered to be in dynamic equilibrium over time. Demand and supply are therefore equal at any point of time. Future trends in the demand and supply of wood up to the year 2004-05 are projected based on certain as sumptions. Pattern of growing stock distribution of trees in homesteads is also analyzed to estimate the stock and to understand the species preference.

Supply of wood is from homesteads, estates and forests, and by imports. Demand for wood is by households, industries and tertiary sectors, and for export. Field surveys were carried *out* for estimating the quantity of wood used by households in rural areas for construction, furniture, etc., by small industries **as** timber, fuelwood and charcoal, by households in urban areas, tea-shops, restaurants, hostels, etc. as fuel; as well as for estimating the growing stock of trees in homesteads. Relevant registers, files and publications of various government depart ments were used as sources for other data.

The study reveals that the effective demand for wood during the year 1987-88 was 14.645 million m^3 round wood equivalent, of which household demand for wood as fuel and timber accounted for 50 percent. Demand for wood from the tertiary sector as fuel in tea-shops, restaurants, hostels, etc. and as timber and poles in non-residential building and other constructions constituted 28.3 percent. Fuel and industrial wood used in the industries sector accounted for 21.2 percent of the total demand and export only 0.5 percent. Wood as fuel constituted 83 percent of the total demand. Timber, industrial wood and poles accounted for only 17 percent of the total.

In spite of the difficulties in estimating the contribution of different sources of supply, the share of each source is given in a range. Homesteads contributed 74.4 to 83.6 percent, estates 9.3 to 11.8 percent and imports 2.4 percent of the total supply of wood. Natural forests and plantations are estimated to contribute 4.7 to 11.4 percent, although the recorded production of wood from forests is only 1.9 percent of the total supply.

Total number of trees in homesteads of Kerala during 1988-89 is estimated as 442 million. It includes coconut but excludes trees in plantations and other palms. Trees in the lowest diameter class account for 55 percent of the total number which shows that efforts are being made by households in planting trees. The study reveals that multiple-use trees such as coconut, jack, mango, cashew, tamarind, etc. are preferred for planting and maintaining in homesteads. Anjily, teak and matty are the species preferred among trees grown exclusively for wood.

Projections for the future indicate that the likely supply-demand disparity can be neutralized by increasing efficiency in fuelwood-use, reducing consumption of wood by substitution and economising timber-use in construction. Over-exploitation of wood-resources and increasing imports can also augment supply of wood in the short run.

1. INTRODUCTION

Comprehensive and reliable data base on the demand and supply of wood is essential for formulating programmes in production and social forestry. Although it is generally believed that wood, whatever be the quantity produced, is bound to be absorbed in the market, for long-term planning, broad magnitudes of supply and demand are necessary. The real prices of most construction timbers in Kerala have registered a phenomenal increase, particularly after 1976-77. The increase in demand for timber both from within and outside the State and a reduction in supply of timber from the forests of Kerala have cumulatively contributed to the rapid increase in price (Krishnankutty et al., 1985). A preliminary assessment of consumption of wood in Kerala for the year 1981-82 was made by Muraleedharan et *al.*. (1984 mimeo) using secondary data. It is necessary to identify the demand and supply situation in different districts of Kerala so that afforestation programmes can be directed towards solving problems in critical areas. The present study on 'Demand and supply of wood in Kerala and their future trends' was taken up in this context.

1.1 Objectives

The objectives of the present study are (1) to estimate the demand for wood by various sectors and supply from different sources in Kerala during the year 1987-88 and to examine their future trends and (2) to analyse the pattern of growing stock distribution of trees in homesteads and to identify the species preference and potential for the future.

1.2 Plan of the Report

The report is presented in seven sections. Section 2 gives a profile of Kerala and the need for the present study. Methodology and sources of data for the estimation of demand and supply of wood in Kerala and growing stock of trees in homesteads are discussed in section 3. Demand, supply and wood-balance are dealt with in the fourth section. Growing stock and species preference in homesteads are analysed in the fifth section. Future trends in the demand and supply of wood in Kerala are examined in section 6. Conclusions emerging from the study are given in the last section.

2. PROFILE OF KERALA

Kerala State is situated on the South Western part of India. The geographical area of the State is 38,855 km*, of which about 10 per cent comes under lowland region, 42 per cent under midland region and the remaining under highland region (State Land Use Board, 1980)[1]. Kerala has an equable climate and the day temperature varies from 20 to 35°C. The mean annual rainfall is about 3,000 mm.

2.1 Socio-economic Conditions

Kerala is the most densely populated State in India. The population density of the State and the Country were 655 and 216 persons per km2 respectively according to 1981 Census (Government of India, 1984). The population of Kerala in 1961 was 16.91 million arid this increased to 21.38 million in 1971 and to 25.45 millton in 1981. The compound growth rates during 1961-71 and 1971-81 are 2.4 and 1.8 per cent per annum respectively. The population growth rate during 1981-91 and thereafter is expected to decline. The projected population during 1987-88 was 28.58 million (Department of Economics and Statistics, 1988a).

The net State domestic product in 1987-88 was Rs.74,263 million at current prices and the per capita income was Rs.2598 (State Planning Board, 1989). The contribution of forestry and logging to the net State domestic product at 1970-71 prices has declined from 1.96 per cent in 1980-81 to 0.21 per cent in 1986-87(Department of Economics & Statistics,l988a).

2.2 Agricultural Land-Use

Of the total geographical area of the State 56.8 per cent was used for agricultural purposes durlng 1986-87. Coconut accounts for 32 per cent of the net cultivated area, rubber 16 per cent, tea, coffee and cardamom 7 per cent and rice 14 per cent (Department of Economics and Statistics, 1988a). Mixed cropping is a characteristic feature of land-use in Kerala which integrates agricultural crops with several perennial tree crops.

2.3 Forest Resources

Forests in Kerala are under public ownership and cover an area of 11225 km2 (Kerala Forest Department, 1987-88). The district-wise break up of area under forests by legal status for the year 1987-88 is given in Appendix-1. All the districts except Alappuzha have forests. The effective forest area in Kerala and the growing stock of wood in the forests have been estimated as 9400 kmo and 185 million m3 underbark respectively in the year 1970 (Chandrasekharan,l973).

~The lowland and midland and highland regions are the three broad natural regoins based on altitude. Tbe land lying below 7.6 m elevation is lowland, between 7.6 to 76 m midland and above 76 m highland.

Forest plantations started in Nilambur in the year 1842 with teak. Since then, teak plantations were established in many accessible forest areas. The area under forest plantations of different species in various years in Kerala is given in Table 2.1. Since 1960, the area iinder eucalypt plantations increased rapidly. The area under teak has also increased. Further growth of forest plantations is likely to be marginal in future.

Table 2.2 gives the recorded out–turn of timber, poles, firewood and charcoal per year from the forests of Kerala. As can be seen in the Table, the production has declined in the 1980's.

Table 2.1 Forest plantations in Kerala

(area in ha)

Year	Teak	Euca-lypts	Teak mixed	Cashew	Others[2]	Tatal
1956-57	**26452**	**108**	**3475**	**1401**	**1265**	**32701**
	(80.9)	**(0.3)**	**(10.6)**	(4.63)	**(3.9)**	**(100.0)**
1960-61	**33107**	**317**	**7306**	**5043**	**1913**	**47686**
	(69.4)	**(0.7)**	**(15.3)**	**(10.6)**	**(4.0)**	**(100.0)**
1970-71	**53483**	**23232**	**18418**	**3226**	**3460**	**101819**
	(52.5)	**(22.8)**	**(18.1)**	**(3.2)**	**(3.4)**	**(100.0)**
1980-81	**75038**	**40018**	**24066**	**4955**	**6432**	**150509**
	(49.8)	**(26.6)**	**(16.0)**	**(3.3)**	**(4.3)**	**(100.0)**
1987-88	**78583**	**42660**	**28527**	**4157**	**10036**	**163963-**
	(47.9)	**(26.0)**	**(17.4)**	**(2.6)**	**(6.1)**	**(100.0)**

Source: Administration Report of the Kerala Forest Department [various issues) and Annual Report of Kerala Porest Development Corporation (various issues)

Table 2.2 Recorded out-turn of timber and other products from Kerala forests

Period	Out-turn per year			
	round logs ('000m^3)	Poles ('000 nos)	Fuelwood ('000 tonnes)	Charcoal ('000 tonnes)
1975-76 to 1979-80	**514**	**1312**	**242**	**1.1**
1980-81 to 1984-85	**280**	**1193**	**141**	**0.4**
1985-86 to 1987-88	**80**	**1117**	**281**	**0.1**

Source: computed from Administration Report of the Kerala Forest Department (various issues).

[2]others include balsa, wattle, acacia, jack,anjily,rosewood,hopea,murikku,matty , silver oak, ruhber, albizia, bamboo, reed, etc. Fbr botanical names of trees, see Apperdix-17.

2.4 Social Forestry in Kerala

Several social forestry schemes have been launched in Kerala in order to increase the supply of fuelwood and small timber. They are National Rural Employment Programme, Rural Fuelwood **Scheme,** Rural Landless Employment Guarantee Programme, Drought Relief Scheme and the World Bank Scheme. Under these schemes, plantations have been raised through block, strip and avenue planting in forest areas, waste lands, etc. A large number of seedlings have also been raised in nurseries under these schemes and distributed to farmers and social organizations to raise in homesteads and around public buildings respectively. Table **2.3** and 2.4 show the area under plantations raised under World Bank Scheme and other schemes respectively.The total area at the end of 1987–88 comes to 27149 ha. The species planted and distributed are mainly *Acacia auriculiformis, Eucalyptus tereticornis* and *Casuarina equisetifolia*. The plantations have not yet been harvested.

Table 2.3 Area planted under World Bank aided social forestry project in Kerala

Year	Block planting (area in ha)	Avenue/ Strip planting (area in ha)	Tribal fuelnood plantation (area in ha)	Total (area in ha)	Seedlings distributed (no.in '000)
1984–85	346	50	--	396	23500
1985–86	1433	189	61	1683	49154
1986–87	2511	66	149	2726	105242
1987–88	2866	169	214	3249	78027
Upto 1987–88	7156	474	424	8054	255923

Sources: Kerala Forest Department, 1987a, 1987b, 1988a. and 1987-88 mimeo),

Table 2.4 Area planted under other social forestry schemes

Year	Compact plantation (area in ha)	Belt plantation (area in ha)	Total (area in ha)	Seed1ings distributed (no.in '000)
1982–83	1643	398	2041	-
1983–84	1702	2534	4236	130128
1984–85	1659	707	2366	58128
1985–86	1083	1190	2273	50675
1986–87	5480	7	5487	21802
1987–88	2692	--	2692	14120
Upto 1987–88	14259	4836	19095	274853

Sources: Kerala Forest Departrent, 1985, 1986, 1987a, 1987b, 1988a and 1987-88 (mimeo)

2.6 Wood-Based Industries

There are many wood–based industries in Kerala. At the end of 1987, there were 2916 registered industrial units which include saw mills and units which produce plywood, splints and veneers, furniture and fixtures, packing case, pulp and paper, etc. (Department of Factories and Boilers, Thiruvananthapuram). Several large and small industrial units use wood as fuel. Besides, there are a large number of small scale units including household enterprises using wood as timber and fuel. Most of the wood–based and fuel–using industries depend on wood from homesteads and estates.

2.6 Need for the Present Study

The pattern of wood consumption by various sectors and the contribution of different sources of supply in Kerala have not been studied so far. Supply of wood from the forests of Kerala has declined during the 1980s. Homesteads appear to be an important source of wood supply,but the available data on land use do not reveal the composition of tree crops and the growing stock distribution in homesteads. In this context, the present study on 'Demand and supply of wood in Kerala and their future trends' is of great relevance in planning wood–resource development in the state.

3. METHODOLOGY AND DATA BASE

The term "wood" includes both fuel and non-fuel. Fuelwood including charcoal belongs to the former while timber, industrial wood and poles belong to the latter category. Demand for wood is defined as the effective demand which is taken as the sum of domestic consumption of wood and export in a year. The current demand is therefore defined as identical with the current supply comprising current production and imports. Inventory[3] of wood is ignored as it is consfdered to be in dynamic equilibrium over time. The demand and supply of wood dealt in this section pertains to the year 1987-88.

3.1 Demand for Wood

Demand for wood is disaggregated into the demand for wood by the household, industries and tertiary enctors and for exports. The methodology of estimation and the data base of various sectors are explained below.

3.1.1 Household Sector

Wood is used by households in two ways: as timber and fuelwood. Timber is used for house construction, repair, alteration and making furniture, fixtures Implements, etc[4] A sample survey was conducted to estimate the demand for timber by households in the rural areas of Kerala[5] . For estimating the quantity of timber used in urban households, the total number and plinth area of residential houses constructed in urban areas of Kerala for the years 1981 to 1985 were compiled from Department of Economics and Statistics (1988b). Total number of houses and plinth area per year were worked out and assumed .as that of 1987-88. Based on these estimates and the average timber requirement in m^3 per residential house in India as calculated by Central Building Research Institute (1985) (0.23 + 0.0232A, where A is the plinth area of a house in m^2), timber used in residential house construction in the urban areas of the state is estimated[6] .

Household fuel requirements are met from a mix of commercial and non-commercial energy sources. Commercial fuels include kerosene, LPG and electricity

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[3] In any particular year, a portion of the accumulated inventories enters the market as supply while at the same time part of the current production will be added to the inventories. Inventory behavior is assumed constant and therefore not included in the analysis.

[4] Only use of timber for construction, furniture making, etc, in households is considered Finished woood-products purchased by households is excluded as they are accounted in the industries sector. Houses include residential and non-residential buildings for household use.

[5] The methodology of the sample survey is discussed in section 3.3.

[6] The quantity of timber used for making furniture, fixtures and implements in urban areas is assumed to be negligible since most of them are purchased by the households.

Non–commercial fuels are fuelwood and crop residues[7]. However, fuelwood can be both commercial and non–commercial depending on the source of supply. Therefore fuelwood is considered as semi–commercial. Fuel–use depends mainly on size and the socio–economic status of the household. Availability of fuelwood also significantly influences its consumption. Measurement of fuel–use involving a large sample of households is quite problematic and 'recall method' is unreliable when non–standardized fuels from non–commercial sources predominate. Studies on household fuel use in Kerala have been done by Thampi (1983), State Planning Board (1986) and ANERT (1987). Among these, only Thampi has actually measured the quantity of fuel used, based on a survey in three villages. The other studies have adopted the recall method. The State Planning Board's study which is based on a survey in 50 sample villages in 8 districts has been used to estimate the per capita fuelwood and non–wood biomass fuel consumption by households in the rural areas of Kerala, primarily due to the wider coverage.The fuelwood consumption in Kerala during 1987-88 is estimated based on the per capita fuelwood consumption and the estimated rural population of Kerala in 1987-88. For estimating the per capita fuelwood consumption by urban households, one cluster, consisting of 150 households, each was selected from four municipal areas and one town village in Thrissur District and surveyed (see Appendix–15). The per capita fuelwood consumption estimated for households in the urban areas of Thrissur District is assumed to hold good in other districts also. Fuelwood consumption by households in the urban areas is estimated based on the per capita fuelwood consumption and the estimated urban population in 1987-88.

3.1.2 Industries Sector

Industries sector consists of all industries which use wood as raw material and or as fuel8. Industries such as packing case, plywood, match, furniture, pencil, photo frames. boat making, handicrafts, pulp and paper, etc. use wood as raw material. Industries like tile–manufacturing, brick–making, tea–processing, automobile workshops, metal industries, textile mills, production of hand tools, rubber goods etc., consume wood and or charcoal as fuel. Industries sector is comprised of two broad groups: organized and unorganized sectors. All industrial units registered under sections 2(m) and 85 of the Factories Act are included in the organized sectors. The unorganized sector consists of units registered as

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[7] Fuelwood includes chopped woood, lopping of trees, off-cuts, saw-dust, industrial wood-waste, etc. Crop residues include dryleaves and palm by-products such as coconut leaf, sheath, husk, shell, etc.

[8] In this study, wood processd in saw mills has been accounted intheir finished state inhuilding construction, furniture, fixtures, etc. Therefore, inorder to avoid double counting, wood used by saw milling industry has not been separately sbown.

[9] Factories which are using powerand employing 10 or more workers and those which are not using power and employing 20 or more workerson any day during the accounting year come under Section2(m. Factories employing less than 10 workers and working with the aid of power and those employing lessthan20 workers and working without the aidof power onanydayduring the year come under Section 85.

small-scale industry and other unregistered industrial units.

Annual Survey of Industries (ASI) .provide valuable information on consumption of raw materials including timber, fuelwood and charcoal. The factories registered under Section 2(m) are subclassified in the AS1 into census and non-census sectors[10], The AS1 covers all units in the census sector every year. Half of the units in each industry in the non-census sector is surveyed in each year by rotation so as to cover all units within a period of two years. The AS1 data pertaining to the years from 1979-80 to 1985-86 except 1982-83 were collected Prom the Department of Economics and Statistics, Thiruvananthapuram[11] Based on the number of units and the quantity consumed in each year, weighted average consumption of timber, fuelwood and charcoal by different industries in the census and non-census sectors in each district were worked out. The mean consumption of wood by industries coming under Section 86 is taken to be the same as that for industries in the non-census sector12. An attempt was made to collect data on wood consumption in certain industries by a survey for the year 1987-88. This data was 'used to cross-check with the norms of consumption derived from the AS1 data and it was found that in many cases, they are in broad agreement. It was therefore decided to use the AS1 data in view of wider coverage. The number of factories functioned during 1987-88 in respect of census, non-census sectors and Section 86 in each district were compiled from Department of Factories and Boilers(1984 and 1987) and from registers maintained by that Department. The wood consumption by different industries in each district during 1987-88 is estimated on the basis of the number of units and average wood consumption per unit.

Data on the number of various small-scale industrial units were collected from the Small Industries Service Institute, Thrissur. Sample units were surveyed to estimate the average consumption of wood. Consumption of wood by small-scale industries is arrived at based on the number of units in each category and the average consumption per unit. Wood consumption by other unregistered industrial units including household enterprises is estimated based on the data on the number and consumption of wood per unit in the selected villages of the sample survey.

3.1.3 Tertiary Sector

Tertiary sector is defined to include all wood using agencies other than households and Industries. Business establishments, restaurants, hostels, hospitals, government departments, railways, road construction, etc. come in this sector. Wood consumption in the tertiary sector is in the form of construction timber, fuelwood, charcoal,

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[10] The units employing 50 or more workers working With the aid of power and those employing 100 or more workers without using power come under census sector. The non-census sector includes the remaining factories coming under section 2(m).

[11] The data for the year 1982-83 were not available.

[12] Since the technology used in both the groups of wood-based industries is the *same*, there is not such difference in the consumption of wood.

electricity transmission poles, railway sleepers, etc.

3.1.3.1 Non-residential Building Construction

From the data on number and plinth area of non-residential buildings constructed in the private and public sectors in the urban areas for the period **1981** to **1985** according to type of buildings, compiled from Department of Economics and Statistics (1988b), the total number and plinth area per year are worked out and assumed as the total number and plinth area of non- residential buildings constructed during **1987-88** in the urban areas. Timber consumption is worked out on the basis of the estimated total number and plinth area for **1987-88** and the average timber requirement per house provided by the Central Building Research Institute. Timber consumption in the rural areas is estimated based on the number of newly built non- residential buildings in the desoms of the selected villages of the sample survey (meant for the estimation of timber-use for house construction and other purposes by households in the rural areas) and the average quantity of timber used. The actual timber consumption for buildings constructed by the Central Public Works Department is added to give the total timber-use in the non-residential construction sector.

3.1.3.2 Tea shops, hostels, hospitals, etc.

Tea-shops and restaurants form the principal component consuming a substantial quantity of fuelwood and charcoal in the tertiary sector[13]. There exists a large number of such establishments both in rural and urban areas catering to the floating population and those who take food outside the households. According to the **1980** Economic Census, there were **74737** and **15178** tea-shops and restaurants in the rural and urban areas of the State respectively (Department of Economics and Statistics, **1987).** The number of such units in the rural and urban areas during **1987-88** is estimated to be **83927** and **17044** respectively taking the same growth rate as that of the population. The break-up of the number of tea-shops and restaurants in the rural and urban areas in different districts is done in proportion to the projected rural and urban population of **1987-88** in different districts. The total consumption of fuelwood and charcoal by them in the rural and urban areas during **1987-88** is estimated based on the number of units in rural and urban areas and the average quantity of fuelwood and charcoal consumed per unit in the rural and urban areas respectively[14].

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[13]Consumption of fuelwood by such establishments would have been accounted for if per capita fuelwood consumption for the State had been estimated from total consumption. But, the consumption of fuelwood by households is estimated based on the per capita consumption which is derived from the actual consumption of fuelwood by households.

[14] Randomsamples of 62 establishments fran rural areas and 56 urban areas of Thrissur District were selected fran exhaustive lists maintained by Panchayats and Muncipalities, and were surveyed on fuelwood and charcoal consumption. The consumption per unit estimated for the rural and urban areas of Thrissur District is assumed to hold good in other districts also.

Total quantity of fuelwood used in hospitals, hostels, jails, orphanages, etc. is worked out based on the data on number of such institutions and the respective number of inmates compiled from Department of Economics and Statistics (1988a) and the estimated average quantity of fuelwood used per inmate and per unit[15]. To estimate the fuelwood consumption in temples, etc. the percentage of the places of worship to the total number of residential houses was calculated from the Department of Economics and Statistics (1988b). Then, from total fuelwood consumption by the household sector, the above percentage was worked out as the quantity of fuelwood used in such places.

3.1.3.3 Others

Volume of wood used as poles by government departments and as railway sleepers is estimated from the data available in the administration report of the Forest Department. Fuelwood used for bitumen melting in road construction and repair is estimated based on data available in State Planning Board (1985b) on length of different types of roads and information collected from the Public Works Department.

3.1.4 Export

Considering the fact that timber moves out of Kesala, an attempt was made to estimate the quantum of outflow. The quantity of timber moved out of Kerala by road is worked out based on the data in the registers maintained at fourteen forest check-posts (see Appendix-15)16. Besides, data from records available at Railway Stations and Cochin and Calicut Chamber of Commerce for Ports were taken to estimate the total export demand.

3.2 Supply of Wood

Supply of wood in Kerala includes production of wood from forests, estates and homesteads, and imports. Production of wood refers to the actual quantity of wood consumed as timber and fuelwood or brought to the market in the year 1987-88.

3.2.1 Forests

Recorded production of wood from forests is taken from data available in the administration report of the Kerala Forest Department. However, unrecorded production of industrial wood is assumed to range from 10 to 20 per cent of the

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[15]Sample institutions were surveyed on fuelwood consumption and mean consumption per inmate and per unit are estimated.

[16] There are a few more border exit points. The data pertaining to these were not collected due to non availability of registers in sane check-posts and non-existence of check-posts. However the movement of wood through these exit points has been reported to be very

recorded production[17]. Unrecorded production of fuelwood from forests used by households is taken as the sum of consumption of fuelwood by the population living within forests and 5 to 20 per cent of the requirement of the population living in villages adjoining forests [18] Unrecorded production of fuelwood from forests used in tea shops, hotels etc. in the tertiary sector is calculated to range from 10 to 20 percent of the quantity of fuelwood used in the tertiary sector in villages adjoining[19]. Unrecorded production of charcoal from forests is worked out to range from 15 to 75 per cent of the difference between the total consumption of charcoal and the sum of the recorded production from forests and import of charcoal.

3.2.2 Estates

Estates include plantations of rubber, cardamom, coffee and tea. The supply of wood from rubber plantations is arrived at based on the area replanted per annum and the yield of wood per ha. It is estimated by the officials of the Rubber Board that about 5000 ha are replanted annually and the yield of rubber wood is 199.76 m^3 per ha. The distribution of stem wood (timber) and branch wood (fuelwood) is 60 and 40 per cent respectively (see Haridasan et al., 1985). The Rubber Board permits a maximum of 20 trees per ha other than rubber to be retained in rubber plantations. Valuable trees of medium growth are usually retained by farmers at the time of planting rubber. Assuming that two to four trees of dbh above 65 cm are felled during replantation of rubber, the volume of such trees is taken to range from 8.638 to 17.256 m^3 per ha. As regards coffee, tea and cardamom plantations, the wood supply is calculated assuming that one to two trees above 45 em dbh are felled producing 1.953 to 3.906 m^3 per ha in all plantations.

3.2.3 Imports

Quantity of timber imported to Kerala from outside the State and from other countries is arrived at by perusing the records available at fourteen border forest check–posts (see Appendix–15), Railway Stations, and Cochin and Calicut Chambers of Commerce for Ports.

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[17]Unrecorded production of wocd from forests is assumed as 10 percent of the recorded production for the estimation of state income by the Department of Economics and Statistics (1986: p4),

[18]It is assumed that the population living within forests fully depend on fuelwood collected directly. Further, the population in villages adjoining the forests are assumed to collect 5 to 20 percent of their requirement fran the forests. The population for 1987-88 is projected based on the 1981 census. The fuelwocd consumption is estimated on the basis of the projected population of both of the groups and the per capita fuelwood consumption in the rural areas of Kerala, including the fuelwocd equivalent of fuel fran coconut/palmyra trees and crop residues.

[19]The total fuelwood used in the tertiary sector in villages adjoiningforests is taken as the same percentage as that of the population in these villages.

3.2.4 Homesteads

A sample survey was conducted during 1988-89 to estimate the volume of growing stock of trees in homesteads, the crop-mix and the preference for particular species. Homesteads include house compounds and farm lands. Dry land area under agricultural use (see foot-note 18) less area under estates is defined as the area under hamesteads. A survey on tree-felling in homesteads was also attempted to quantify the wood production from homesteads. There is lack of information regarding the restrictions imposed by the government on felling of certain trees in private lands. The respondents were found to conceal actual tree-felling due to fear of bureaucratic harassment later. Also the recall method adopted for the survey had several defects, the most important being the non-availability of exact dimensions of the already felled trees. Due to unreliability in the data, it was not used for further analysis. Wood production from homesteads is therefore taken as the difference between the demand for wood and the sum of wood production from forests and estates, and imports.

3.3 Methodology of the Sample Survey

A stratified three-stage sampling procedure was adopted for the selection of samples. For each revenue village in Kerala, the percentage of dryland (garden land) area under agricultural use to the total area under agricultural use20 and popuIation density were calculated from the data available with the State Land-use Board and in the **1981** Census report respectively. By forming 5 classes for the percentage of dryland area under agricultural use to total area under agricultural use and **3** classes for the population density, **15** strata were formed and the villages were classified in different strata accordingly[21]. Revenue villages in each stratum were treated as first-stage units of sampling. Out of the total number of villages in Kerala according to **1981** census, **2.5** per cent were distributed in different strata approximately in proportion to the dryland area under agricultural use in each stratum ensuring that at least one village was included from each stratum. The villages in each stratum were chosen at random and in all **30** villages were selected (see Appendix-**16).** Census villages or desoms were taken as second stage units of sampling since several desoms form a revenue village. One desom each was randomly selected from the chosen revenue villages and all the households in the selected desom were visited to collect information such as year of house construc-tion, whether there was any construction activity using timber in the year **1987-88,**

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[20] In this study the total area under agricultural use is defined to include land under miscellaneous tree crops, cultivable waste, current and other fallow and net area sown. The dryland area under agricultural use equals the total area under agricultural use less the area under wet land (paddy fields). Fur each Village the data is available in the files of State Land Use Board, Thiruvanthapuram.

[21] A two way stratification was adopted since the wood availability depends on the extent of dry lands where trees are maintained and the wood consumption depends on population density. Different classes of percentage of dryland area under agricultural use to total area under agricultural use are: 0-50, 50-70, 70-80, 80-90 and 90-100 and various classes of population density are: below 500, 500-1000 and above l000 persons per lad.

size of dryland holding[22]. etc.

3.3.1 Estimation of timber–use in rural households

The households, where timber was utilized during 1987-88 for (i)new house construction, (ii) house repair and alterations, (iii) making furniture, fixtures, implements, etc., were the third–stage units of sampling for estimating the quantity of timber used for various purposes by households in rural areas. In a selected desom, 10 households were randomly and independently chosen from the list of households of the above three categories. Actual quantity of timber used was measured in each selected households.

The per capita quantity of timber used during 1987-88 for (i) new house construction, (ii) house repair and alterations, (iii) making furniture, fixtures, implements, etc. by households in the hth stratum, Q_h is derived using the formula,

$$\hat{\bar{Q}}_h = \frac{\sum_i \{ 1/10 \sum_{j=i}^{10} q_{hij} \} r_{hi}}{\sum_i p_{hi}}$$

where q_{hij} denotes the quantity (in m3) of timber used in the j^{th} selected household in the selected desom of the i^{th} chosen village in the h^{th} stratum; r_{hi} and p_{hi} represents the total number of households *of* each of the above three categories of timber–use and the population during; 1987-88 of the selected desom ofthe i^{th} village in the h^{th} stratum respectively. $\bar{Q}_h$ is calculated separately for each of the three categories of timber-use. The quantity of timber used in all households in the rural areas of Kerala, Q is estimated by

$$\hat{Q} = \sum_h \hat{\bar{Q}}_h P_h$$

where P_h denotes the 1987-88 rural population in the h^{th} stratum[23]. $\hat{Q}$ is computed for each of the three categories and added together to give the total quantity of timber used by the households in the rural areas of Kerala.

3.3.2 Estimation of growing stock of trees in homesteads

The households in the selected desom were classified on the basis of size of dry–land holding[24]. The households with dry– land holding formed the

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[22] Cost of the survey was a major constraint and hence only one second-stage unit was selected from the first stage unit.

[23] The population in 1987-88 is estimated on the basis of population according to the 1981 census and the annual population growth.

[24] The tree cropping intensity partly depends on the size of dryland holding (Nair and Krishnankutty, 1987). It is, therefore, reasonable to classify the house holds on the basis of size of dryland holding. The different size classes are: below 0.09 acre, 0.1-0.24,

third–stage units of sampling. Twenty five households were allocated proportional to the number of households in each class and households in each class were randomly and independently selected. All dryland belonging to the sample households in the desom were surveyed. In the homesteads of the selected households all trees by species coming under different diameter classes (dbh)[25] and coconut palms were enumerated. Other palms and plantations of rubber, cardamom, coffee and tea were excluded from the definition of trees. The average number of trees per ha in the h^{th} stratum, $\bar{T}_h$, is arrived at using,

$$\hat{\bar{T}}_h = \frac{\sum_{ijt} T_{hijk}}{\sum_{ijt} a_{hijk}}$$

where T_{hijk} and a_{hijk} are the number of trees and dry land area under agricultural use respectively in the k^{th} selected homestead. of j^{th} land holding size class of the selected desom in the i^{th} chosen village in the h^{th} stratum. $\hat{\bar{T}}_h$ is calculated far each species with respect to different diameter classes. The growing stock of trees in number by species and diameter classes in the state during 1988–89 is worked out by $\Sigma \hat{\bar{T}}_h D_h$ where Dh stands for the total dry–land area under agricultural use[26] in the stratum.

Growing stock of trees in terms of 'commercial volume' and 'total volume' are separately worked out. Commercial volume **(CV)** refers to that volume underbark of wood above 60 cm girth overbark. It need not indicate commercial utility. Commercial timber can also be used as fuelwood and vice versa. Total volume refers to the sum of CV overbark where existing and fuelwood volume which is the volume of wood overbark including branch wood below 60 cm and above 10 cm girth. Tables for CV and fuelwood volume of different species are available from 20 to 30 cm dbh class upwards for the forest trees of Kerala (Nair, 1971). Species for which volume tables are not available were divided into evergreen 'and deciduous and the volumes are estimated using the Tables for 'collated miscellaneous evergreen species' and 'collated miscellaneous deciduous species' of Nair (1971). Growing stock of trees in terms of commercial volume is computed by multiplying the number of trees by species and diameter classes with the corresponding commercial volume given in the volume tables of Nair (1971).

'Total volume' of wood overbark including branch wood above **30** cm girth is arrived at by adding the growing stock volume of fuelwood calculated from Nair (1971) and the commercial volume of wood overbark. Fuelwood volume given in Nair (1971) includes volume of fuelwood in the girth range 60 to **30** cm only. Considering the fact that branch wood of smaller sizes is also used as fuel by households, fuelwood

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0.50-0.99, 1.0-1.99, 2.0-2.99, 3.0-4.99 and above 5 acres.

[25]Diameter at breast height **(dbh) is** measured at **1.37** m fran the ***ground.*** The different classes are: below 10an, 10-20, 20.30, 30-40, 40-50, 50-60, 60-70, 70-80, 80-90 and above 90an.

[26]This does not include the area under plantations of rubber, cardamm, coffee and tea.

in the 30 to 10 cm girth range is also included by adding 22 per ceht of the total volume of wood including branch wood of above 30 cm girth. Thus the total volume of wood overbark including branch wood of above 10 cm girth is worked out with respect to each tree species according to different diameter classes. Volume of trees in the dbh classes below 10 cm and 10 to 20 cm are taken as 0.004 m^3 and 0.175 m^3 per tree respectively for all the species. Growing stock of trees in terms of 'total volume' is computed by multiplying the number of trees by species and diameter class with the corresponding volume per tree. Growing stock of coconut palms in terms of total and commercial volumes are estimated by multiplying the number of coconut palms with 0.36 and 0.072 m^3 respectively.

Trees of different species are classified into two groups, trees with multiple-use value and trees with only wood value. They are further subclassified by suffixing 1, 2, 3, and 4 ranked according to durability and commercial wood value. They are high value, medium value, low value and very low value respectively. The first group-CO, M2,M3 and M4-consist of coconut and other multiple-use trees. The second group- T1,T2, T3, T4 and ACE- consist of trees with only wood value. ACE stands for *Acacia auriculiformis, Casuarina equisetifolia* and *Eucalypts.*

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[27] Volume of bark varies fran 10 to 40 percent of the volume of the tree overbark (FRI & Colleges, 1970). On the average 20, 15, 10 and 5 percent are assumed as the bark percentage for trees with dbh 20-30 an, 30-50 cm, 50-70 cm and above 70 cm respectively. Bark percentage, BP = (VOB)100/VOB where VOB and VUB are the volume of wood overbark and underbark respectively . The volume overbark is calculated as VOB = [100/(100-BP')]VUB.

[28] Theweight of branch wood of 10-30 an girth overbark was estimated as 0.219 tonnes per tree (Chacko et al. 1989) equivalent to 0.292 cubic meter which is about 22 percent of the volume of wood overbark including branch wood above 30cm girth overbark.

[29] Multiple use trees are those which provide a combination of uses such as timber, fruit, *green* manure, fodder, shade, ornamental purpose, support for pepper vines, etc.

[30] Durability (life span in *years* obtained in graveyard test) below two years: perishable: 2-5 years: non-perishable; 5-7 *years:* moderately durable; 7-10 years: durable; and above 10 years: very durable (Nazma, *et al.,* 1981). Trees with durability of above 5 years: medium value, 2-5 years: low value and below 2 years: very low value.

4. DEMAND, SUPPLY AND WOOD-BALANCE

The wood-balance in Kerala for the year 1987-88 is presented in this section. The demand for wood in the household, industries and tertiary sectors is analysed followed by the supply of wood from different internal sources and imports. Export of wood from Kerala is included in the demand side.

4.1 Demand for Wood

4.1.1 Household sector

The per capita annual consumption of sawn timber in the household sector of Kerala is estimated as 0.0195 m^3 2nd that for the rural and urban areas are 0.0225 m^3 and 0.0067 m^3 respectively. The total quantity of sawn timber used for house construction, repair, alterations and making furniture, fixtures, implements, etc. is estimated as 0.558 million m^3 of which coconut wood accounted for 27.0 per cent. In round wood equivalent, the total quantity is worked out to be 1.133 million m^3 of which coconut wood accounted for 52.1 per cent[31], Coconut, jack and anjily are the most common timbers used in house construction. Teak wood is used in small quantities by the household sector for furniture, door and window shutters.

The per capita annual consumption of fuelwood by households in the rural and urban areas of Kerala are worked out as 0.178 and 0.151 tonnes respectively. The total demand for fuelwood in the household sector of Kerala is estimated as 4.943 million tonnes (4.134 and 0.809 million tonnes in the rural and urban areas respectively), or 6.591 million m^3 round wood equivalent. This does not include coconut palm by-products and crop residues used by households as fuel. The total quantity of such non-wood biomass fuel materials accounts for 7.32 million tonnes in rural areas and 0.72 million tonnes in urban areas.

Among the districts, household sector of Thiruvananthapuram had the highest demand for wood. (The district-wise household demand for timber and fuelwood is given in Appendix-2).

4.1.2 Industries sector

Table 4.1 gives the industrial demand for wood in Kerala[32]. The total quantity of wood used in the industries sector is estimated as 1.061 million m^3 round wood.

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[31] The sawn wood recovery of 1 m^2 of round leg of coconut wood is 0.255 m^3 (Gnanaharan et al., 1988). For other timber it is taken as 0.75 m^3. See also Forestry Commission (1965).

[32] Saw-milling is the most important wood-using industry in Kerala. Wood processed in sawmills is estimated as 1.572 million m^2 during 1987-88. Of this, 0.75 million m^2 represents custom sawing of wood brought by users directly. Sawn timber from sawmills is used in the household, industries and tertiary sectors and for export is accounted for in the total demand for wood. Therefore to avoid double counting, wood used in saw milling is not shown separately.

Table 4.1 Industrial demand for wood in Kerala during 1987-88

Industry	Wood (round logs in m^3)	Percentage to total
Packing case	319,224	30.1
Match	283,346	26.7
Furniture	152,437	14.4
Plywood and veneer	131,998	12.4
Pulp and paper[33]	111,374	10.5
Others[34]	62,562	5.9
Total	1,060,941	100.0

The highest demand for wood is in the packing case industry. Match industry ranked next followed by furniture industry. Wood–based industries in Kottayam had the highest demand for wood among districts (see Appendix–3). mainly because of one pulp and paper unit.

Industrial demand for fuelwood and charcoal is 'given in Table 4.2 and 4.3 respectively. The estimated total demand for fuelwood is **1.298** million tonnes

Table 4.2 Industrial demand for fuelwood in Kerala during 1987-88

Industry	Fuelwood (tonnes[35])	Percentage to total
Tile and brick-making	795,200	61.3
Chemical industries	153,315	11.8
Tea and coffee processing	144,157	11.1
Rubber products	29,990	2.3
Ayyrvedic medicines	28,199	2.2
Textiles	26,092	2.0
Others[36]	120,791	9.3
Total	1,297,744	100.0

[33] **Two pulpbased** units were lyins closed *during* the reporting year.

[34] **Others** include industries producing hand tools, agricultural implements, industrial goods, wooden structural goods, pencil, photo frames, wooden toys, wooden boats, transport eqipments, etc.

[35] For conversion from tonne to m^3 equivalent, see foot-note 41.

[36] Others include industries such as plywood, *dairy* products, spirit distilling, printing and binding, allopathic medicines, agricultural implements **and** hand tools, casting of iron and steel, metal utensils, bakery products, soap, matches, **knitting** mills, repair of motor vehicles, etc.

Table 4.3 Industrial demand for charcoal in Kerala during 1987-88.

Industry	Charcoal (tonnes)	Percentage to total
Textile mills	18,954	36.5
Rubber products	4,792	9.2
Hand tools	2,704	5.2
Tile industry	2,327	4.5
Others[37]	23,174	44.6
Total	51,951	100.0

Tile and brick-making industry together accounted for 61.3 per cent of the fuelwood consumption in this sector. The total demand for charcoal is estimated as 0.052 million tonnes of which 36.5 per cent was used by textile mills. Compared to other districts, industries in Thrissur and Kannur had the highest demand for fuelwood and charcoal respectively (see Appendices 4 and 5).

4.1.3 Tertiary sector

Quantity of sawn timber used for non-residential building and other uses is estimated as 0.116 million m3. The round wood equivalent of it is 0.224 million m3 of which 46 per cent was accounted by coconut wood. The estimated use of

Table 4.4 Export[38] of wood from Kerala during 1987-88

Products		Unit	Quantity
Round logs[39]	Teak wood	m3	19,288
	Rosewood	"	125
	Sandal wood	"	8
	Wood of other kinds	"	25,123
Poles[40]	Teak	'000 nos.	297
		m3	6,670
	Casuarina	'000 nos.	43
Total (round wood)		m3	75,328

[37] Others include automobile workshops, metal industry, printing and publishing, metal utensils, industrial machinery, repair of ships and boats, engineering goods, blacksmith, etc.

[38] Does not include wad-products like packing cases, veneers, plywood, etc.

[39] Includes sawn timber which is converted into round wood equivalent using the conversion factor 1 m' of sawn timber equals 1.33 m' of round wood.

[40] The conversion factor used in the total is 14.1 number of medium-size poles equals 1 m^3 round wood (Statstics Division, 1979).

fuelwood and charcoal in the tertiary sector is 2.870 and 1.045 million m3 round wood equivalent respectively. Among the districts, tertiary sector of Ernakulam accounted for the largest use of wood (see Appendix 6).

4.1.4 Export of wood from Kerala

Sawn timber, round logs and poles are being exported from Kerala to other States in India and sawn timber to other countries (see Appendix 7). Table 4.4 provides the data on export wood from Kerala. A quantity of 0.075 million m3 round wood equivalent of timber and poles has moved out of Kerala during 1987-88. Poles in round wood equivalent contributed to 41 per cent. Teak wood accounted for the major share of export of sawn timber.

4.1.6 Demand for wood: An overview

Table 4.6 shows the demand for wood in Kerala. The estimated demand for wood

Table 4.5 Demand for wood in Kerala during 1987-88

(in million m3 round wood equivalent41)

Sectors	Fuel		Non-fuel42		Total wood
	quantity	(%)	quantity	(%)	
Household[43]	6.195 (42.3)	51.0	1.133 (7.7)	45.4	7.328 (50.0)
Industries	2.042 (13.9)	16.8	1.061 (7.3)	42.6	3.103 (21.2)
Tertiary	3.915 (26.8)	32.2	0.224 (1.5)	9.0	4.139 (28.3)
Export	0.000 *(0.0)*	0.0	0.075 (0.5)	3.0	0.075 (0.5)
Total demand	12.152 (83.0)	100.0	2.493 (17.0)	100.0	14.645 (100.0)

The figures in parentheses are percentages to the total demand.

[41] The conversion factors adopted are for fuelwood 0.750 tonnes equivalent to 1m³ and for charcoal 1 tonne equivalent to 6m³ (FAO, 1979).

[42] Includes conversion waste from round wood to sawn sizes and other industrial wood-waste.

[43] Household fuelwood demand would actually be higher by 0.3% million m³ as half the estimated quantity of 0.685 million of sawmill waste and 0.053 million m³ of wood waste from other industries (5 percent of industrial wood used) used as fuel in households is not included. Further 8.04 million tonnes (approximately 8.04 million of fuelwood equivalent) of non-wood biomass materials used by households as fuel is not included (see Thampi, 1983 for fuelwood equivalent of coconut palm

is 14.645 million m^3 round wood equivalent. Of the demand. household sector accounted for the major share (50.0 per cent), tertiary sector ranked next (28.3 per cent) followed by industries sector (21.2 per cent). Wood exported was relatively negligible (0.5 per cent). Of the household demand. wood as fuel accounted for 84.5 per cent and as non-fuel(timber) 15.5 per cent. Of the industrial demand, wood as fuel constituted 66.8 per cent and as non-fuel (industrial wood) 34.2 per cent. The demand for wood as fuel was 94.6 per cent and as non-fuel (timber and poles) 6.4 per cent of the demand for wood in the tertiary sector.

Of the total demand, wood as fuel accounted for 83.0 per cent and as non-fuel (timber, industrial wood and poles) for industries, construction, etc. 17.0 per cent. Of the fuel demand, household sector accounted for the major share (51.0 per cent), tertiary sector ranked next (32.2 per cent) followed by the industries sector (16.8 per cent). Household sector accounted for 45.4 per cent of the non-fuel (timber) demand, industries sector 42.6 per cent, tertiary sector 9.0 per cent and export only 3.0 per cent. Coconut wood contributed to 27.8 per cent of wood used as. timber in Kerala indicating the importance of coconut wood in the timber economy of Kerala.

4.2 Supply of Wood

4.2.1 Homesteads

Total production of wood including fuelwood obtained from pruned and fallen materials and coconut wood from homesteads during 1987-88 is estimated to range from 10.899 to 12.246 million m3 of which 80 to 90 per cent was fuel. Pruned and fallen materials from trees in homesteads used as fuelwood[44] is worked out to be 0.330 million m3. The number of coconut palms felled mainly for timber[45] is worked out to be 1.303 million which provided 0.693 million m3 of wood. The number of palms felled and used as fuel is taken to be 3.909 million which provided 1.884 million m3 of fuelwood46. The total production of coconut wood47 is estimated as 2.577 million m3. Non-good fuel from coconut used in households is arrived at about 5.05 million m3 fuelwood equivalent. Non-wood fuel materials from coconut is also used in the tertiary sector which has not been estimated. Therefore, 5.05 million

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[44]There are 8.261 million trees above 40 cm dbh. The quantity of fuelwood obtaining from pruned and fallen materials from a tree is assumed to be 0.040 m^3 per tree per annum.

[45]To estimate the number of coconut palms felled for timber, sawn coconut wood used in the household and tertiary sectors during 1987-88 was amverted to round wood equivalent and divided by 0.532 m^3 which is the average volume of wood per over-matured palm.

[46]The number of coconut palms felled for replacing diseased or low yielding and used as fuel is taken to be 3.909 million assuming 3 times of the number of eoconut palms felled and used as timber. The average wood volume of a coconut tree felled and used as fuel is taken to be 0.482 m^3 (Gnanaharan et al.,1988.

[47]According to the Coconut Development Board, Cochin, the total number of coconut trees both bearing and young in 1986-87 was 161.56 million of which 10.1 percent were of age above 50 years. The estimated number of palms felled during 1987-88 is 5.212 million which is 3.2 percent of the total number of coconut trees in Kerala.

m3 can be taken as the minimum production of non-wood coconut fuel. However, the non-wood component of fuel has not been included in the present analysis.

The upper limit of 12.246 million m³ of wood production represents 8.3 m3 per ha of homestead lands used exclusively for agriculture or 7m3 per ha of homestead lands plus area under non-agricultural uses within homesteads. The definition of wood used in this study is different from the conventional definition where, usually, only wood above 60 cm girth is considered. Our definition of wood includes woody materials up to 10 cm girth in the case of fuelwood. Therefore 7 m3 per ha can not be considered to be a very high figure. No attempt has been made to assess the sustainability of wood production from homesteads considering the present level of production.

4.2.2 Estates

Wood production from rubber plantations including small holdings during 1987-88 is estimated as 0.999 million m3. In addition to rubber wood, wood of other trees like anjily, jack, etc. is also obtained during felling of rubber plantations. The quantity of such wood is estimated to range from 0.043,to 0.086 million m3 of which 42.2 per cent is timber and the balance fuelwood. The supply of timber and fuelwood from plantations of tea, coffee and cardamom is worked out to range from 0.318 to 0.686 million m³ of which 49.7 per cent timber. The total supply of wood from all estates is thus arrived at to range from 1.360 to 1.721 million m3 round wood.

4.2.3 Forests

Supply of wood from the natural forests and plantations of Kerala during 1987-88 is presented in Table 4.6. The supply of wood is calculated to range from 0.686 to

Table 4.6 Supply of wood from forests of Kerala during 1987-88

Products	Unit	Recorded production	Unrecorded production (in range)	Total production (in range)
Timber logs	m³	51,151	5,115 - 10,230	56,266 - 61,381
Eucalypt wood	tonnes	97,815	9,782 - 19,563	107,597 - 117,378
Puelwood	,,	25,438	151,639 - 335,596	177,077 - 361,034
Sandalwood	,,	123	12 - 25	135 - 148
Poles	'000 nos.	957	96 - 192	1,053 - 1,149
Charcoal	tonnes	19	29,851 - 149,255	29,870 - 149,274
Total[48] (in round wood equivalent)	m³	280,194	405,928 - 1,392,266	686,122 - 1,672,460

[48] The round wood equivalent has been worked out using conversion factors 1 m³ equals 0.740 tonnes for Eucalyptus *grandis* wood, 0.980 for *E. tereticornis* wood and 0.945 tonnes for sandalwood (Nazma *et al.*,

1.672 million m^3 round wood equivalent. The recorded production is worked out to range from 16.8 to 40.8 per cent of the total supply from the forests. Eucalypt wood accounted for the major share (45.3 percent) of the recorded production. Of the total unrecorded production, fuelwood and charcoal constituted 94 to 97 per cent. Fuelwood and charcoal accounted for 61 to 82 per cent of the total supply of wood from the forests.

4.2.4 Imports

A substantial quantity of wood is being imported to Kerala (see Appendix 8). Table 4.7 presents the details regarding the import of wood to Kerala from other states in India and abroad in 1987– 88. The total quantity of wood imported was 0.353 million m3 of which 46.2 per cent was round wood equivalent of charcoal. Timber imported from Malaysia was about 0.104 million m3 which is about 55 per cent of the total timber imported.

Table 4.7 Import[49] of wood to Kerala during 1987-88

Products		Unit	Quantity
Round logs	Eucalypt wood	tonnes	4,678
"	Rosewood	m3	2,023
"	Teak wood	"	1,553
"	Sandalwood	"	552
"	Wood other kinds[50]	"	173,331
Sawn timber	Wood other kinds	"	156
Poles	Casuarina	'000 nos.	81
Charcoal		tonnes	27,122
Total (round wood equivalent)		m3	352,518

4.2.5 Supply of wood in Kerala: An overview

The supply of wood in Kerala from different sources is shown in Table 4.8. Homesteads contributed 74.4 to 83.6 per cent of the total wood supply and estates 9.3 to 11.8 per cent. Forests produced only 4.7 to 11.4 per cent of the total supply although the recorded production was only 1.9 percent. Wood imported from other states and countries was 2.4 per cent. Of the total supply of timber, industrial wood and poles, homesteads produced 42.4 to 50.4 per cent. Of the total fuelwood supply, homesteads provided 81.0 to 90.4 per cent. Fuel from coconut includjng both wood

[49] Timber logs of 898 m^3 imported by rail is also included. Wood-pulp of 5259 tonnes imported fran New Zealand, Norway, USA, etc. is excluded.

[50] Of the total quantity of wood other kinds, 60 per cent was imported fran Malaysia.

Table 4.8 Supply of wood in Kerala during 1987-88

(range in million m3 round wood equivalent)

Source	Fuel	Non-fuel	Total wood
Homesteads	10.989 - 9.842 (75.0 - 67.2)	1.257 - 1.057 (8.6 - 7.2)	12.246 - 10.899 (83.6 - 74.4)
Estates	0.585 - 0.770 (4.0 - 5.3)	0.775 - 0.951 (5.3 - 6.5)	1.360 - 1.721 (9.3 - 11.8)
Forests	0.415 - 1.377 (2.9 - 9.4)	0.271 - 0.295 (1.8 - 2.0)	0.686 - 1.672 (4.7 - 11.4)
Imports	0.163 (1.1)	0.190 (1.3)	0.353 (2.4)
Total supply	12.152 (83.0)	2.493 (17.0)	14.645 (100.0).

figures in the parentheses are percentages to the total supply.

Table 4.9 **Wood-balance in Kerala during 1987-88**
(in million m^3 round wood equivalent)

District	Production[31]	Domestic consumption	Difference
Thiruvananthapuram	1.108	1.402	(-) 0.294
Kollam	0.732	1.315	(-) 0..583
Pathanamthitta	0.602	0.560	0.042
Alappuzha	0.470	0.930	(-) 0.460
Kottayam	0.877	1.001	(-) 0.124
Idukki	1.323	0.568	0.755
Ernakulam -	0.754	1.629	(-10.875
Thrissur	0.940	1.647	(-) 0.707
Pa1akkadu	1.672	1.133	0.539
Malappuram	1.430	1.189	0.241
Kozhikodu	1.199	1.401	(-)0.202
Wayanad	0.663	0.299	0.364
Kannur	1.532	1.094	0.438
Kasaragod	0.990	0.402	0.588
Total Kerala	14.292	14.570	(-) 0.278*

*The net import of wood to Kerala during 1987-88 was 0.278 million

51The district-wise break-up of production of wood (the lower limit for forests and estates) other than that from homesteads is arrived at as follows: The production of wood from forests is distributed in proportion to the area under forests in different districts. wood production from estates is distributed on the basis of area of rubber replanted and other plantations in different districts respectively. The production of wood fran homesteads (the upper limit) in each district is allocated at the same proportion as the distribution of growing stock in districts.

and non–wood materials comes to 7.172 million m3 fuelwood equivalent. Even when excluding the contribution of coconut to the tertiary sector, this is 69.8 per cent of the combined production of fuelwood and charcoal from all other trees and all sources in Kerala put together. The importance of trees in homesteads, particularly coconut, in the wood economy of Kerala is thus very obvious.

4.3 Wood–Balance in Kerala

Table 4.9 presents the wood–balance for the state of Kerala. The wood–surplus in districts is an indirect reflection of wood availability and wood–deficit is a reflection of density of population and wood consuming industries. These also indicate the movement of wood across districts. The production and domestic consumption of wood in Kerala during 1987-88 are 14.292 and 14.570 million m^3 round wood equivalent respectively. The difference of 0.278 million m^3 is the net import, where the import and export of wood are 0.353 and 0.075 million m^3 respectively.

The analysis of wood– balance in Kerala reveals that the effective demand for and supply of wood during 1987-88 was 14.645 million m^3 round wood equivalent. Fuelwood constituted 83 per cent of the total wood consumption. Among different sources of supply, homesteads occupied the dominant position accounting for 74.4 to 83.6 per cent of the total supply of wood.

5. DISTRIBUTION OF GROWING STOCK OF TREES IN HOMESTEADS

Growing stock of trees in number and volume and the species preference in homesteads of Kerala are analysed in this section. Palms other than coconut are not included in the growing stock of trees. Neither are trees in plantations of rubber, coffee, tea and cardamom.

5.1 Growing Stock of Trees

Tables 5.1 presents the number of trees in the growing stock in homesteads during 1988–89. The estimated total number of trees is 443.165 million of which trees below 10 cm dbh account for 42.91 per cent. When coconut palms are excluded trees in the lowest class comes to 54.63 per cent of the total number. While trees above 30

Table 5.1 Number of trees in the growing stock in homesteads of Kerala during 1988-89

(number in '000)

Trees	Diameter at breast height (in cm)									Total
	(10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80	
CO [52]	-	-	94920	-	-	-	-	-	-	94920 (21.47)
M2	11550	8624	5837	3146	1699	938	195	67	50	32106 (7.26)
M3	19700	12856	5908	2497	1191	560	216	70	100	43098 (9.75)
M4	87456	42322	12126	2652	937	208	116	28	0	145845 (32·98)
T1	14069	5607	1709	376	148	15	0	0	5	2192' (4.96)
T2	9869	7901	3475	1347	588	423	114	7	12	23736 (5.37)
T3	9242	8007	1870	242	84	24	4	5	0	19478 (4.40)
T4	29970	17877	3790	919	226	160	50	8	13	53013 (11.99)
ACE	7860	150	30	0	0	0	0	0	0	8040 (1.82)
Total	189716 (42.91)*	103344 (23.37)	129665 (29.32)	11179 (2.53)	4873 (1.10)	2328 (0.53)	695 (0.16)	185 (0.04)	180 (0.04)	442165 (100.00)

CO stands for coconut palms, M2 for jack, M3 for mango, tamarind, gooseberry, etc., M4 for cashew, breadfruit, guava, etc., T1 for teak, rosewood and sandal, T2 for *anjily, chadachy, irul,* etc., T3 for *kanjiram, manjakadmbu, thanni,* etc., T4 for *matty, mullilavu,ezhilampala* etc., ACE for *Acacia auriculiformis,* Casuarina and Eucalypts. For complete list see Appendix_17.*The figures in parentheses are percentages to total.

[52]Include only those coconut palms above 5years old which have stem wood. The average diameterof coconut palm is assumed tobe in 20-30 cm class.

cm dbh account.for only 4.4 per cent of the total number, new plantings of trees (less than 10 cm dbh) other than coconut palms account for **54.63** per cent. This shows that efforts are being made at the homestead level in planting of trees.

The volume of growing stock of treers in total volume is estimated as **104.248** million m^3 overbark including volume of branch wood above 10 cm girth. The commercial volume is estimated as **28.526** million m^3 underbark (see Tables **5.2** and **6.3).** The commercial volume accounts for **27.4** per cent **of** the total volume. The remaining **72.6** per cent is the growing stock of fuelwood. However, commercial volume also includes volume of trees with **only** fuelwood value, when felled, such as tamarind.

5.2 Species preference

Trees with multiple uses account for **71** per cent **of** the total number of trees, **81** per cent of the total volume overbark of all trees and **83** per cent **of** the total commercial volume (see Tables 5.1, **5.2** and **5.3).** Also among trees above 60 cm dbh, trees providing multiple benefits constitute **74** per cent of the total number, 83 per cent of the total volume overbark of all trees and 85 per cent of total

Table 5.2 Total volume **of** growing stock **of** trees in homesteads of Kerala during 1988-89
(volume in '000 m^3 overbark including branch wood of **lOcm** and above girth)

Trees	Diameter at breast **height** (in **cm)**									Total
	(10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80	
CO	-	-	34171	-	-	-	-	-	-	34171 (32.78)
M2	46	1509	2422	3072	3484	3126	968	447	489	15563 (14.93)
M3	79	2250	2576	2469	2417	1834	1060	455	908	14048 (13.48)
M4	350	7406	6801	2845	1784	609	529	164	0	20488 (19.66)
T1	56	981	767	372	266	45	0	0	38	2525 (2.42)
T2	39	1383	1568	1290	986	1061	407	33	98	6865 (6.58)
T3	37	1401	951	248	164	73	17	27	0	2918 (2.80)
T4	120	3129	1974	1009	450	513	242	51	107	7595 (7.28)
ACE	33	26	18	0	0	0	0	0	0	75 (0.07)
Total	758 !0.73)*	18085 (17.34)	51248 (49.16)	11305 (10.84)	9551 (9.16)	7261 (6.97)	3223 (3.09)	1177 (1.23)	1640 (1.57)	104248 (100.00)

*The Figcres in parentheses are percentages to total.

Table 53 Commercial volume of growing stock of trees in homesteads of Kerala during 1988-89

(volume in '000 m3 underbark)

Trees	Diameter at breast height (in cm)							Total	(%I
	20-30	30-40	40-50	50-60	60-70	74-80	>80		
CO	6834	0	0	0	0	0	0	6834	23.96
M2	817	1605	1767	1586	477	222	236	6710	23.52
M3	844	1274	1220	921	512	219	440	5430	19.02
M4	1941	1352	863	284	216	67	0	4723	16.55
T1	406	144	112	18	0	0	20	700	2.45
T2	475	390	318	367	157	14	39	1760	6.17
T3	285	122	80	34	7	11	0	539	1.90
T4	616	519	232	280	114	25	40	1826	. 6.41
ACE	4	0	0	0	0	0	0	4	0.02
Total	12222	5406	4592	3490	1483	558	775	28526	
(%I	42.85	18.95	16.10	12.23	5.20	1.95	2.72		100.00

commercial volume. These indicate the preference for planting and maintaining trees having multiple uses. Such a marked preference for multiple-use trees can be seen in every district (see Appendices 9.10 and 11). Trees such as *Acacia auriculiformis, Casuarina equisetifolia* and Eucalypts account only for 1.82 per cent of the total number, 0.07 per cent of the total volume of all trees and 0.02 per cent of the total commercial volume. Timber and multiple-use trees in the high value classes contribute to the timber supply and those in the low value classes contribute to both timber and fuelwood supply.

5.3 Pattern of Growing Stock Distribution

The pattern of growing stock distribution of trees in the homesteads of Kerala gives a very interesting picture of the preference for different trees for planting by households (see Table 5.4 and Appendices 12, 13, and 14). Just 10 species account for 74 per cent of total number, ***85*** per cent of total wood volume and 87 per cent of the commercial timber volume of trees in homesteads. Among the species, the prominent position of coconut is very clearly brought out. It may be recalled that coconut provides about ***28*** per cent of total timber consumption and about 16 per cent of the total fuelwood consumption. When non-wood fuel from coconut is also considered, the contribution of coconut is 69.8 per cent of the total consumption of fuelwood and charcoal from all other trees and all sources put together even when excluding the contribution of coconut to the tertiary sector in the state. After a pre-bearing stage of about 6 years, the continuous production of nut for home consumption and sale and continuous production of fuel in the form of leaf, sheath, husk, shell, etc. for over 60 years are important advantages. Coconut combines the benefits of an agricultural crop and a tree in the sense that even a low input passive management brings in a fair return while it is very responsive to increased

Table 5.4 Pattern of growing stock distribution of trees in homesteads of Kerala during 1988-89

Trees	Percentage of growing stock to total growing stock in		
	number	volume	commercial volume
Coconut (CO)	21.47	32.78	23.96
Jack (M2)	7.26	14.92	23.52
Mango (M3)	7.29	10.90	15.78
Cashew (M4)	9.30	11.65	12.54
Anjily (T2)	2.28	4.00	3.86
Tamarind (M3)	1.54	1.66	2.12
Teak (T1)	4.11	1.91	2.04
Murikku (M4)	10.38	3.90	1.99
Vatta (M4)	5.96	1.92	0.72
Matty (T4)	4.17	1.24	0.67
Other trees	26.24	15.12	12.80
Total	100.00	100.00	100.00

inputs of irrigation, fertilizer, etc. Murikku and vatta are the other trees most integrated with agriculture. They provide support for pepper vine, a high return crop, and produce excellent leaf manure. However, they do not contribute much to the total commercial volume of wood. Jack and mango are planted for fruits and shade. The leaf of jack is a very good fodder. Jack produces premium timber for construction and furniture. The timber of mango, though not as valuable, is used as industrial wood and for construction. Cashew has a very short pre-bearing stage and provides a high annual return from nuts. Its wood is used as fuel and in packing case industry. Anjily, which provides a long straight bole, is used for construction, boat building, etc. Tamarind produces fruit which is a condiment in daily use. Tamarind wood is an excellent fuel and the tree has the capability to establish and grow in dry areas and adverse conditions. Teak is the traditional high quality, high value timber of Kerala which can be used for any purpose. It has also high export demand. Matty, a fast growing tree, has been popularized in the recent past due to demand from match industry.

The data show that trees with multiple benefits are preferred to single-use trees. Even among multiple-use trees, trees which provide products for home consumption have precedence. The potential for recurring annual income generation is an important consideration in the choice of trees in homesteads. Timber value is another consideration. Trees which are complementary to agricultural crops for providing support or manure are also preferred. Coconut followed by jack, mango, cashew, anjily, tamarind, teak, murikku, vatta and matty are the most preferred species for planting and maintaining in homesteads. However, the crop-mix and preference for particular species vary with respect to different regions in Kerala (see Appendices 16.1 to 16.14). Fuelwood and very low value trees with single use have very low preference in homesteads. Even among fuel producing trees, coconut is the most preferred tree.

6. FUTURE TRENDS IN THE DEMAND AND SUPPLY OF WOOD IN KERALA

In this section future trends in the demand and supply of wood in Kerala are examined. Based on the present (1987-88) data, forecasting is attempted for three time points namely 1994-1995, 1999-2000 and 2004-2006. Several constraints, particularly the absence of time series data on demand and supply of wood in Kerala. have necessitated the use of certain assumptions which are explained in the appropriate places. The forecasts give only a general indication of the possible range in the future demand for wood by various sectors and supply from different sources in the State.

6.1 Future Trend8 in the Demand for Wood

For forecasting forest-products requirements. one of the generally accepted methods is to consider the per capita consumption and future population (Hanson, 1962). This approach is adopted for forecasting the wood requirements by the household and tertiary sectors. The wood consumption in 1987-88 pertaining to various sectors are separately projected to arrive at the future consumption. The projected rural and urban populations of Kerala used for forecasting are presented in Table 6.1

Table 6.1 Projected population of Kerala[53]

(in million)

Year as on lst October	Rural	Urban	Total
1994	24.676	7.293	31.969
1999	25.792	8.432	34.224
2004	26.676	9.654	36.330

6.1.1 Household sector

Future timber-use by the household sector for house construction, repair, furniture making, etc. is projected on the basis of the present per capita consumption of timber in the rural and urban areas and the projected rural and urban population. Rapid price rise for timber in Kerala (Krishnankutty, 1989), popularization of wood saving technologies in construction and ready availability of substitutes for furniture and fixtures indicate a slightly lower per capita consumption of timber in future. Projection is done assuming the range of per capita timber consumption in households to decline at a compound rate of one per cent per annum and to remain constant at the present level both in rural and urban areas.

[53] The population projections for India by the Planning Commission cited in Advisory Board on Energy (1985) are used for projecting the population of Kerala. The rural and urban population are worked out based on the methodology provided in the above publication.

The demand for energy for cooking, water heating and space heating by households is met from a variety of fuels. Table 6.2 shows the present fuel–mix. It indicates that 524 and 551 kilo calories of useful heat are utilized to meet the daily cooking needs of an individual in the rural and urban areas respectively. The useful heat consumed is expected to change with economic development and rise in per capita real income. However, marked changes are common more in space heating than in cooking. Any increase in per capita useful heat consumption in Kerala is therefore assumed to be neutralized by shift in the fuel–mix in favour of non–wood commercial fuels, as space heating is unnecessary in most parts of Kerala. In rural areas, **35** per cent of the cooking energy is from fuelwood and about 60 per cent is from non–wood fuel from coconut palms and crop– residues. Changes in price and scarcity of fuelwood will induce change in the fuel– mix used in the households. Two kinds of shifts in the fuel–mix can be envisaged –one towards inferior fuels such as non–wood fuels from coconut palms and crop–residues, and the other towards superior fuels such as kerosene, LPG and electricity. Additionally, popularization of fuel–efficient stoves can lead to fuelwood savings[54]. The change in fuel–mix in future is assumed to effect a compound rate of decline ranging from 2 to 4 per cent in the per capita 'consumption of fuelwood annually in rural areas. In urban areas the fuel wood component in the total useful heat consumption is only **28.5** per cent and non–wood fuels from coconut palms and crop– residues account

Table 6.2 Fuel-six in the rural and urban areas of Kerala[55]

Fuel-mix	Useful heat consumed for cooking, water heating and space heating per capita per day(k.cl)	
	Rural	Urban
Fuelwood	185 (35.30)	157 (28.53)
Non-wood fuel from coconut palms and crop-residues	311 (59.44)	140 (25.32)
Kerosene	20 (3.73)	147 (26.69)
LPG	5 (0.88)	95 (27.21)
Electricity	3 (0.65)	12 (2.25)
Total	524 (100.00)	551 (100.00)

The figures in parentheses are percentages to total.

[54] The appliance efficency of fuewood use for is generally 8 percent (Advisory Board an Energy, 1985). If the efficiency is increased from 8 to 10 percent by improved stove or other methods, 20 or 33.3 percent of fuelwood can be saved. If the present efficiency is doubled, half of the fuelwood requirement can be saved.

[55] The figures for urbanareas are estimated through our sample survey in 1989 and those for rural areas are computed from State Planing Board

for 25 per cent. The same type of shift in fuel–mix as in rural areas is expected in urban areas also. Further, kerosene and LPG are increasingly available and used in urban areas. Future trend in their supply is crucial to fuel shifts. Considering an annual increase of 6 to 10 per cent in the supply of LPG[56], 5 per cent increase per annum in the supply of kerosene in Kerala and the effects of shift in the fuel–mix and popularization of fuel–efficient stoves, decline in the per capita fuelwood consumption ranging from 3 to 5 per cent compound rate per annum in urban areas is expected in the coming years. The fuelwood consumption by the households is projected on the basis of the projected rural and urban population and the assumed level of per capita fuelwood consumption in rural and urban areas.

6.1.2 Industries sector

Wood–use in the industries sector is not expected to increase substantially as government supplies from forest areas has declined drastically. Several industries are switching over from wood to other forms of packing materials and several industrial units are shifting to neighbouring states due to various reasons. Fuelwood and charcoal requirements in industries depend largely on the type of industry and processing involved, and hence in Kerala the scope of substitution between fuelwood and alternative formn of fuel is rather limited. Growth of number of industrial units using fuelwood and or charcoal is not expected to continue as in the past. The net effect of these processes is expected to decrease wood consumption by industries in Kerala. However, increasing imports of wood to Kerala may prevent the drastic fall in industrial timber consumption. Therefore the range of wood consumption in the industries sector[57] in future is assumed to be constant at the present level and to increase by a compound rate of one per cent per annum.

6.1.3 Tertiary sector

The forecast of timber–use in the tertiary sector is based on two factors. One, increase in consumption due to increased commercial activities and two, decline in consumption due to substitution of wood owing to disproportionate increase in price of wood in relation to its substitutes such as cement, steel, aluminum, etc. It is therefore expected that in the tertiary sector both will almost cancel out leaving a range of per capita timber consumption constant and a possible decline of one per cent per annum in future. With regard to the future consumption of fuelwood in tea-shops and restaurants, the present per capita consumption is assumed to decline at tho same rate in the rural and urban areas similar to those in the household sector

[56] The LPG supplied by the Indian Oil Corporation in Kerala has increased by 8.3 percent compound per annum during the period 1986-87 to 1988-89.

[57] For projecting the consumption of wood by industries, the annual requirement of the two pulp and paper industries which were not functioning during 1987–88 are added to the quantity of wood consumed by idustries in the reference year.

as mentioned earlier[58]. The trend of per capita consumption of charcoal in the tertiary sector is assumed to range from the current level to a decline of 1 per cent and 2 per cent in rural and urban areas respectively, Most of this charcoal is used in tea shops for boiling water in samovar which has little substitutes. Fuelwood for cooking in non-commercial establishments such as hostels, hospitals, jails, temples, etc. and in road construction is assumed to decline at a range of 2 to 4 per cent compound per capita per annum due to substitution and fuel saving effects.

6.1.4 Export

The trend in the exports of timber from Kerala during 1980-81 to 1987-88 shows a compound rate of decline[59] of 20.67 per cent per annum (see Appendix 7). The range of exports in future is expected to continue at the above rate and to remain at the current level.

Table **6.3** Projected demand for wood in Kerala
(range in million m3 round wood equivalent)

Sectors	Years 1994-95			1999-2000			2004-05		
Household									
Fuel	5.019	to	5.833	4.261	to	5.521	3.569	to	5.166
Timber & poles	1.143	to	1.226	1.145	to	1.292	1.137	to	1.349
Industries									
Fuel	2.042	to	2.189	2.042	to	2.301	2.042	to	2.418
Industrial rood	1.241	to	1.331	1.241	to	1.398	1.241	to	1.470
Tertiary									
Fuel'	3.603	to	4.115	3.311	to	4.151	3.031	to	4.166
Timber & poles	0.229	to	0.246	0.231	to	0.260	0.231	to	0.274
Export									
Timber & poles	0.015	to	0.075	0.005	to	0.075	0.001	to	0.075
Total fuel	10.664	to	12.137	9.614	to	11.973	8.642	to	11.750
Total non-fuel	2.628	to	2.878	2.622	to	3.025	2.610	to	3.168
Total wood	13.292	to	15.015	12.236	to	14.998	11.252	to	14.918

[58] Decline in fuelwood consmption is assumed considering a shift from fuelwood to fuel from coconut and cropresidues and increase in the use of *commercial* fuels *such* as LPG and kerosene.

[59] Time series data from 7 major exit points were analyzed. The estimated equation is $\log E = 12.54_{(0.24)} - 0.23t_{(0.05)}$, $R^2 = 0.80$ where E is export of timber and t the years.

The projected demand for wood in Kerala for the years **1994-95, 1999-2000** and 2004–05 is presented in Table **6.3.**

6.2 Future Rends in the Supply of Wood

Supply of wood in Kerala from different sources is projected for the same years as for the demand projection based on the lower limit of wood production for forests and estates, upper limit for homesteads and keeping imports same for the year **1987-88.**

6.2.1 Homesteads

The methodology adopted for projecting the availability of wood from homesteads is as follows. To estimate the annual volume increment of trees in homesteads, volume of trees in different diameter class are tabulated and the total volume of trees in each diameter class is divided by the estimated average age of trees in each class, and then aggregated. Average age of trees ,in each diameter class is calculated by dividing the mid girth of each class with the mean annual girth increment which was calculated from FRI & Colleges **(1980** and **1983).** The range of mean annual girth increment in different species for different ages was reported as **7.2** cm to **1.7** cm. The mean annual girth increment used in the present study takes 5 and **6** cm for the diameter class below 20 cm based on the relative rates of growth. For dbh classes **20-30, 30-50, 50-70** and above **70** cm, mean annual girth increment of 5, 4,3 and **2** cm are taken respectively. For coconut, the mean annual volume increment is assumed as 0.02 **m3** per tree. The estimated annual volume increment of the growing stock during **1988-89** is **6.293** million m3 which accounts for **6.037** per cent **of** the growing stock of trees in homesteads. The wood production from homesteads during **1987-88** was **11.916** million m3 which represents **10.258** per cent of the growing stock60. Two scenarios using different rates of volume increment and production are presented. For the lower limit of wood production the current increment rate of **6.037** per cent is expected to increase by **3** per cent per annum to **9.688** per cent in **2004-05** and the current rate of wood production which is **10.258** per cent is expected to decline by **4** per cent per annum to **5.125** per cent in **2004-05.** For the upper limit of production, the current increment rate is expected to increase by **4** per cent to **11.307** per cent in **2004-05** and the rate of wood production is expected also to rise by **1** per cent to **12.149** per cent **of** the current level in **2004-05.** The first scenario implies that the growing stock of wood in homesteads would approximate the current level in **2004-05** (ie., from **104** at present to **103** million m3 then). The second scenario implies that the growing stock is depleted to **54** million m^3 in **2004-05.** Additionally, availability of fuelwood from fallen branches and pruned materials from trees other than coconut is expected to range from the level of **1987-88** to decline at the rate of 2 per cent per annum in future considering change in the age composition of trees.

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[60]The production of wood, **excluding** the Quantity of fuelwood obtained from pruned and fallen materials from trees, from homesteads during **1987-88** was **11.916** million **m³ which account** for **10.258 percent** of **the** ***growing*** stock of the estimated **116.164** million **m³ in 1987-88 which is** the sum of the ***growing*** stock in **1988-89** and production during **1987-88.**

6.2.2 Estates

The area under rubber plantations for replanting in future is assumed to increase at a range of 3 to 5 per cent compound per annum. Wood production from rubber plantations is projected based on the area to be replanted and the expected yield per ha. The supply of wood from plantations of tea, coffee and cardamom in future is assumed to increase at a range of 4 to 6 per cent compound per annum.

6.2.3 Forests and public lands

With regard to the future availability of wood from the forests of Kerala, teak and eucalypt plantations will be the major source[61]. The future availability of wood from teak plantations in Kerala is estimated to range from 70 to 100 per cent of the predicted production figures of Jayaraman and Krishnankutty (1990)[62]. The lower limit is to adjust for less than full stocking in teak plantations[63]. The availability of wood from eucalypt plantations in Kerala is predicted on the basis of the existing plantations taking the felling cycle as 10 years and the average yield of wood ranging from 51.54 to 103.08 m^3 per ha for *Eucalyptus tereticornis* and 97.72 to 195.44 m^3 per ha for *E.grandis*[64]. The future unrecorded removal of wood from the forests is assumed to increase at a range of 4 per cent to 5 per cent of the current figure.Wood availability from plantations raised under various Social Forestry Schemes on public lands is estimated on the basis of the present area under plantations and assuming additional planting of 5000 ha per annum up to 1996–97. A felling cycle of 8 years and an output of 6 to 12 m^3 per ha per year for the first and subsequent rotations are also assumed[65].

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[61] Although there are plantations of other species such as anjzly, rosewood, matty albizia, etc. the area under them is relatively low and the availability of wood fran these plantations for the period of projection is negligible.

[62] Jayaram and Krishnankutty (1990) have predicted the potential yield, with laver and upper limits, fran teak plantations in Kerala for selected rotation ages of 50, 55 and 60. In the present study, the average of the laver and upper levels of potential yield for the rotation age of 55 is taken.

[63] The stocking in teak plantations in Kerala is generally poor (Statistics Division, 1979 and FAO, 1984).

[64] The average yield of wood from Eucalyptus *tereticornis* and *E.grandis* plantations in Kerala are 72.59 and 137.64 m^3 stacked volume per ha at a rotation of 10 years and the yield ranged. fran 1.708 to 209.548 m^3 per ha and 38.690 to 284.303 m^3 per ha for the two species respectively (Jayaraman and Krishnankutty, 1990). The same yield is assumed for the other rotatians also. Using the conversion factor of 1 m^3 stacked volume = 0.71 m^3 solid volume suggested by chaturvedi and Khanna (1982) for *E. tereticornis*, the average yields were worked out as 51.54 and 97.72 m^3 solid volume per ha for *E. tereticornis* and *E.grandis* respectively. These are taken as the lower limits for prediction and twice the volume as the upper limits for the two species.

[65] Social forestry plantations in Kerala are mostly of *Acacia auriculiformis, Casuarina equisetifolia and Eucalyptus tereticornis*. Higher yield figures such as 10 to 20, 6 to 18 and 12 to 25 m^3 per ha per year for the same species have been reported by Webb, *et al.* (1980).

6.2.4 Imports

The trend in imports of wood to Kerala during 1980-81 to 1987-88 indicates that imports have been increasing at a compound rate[66] of 32.3 per cent per annum (see Appendix 8). The increase in imports can not continue indefinitely as change in import price, wood availability in exporting countries and foreign exchange reserves will necessitate a review of the present liberalized policy on timber imports. The lower and upper limits of imports are assumed to increase by approximately 24 to 33 per cent. compound per annum up to 1995-96 and then to decline by approximately 5 to 10 per cent per annum. The projected trend in imports is slightly adjusted to accommodate for the effect of minor fluctuations in the trend of production of wood from internal sources.

The projected supply of wood in Kerala from different sources for the years 1994-95, 1999-2000 and 2004-05 is presented in Table 6.4.

Table 6.4 Projected supply *of* wood in Kerala.
(range in million m3)

Sources	Year		
	1994-95	1999-2000	2004-05
Homesteads	7.511 to 9.555	6.246 to 8.377	5.870 to 7.729
Estates	1.701 to 1.946	1.997 to 2.513	2.343 to 3.247
Forests and public lands	1.346 to 2.067	1.646 to 2.568	1.713 to 2.632
Imports	2.734 to 1.447	2.347 to 1.540	1.326 to 1.310
Total	13.292 to 15.015	12.236 to 14.998	11.252 to 14.918

6.3 Discussion

The projected demand for and supply of wood in Kerala are estimated to range from 13.292 to 15.015, 12.236 to 14.998 and 11.252 to 14.918 million m3 for 1994-95, 1999-2000 and 2004-05 respectively. The total demand for wood in Kerala is extremely sensitive to changes in fuel–use since fuel accounts for **83** per cent of the wood–use at present. Technology for fuel–efficient wood–burning stove is already available and several governmental and non–governmental agencies are promoting and popularizing the use of such stoves. The availability of kerosene and **LPG** is also increasing. In this situation, a definite saving in wood–use for fuel can be expected. The projection implies that the trend in demand for wood as fuel is declining. This, in turn, will affect the total demand for wood in future. For non-

[66] The series data from 7 major entry points were analyzed. The estimated equation is $\log I = 10.13_{(0.27)} + 0.28t_{(0.03)}$, $R^2 = 0.82$ where I is the irnport and t *the* year.

fuel wood such as construction timber, industrial wood, etc., no decline in demand is anticipated.

The supply from forests is expected to increase due to large areas of plantations raised in various Social Forestry Schemes, teak plantations and the earlier industrial plantations of eucalypts which are due for felling during the period of projection. The production of wood from non–forest plantations, particularly rubber,, is also expected to increase. But the wood production from homesteads is expected to decline. This is even after providing for an increase over time in volume increment of the growing stock in homesteads. The increment can be improved by intensifying planting and by ensuring the survival of seedlings and saplings. The largest proportion of trees in the lowest diameter class in the distribiition of trees in homesteads (Table **5.1** in section **5)** is a positive indicator of the interest shown by households for regenerating the stock of tree crops. The potential for increasing the growing stock of wood is very high if the survival rate of the existing seedling and sapling crop is improved. The effect of improving survival can contribute to increasing growing stock faster than new planting activities since the young trees are already established and no additional investment is required.

Imports, both from other states in India and from foreign countries, are expected to increase conspicuously in the medium term and decline in the long term. However, even in **2004-05** the level of imports will be much higher than the present. The existing international market for timber is very favourable for importing countries. Even India imports substantial quantity of timber from tropical countries as far away as Brazil, Papua New Guinea, etc. and from Malaysia. The liberal import policy of India also contributes to the prospects of rise in imports in the medium term.

The total quantities of demand and supply in the years of projection are shown as identical. This is due to inclusion of projections of exports and imports also in the analysis.

7. CONCLUSIONS

Demand for wood by various sectors and supply from different sources in Kerala for the year **1987-88,** growing stock of tree crops and species preference in homesteads are summarized below. Future trends in the demand and supply of wood are also indicated.

The effective demand for wood in Kerala during **1987-88** is estimated as **14.645** million m3 round wood equivalent. Of the demand, household sector accounted for ***50*** per cent and tertiary sector for **28.3** per cent followed by industries sector, **21.2** per cent. Export accounted for only a small quantity (0.6 per cent). Wood used as fuel accounted for **83** per cent of the total demand for wood and as timber, industrial wood and poles for **17** per cent. Of the supply of wood from different sources, homesteads in Kerala accounted for **74.4** to **83.6** per cent. Estates contributed **9.3** to **11.8** per cent of the total supply and imports **2.4** per cent. Supply of wood from forests including plantations and illicit felling accounted for only **4.7** to **11.4** per cent although the recorded production from forests was only **1.9** percent of the total supply. The wood-balance in Kerala shows that the production and domestic consumption of wood are **14.292** and **14.570** million m3 round wood equivalent respectively and the difference of **0.278** million m3 was the net imports.

Total number of trees in homesteads excluding that in plantations and palms other than coconut is estimated as **442** million in **1988-89.** Coconut palms constituted **21.5** per cent **of** the total number. Trees in the lowest diameter class accounted for **55** per cent of the total number of trees which shows that efforts are being made at the homestead level in planting trees. Multiple use trees such as coconut, jack, mango, cashew and tamarind are the most preferred species for planting in homesteads. Anjily, teak and matty are the species preferred among trees grown exclusively for wood. However, the crop-mix and preference for particular species vary with respect to different regions.

Projections for the future indicate that the likely supply-demand disparity can be neutralized by increasing fuel efficiency in wood-burning stoves, economising timber-use in construction, reducing consumption of wood by substitution and by increasing imports. Accelerated depletion of growing stock of wood in homesteads and estates can also increase production in the short run.

One of the important functions of forests is to provide wood. Rut forests in Kerala accounted for only **4.7** to **11.4** per cent of the total supply during **1987-88.** It is now possible to consider the option of conserving the remaining natural forests as the supply of wood from forests is not critical in the total supply. However, the potential that exist for achieving drastic increases in production from plantations and public lands by improving stocking, etc. should be exploited. Homesteads provided **74.4** to **83.6** per cent of the total supply of wood during **1987-88.** Rut wood-resources in homesteads may continue to be depleted. Therefore, it is essential to improve the survival of the young trees which are already established and to promote planting of multiple-use trees in homesteads and fallow lands for enhancing the stock of wood-resources for the future.

Although the outlook for supply and demand for wood in Kerala is not alarming, it is important to augment the growing stock of wood to avoid depletion of a resource which has several environmental benefits also. Increasing the stock of wood is not easy in the short run. But considering that wood saved is wood produced, vast potential exists for economising wood–use byincreasing the efficiency of wood-burning stoves and by appropriate design innovations in construction which should be utilized to the fullest extent in the short run.

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APPENDIX-1

FOREST AREA IN KERALA BY LEGAL STATUS DURING 1987-88

District	Area under forests (km2)	Percentage to total
Thiruvananthapuram	593	5.3
Kollam	730	6.5
Pathanamthitta	1503	13.4
Alappuzha	0	0.0
Kottayam	80	0.7
Idukki	3116	21.8
Ernakulam	299	2.7
Thrissur	1015	9.0
Palakkadu	1608	14.3
Malappuram	759	6.7
Kozhikode	336	3.0
Wayanad	832	7.4
Kannur	243	2.2
Kasaragod	111	1.0
Kerala	11,225	100.0

Source: Kerala Forest Department, 1988b.

APPENDIX-2

DEMAND FOR WOOD BY THE HOUSEHOLD SECTOR OF KERALA DURING 1987-88

(m3 roundwood equivalent)

District	Wood		Total wood	
	Fuel	Non-fuel (Timber)	Quantity	(%)
Thiruvananthapuram	665319	129023	794342	10.28
Kollarn	570924	109518	680442	8.81
Pathanamthitta	292734	63809	356543	4.62
Alappuzha	483298	75079	558377	7.23
Kottayam	445928	88502	534430	6.92
Idukki	256539	47560	304099	3.94
Ernakulam	635141	78964	714105	9.24
Thrissur	629365	91176	720541.	9.33
Palakkadu	536562	85742	622304	8.05
Malappuram	633137	124299	757436	9.81
Kozhikodu	573764	100449	674213	8.73
Wayanad	147740	25126	172866	2.24
Kannur	489757	72231	561994	7.28
Kasaragod	230847	41096	271943	3.52
Kerala	6,591,055	1,132,580	7,723,635	100.00

APPENDIX-3
INDUSTRIAL DEMAND FOR WOOD IN KBRALA DURING 1987-88

(m3roundwood)

District	Industry					Total wood	
	Packing case	Matches	Plywood & veneer	Furni-ture	Others	Quantity	(%I
Thiruvananthapuram	2072	11362	1280	9098	3261	27073	2.55
Kollam	50209	43461	12455	9856	15571	131552	12.40
Pathanamthitta	231	2818	5840	3360	1326	13575	1.28
Alappuzha	3450	14526	925	10955	317	30173	2.84
Kottayam	29941	14833	13063	10004	114103	181944	17.15
Idukki	1107	3115	0	2980	294	7496	0.71
Ernakulam	82955	27277	11066	21550	4153	147001	13.85
Thrissur	101425	25375	7475	25844	14070	174189	16.42
Palakkadu	7314	67479	6017	25239	1803	107852'	10.17
Malappuram	12802	17864	5040	13799	10621	60126	5.67
Kozhikode	24114	30777	27832	8942	4717	96382	9.08
Wayanad	489	0	440	221'3	43	3185	0.30
Kannur	2045	21344	38845	5299	3501	71034	6.70
Kasaragod	1070	3115	1720	3298	156	9359	0.88
Kerala	319,224	283,346	131,998	152437	173,936	1,060,941	100.00

APPENDIX-4
INDUSTRIAL DEMAND FOR FUELWOOD IN KERALA DURING 1987-88

(tonne)

Dist-rict	Industry						Total fuelwood	
	Tile industry & brick making	Tea & coffee proce-ssing	Text-iles	Rubber produ-cts	Ayur-Vedic medi-cine	Others	Quantity	(%)
TPM	76327	1646	397	876	3098	19948	102292	7.88
KLM	129045	0	394	1254	1863	15162	147718	11.38
PTA	39358	1075	0	1456	271	2477	44637	3.44
ALP	21151	0	112	1770	4006	18818	45857	3.53
KTM	17406	5150	48	11886	1055	5685	41230	3.18
IKI	7643	94566	0	1138	80	944	104371	8.04
EKM	35332	0	886	2336	270	131759	170583	13.14
TSR	221487	3228	2076	2370	2594	32650	264405	20.37
PKD	48195	1743	2771	760	4015	15538	73022	5.63
MPM	29047	581	276	611	9097	2541	42153	3.25
KKD	142906	5150	4456	4438	969	13979	171898	13.25
WYD	10094	25353	0	228	1	997	36673	2.83
KNR	10735	5264	14088	774	862	12743	44466	
KGD	6474	401	588	93	18	865	8439	0.65
Kerala	795,200	144,157	26,092	29,990	28,199	274,106	1,297,744	100.00

APPENDIX-5
INDUSTRIAL DEMAND FOR CHARCOAL IN KERALA DURING 1987-88

(tonne)

District	Industry				Total charcoal	
	Textile mills	Rubber goods	Hand tools	Others	Quantity	(%)
Thiruvananthapuram	2133	639	186	419	3377	6.50
Kollam	3	260	215	1232	1710	3.29
Pathanamthitta	0	115	1	696	812	1.56
Alappuzha	1	215	126	2136	2478	4.77
Kottayam	1	990	41	2059	3091	5.95
Idukki	0	181	20	1455	1656	3.19
Ernakulam	5167	301	158	2059	7685	14.79
Thrissur	98	636	116	3441	4291	8.26
Palakkadu	11	140	1728	5765	7644	14.71
Malappuram	16	538	51	1876	2481	4.78
Kozhikode	1544	474	1	1319	3338	6.42
Wayanad	0	64	0	744	808	1.56
Kannur	9891	216	40	1291	11438	22.02
Kasaragod	89	23	21	1009	1142	2.20
Kerala	18,954	4,792	2,704	25,501	51,951	100.00

APPENDIX-6
DEMAND FOR WOOD BY THE TERTIARY SECTOR* OF KERALA DURING 1987-88

(m^3 roundwood equivalent)

District	Fuel		Non-fuel (timber,	Total wood	
	Fuelwood	Charcoal		Quantity	(%)
Thiruvananthapurarn	327640	117738	19642	465020	11.24
Kollam	226625	85188	18541	330354	7.98
Pathanamthitta	95049	35916	10535	141500	3.42
Alappuzha	205335	76248	13329	294912	7.12
Kottayam	160511	59220	17099	236830	5.72
Idukki	80474	30768	11921	123163	2.98
Ernakulam	376588	138828	17917	533333	12.89
Thrissur	287076	103956	20182	411214	9.93
Palakkadu	203692	72330	16358	292380	7.06
Malappuram	230974	80718	25438	331813	8.17
Kozhikode	288157	104658	21594	414409	10.01
Wayanad	57258	15918	5016	78192	1.89
Kannur	251671.	95802	15608	363081	8.77
Kasaragod	78365	27885	9873	116727	2.82
Kerala	2,870.016	1,045,176	224,053	4,139,245	100.00

*Tertiary sector includes all-wood using agencies other than households and industries

APPENDIX-7

EXPORT OF WOOD FROM RERALA THROUGH 7 FOREST CHECK-POSTS*

Years	Timber round logs (m3)	Teak poles ('000 nos)	Casuarina poles ('000 nos)	Fuel-wood (m3)	Char-coal (tonne)	Total roundwood equivalent (m3)
1980-81	19669	450	26	110103	1	163537
1981-82	18031	407	37	106122	0	155642
1982-83	23759	402	71	136836	0	194141
1983-84	41290	268	31	55204	121	118426
1984-85	35268	333	27	79773	31	140759
1985-86	19934	388 (+22 m3)	67	32	77	52720
1986-87	17126	487 (+179 m3)	46	0	28	55274
1987-88	16168	230 (+770 m3)	43	0	0	36300

APPENDIX-8

IMPORT OF WOOD TO KERALA THROUGH 7 FOREST CHECK-POSTS*

Years	Timber round logs (m3)	Timber sawn sizes (m3)	Casuarina poles ('000 nos)	Fuel-wood (tonne)	Char-coal (m3)	Total roundwood equivalent (m3)
1980-81	33361	120	18	6983	120	42500
1981-82	44790	25	53	3745	175	53377
1982-83	50782	9	25	2857	149	56318
1983-84	54297	19	48	921	184	59752
1984-85	43842	88	68	269	666	53047
1985-86	70242	34	88	465	6987	18915
1986-87	109830	185	79	600	18736	228695
1987-88	142033	103	81	0	26090	304455

*The forest check-posts are Kotekar, Jalsur, Iritty, Tholpetty, Walayar, Anapady and Parasala. Time series data were available only at these 7check--posts.

APPENDIX-9

NUMBER OF TREES IN THE GROWING STOCK IN HOMESTEADS OF KERALA DURING 1988-89

(number in '000)

DIST	CO	M2	M3	M4	T1	T2	T3	T4	ACE	TOTAL
TPM	10533	3024	4043	10625	984	1839	995	3861	67	35971
(%)	(29.3)	(8.4)	(11.2)	(29.5)	(2.7)	(5.2)	(2.8)	(10.7)	(0.2)	(100.0)
KLM	5743	1773	2377	6969	766	1000	664	2648	222	22162
(%)	(25.9)	(8.0)	(10.7)	(31.4)	(3.5)	(4.5)	3.0)	12.0)	(1.0)	(100.0)
PTA	4385	1282	1482	4986	682	982	339	1755	25	15918
(%)	(27.5)	(8.1)	(9.3)	(31.3)	(4.3)	(6.2)	2.1)	11.0)	(0.2)	(100.0)
ALP	6059	1014	2124	4355	437	599	526	2929	34	18077
(%)	(33.5)	(5.6)	(11.8)	(24.1)	(2.4)	(3.3)	2.9)	(16.2)	*(0.2)*	(100.0)
KTM	4024	1234	1472	5226	896	1103	506	1471	108	16040
(%)	(25.1)	(7.7)	(9.1)	(32.6)	(5.6)	(6.9)	(3.2)	(9.1)	(0.7)	(100.0)
IKI	3879	2364	2200	13114	2369	1881	1923	2411	305	30446
(%)	(12.7)	(7.8)	(7.2)	(43.0)	(7.8)	(6.2)	(6.3)	(8.0)	(1.0)	(100.0)
EKM	4329	1341	2313	6092	700	929	925	3008	523	20160
(%)	(21.5)	(6.7)	(11.5)	(30.2)	(3.4)	(4.6)	(4.6)	(14.9)	(2.6)	(100.0)
TSR	9417	1639	3727	7294	1107	1530	1193	4162	20	30089
(%)	(31.3)	(5.5)	(12.4)	(24.3)	(3.7)	(5.1)	(3.8)	(13.8)	(0.1)	(100.0)
PKD	9300	3389	5862	16387	3395	3110	2865	7451	1071	52830
(%)	(17.6)	(6.4)	(11.1)	(31.0)	(6.4)	(5.9)	(5.4)	(14.1)	(2.1)	(100.0)
MPM	10249	3900	4898	17136	2033	2404	2155	7468	1622	51865
(%)	(19.8)	(7.5)	(9.4)	(33.1)	(3.9)	(4.6)	(4.2)	(14.4)	(3.1)	(100.0)
KKD	11268	3147	3851	12782	1825	2424	1272	5371	72	42012
(%)	(26.8)	(7.5)	(9.2)	(30.4)	(4.3)	(5.8)	(3.0)	(12.8)	(0.2)	(100.0)
WYD	1679	1479	1522	7563	1455	1100	1372	1878	1443	19491
(%)	(8.6)	(7.6)	(7.8)	(38.9)	(7.5)	(5.6)	(7.0)	(9.6)	(7.4)	(100.0)
KNR	9379	3830	4336	19010	2988	2868	2494	5007	654	50566
(%)	(18.5)	(7.6)	(8.6)	(37.6)	(5.9)	(5.7)	(4.9)	(9.9)	(1.3)	(100.0)
KGD	4676	2690	2891	14306	2292	1967	2249	3593	1874	36538
(%)	(12.8)	(7.4)	(7.9)	(39.1)	(6.3)	(5.4)	(6.2)	(9.8)	(5.1)	(100.0)
KERALA	94920	32106	43098	145845	21929	23736	19478	53013	8040	442165
(%)	(21.5)	(7.3)	(9.8)	(33.0)	(4.9)	(5.3)	(4.4)	(12.0)	(1.8)	(100.0)

APPENDIX-10

TOTAL VOLUME OF GROWING STOCK OF TREES IN HOMESTEADS OF KERALA DURING 1988-89

(volume in '000 m^3 overbark including branchwood of 10 cm and above girth)

DIST	CO	M2	M3	M4	T1	T2	T3	T4	ACE	TOTAL
TPM	3792	1331	1235	1585	142	506	130	520	2	9243
(%)	(41.0)	(14.4)	(13.4)	(17.1)	(1.5)	(5.5)	(1.4)	(5.7)	**(0.0)**	(100.0)
KLM	2067	803	683	934	101	326	97	328	3	5342
(%)	(38.7)	15.0)	12.8)	(17.5)	(1.9)	6.1)	(1.8)	(6.1)	(0.1)	100.0)
PTA	1579	572	410	567	82	352	49	211	1	3823
(%)	(41.3)	15.0)	10.7)	(14.9)	(2.1)	9.2)	(1.3)	(5.5)	**(0.0)**	100.0)
ALP	2181	453	689	485	40	107	87	331	1	4383
(%)	(49.8)	10.4)	15.9)	**(11.1)**	(0.9)	2.4)	(2.0)	(7.5)	**(0.0)**	100.0)
KTM	1449	582	910	665	98	381	70	219	1	4375
(%)	(33.1)	(13.3)	20.8)	(15.3)	(2.2)	(8.6)	(1.6)	(5.1)	(0.0)	(100.0)
IKI	1396	1299	740	2338	274	597	251	438	7	7340
(%)	(19.0)	(17.7)	10.1)	(31.9)	(3.7)	(8.1)	(3.4)	(6.0)	(0.1)	(100.0)
EKM	1558	695	827	805	92	236	158	442	3	4846
(%)	(32.4)	14.4)	17.2)	(16.7)	(1.9)	4.8)	(3.3)	(9.2)	(0.1)	(100.0)
TSR	3390	807	1224	879	118	340	180	573	0	7511
(%)	(45.2)	10.7)	16.3)	(11.7)	(1.6)	4.5)	(2.4)	(7.6)	**(0.0)**	(100.01
PKD	3348	1752	2154	2490	334	782	425	1196	9	12490
(%)	(26.8)	14.0)	17.2)	20.0)	(2.7)	6.3)	(3.4)	(9.5)	(0.1)	**(100.0)**
MPM	3689	1801	1356	2062	274	722	375	964	12	11255
(%)	(32.8)	16.0)	12.0)	18.4)	(2.4)	6.4)	(3.3)	(8.6)	(0.1)	(100.0)
KKD	4057	1448	1027	1676	217	738	173	663	4	10003
(%)	(40.6)	14.5)	10.3)	16.8)	(2.2)	7.4)	(1.7)	(6.5)	**(0.0)**	(100.0)
WYD	604	720	476	943	145	320	228	339	9	3784
(%)	(16.0)	(19.0)	(12.6)	25.0)	(3.8)	8.5)	(6.0)	(8.9)	(0.2)	(100.0)
KNR	3377	1948	1391	3011	352	890	345	766	9	12089
(%)	(27.9)	(16.1)	(11.5)	24.9)	(2.9)	7.4)	(2.8)	(6.4)	(0.1)	(100.0)
KGD	1684	1352	917	2048	256	568	350	605	14	7794
(%)	(21.6)	(17.3)	(11.8)	(26.3)	(3.3)	(7.3)	(4.5)	(7.7)	(0.2)	(100.0)
KERALA	34171	15563	14048	20488	2525	6865,	2918	7595	75	104248
(%)	(32.7)	(15.0)	(13.5)	(19.6)	(2.4)	(6.6)	(2.8)	(7.3)	(0.1)	(100.0)

APPENDIX-11

COMMERCIAL VOLUME OF GROWING STOCK OF TREES IN HOMESTEADS OF KERALA DURING 1988–89

(volume in '000 m3 underbark)

DIST	CO	M2	M3	M4	T1	T2	T3	T4	ACE	TOTAL
TPM	758	557	471	350	50	134	21	133	0	2474
(%)	(30.6)	(22.5)	(19.1)	(14.2)	(2.0)	(5.5)	(0.8)	(5.3)	(0.0)	(100.0)
KLM	413	340	260	199	32	87	18	76	0	1425
(%)	(29.0)	(23.9)	(18.2)	(14.0)	(2.2)	(6.1)	(1.3)	(5.3)	(0.0)	(100.0)
PTA	316	242	154	103	25	94	9	44	0	987
(%)	132.0)	(24.5)	(15.6)	(10.4)	(2.5)	(9.5)	(0.9)	(4.6)	(0.0)	(100.0)
ALP	436	198	285	100	10	23	17	72	0'	1141
(%)	(38.2)	17.4)	(25.0)	(8.8)	(0.9)	(2.0)	(1.5)	(6.2)	(0.0)	(100.0)
KTM	290	249	399	138	27	100'	13	53	0	1269
(%)	(22.9)	19.6)	(31.4)	(10.9)	(2.1)	(7.9)	(1.0)	(4.2)	(0.0)	(100.0)
IKI	279	571	283	630	78	155	. 42	116	1	2155
(%)	(12.9)	26.5)	(13.2)	(29.3)	(3.6)	(7.2)	(1.9)	(5.4)	(0.0)	(100.0)
EKM	312	305	323	173	25	56	32	112	0	1338
(%)	(23.3)	22.8)	(24.1)	(12.9)	(1.9)	(4.2)	(2.4)	(8.4)	(0.0)	(100.0)
TSR	678	353	480	187	31	79	32	140	0	1982
(%)	(34.2)	17.9)	(24.2)	(9.5)	(1.6)	(4.0)	(1.6)	(7.0)	(0.0)	(100.0)
PKD	670	767	845	599	81	190	81	299	1	3533
(%)	(19.0)	21.7)	(23.9)	(16.9)	(2.3)	(5.4)	2.31	(8.5)	(0.0)	(100.0)
MPM	738	768	497	429	77	188	74	209	0	2980
(%)	(24.8)	25.8)	(16.7)	(14.4)	(2.6)	(6.3)	2.5)	(6.9)	(0.0)	(100.0)
KKD	811	616	380	372	65	193	29	148	0	2614
(%)	(31.0)	(23.6)	14.5)	(14.2)	(2.5)	(7.4)	1.1)	(5.7)	(0.0)	(100.0)
WYD	121	310	175	203	33	84	45	84	0	1055
(%)	(11.5)	(29.3)	16.6)	(19.2)	(3.1)	(8.0)	4.3)	(8.0)	(0.0)	(100.0)
KNR	675	846	534	753	101	231	60	190	1	3391
(%)	(19.9)	(24.9)	15.7)	(22.3)	(3.0)	(6.8)	1.8)	(5.6)	(0.0)	(100.0)
KGD	337	586	344	487	65	146	66	150	1	2182
(%)	(15.4)	(26.9)	(15.8)	(22.3)	(3.0)	(6.7)	(3.0)	(6.9)	(0.0)	(100.0)
KERALA	6834	6710	5430	4723	700	1760	539	1826	4	28526
(%)	(24.0)	(23.5)	(19.0)	116.5)	(2.5)	(6.2)	(1.9)	(6.4)	(0.0)	(100.0)

APPENDIX-12

NUMBER OF IMPORTANT TREES IN THE GROWING STOCK IN HOMESTEADS OF KERALA DURING 1988-89

(number in '000)

Trees	Diameter at breast height (in cm)									Total (%)
	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80	
Coconut	-	-	94920	-	-	-	-	-	-	94920 (21.47)
Murikku	30434	13034	2053	287	58	30	0	0	0	45896 (10.38)
Cashew	14700	15109	8207	1959	857	155	116	21	0	41124 (9.30)
Mango	13641	10168	4672	1983	961	445	190	56	98	32214 (7.29)
Jack	11549	8624	5837	3146	1699	939	195	67	50	32106 (7.26)
Vatta	17999	7362	899	89	12	5	0	0	0	26366 (5.96)
Tamarind	4040	1454	730	314	155	71	26	14	1	6805 (1.54)
Teak	11776	4638	1368	262	112	4	0	0	0	18160 (4.11)
Matty	13240	4658	356	114	25	17	11	0	0	18421 (4.17)
Anjily	4132	2415	1672	892	480	369	109	14	0	10083 (2.28)
Other trees	68205	35882	8951	2133	514	293	48	13	31	116070 (26.25)
Total (%)	189716 (42.91)	103344 (23.37)	129665 (29.32)	11179 (2.53)	4873 (1.10)	2328 (0.53)	695 (0.16)	185 (0.04)	180 (0.04)	442165 (100.00)

APPENDIX-13

TOTAL VOLUME OF IMPORTANT TREES IN THE GROWING STOCK IN HOMESTEADS OF KERALA DURING 1988-89

(volume in '000 m^3 overbark including branchwood of 10 cm and above girth)

Trees	Diameter at breast height (in cm)									Total (%)
	<10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80	
Coconut	–	-	34171	-	–	-	–	-	-	34171 32.78)
Jack	46	1509	2422	3071	3483	3126	968	446	489	15560 14.92)
Cashew	59	2644	4604	2103	1630	455	529	122	0	12146 11.65)
Mango	55	1779	1939	1935	1970	1483	943	372	893	11369 (10.90)
Murikku	122	2281	1152	308	110	88	0	0	0	4061 (3.90)
Vatta	72	1288	504	95	24	14	0	0	0	1997 (1.92)
Tamarind	16	254	410	337	294	209	118	82	15	1735 (1.66)
Anjily	16	423	776	816	772	900	391	33	48	4175 (4.00)
Teak	47	812	667	256	195	9	0	0	0	1986 (1.91)
Matty	53	815	148	111	52	56	55	0	0	1290 (1.24)
Other trees	272	6280	4455	2273	1021	921	210	122	195	15758 (15.12)
Total (%)	758 (0.73)	18085 (17.34)	51248 (49.16)	11305 (10.84)	9551 (9.16)	7261 (6.971	3223 (3.09)	1177 (1.23)	1640 (1.57)	104248 (100.0)

APPENDIX-14

COMMERCIAL VOLUME OF IMPORTANT TREES IN THE GROWING STOCK HOMESTEADS OF KERALA DURING 1988-89

(volume in '000m3 underbark)

Trees	Diameter at breast height (in cm)							Total	(%)
	20-30	30-40	40-50	50-60	60-70	70-80	>80		
Coconut (CO)	6834	-	-	-	-	-	-	6834	23.96
Jack (M2)	817	1605	1767	1586	477	222	236	6710	23.52
Mango (M3)	654	1011	1000	752	464	185	435	4501	15.78
Cashew (M4)	1313	999	788	212	216	50	0	3578	12.54
Tamarind (M3)	117	160	142	97	48	34	6	604	2.12
Murikku (M4)	329	146	53	41	0	0	0	569	1.99
Vatta (M4)	144	45	12	6	0	0	0	207	0.72
Anjily (T2)	200	187	221	306	150	14	22	1100	3.86
Teak (T1)	369	118	91	5	0	0	0	583.	2.04
Matty (T4)	50	58	26	29	27	0	0	190	0.67
Other trees	1395	1077	492	456	101	53	76	3650	12.80
Total	12222	5406	4592	3490	1483	558	775	28526	
(%)	42.85	18.95	16.10	12.23	5.20	1.95	2.72		100.0

APPENDIX-15

Sample villages for the estimation of growing stock of trees in homesteads, timber-use in building construction, timber and fuel-use by unregistered manufacturing units, etc. are : Karumkulam and Karakulam in Thiruvananthapuram District, Kalluvathukkal and Kulathupuzha in Kollam District, Pramadam in Pathanamthitta District, Ramankary in Alappuzha District, Vellavoor and Melukavu in Kottayam District, Elappara, Konnathady and Kodikulam in Idukki District, Maneed and Parakkadavu in Ernakulam District, Mattathur, Chenthrappini, Koorkanchery and Peringandoor in Thrissur District, Elavanchery, Ambalappara-I and Anakkara in Palakkadu District, Angadippuram and Pulikkal in Malappuram District, Unnikulam and Vanimel in Kozhikodu District, Vengappally and Thavinjal in Wayanad District, Edakkad and Pariyaram in Kannur District and Karindalam and Meenja in Kasaragod District.

For estimating the quantity of wood imported and exported, registers maintained at the following forest check-posts, railway stations and offices were referred to.

Forest check-posts: Kotekar, Ukkuda, Jalsur, Iritty, Muthanga, Noolpuzha, Tholpetty, Vazhikkadavu, Walayar, Parambikulam, Kumily, Achencovil, Arienkavu and Parasala.

Port: Cochin Chamber of Commerce and Calicut Chamber of Commerce.

For estimating the fuel consumption in urban households, samples were surveyed from Thrissur, Chalakudy, Kunnamkulam, Kodungallur and Ayyanthole.

For estimating the consumption of fuelwood and charcoal in tea-shops, restaurants, hostels etc. sample units from Thrissur, Chalakudy, Kodungallur, Irinjalakuda and Chavakkad were surveyed.

APPENDIX 16-1

DISTRIBUTION OF TREES IN HOMESTEADS IN THIRVANANTHAPURAM DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use2)

Trees3	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Coconut	-	-	-	-	-	184.0	184.0	40.6
Jack	19.1	12.6	7.0	1.9	1.9	-	42.5	9.4
Mango	13.1	9.9	6.2	1.6	1.4	-	32.2	7.1
Anjily	18.9	4.3	2.6	0.8	1.5	-	28.1	6.2
Matty	11.6	4.3	1.3	0.3	0.2	-	17.7	3.9
Manjapavatta	6.1	8.8	0.9	0.1	0.0	-	15.9	3.5
Cashew	7.0	6.0	1.1	0.3	0.4	-	14.8	3.3
Tamarind	5.6	1.0	0.6	0.4	0.5	-	8.1	1.8
Vatta	5.6	2.0	0.2	0.0	0.0	-	7.8	1.7
Murikku	5.2	1.0	0.2	0.0	0.1	-	6.5	1.4
Arecanut	-	-	-	-	-	5.0	5.0	1.1
Poovarasu	3.6	1.1	0.0	0.0	0.0	-	4.7	1.0
Panjipoola	0.9	1.2	0.7	0.2	0.3	-	3.3	0.7
Vaka	3.0	0.2	0.0	0.0	0.0	-	3.2	0.7
Punna	2.0	0.3	0.1	0.0	0.0	-	2.4	0.5
Aryaveppu	0.9	0.2	0.0	0.0	0.0	-	1.1	0.2
Pezhu	0.1	0.8	0.2	0.0	0.0	-	1.1	0.3
Kalash	0.5	0.3	0.1	0.1	0.0	-	1.0	0.2
Fruit trees4	37.0	7.2	0.1	0.1	0.0	-	44.4	9.8
Other trees	19.3	6.4	1.4	0.3	0.2	-	27.6	6.2
Other palms	-	-	-	-	-	2.0	2.0	0.4
Total	159.5	67.6	22.7	6.1	6.5	191.0	453.4	
(%)	35.2	14.9	5.0	1.4	1.4	42.1		100.0

'Based on the data pertaining to the villages coming in the district.
2See foot-note20 for definition of dry-land area under agricultural use. ,
names of trees are given in Appendix-17.
4 Include trees such as ***pera, aatha, chamba, muringa, narakam, kadaplavu,*** etc.

APPENDIX 16-2

DISTRIBUUON OF TREES IN HOMESTEADS IN KOLLAM DISTRICT DUUING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Coconut	-	-	-	-	-	60.0	60.0	18.3
Murikku	43.8	9.8	1.5	0.2	0.0	-	55.3	16.9
Arecanut	-	-	-	-	-	36.0	36.0	11.0
Jack	10.0	10.1	4.0	1.5	2.5	-	28.1	8.6
Cashew	8.9	12.8	3.4	1.5	0.9	-	27.5.	8.4
Vatta	15.2	4.6	0.1	0.0	0.0	-	19.9	6.1
Mango	8.0	7.5	2.4	0.5	4.8	-	19.2	5.9
Manjapavatta	3.5	3.2	0.0	0.1	0.0	-	6.8	2.1
Pezhu	0.3	4.4	0.8	0.1	0.0	-	5.6	1.7
Tamarind	3.3	1.2	0.4	0.0	0.1	-	5.0	1.5
Teak	2.1	1.9	0.0	0.0	0.0	-	4.0	1.2
Panjipoola	1.1	1.7	0.5	0.2	0.4	-	3.9	1.2
Vaka	1.8	0.7	0.2	0.0	0.0	-	2.7	0.8
Anjily	2.1	0.1	0.0	0.0	0.0	-	2.2	0.7
Matty	1.0	0.6	0.0	0.0	0.0	-	1.6	0.5
Venga	0.3	0.3	0.5	0.1	0.0	-	1.2	0.4
Nelly	0.7	0.3	0.1	0.0	0.0	-	1.1	0.4
Ezhilampala	0.7	0.3	0.0	0.0	0.0	-	1.0	0.3
Kalash	0.3	0.6	0.1	0.0	0.0	-	1.0	0.3
Fruit trees	9.7	4.4	0.3	0.1	0.0	-	14.5	4.4
Other trees	14.0	13.3	2.9	0.2	0.0	-	30.5	9.3
Total	126.8	77.8	17.2	4.5	4.8	96.0	327.1	
(%)	38.8	23.8	5.3	1.4	1.4	29.3		100.0

APPENDIX 16-3

DISTRIBUTION OF TREES IN HOMESTEADS IN PATHANAMTHITTA DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Vatta	41.2	11.3	0.6	0.0	0.0	-	53.1	18.4
Coconut	-	-	-	-	-	46.0	46.0	16.0
Jack	13.4	4.5	6.0	2.4	1.1	-	27.4	9.5
Arecanut	-	-	-	-	-	26.0	26.0	9.0
Anjily	11.9	4.5	5.7	2.1	1.1	-	25.. 3	8.7
Teak	13.2	3.4	1.9	0.3	0.1	-	18.9	6.6
Mango	5.8	3.6	1.8	0.6,	0.2	-	12.0	4.2
Cashew	4.8	4.5	0.9	0.1	0.0	-	10.3	3.6
Matty	7.3	0.1	0.0	0.0	0.0	-	7.4	2.5
Kudappu1i	1.9	1.5	0.4	0.0	0.1		3.9	1.4
Tamarind	1.0	0.7	0.0	0.1	0.5	-	2.3	0.8
Kalash	1.2	0.7	0.0	0.1	0.1	-	2.1	0.7
Ezhilampala	1.6	0.0	0.0	0.1	0.2	-	1.9	0.7
Murikku	0.7	0.4	0.0	0.0	0.1	-	1.2	0.4
Fruit trees	22.5	1.9	0.1	0.0	0.0	-	24.5	8.5
Other trees	17.6	5.8	1.4	0.1	0.9	-	25.8	9.0
Total	144.1	42.9	18.8	5.9	4.4	72.0	288.1	
(%)	50.0	14.9	6.5	2.0	1.5	25.1		100.0

APPENDIX 16-4
DISTRIBUTION OF TREES IN HOMESTEADS IN ALAPPUZHA DISTRICT DURING 1988-89
(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Coconut	-	-	-	-	-	137.0	137.0	42.1
Matty	9.6	21.3	7.0	1.0	0.7	-	39.6	12.2
Arecanut	-	-	-	-	-	37.0	37.0	11.4
Mango	8.6	7.3	6.2	4.7	4.4	-	31.2	9.6
Poovarasu	7.0	10.7	4.2	1.0	0.0	-	22.9	7.0
Jack	5.2	3.4	3.4	2.1	0.2	-	14.3	4.4
Punna	0.7	1.6	0.0	0.3	0.0	-	2.6	0.8
Cashew	1.0	1.0	0.0	0.0	0.3	-	2.3	0.7
Panjipoola	0.0	0.8	0.5	0.0	0.3	-	1.6.	0.5
Murikku	0.0	0.5	0.3	0.0	0.5	-	1.3	0.4
An]ily	0.3	0.5	0.0	0.2	0.0	-	1.0	0.3
Ezhilampala	0.3	0.5	0.0	0.0	0.2	-	1.0	0.3
Fruit trees	6.8	8.6	1.6	0.0	0.7	-	17.7	5.4
Other trees	5.0	6.3	2.1	1.8	0.8	-	16.0	4.9
Total	44.5	62.5	25.3	11.1	8.2'	174.0	325.5	
(%)	13.7	19.2	7.8	3.4	2.5	53.4		100.0

APPENDIX 16-5
DISTRIBUTION OF TREES IN HOMESTEADS IN KOTTAYAM DISTRICT DURING 1988-89
(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Teak	22.8	8.7	2.7	0.6	0.1	-	34.9	20.1
Coconut	-	-	-	-	-	34.0	34.0	19.6
Anjily	6.0	5.0	2.6	2.1	2.0	-	17.7	10.2
Arecanut	-	-	-	-	-	16.0	16.0	9.2
Jack	3.3	3.4	3.1	2.2	2.0	-	14.0	8.1
Murikku	4.9	7.9	0.3	0.1	0.0	-	13.2	7.6
Vatta	3.1	2.4	0.5	0.0	0.0	-	6.0	3.5
Mango	2.3	1.9	0.6	0.3	0.2	-	5.3	3.1
Matty	3.4	0.9	*0.0*	0.0	0.1	-	4.4	2.5
Cashew	1.4	1.2	0.1	0.1	0.0	-	2.8	1.6
Pullamaruthu	0.7	1.1	0.6	0.1	0.1	-	2.6	1.5
Mu1ilavu	0.2	1.0	0.3	0.1	0.0	-	1.6	0.9
Fruit trees	6.5	2.7	0.2	0.1	0.0	-	9.5	5.5
Other trees	3.9	4.3	0.9	0.4	0.9	-	10.4	6.0
Other palms	-	-	-	-	-	1	1.0	0.6
Total	58.5	40.5	11.9	6.1	5.4	51.0	173.4	
(%)	33.7	23.4	6.9	3.5	3.1	29.4		100.0

APPENDIX 16-6

DISTRIBUTION OF TREES IN HOMESTEADS IN IDUKKI DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Arecanut	-	-	-	-	-	81.0	81.0	28.9
Coconut	-	-	-	-	-	52.0	52.0	18.6
Murikku	29.7	6.6	0.4	0.0	0.0	-	36.7	13.1
Jack	4.3	4.1	3.4	2.2	2.5	-	16.5	5.9
Anjily	3.0	2.0	2.3	1.3	1.9	-	10.5	3.7
Mango	2.0	3 .0	2.6	1.0	0.2	-	8.8	3.1
Pullamaruthu	1.0	4.0	1.2	0.1	0.1	-	6.4	2.3
Cashew	1.4	1.6	1.7	0.4	0.1	-	5.2	1.9
Teak	2.2	1.4	0.6	0.2	0.2	-	4.6	1.6
Vempu	2.9	1.2	0.4	0.0	0.1	-	4.6	1.6
Matty	3.5	0.3	0.0	0.0	0.1	-	3.9	1.4
Rosewood	1.7	1.7	0.3	0.1	0.0	-	3.8	1.4
Silver oak	3.0	0.1	0.2	0.0	0.0	-	3.3	1.2
Vatta	1.0	1.0	0.3	0.0	0.0	-	2.3	0.8
Tamarind	0.3	0.7	0.1	0.1	0.0	-	1.2	0.4
Panjipoola	0.3	0.5	0.2	0.2	0.0	-	1.2	0.4
Ezhilampala	0.3	0.4	0.2	0.1	0.0		1.0	0.4
Manjakadambu	0.2	0.6	0.0	0.0	0.2	-	1.0	0.4
Albecia	0.1	0.4	0.1	0.0	0.4	-	1.0	0.4
Fruit trees	4.6	2.5	0.5	0.8	0.0	-	8.4	3.0
Other trees	9.4	8.8	2.5	0.6	0.6	-	21.9	7.7
Other palms	-	-	-	-	-	5	5.0	1.8
Total	70.9	40.9	17.0	7.1	6.4	138.0	280.3	
(%)	25.3	14.6'	6.1	2.5	2.3	49.2		100.0

APPENDIX 16-7

DISTRIBUTION OF TREES IN HOMESTEADS IN ERNAKULAM DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Coconut	-	-	-	-	-	58.0	58.0	20.7
Matty	35.7	16.4	0.3	0.3	0.1	-	52.8	18.8
Arecanut	-	-	-	-	-	30.0	30.0	10.7
Mango	8.9	7.3	2.9	1.4	2.0	-	22.5	8.0
Jack	5.9	5.0	3.3	2.5	1.8	-	18.5.	6.6
Vatta	10.5	3.2	0.0	0.0	0.0	-	13.7	4.9
Cashew	6.9	4.2	1.8	0.4	0.3	-	13.6	4.8
Murikku	5.7	3.8	0.1	0.0	0.0	-	9.6	3.4
Teak	5.7	2.4	0.4	0.0	0.0	-	8.5	3.0
Kalash	2.4	2.6	1.0	0.3	0.0	-	6.3	2.2
Tamarind	2.8	0.8	0.8	0.4	0.0	-	4.8	1.7
Panjipoola	1.6	1.5	0.1	0.1	0.2	-	3.5	1.2
Ezhilampala	1.3	1.1	0.1	0.0	0.0	-	2.5	0.9
Anjily	1.0	1.0	0.3	0.1	0.0	-	2.4	0.9
Marotty	0.3	0.8	0.2	0.2	0.4	-	1.9	0.7
Mu11i1avu	0.4	1.2	0.1	0.0	0.0	-	1.7	0.6
Kanjiram	0.5	0.4	0.1	0.0	0.0	-	1.0	0.4
Fruit trees	9.5	3.5	0.3	0.1	0.0	-	13.4	4.8
Other trees	6.5	6.0	0.7	0.4	0.3	-	13.9	4.9
Other palms	-	-	-	-	-	2	2.0	0.8
Total	105.6	61.2	12.5	6.2	5.1	90.0	280.6	
(%)	37.6	21.8	4.5	2.2	1.8	32.1		100.0

APPENDIX 16-8

DISTRIBUTION OF TRESS IN HOMESTEADS IN THRISSUR DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Arecanut	-	-	-	-	-	125.0	125.0	25.6
Coconut	-	-	-	-	-	101.0	101.0	20.7
Murikku	17.4	15.2	0.7	0.0	0.0	-	33.3	6.8
Mango	10.0	7.4	6.0	3.1	0.9	-	27.4	5.6
Cashew	6.3	6.4	5.5	3.0	1.0	-	22.2	4.5
Jack	6.0	2.5	4.0	3.0	1.7	-	17.2	3.5
Vatta	10.1	5.0	1.5	0.1	0.0	-	16.7	3.4
Mil1ilavu	7.1	4.8	2.1	0.4	0.1	-	14.5	3.0
Tamarind	5.4	3.1	2.4	1.1	0.5	-	12.5	2.6
Matty	10.1	0.9	0.0	0.1	0.0	-	11.1	2.3
Panjipoola	2.7	3.3	3.0	0.4	0.0	-	9.4	1.9
Teak	4.6	1.9	1.0	0.2	0.0	-	7.7	1.6
Kalash	2.6	2.6	0.2	0.0	0.0	-	5.4	1.2
Anjily	1.8	1.0	0.6	0.2	0.0	-	3.6	0.7
Manjapavatta	2.2	0.7	0.5	0.0	0.0	-	3.4	0.7
Njaval	1.5	0.8	0.7	0.0	0.2	-	3.2	0.7
Vaka	1.3	0.9	0.5	0.2	0.0	-	2.9	0.6
Pullamarutbu	0.7	1.0	0.6	0.0	0.0	-	2.3	0.5
Ungu	1.1	0.9	0.2	0.0	0.0	-	2.2	0.5
Kudappuli	1.1	0.4	0.1	0.2	0.0	-	1.8	0.4
Ezhilampala	0.9	0.5	0.2	0.0	0.0	-	1.6	0.3
Kanjiram	0.8	0.6	0.2	0.0	0.0	-	1.6	0.3
Sandal	1.1	0.1	0.0	0.0	0.0	-	1.2	0.2
Rosewood	0.2	0.1	0.2	0.1	0.4	-	1.0	0.2
Nelly	0.2	0.0	0.3	0.0	0.5	-	1.0	0.2
Fruit trees	14.5	7.3	2.4	0.6	0.1	-	24.9	5.1
Other trees	20.3	7.5	2.2	0.1	0.9	-	31.0	6.3
Other plams	-	-	-	-	-	3.0	3.0	0.6
Total	130.0	74.9	35.1	12.8	6.3	229.0	488.1	
(%)	26.6	15.3	7.2	2.6	1.3	47.0		100.0

APPENDIX 16-9

DISTRIBUTION OF TREES IN HOHESTEADS IN PALAKKADU DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Arecanut	-	-	-	-	-	75.0	75.0	14.8
Teak	50.4	12.2	0.7	0.0	0.0	-	63.3	12.5
coconut	-	-	-	-	-	53.0	53.0	10.5
Mango	14.1	12.9	5.6	2.4	2.5	-	37.5	7.4
Tamarind	19.6	6.2	1.7	1.0	0.8	-	29.3	5.8
Cashew	11.5	10.4	2.1	0.3	0.1	-	24.4	4.7
Nanjapavatta	13.8	8.8	0.9	0.0	0.0	-	23.5	4.6
Sandal	11.6	3.0	0.0	0.0	0.0	-	14.6'	2.9
Kanjiram	9.8	4.5	0.3	0.0	0.0	-	14.6	2.9
Jack	4.9	2.8	2.7	1.3	1.8	-	13.5	2.7
Mulli lavu	6.6	5.5	0.9	0.1	0.1	-	13.2	2.5
Matty	6.7	5.1	0.1	0.0	0.1	-	12.0	2.4
Vatta	6.0	5.5	0.5	0.0	0.0	-	12.0	2.4
Njaval	1.2	7.3	2.7	0.1	0.0	-	11.3	2.2
Aryaveppu	3.9	3.7	1.0	0.1	0.2	-	8.9	1.8
Vaka	3.7	1.4	0.6	0.0	0.1	-	5.8	1.1
Panjipoola	2.4	1.5	0.8	0.0	0.2	-	4.9	1.0
Venga	2.4	0.8	0.1	0.2	0.0	-	3.5	0.7
Poovam	2.1	1.0	0.2	0.0	0.1	-	3.4	0.7
Ezhilampala	0.8	1.1	0.2	0.0	0.2	-	2.3	0.5
Ungu	0.6	0.7	0.0	0.0	0.2	-	1.5	0.3
Nelly	0.6	0.4	0.5	0.0	0.0	-	1.5	0.3
Pullamaruthu	0.8	0.3	0.0	0.0	0.0	-	1.1	0.2
Manchady	0.7	0.4	0.0	0.0	0.0	-	1.1	0.2
Kalash	0.3	0.5	0.1	0.0	0.1	-	1.0	0.2
Fruit trees	9.3	4.8	0.9	0.2	0.0	-	15.2	3.0
Other trees	25.8	13.9	1.6	0.7	1.0	-	43.0	8.5
Other palms	-	-	-	-	-	16.0	16.0	3.2
Total	209.6	114.7	24.2	6.4	7.5	144.0	506.4	
(%)	41.4	22.6	4.8	1.3	1.5	28.4		100.0

APPENDIX 16-10

DISTRIBUTION OF TREES IN HOMESTEADS IN MALAPPURAM DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Coconut	-	-	-	-	-	81.0	81.0	21.3
Vatta	37.9	20.3	1.4	0.0	0.1	-	59.7	15.7
Cashew	16.4	9.2	3.8	1.0	0.0	-	30.4	8.0
Matty	21.5	5.0	0.3	0.0	0.0	-	26.8	7.1
Mango	15.5	5.8	1.9	1.1	0.5	-	24.8	6.5
Jack	12.3	7.4	2.4	0.9	0.9	-	23.9	6.3
Arecanut	-	-	-	-	-	23.0	23.0	6.1
Teak	6.9	2.0	0.1	0.0	0.0	-	9.0	2.4
Murikku	6.0	2.1	0.3	0.1	0.0	-	8.5	2.2
Mullilavu	4.3	2.8	0.7	0.1	0.0	-	7.9	2.1
Tamarind	4.0	0.9	0.3	0.0	0.2	-	5.4	1.4
Sandal	2.7	0.1	6.0	0.0	0.0	-	2.8	0.7
Kanjiram	1.5	1.1	0.2	0.0	0.0	-	2.8	0.7
Vaka	1.8	0.7	0.0	0.0	0.0	-	2.5	0.7
Panjipoola	1.2	0.8	0.1	0.2	0.0	-	2.3	0.6
Elanji	0.9	0.3	0.0	0.0	0.0	-	1.2	0.3
Venga	0.7	0.4	0.0	0.0	0.0	-	1.1	0.3
Fruit trees	17.7	2.9	0.5	0.0	0.0	-	21.1	5.6
Other trees	26.8	15.1	1.7	0.1	0.0	-	43.7	11.5
Other palms	-	-	-	-	-	2.0	2.0	0.5
Total	178.1	76.9	13.7	3.5	1.7	106.0	379.9	
(%)	46.9	20.2	3.6	0.9	0.4	28.0		100.0

APPENDIX 16-11

DISTRIBUTION OF TREES IN HOMSTEADS IN KOZHIKODE DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Arecanut	-	-	-	-	-	140.0	140.0	26.2
Coconut	-	-	-	-	-	121.0	121.0	22.6
Murikku	41.0	15.6	1.2	0.5	0.0	-	58.3	10.9
Vatta	32.9	19.6	1.2	0.2	0.0	-	53.9	10.1
Jack	15.1	7.2	6.0	3.0	2.0	-	33.3.	6.2
Mango	15.3	8.0	3.2	1.7	2.2	-	30.4	5.7
Cashew	8.8	4.5	2.1	1.0	2.5	-	16.9	3.2
Irul	3.0	2.5	0.9	0.5	0.4	-	7.3	1.4
Teak	2.4	1.3	0.5	0.2	0.1	-	4.5	0.8
Mu11ilavu	0.9	1.7	0.3	0.3	0.4	-	3.6	0.7
Vaka	2.7	0.4	0.2	0.0	0.0	-	3.3	0.6
Tamarind	2.1	0.8	0.2	0.2	0.0	-	3.3	0.6
Panjipoola	1.2	0.5	0.5	0.1	0.0	-	2.3	0.4
Kambily	0.7	0.9	0.3	0.3	0.1	-	2.3	0.4
Kanjiram	1.1	*0.5*	*0.0*	0.0	0.0	-	1.6	0.3
Fruit trees	16.8	2.9	0.2	0.0	0.0	-	19.9	3.7
Other trees	14.2	9.7	3.5	0.4	0.4	-	28.2	5.3
Other palms	-	-	-	-		5.0	5.0	0.9
Total	158.2	76.1	20.3	80.4	6.3	266.0	535.1	
(%)	29.6	14.2	3.8	1.6	1.1	49.7		100.0

APPENDIX 16-12

DISTRIBUTION OF TREES IN HOMESTEADS IN WAYANAD DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Murikku	68.5	25.8	4.8	0.9	0.2	-	100.2	27.1
Arecanut	-	-	-	-	-	47.0	47.0	12.7
Cashew	20.2	13.3	5.4	0.9	0.0	-	39.8	10.8
Jack	11.6	10.5	6.8	3.4	2.4	-	34.7	9.4
Silver oak	18.8	5.8	0.3	0.0	0.0	-	24.9	6.7
Mango	6.3	6.9	3.5	1.1	0.5	-	18.3	5.0
Vetty	4.2	10.7	2.4	0.5	0.0	-	17.8	4.8
Rosewood	6.7	3.5	1.4	0.6	0.3	-	12.5	3.4
Coconut	-	-	-	-	-	10.0	10.0	2.7
Anji1y	2.8	3.0	1.9	0.9	'0.5	-	9.1	2.5
Thanni	1.1	1.8	0.9	0.2	0.0	-	4.0	1.1
Vaka	1.6	1.2	0.5	0.3	0.2	-	3.8	1.0
Vatta	1.3	1.7	0.7	0.1	0.0	-	3.8	1.0
Kalash	0.6	1.5	0.7	0.2	0.0	-	3.0	0.8
Pezhu	0.7	1.3	0.1	0.0	0.0	-	2.1	0.6
Matty	1.7	0.1	0.0	0.0	0.0	-	1.8	0.5
Njaval	0.3	1.7	0.4	0.2	0.1	-	2.7	0.7
Kambi1y	0.4	0.8	0.2	0.0	0.1	-	1.5	0.4
Kudappuli	0.4	0.6	0.4	0.0	0.1	-	1.5	0.4
Venteak	0.2	0.6	0.2	0.2	0.1	-	1.3	0.4
Teak	0.6	0.5	0.1	0.0	0.0	-	1.2	*0.3*
Panjipoola	0.2	0.6	0.1	0.1	0.0	-	1.0	0.3
Fruit trees	1.5	1.2	0.3	0.0	0.0	-	3.0	0.8
Other trees	6.9	11.8	3.0	0.8	0.7	-	23.2	6.3
Other palms	-	-	-	-	-	1.0	1.0	0.3
Total	156.6	104.9	34.1	10.4	5.2	58.0	369.2	
(0)	42.5	28.4	9.2	2.8	1.4	15.7		100.0

APPENDIX 16-13

DISTRIBUTION OF TREES IN HOMESTEAD IN KANNUR DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Cashew	36.0	50.1	33.7	5.5	2.9	-	128.2	27.4
Coconut	-	-	-	-	-	66.0	66.0	14.1
Murikku	23.4	14.0	3.2	0.1	0.0	-	40.7	8.7
Mango	18.9	13.8	3.7	1.6	2.7	-	40.7	8.7
Jack	7.6	7.3	4.6	2.3	2.7	-	24.5'	5.2
Arecanut	-	-	-	-	-	24.0	24.0	5.1
Vatta	19.1	2.9	0.8	0.0	0. 0	-	22.8	4.9
Teak	11.9	5.8	2.3	0.3	0.2	-	20.5	4.4
Kanjiram	9.8	5.6	1.8	0.1	0.1	-	17.4	3.7
Tamarinti	3.6	1.1	0.7	0.2	0.3	-	5.9	1.3
Irul	2.6	1.7	0.0	0.0	0.0	-	4.3	0.9
Mu11ilavu	1.0	0.6	0.5	0.1	0.0	-	2.2	0.5
Ezhilampala	1.2	0.1	0.2	0.0	0.1	-	1.6	0.3
Vaka	0.7	0.6	0.2	0.0	0.0	-	1.5	0.3
Sandal	1.3	0.1	0.0	0.0	0.0	-	1.4	0.3
Kalash	0.5	0.5	0.2	0.1	0.0	-	1.3	0.3
Fruit trees	5.2	1.2	0.3	0.0	0.0	-	6.7	1.4
Other trees	34.8	15.2	4.6	0.6	0.4	-	55.6	11.9
Other palms	-	-	-	-	-	3.0	3.0	0.6
Total	177.6	120.6	56.8	10.9	9.4	93.0	468.3	
(%)	37.9	25.8	12.1	2.3	2.0	19.9		100.0

APPENDIX 16-14

DISTRIBUTION OF TREES IN HOMESIEADS IN KASARAGOD DISTRICT DURING 1988-89

(number of trees per ha of dry-land area under agricultural use)

Trees	Diameter at breast height (in cm)					Palms	Total	(%)
	<10	10-20	20-30	30-40	>40			
Arecanut	-	-	-	-	-	299.0	299.0	49.8
Casuarina	87.9	0.3	0.0	0.0	0.0	-	88.2	14.7
Cashew	14.3	13.9	6.1	2.1	2.3	-	38.7	6.4
Murikku	21.1	11.4	3.5	0.5	0.0	-	36.5	6.1
Coconut	-	-	-	-	-	36.0	36.0	6.0
Vatta	12.4	3.4	0.6	0.2	0.1	-	16.7	2.8
Jack	3.9	4.1	3.4	1.3	1.5	-	14.2	2.4
Mango	3.9	3.6	2.1	0.5	1.2	-	11.3	1.9
Teak	4.0	2.3	0.9	0.0	0.0	-	7.2	1.2
Kanjiram	2.5	1.5	0.1	0.1	0.0	-	4.2	0.7
Mulilavu	1.4	1.8	0.8	0.1	0.0	-	4.1	0.7
Rosewood	2.8	0.4	0.1	0.0	0.1	-	3.4	0.6
Tamarind	1.0	0.6	0.3	0.0	0.3	-	2.2	0.4
Irul	0.8	0.7	0.2	0.0	0.1	-	1.8	0.3
Mulleelam	0.9	0.5	0.2	0.0	0.0	-	1.6	0.3
Kudappuli	1.3	0.2	*0.0*	0.0	0.0	-	1.5	0.2
Fruit trees	4.9	1.3	0.2	0.0	0.1	-	6.5	1.1
Other trees	14.6	7.7	1.9	0.3	0.8	-	25.3	4.2
Other palms	-	-	-	-		2.0	2.0	0.3
Total	177.7	53.7	20.4	5.1	6.5	337.0	600.4	
(%)	29.6	8.9	3.4	0.9	1.1	56.1		100.0

APPENDIX-17

NAMES OF TREES IN HOMESTEADS OF KERALA

LOCAL NAME(TRADE NAME)	CLASS	BOTANICAL NAME*
Aatha	M4	*Annona reticulata Linn.*
Acacia	ACE	*Acacia auriculiformis* A. Cunn.ex Eenth.
Aki1	T2	*Dysoxylum malabaricum* Bedd. ex Hiern
Albizia	T2	*Albizia falcataria* (Linn.) Fosberg.
Ambazham (Indian Hogplum)	M4	*Spondias pinnata* (L1nn.f.) Kurz
Anjily (Ayani)	T2	*Artocarpus hirsutus* Lamk.
Annakara	T4	*Garuga pinnata* Roxb.
Aranamaram	M4	*Polyalthia longifolia* (Sonner.)Thw
Aryaveppu (Neem)	M3	*Azadirachta indica* A. Juss.
Athi	T3	*Ficus racemosa* Linn.
Badam (Indian almound)	M3	*Terminalia catappa* Linn.
Chadachi (Dhaman)	T2	*Grewia tiliifolia* Vahl.
Chandanam (Sandal)	T1	*Santalum album* Linn.
Chembakam (Chembak)	M4	*Michelia champaca* Linn.
Cheru	T3	*Holigarna arnottiana* Hk.f.
Choolamaram	ACE	*Casuarina equisetifolia* J.R. & G.Forst.
Edana	T3	*Cinnamomum sp.*
Elanji (Bulletwood)	T2	*Mimusops elenji* Linn.
Eucaly (Eucalypt)	ACE	*Eucalyptus* sp.
Ezhilampala (Shaitan wood)	T4	*Alstonia scholaris* (Linn.) R. Br.
Irul	T2	*Xylia xylocarpa* (Roxb.) Taub.
Kadaplavu (Breadfruit)	M4	*Artocarpus cummunis* J.R.& G.Forst.
Kalash	T3	*Lannea coromandelica* (Houtt.) Merr.
Kambily	T4	*Euodia lunu-ankenda* (Gaertn.)Merr.
Kanakamaram	M4	*Cananga odoratta* Hk.f. & Thoms.
Kanikonna (Indian laburnum)	T2	*Cassia fistula* binn.
Kanjiram	T3	*Strychnos nux-vomica* Linn.
Kara	T3	*Elaeocarpus tectorius* (Lour.) Poir.
Kasumavu (Cashew)	M4	*Anacardium occidentale* Linn.
Koovalam	M3	*Aegle marmelos* (Linn.) Corr.
Kudappuli	M3	*Garcinia gummi-gutta* (Linn.) Robs.
Kumizhu (Gamari)	T3	*Gmelina arborea* Roxb.
Kunnivaka	T2	*Albizia odoratissima* (Linn.f.) Benth.
Mahagony	T2	*Sweitenia mahagony* (Linn.) Jacq.
Manchady	T3	*Adenanthera pavonia* Linn.
Manjakadambu (Haldu)	T3	*Haldina cordifolia* (Roxb.) Ridsd.
Manjapavatta	T3	*Morinda pubescens* J.E.Sm.
Marotty	M3	*Hydnocarpus pentandra* (Buch-Ham.) Oken.
Matty	T4	*Ailanthus triphysa* (Dennst.) Alston.
Mavu (Mango)	M3	*Mangifera indica* Linn.
Mullankainy Kasi)	T2	*Bridelia roxburghiana* (Muell.-Arg) Gehm.
Mu11eelam	T3	*Zanthoxylum rhetsa* (Roxb.) DC.
Mullilavu (Semul)	T4	*Bombax ceiba* Linn.
Murikku	M4	*Erythrina stricta* Roxb.
Nelly (Gooseberry)	M3	*Emblica officinalis* Gaertn.
Njaval	T2	*Syzygium cumini* (Linn.) Skeels.
Othalam	T4	*Cerbera odollam* Gaertn.

LOCAL NAME (TRADE NAME)	CLASS	BOTANICAL NAME
Panjipoola (Kapok)	T4	*Ceiba pentandra* (Linn.) Gaertn.
Parakam	T3	*Ficus hispida* Linn.f .
Pathiri (Padri)	T3	*Stereospermum colais(Buch-Ham-ex* Dillw.) Mabber .
Payyani	T4	*Oroxylum indicum* (Linn.)Vent.
Pera (Guava)	M4	*Psidium guajava* Linn.
Peral (Banyan)	T3	*Ficus benghalensis* Linn.
Pezhu (Kumbi)	T4	*Careya arborea* **Roxb.**
Plavu (Jack)	M2	*drtocarpus heterophyllus* Lamk.
Poovam	T2	*Schleichera oleosa* (Lour) Oken
Poovarasu	T2	*Thespesia populnea* **(Linn.)Soland.ex.Correa**
Pottami	T4	*Trema orientalis* (Linn.) **Bl.**
Pulimaram (Tamarind)	M3	*Tamarindus indica* Linn.
Pulla Maruthu (Kindal)	T2	*Terminalia paniculata* Roth.
Punna (Alexandrian laurel)	T2	*Calophyllum inophyllum* Linn .
Silver oak	M4	*Grevillea robusta* A. Cunn.
Sinduram	M3	*Mallotus phillippensis* (Lamk.) Muel1.-Arg
Thanni	T3	*Terminalia bellirica* (Gaertn.) *Roxb.*
Thekku (Teak)	T1	*Tectona grandis* Linn. *f.*
Thembavu	T2	*Terminalia crenulata Roth*
Thengu (Coconut)	CO	*Cocos nucifera* Linn.
Therakam	T3	*Ficus exasperata* **Vahl**
Ungu (Indian *beech)*	T4	*Pongamia pinnata* (Linn.) Pierre.
Vaka	T2	*Albizia* sp.
Varangu	T4	*Carallia brachiata* (Lour.) Merr .
Vatta	M4	*Macaranga peltata (Roxb.)* Muell-Arg.
Veeti (Rosewood)	T1	*Dalbergia latifolia Roxb.*
Vempu	T3	*Toona ciliata* Roemer
Venga (Bijasal)	T2	*Pterocarpus marsupium* Roxb.
Venthekku (Venteak)	T2	*Lagerstroemia microcarpa* Wt.
Vetty	T3	*dporusa lindleyana* (Wt.) Baill.

* Botanical names are taken from Sasidharan, 1987.