ECONOMY OF THE FORESTS

Forests are the source of numerous products and raw materials, which are put to a variety of uses. The raw materials play a decisive role in the agroindustrial economy. Therefore, a knowledge of forest products is essential. In fact, every forest product, right from decaying leaf-litter to highly valuable teak timber, has direct or indirect economic importance. It is customary to distinguish principal and subsidiary forest products into two categories:

i) Major forest products

ii) Minor forest products

Major forest products include mainly timber and fire-wood (including charcoal) while the minor products are leaves, fruits, grasses, bamboos, gum, lac, honey etc. On the basis of these variety of raw materials, cottage industries like bidimaking and large scale industries like pulp-wood manufacture in this region have developed.

Timber is classified into hard-wood and soft-wood. The main species of hardwood found in
this region are teak, babhul, dhavada, ain, shisam, tiwas and shiras. Teak is the most important timber specie in this region. The numerous uses of this specie are well known. It stands out as a prized specie of this region due to its superior working quality, stability and durability, as compared to other species. The quality of teak depend upon the geographical conditions in which it grows. Consequently, its soundness and the rate of growth vary spatially in the western ghats region. These spatial variation are revealed in the graphs showing relative age and height, age and girth, age and volume etc. Fig. 47 reveals that, in the western districts, namely, Thana, Kolaba and Ratnagiti and in the Feint of Nasik district, teak attain a greater height than those growing in eastern districts of Poona and Satara. In the former region, teak attain a height of more than 14 metres at the age of fifty while in the district of Poona, they do not attain that much height even after 100 years. Same is the case with age and volume, the relation between which is represented in graph (Fig. 48). Height and diameter increases at a constant rate as shown in graph (Fig. 49). In the western districts, teak attain a height ranging between 16 and 20 metres and a diameter of 30 cms. at the
Height and age relation of teak tree

- Sawantwadi
- Peint
- Thana
- Kolaba
- Satara
- Poona

X axis: Age in years
Y axis: Height in meters

See fig. 50 for source.

Fig. 47
Volume & age relationship of teak tree

X axis: Age in years.
Y axis: Volume in cub. meters.

See fig. 50 for the source.

Fig. 48
Height and diameter relationship of teak tree

Sawantwadi
Peint
Thanha
Kolaba
Satara
Poona

X axis: Dia. in cm.
Y axis: Height in meters

See fig. 50 for source.

Fig. 49
age of 50-70 years. On the other hand, the teak trees in Satara and Poona attain the same diameter at the age of 60-80 years, and still have lesser height which is about 14 metres. During the first 50 years of their growth, a sharp rise is observed in the height of teaks invariably in all parts of the region. However, in the eastern areas i.e. in Poona and Satara districts, there is only a small rise after this age while they keep on growing high in the western regions even after. One finds a constant increase in the height of teak even up to the age of 100 years in Point area. Similar contrasts are observed in volume and height (Fig. 50) of teak in these areas, It may be stated that the region lying to the east of the ghats is economically unsuitable for teak plantation as compared to the areas lying to the west of the ghats. The seeds of teak are profuse almost every year, and by their characteristics, they are resistant to fire and grazing. In spite of these facts, teaks do not regenerate in this region on a satisfactory scale. On the contrary, timber species of secondary importance, like air, dhavada, babul have a better regeneration. The result has been that, teak seeds have to be regenerated in nurseries leading to an increase in the cost of production. The other
Height and volume relationship of teak tree

X-axis: Volume in cubic meters
Y-axis: Height in meters

Source: Working plan (1969 to 89) for the reserved forest of Thana, Kolaba, Peint, Satara, Poona, and Sawantwadi.

Fig. 50
hardwood timber species are babhul, ain, shiras, shisham and tiwas.

Red, mango, jambhul and sawar are some of the softwood species, which have special significance in industries like manufacture of matchboxes, packing cases etc. Ain, dhavada, hirda and moha are mainly used as fire-wood or in preparing charcoal. Now-a-days, any wood, which is not used as a timber, is utilized as fire-wood. Bamboo ranks next to teak in importance on account of its wide application and uses. It plays a very important role in rural economy. Katas, manvel and bundi, are the three most remarkable species of bamboo found in this region.

The total expenditure and revenue obtained from forests are shown in graph (Fig. 51A & B). It is obvious that forestry is always profitable. In the region under present study, the average net profit is highest (223.67%) in the district of Thana, while it is 174.45% in Kolaba and 123.76% in Sawantwadi. In general, economy of forests is always profitable.

A considerable amount of expenditure has been incurred for the development of forests since 1953 in the district of Thana which has returned an increasing amount of net profit but there is no constant relation
Graph showing the expenditure on, and revenue from forest.

Fig. 51A
Sawantwadi

Graph showing the expenditure on, and revenue from forest

--- Estimated values

See fig. 50 for source

Fig. 51B
between these two factors found over this period. It can be seen that there have been wide fluctuations in the monetary investment in forests and the net output gained from them. In spite of the increasing net profit, the prices of timber, fire-wood, charcoal and even bidi-leaves are constantly increasing. The rate of increase has been so great that the prices of all these commodities have doubled during the last decade. The increase during the period 1936-46 i.e. preceding and succeeding the world war II, was witnessed to about 2.5 times (Fig. 52). Since then, the prices are rapidly increasing without any check. The regional comparison reveals that the prices of timber and other forest material have always been less in Peint region than in Thana and Kolaba. The rate of increase is also slow in the former region than in the latter areas. This is due to the facts that till recently, there were no forest-based industries in Peint and the communication facilities were least. The conditions have been changing in favour of industries in the present decade. The prices have been higher in Thana district than in Kolaba more or less for the same reasons. The industries of Bombay are consuming a greater amount
RATE OF INCREASE since pre-war period

I) Teaks 121 cm. girth & above 2 m. length
II) Teaks 90-120 cm. girth & above 4 m. length
III) Teaks 61-90 cm. girth & above 4 m. length
IV) Teaks 51-90 cm. girth & above 4 m. length
V) Teaks 22-45 cm. girth & less than 4 m. length
VI) Charcoal: in metric tonnes
VII) Fire wood: in metric tonnes

Rates of Teak in cubic meters.

See Fig. 50 for source.

Fig. 52
of raw material from forests every year. The pulp-wood industry of Thane district requires more than 250 tonnes of wood per day. That is to say, the pulp-wood industry consumes about 72,000 tonnes of forest material per annum. Eucalyptus and bamboos are mainly used for this purpose.

The price of teak timber was 640 Rs. per cu. m. in 1972-73 in the district of Nasik. It increased to Rs. 830 in 1974-75 and now it is 980 Rs. i.e. the rate of teak timber increased by 51.6% as compared to that in 1972-73. Similarly, the rates of Inajli timber, fire-wood and charcoal increased respectively by 48% per cu. m., 100% per m.t. and 84% per m.t. The rates are increasing due to the increasing rate of industrialization in this district. In 1971-72, there were only 57 forest based industries in this region, out of which 23 were wood and cork factories, while during 1976-77, the number of these factories, increased by 102.

Graph (Fig. 53) shows average forest income of 10 years (1965-75). On the basis of this output, the region under present study can be divided into two zones. The first region includes district lying to the west of the ghats while the second includes those lying to the east, covering a part of Maharashtra plateau. The
western districts include Thana, Kolaba, Ratanagiri, Nasik and Dhulia, having an income of more than one million rupees each. On the other hand, the eastern districts have income of less than one million rupees. These include districts of Poona, Satara, Sangli, Ahmednagar and Kolhapur. More than half the income from forest is gained from fuel in the western region mainly in Thana, Kolaba and Dhulia while timber is the main source of income in Nasik and Ratnagiri districts. Though Ratnagiri district has only 3% of its geographical area under forests, its average annual income from forests is more than Rs. 1.2 million. The forests of Sawantwadi cover about 37% of the total forested area of the district of Ratnagiri. In this region, as shown in graph (Fig. 53), a greater amount of income is gained from major products including timber and fuel as compared to minor products, namely grass, bamboo, gum, honey etc. In the district of Kolhapur and Satara, timber and fuel account for more than half of the income while grass alone yields that much income in the district of Poona. Sandlewood is found in a greater quantity in the eastern districts than in the western region. The greatest amount of income from sandlewood is yielded in Kolhapur, whereas it is relatively less in the districts of Poona, Sangli and Ahmednagar.
Major Products

Million Rs.

10

9

8

7

6

5

4

3

2

1

0

THANA

KOLABA

DHULIA

NASIK

RATNAGIRI

Revenue from major and minor products.

Fig. 53A

Minor Products

B bamboo
G grass
O other products (leaves, honey etc.)

0,000 Rs.

0

1

2

3

4

5

6

Thana

Kolaba

Dhulia

Nasik

Ratnagiri

FUEL
TIMBER
MINOR PRODUCTS
Revenue from major and minor products

Fig 53B

- KOLHAPUR
- POONA
- SATARA
- AHMEDNAGAR
- SANGLI

- Fuel
- Timber
- Sandalwood
- Bamboo
- Grass and Grazing
- Other Products (leaves, honey etc.)
The forest products other than timber, bamboo and fire-wood are classed as Minor forest produce. They are grouped into grasses, stems, roots, leaves, flowers, fruits and seeds. Grasses are of great importance in our agro-based economy as animal feed cattle are fed on pastures in the forest while agricultural cattle are provided with cut-fodder. The grass cut from forests has an important stand for the cattle population of areas adjoining forests, especially during famines. The common types of grass found in this region are Dongrigavat, Marvel, Gondval, Kunda and Sheda. The use of grass for thatching is strictly local. The species which are locally available are used for this purpose. Rosha grass yields the commercially important Rosha-oil, which is commonly used in soaps and scents. Stems and roots are used for fibres, tannins, dyes and medicines. Apta, Bhendi, Kandol and Warang provide for manufacturing ropes. A few of them yield fine fibre. Jamba, Bor, Ain; Babhul and Bava are some of the important species used for preparing tannin. Dyes are extracted from the following species:
L

<table>
<thead>
<tr>
<th>Local name of the vegetation</th>
<th>Type</th>
<th>Botanical name</th>
<th>Part used</th>
<th>colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anjani</td>
<td>tree</td>
<td>Memecylon edule</td>
<td>leaves</td>
<td>yellow</td>
</tr>
<tr>
<td>Adulsa</td>
<td>shrub</td>
<td>Adhatoda vasica</td>
<td>leaves</td>
<td>yellow</td>
</tr>
<tr>
<td>Dhyti</td>
<td>shrub</td>
<td>Woodfordia floribunda</td>
<td>flower, leaves, twigs,</td>
<td>red</td>
</tr>
<tr>
<td>Palas</td>
<td>tree</td>
<td>Butea frondosa</td>
<td>flower</td>
<td>yellow</td>
</tr>
<tr>
<td>Palaswel</td>
<td>climber</td>
<td>Butea superba</td>
<td>flower</td>
<td>yellow</td>
</tr>
<tr>
<td>Bihaul</td>
<td>tree</td>
<td>Acacia arabica</td>
<td>barks</td>
<td>safron</td>
</tr>
<tr>
<td>Lokhandi</td>
<td>tree</td>
<td>Oxora parviflora</td>
<td>roots</td>
<td>brown</td>
</tr>
</tbody>
</table>

The colours extracted from these parts of trees are used for dying cloths, paper etc. Gum extracted from dhavada is used in printing of cloth. Charcoal prepared of kapshi is used for making gun-powder. Many species are classed as medical herbs and are used in homeopathic medicines. Some products like gum of wawar and tivas are used in medicines. Hirda is used in Trifala churna (powder of three types of fruits). Nimb is used for making medical oil and scopg. The following species are significant as medical herbs:

<table>
<thead>
<tr>
<th>local name of vegetation</th>
<th>Type</th>
<th>Botanical name</th>
<th>Parts used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adulsa</td>
<td>shrub</td>
<td>Adhatoda vasica</td>
<td>roots, leaves, flowers, &amp; fruits</td>
</tr>
<tr>
<td>Avala</td>
<td>tree</td>
<td>Phylanthus emblica</td>
<td>bark, fruits, flowers, seeds.</td>
</tr>
<tr>
<td>Kuda</td>
<td>shrub</td>
<td>Holarrhena antidysenterica</td>
<td>bark, leaves, seeds, flowers</td>
</tr>
</tbody>
</table>
Many species are loped as leaf fodder.
The most important among them are babul, belm apta. Agave leaves yield valuable fibre, widely used in rope making. Leaves of palas and toddy palm are used for thatching. Most remunerative leaves are the bidi-leaves obtained from tembhurni, apta and others. The total revenue obtained from leaves amounts to almost one-third of the total revenue by way of selling minor forest products.

**Forest Management, history, exploitation and conservation**

Before the Marathas came into the power (1674), when Shivaji's coronation took place, there was no check on forest exploitation. The Maratha rulers had controlled the forests and their produce in some definite manner over the area of western ghats excluding Peint region as it was under Mughal administration. Maratha government had notified teak and black wood (khair) as 'Royal wood' which was the property of Government. Such trees
were, however, conceded under written grants (Sanads) to temples. Naturally these forests were protected well till now. An old forested area exists at a place located about a mile away from Sonavadi in the Mulshi Tahasili of Poona district. The area is known as "Davachi Rathi" (Sample no. 18). Another example which may be cited in this context is that of the forests near Shirgaon (Bhor tahasili, Poona district) still unexploited (Sample no. 35). There is a pond called 'Nira Kund' in which an image of Lord Shiva has been placed and people take it as God's order not to cut the trees in that forest. Besides the general right of disposal of 'Royal trees', the Maratha government had reserved the right to dispose off timber, firewood and grass from certain areas, which were known as 'Kuranas'. These Kuranas were given for disposal on contract basis for a certain period, which was known as 'Vanamakta' (Monopoly in forest). The rights for grazing were also given on contract and were known as 'Vanachari' (grazing in forests). Taxes were imposed on these activities in forests. Besides that forest management, Marathas had also taken steps to preserve natural vegetation around forts and in the valleys with the intention of preventing easy approach to their fortifications. This is revealed in the order executed 'Ramachandra Amatya', in which it has been explained that there were big foot paths to Gaths (Forts) and these were to be disturbed and trees to be planted so that the enemy could not attack easily.
It has also mentioned that the executive officer would be annoyed if the trees plantation carried by forefathers, were cut. Thus, Maratha Government always cared for forests and trees¹.

Most of the tributary revines of Bankot creek were covered with fine teak prior to 1756. This teak was highly valued as 'Bankot knees', which was exported to Bombay. Most of the fine old ships of Indian navy came from Bankot and its neighbourhood. The forests along Savitri and Vasishti river (Ratnagiri district) were used for similar purposes. During the same period, the Arab traders carried a lot of wood from the forests along Kajvi and Muchkundi rivers to Basibar. At present, the area immediately around Malvan has less than 10 percent of the total area under forests, but the historical references prove that it was thickly forested during Maratha regin. Marathas had large ship building yards at Malvan and Vijaydurg. Though they consumed much of the fine timber, steps were taken to preserve tree and maintain the supply¹. In spite of the fact that these three i.e. Marathas, Arabs and British rulers made use of forests for various purposes, the forested area was maintained very well

till 1829 A.D.

The forested area around Dapoli has been preserved since 1880 A.D. Consequently, it still has more than 30% of the total area under forest cover. The forested area in the adjacent tahsils of Rajapur and Deogad, have been preserved for an even longer period than the forests of Dapali. This area was owned by Kanhoji Angre, the then admiral of emperor Shivaji in 1680 A.D. Presently, the forested area in this region ranges between 30-100%, the maximum being found around village Sherigherre-kamte located in the Deogad tahsil of Ratnagiri district, only 432 villages have forests, while the remaining 1090 have no forested area at all.

After the downfall of Marathas (1808), the British started surreptitious occupation of lands and stripping them of their growth for cultivation spelt ruination of forested areas. The need for conservation of forests was not recognized till 1840, when Dr. Gibson was appointed by British government to inspect the forest area of Deccan. The purpose for dockyards and was to supplement the depleted teak supplies from Kanara and Malabar for dock yards. He commanded in the forests as of little account for external commercial purposes, although capable of being turned to profitable use.
After 1840, arrangements were made to demarcate reserve forests around villages and a system of management was organized by the forest department after 1854. 'Vanmakta' system was abolished and department system was started in 1862. However, till 1890, there was no systematic plan for exploitation as well as conservation. It was only after 1890 that, the district wise plans were prepared for this purpose. During 1894-1905, various types of plans were prepared for Thana district e.g. Working Plan for forests of Bassein, Bahim and Vada range (Millett-1895). A plan was prepared by Fisher in 1902 for Khardi and Murbad ranges. In 1922, Aitchison and Hamilton prepared plan for the district as a whole with a rotation of 80 years. The same plan was revised by Starte in 1935 and again in 1951 by Jadhav. It is again under revision at present. The first plan for Nasik district was prepared by Dodgon in 1898, which was revised in 1912 by Me. Gansalves. A new plan was prepared in 1936 by H.W. Starte, which is being implemented now. Similar plans have been prepared for other districts.

**FOREST TRIBES**

The population in forested areas mainly consists of tribals. Map (Fig. 54) shows the distribution of forest tribes. Of the total tribal population, which is about 2.4 millions, in Maharashtra, nearly half is found
DISTRIBUTION OF DIFFERENT FOREST TRIBES

V - Varli
B - Bhit
M - Koli Mahadev
O - Kokna
T - Thakur
A - Katkari
K - Koli Malhar
N - Naikada
d - Dhodia
u - Dubla
r - Koli Dhor
p - Pardhi

Capital letter 10,000 tribals
Small letter 1000 tribals
in the western Ghat and Konkan region. There are about twelve different types of tribes found in various parts of these areas. The district of Thana alone has about one-third of it (0.5 Million) which account 30% of the district population. Varli, Koli-Mahadev, Koli-Malhar, Thakur, Katkari Kokna, Dhodia and Duble... are the most significant among them. The district of Nasik has the second largest number of tribals mainly including Koli-Mahadev, Kokna, Bhil and Thakur, While Bhils, koknas and Naikadas are found in large number in the talukas of Nandurbar, Sakri and Nawapur of Dhulia district, these talukas being a part of region under present study. Thakurs and Katkaris may be included in the tribals of Kolaba district.

The most common characteristic feature of the tribals is that they are mainly confined to hilly and forested areas. Their livelihood is dependent upon forests to a considerable extent. Among the major tribes, Koli-Mahadevs and Bjiils are found on the plateau, while Varlis, Koli-Malhars and Thakurs are widely spread over the northern coastal region. Koknas are common in both regions. A slow movement of these groups towards each others' territories may also be observed. Varlis and Koknas moved north-eastwards to Peint and Surgana regions of Nasik and to south-
ern hilly parts of Dhulia district, while Bhils are moving southwestwards through the same region. Koli-Mahadevs are found in a region extending north-south from Surgana (Nasik district) to Ambegaon-Junnar tahasils (Poona district), mainly occupying the elevated and forested areas. The following concise account of the way of living of these tribals reveals the relative influence of forests and the tribals upon each other.

Job offered to tribals in forested regions:

Tribals reside in villages located in the forest areas near agricultural lands. The forests offer good job to a number of landless persons belonging to the tribal groups, especially in the agriculturally off season. Owing to poorer soils, traditional methods of farming and lack of monetary investments, these people get a very low and inadequate output by way of agriculture. Consequently, they have to look for other jobs related to forests where they do not have to make any monetary investment. Some of them ply carts, carrying timber and fuel wood. A few of them collect forest products such as wild fruits, gum, honey, barks, and sell them in nearby markets. Others work as labourers with forest contractors or rear cattle in forests.
Farm implements: & Building material

Wood is used for every farm implement e.g.

Nangar (Wooden plough), Kurhad (Axe), Koyata (Sickle) and others including Kudal for digging, alwat for levelling, datal for breaking up lumps. The material required for constructing houses are obtained from the neighbouring forests. The walls are made up of Karvi reeds and the roofs are generally thatched with grass or leaves. The doors are made up of woods, Karvi reeds or bamboos available in the forested tracts. In some houses, the place for bathing and the place for storing fuel is enclosed by Karvi reed partition.

Method of farming, Food, Customs:

The tribals burn leaves, twigs and grasses, in their fields before the onset of rains. This process of preparing land for cultivation is known as 'Rab'. This obviously means cutting of twigs, leaves and grass from forests as a result of which, the forests have only remnants of trees during summer. This is found mainly in Konkan area.

When the stock of foodgrains is exhausted, Varlis cook roots and leaves of some wild trees as vegetables and also eat a number of wild fruits such as Karwand, Umber, Hurde, Jambhul, and Avala. Foodgrains are stored in baskets or in Kangas or Dholis made of bamboo.
Many of the customs of tribals reveal a deep impact of forests. They always make use of leaves and flowers on festival occasions. Particular type of trees are held suspicious on particular festival days. It is interesting to note that in marriage ceremonies, sticks of Umber, Jambhul, Mango and Rui-cotton are lightened by priests in the house. Toran (a bunting made of green mango leaves) is also used on this occasion. Leaves of Apta are exchanged among relatives and friends as greetings on Dasara festival. The exchange of these Twi-leaved leaves indicate the wish that the mutual friendship may till the end of life. Besides this, the names of persons are also many times related to plants e.g. Shirish, Kamak, Jai, Chameli, Bhakul can be cited as example of plant names or names of flowers given to persons. These names are not only common in tribal population but also generally in various societies of Maharashtra.

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An ecosystem is the basic functional unit in nature. It includes both organisms and biotic environment. The solar energy is tapped by the process of photo-synthesis by green plants. These plants are consumed by herbivorous animals and the carnivorous thrive on these animals. This transfer of energy is one of the complex phenomena in the ecosystem. The balance in the flow of energy gets disturbed because of numerous reasons, depending upon the environment. So, it is essential to study and comprehend the factors responsible for the imbalance or disturbance in the ecosystem of a region.

The term ecosystem was first coined in 1935 by the plant ecologist, Tansely, who included the whole complex of living organisms together with the habitat in which they exist in the eco-system. F.R. Fosberg defined it as a 'functioning interacting system composed of one or more living organisms and their effects upon environment, both physical and biological. It was then referred by Heinrich
Walter as an open system, since there is an inflow of external energy from solar radiation and other forms. However, the organisms form the principal component in the eco-system, and on the basis of their significance, three groups of organisms can be clearly identified. The first group includes the producers of mainly green plants, which store the solar energy as chemical energy by way of building organic compounds. The organisms in this group are known as 'Primary producers'.

The second group includes 'The Consumers'. These are animal organisms thriving on plant food. This process is called 'Secondary production'. The third group is of 'The Decomposers'. The process of decomposition results in breaking down or mineralization of plants and animals. Any disturbance in any of these three groups of organisms results in a disequilibrium in the whole system & the harmonious functioning of the system is lost. Left to itself nature tends to restore equilibrium by a result in remedial mechanism, but recurrent interference by man perpetuates this disturbed state. It was observed in the Western Ghat region that the consumers are increasing in population on account of various reasons. This increase has affected the producers, resulting into a disturbance in the eco-system. A qualita-
Tive analysis based on observation shows that the eco-system in this region is characterised by bimodal distribution of plant frequency.

The lack of trees in the intermediate strata is already dealt in the previous chapters. Thus the bimodal distribution of plants fits well in the eco-system even while considering the optimal exploitation of trees for agricultural purposes. The reduction in the population of trees in the higher stratum is the most dangerous factor disturbing the ecosystem in this region. The existence of trees is, in many ways, supplementary to that of grasses. Many shrubs and trees provide fodder and this effects a release in the pressure on grasses. Thus the balance distribution of plants among various strata has its own stability, whereas the bimodal distribution is more susceptible to destruction by man. Besides, the growth of big trees, essentially needs longer duration of time to complete their cycle. The floral composition is tending to a state when there would be enormous reduction in tree population in comparison with that of grasses and hence a greater amount of imbalance in the eco-system. Afforestation is, therefore, essential not only to increase the population of trees but also to maintain the ecological balance of plant life.
Fall in the density of grasses

Interview with the shepherds during the field work revealed that the density of grasses is decreasing. This fact is easily accepted by botanists. Their argument is that the life cycle of a particular grass species needs optimum amount of rainfall. And unless the life cycle is completed, seeds are not available for germination in the succeeding season. This is the cause of reduction in the density of grass, year by year. However, eco-system suggests that this reduction in the amount of grasses, may be due to a decrease in the rainfall, which has been responsible for changing the hereditary characteristics of grasses in the region. Thus, according to botanists, there is an adaptive modification achieved through evolutionary process. The reduction in the rainfall, which forms the basis of the hypothesis of changes in the hereditary characteristics, however cannot be quantitatively proved. The running averages show a slight increase in rainfall. For instance, Vadgaon, Ratnagiri and other places, of which rainfall data are available show a significant decrease in the yearly amount of rainfall. This reduction can be explained as a result of following facts: Firstly, accepting the decrease in the density of grasses, change in the seasonal distribution of rainfall may be considered as the main cause. Seasonal distribution of rainfall is mostly bimodal in the monsoon regions. The region
receives rains in the early monsoon season as well as in the late monsoon season separated from each other by a significant duration of dry spell. Parts of the seeds formed from the growth of grasses in the first part of the monsoon get germinated at the time of last wet spell i.e. in the months of November and December. This may be the cause of reduction in the availability of seeds for the next monsoon season and hence reducing the density of grasses. One may however, argue that the evolutionary processes may be responsible for redressing the coverage of grass by some successful adaptive modifications. This would have been accepted if the rate of evolutionary processes and that of seasonal variability of rainfall is the same. It is worthwhile accepting the limitations of the evolutionary processes giving scope to the factor of seasonal variability of rainfall to be responsible for the change in coverage of grasses, since the seasonal variability noticed in this region has continued ever since and no change has been noticed. A Statistical proof of this can be obtained with more in-depth study covering a large period of time.

The decreasing coverage of grass could also result from the increasing livestock population pressure. The scarcity of fodder may be directly responsible for intensive utilization of grasses, a fact detrimental to the
completion of the life cycle of grasses and the resulting inadequacy of seeds for the next season. This is a type of disturbance in the ecological balance. However, this may not be a particular characteristic phenomenon of the region, but a common feature of the monsoon regions in general. Precise statistics regarding the reduction in the grass coverage can be found after obtaining various types of data.

**Human interference and Plant life in Western Ghats**

The distribution of plant life is affected by human activities. Firstly, the direct destruction is due to the utilization of grasses, trees for the purpose of agriculture. Secondly, the changing land-use patterns cause reduction in the area under natural vegetation cover. For example, establishment of roads, railways, settlements may be cited. The roads and railways serve as paths of human encroachment in forested tracts and thereby impair the natural environment. One can observe both, the qualitative and quantitative changes, in vegetative cover along these lines of communication. The changes due to human activities at Mahabaleshwar and Matheran offer evidence of this state of affairs. A much greater destruction of natural vegetation is observed at Mahabaleshwar than at Matheran. This is obviously in proportion to the human interference at these two hill stations. Building of metalled roads all over Mahaba-
Lesshwar plateau has been responsible for clearing and damaging of forests. As a consequence, gullies are formed on the bare roadsides, stripped of their vegetation initiating a process of soil erosion. This type of anthropogeomorphic causes cannot be neglected.

The ecological changes in the forests of western Ghats can be better understood by examining the changes in the plant cover as a result of changes in different parameters of environment. To take an example, the degree of slope is negatively correlated with the density of plant cover. The facts, however, are different. The flat lands do not carry forests. These, on the contrary offer favourable conditions for agriculture, attracting human settlements on the flat undulating land, that is capable of supporting some population by its agricultural produce. Thus the existence of forests on sloping lands is due to the fact that they escape the human interference, and offer, uninterfered by humanity, full scope for the development of floral association representing sometimes a whole range of species. The intra-species association leads to the stabilization of forests and hence maintains their existence irrespective of unfavourable conditions like soil erosion caused due to high degree of slope.
Increasing demand for agricultural use of land and developed techniques of terracing have increased the scope of human invasion on natural vegetation. Thus the correlation between slope and vegetation, within certain limits, sounds correct if observations are made only within forested zones. Inside the forests, even flat strips of land are observed to have grasses and sloping lands to have trees. This is a peculiarity in the transitional zone between forest and agricultural region. This may be due to the fact that destruction of trees is easier on flat strips than on sloping lands. Once trees are removed from flat strips of land, grasses grow profusely. Grasses need shorter period to get ecological establishment as compared to trees. They can also effectively compete with trees. This may be the reason behind the absence of trees as well as any sort of agricultural activities on the flat land.

The existence of various types of trees and grasses in specific locations has sometimes a delicate equilibrium with its climo-edaphic factors. This is possibly because of the use of water by the trees, and devoid of moisture, the surface gets hardened. Even otherwise the lateritic soils get hardened into a ferri-crust developed in due course. Growing a second generation of trees is rather difficult. This explains the lack of teak along the lateritic
belt along Bankot creek, where there is evidence of the presence of teaks in the past (Chapter VII). The presence of teak trees in the past certainly suggests the existence of favourable soil condition in that area at some stage. The destruction of teak forests would have, possibly initiated the process of soil erosion (superficial layer only) exposing the hard soil, thus creating difficulties in new plantations.

The presence of various types of plant species in various soil zones is also responsible for different ecological sub-systems, as seen in micro-regional variations. The decomposition of organic matter forms the foundation to initiate and maintain the nutrient cycle which is the vital part in the forest eco-system. The resultant rate and magnitude of decomposition of organic matter are the functions of several interacting variable. The rate of decomposition is dependent upon climate, especially on moisture and temperature, as well as the biotic processes like foliage (shedding of leaves). It is already mentioned earlier that the decrease in temperature is the effect of increasing number of trees. The areas suffered by intensive cutting of trees for timber and fire wood show a slight increase in temperature and decrease in humidity in the lower stratum of atmosphere. Consequently, the rate of evaporation is increased leading to lowering of the level of soil moisture. The reduction in the foliage is responsible for reducing the
availability of raw material for humas formation. Thus, once
the areas are deforested, ecological processes are diverted
in such a way that the openness persists and one observes
its spatial spread. Therefore, though the distribution in
the ecological processes appears to be micro-regional in the
beginning, but with the passage of time these small patches take
the shape of belt. Thus the forest-belts are converted into
the present patches of barren lands.

The tribal people set fire to the grass,
because, they believe that this helps in accelerating the seed
forming process. Besides this, fire is also set to the trees,
to facilitate easier transportation of 'charcoal', now the
burnt form of trees. Ecologically this is very harmful. The
burning increases the soil temperature and reduces the
moisture content in the soil. This in the long run affects
the growth of any type of vegetation (grass, shrubs or trees).

The student of plant geography cannot help
suggesting the way out to reestablish the ecological balance
in the region due to which the regeneration of forest may
get initiated.

As the first measure, which any-one
would suggest is the stoppage, of reckless exploitation of
forests. The intensity of use can be witnessed in this region
in 'Rab process' (discussed in detail in Chapter II p. 54) and
'cattle grazing'. The 'Rab process' can be stopped by popularizing the Japanese technique of rice cultivation. While cattle rearing has to be encouraged to supplement agricultural production in the thickly populated areas. This should not lead to the misuse of grasses and tree leaves which can be avoided by introducing new varieties of grasses and other fodder crops, leaving the forests unaffected. Certain patches of grassland could be kept protected for seasonal use. This means that the patches of grassland to be used in a particular month or couple of months can be decided in advance and managed accordingly. This rotational use will allow grasses to complete their life cycle in each patch as it will be disturbed only once a year. It will be the task of agricultural scientists and botanists to find out various types of hybrid varieties, utilizing season (harvesting season) of which is suitable for a certain period. The management of such 'Planned patches of grasslands' could be left to the village concerned.
It is not possible, nor it is relevant to give a detail account of the research findings of the study. But its serious attempt has been made to sum up the results of investigation by bold strokes, in without, any way sacrificing the essentials of the findings. The investigation and the findings related to the explanation of the contrast in the vegetal cover, in the association of species and the forest type, as determined by physical environment and the impact of man through the economic activities, he has undertaken over the years. The main components with which the type and density of forest cover have been related to the elements of relief like slope, degree of dissection, edaphic conditions including soil thickness and chemical composition of soil. Besides these type and of forest cover have been related to the climatic elements, particularly rainfall, its seasonality, its intensity and the sunshine as recorded in different months of a year.

Among the human factor the study has taken into account the impact of primary activities, agricultural forestry, cattle grazing and mining. These have quite often adversely affected the forest cover and have prevented their growth and spatial extension.
Unplanned exploitation in the pre-forestry days and unauthorised infringement during the contemporary period has been a bane to the development of the forests in the Western Ghats.

The forests thus, investigated by the present authors are those which have suffered reckless onslaught of man, catastrophic changes in, not only geomorphic processes but also in climate. These processes of change continue and the plant cover confront today, is not in a well stabilized state. Samples, though selected following an elaborate scientific procedure would give only a partial picture of the plant cover of Western Ghats.

The spatial distribution, variation, type and nature of vegetation in Western Ghats region clearly reflect the influence of various physical factors like topography, altitude, temperature, rainfall etc. In general the vegetative cover is thin in areas which are characterised by rugged topography, steeper slopes, low rainfall etc, while areas with high rainfall, gentle slopes, and thick soil cover are usually covered with thick vegetation.

Forest type and floristic composition:

Though all the four tiers of forest namely Overwood, Underwood, Undergrowth and Ground cover
can be identified in Western Ghats, their distribution has been largely controlled by variation in altitude and rainfall. The four tier morphology is usually associated with Evergreen forests.

Principally, the region has three types of forests, the Evergreen, the Moist-deciduous and the Dry-deciduous. There are other types like, Hilly forest, Semi-evergreen and the Littoral forest. These are highly localised. Evergreen forests are mainly concentrated in a narrow strip running north south through Mahabaleshwar, Lonavala, Khandala and Matheran, broken in parts. These forests prefer areas of high precipitation and low evaporation and are thus confined to higher plateaus, where lower temperatures secure them against excessive loss of moisture, through evaporation. These type of forests are found in areas where the altitude is between 600-900 meters, where the rainy season has a duration of approximately nine months and where the temperature are between 26°-28°C. The most important species are Anjan, Bhma, Par-Jambul. Other species like Lokhand, Fisa, Umber and Mango are concentrated in valleys.

The Moist-deciduous forest largely composed of teak, Ain, Kakad, Pangara etc. is found in Konkan area which do not have a lateritic cover and where the rain-
fall is 2000 mm., but not in the whole Konkan. These type of forests avoid steep slopes and prefer flat and low lands and high temperatures. Thus they are absent on the plateau and the main range of Western Ghat, where the height is 600 meters.

Areas with low rainfall are occupied by Dry deciduous forests with some degree of adaptation to the existing dry conditions, & turning thorny in the process. The most common specie is Babul, which dots the eastern land and the plateau with low rainfall. The forests are not much dense. The trees are about ten to twelve meters high. The undergrowth consists of a few shrubs and grasses.

The variety of species found are less than that in Moist deciduous or Evergreen forests.

Thorny forests occupy regions which are characterised by seven to eight months of dry period. Shrubs are xerophytic in nature.

The factors affecting the plant growth which also determine the floristic composition have been investigated through intensive field-work.

The study of floristic composition as understood through field work, reveal that, Tropical Moist deciduous forests cover more than half the forested
regions (53.53%). The Tropical Moist mixed deciduous forests occupy 12.44 percent of the total forested area. The remaining twenty-nine percent of the forested area is comprised of six other types and sub-types of forests. Most often there are transitional zones between these, as reflected by F.I.C.C. index also, and so it is difficult to identify an exclusive category.

The study of the species and density of forest during the field work also revealed that, the Ever green and Will forests of Western Ghats are characterized by a greater variety of species and higher density of trees as compared to other types of forests. Moist Deciduous and Dry Deciduous forests are moderately thick and have lesser variety of species. Thorny forests show a marked few number of species and densities.

**Physical milieu and the plant cover**

While the thickness of soil and the humus content in the soil, seems to be the most important factor, other variables not changing, in promoting the growth of forests and their increase. The frequency of trees, and the variation in the species is explained by the
chemical elements in soil. This was noticed by chemical analysis of soil and examining the effect of each element on certain trees by a statistical interpretation.

The study of frequency of trees was found to have good correlation with soil. The analysis of soil element like iron, calcium, phosphate, pH, soluble salts etc. explain to a considerable degree, the areal variation in forest types. Areas having soil with 7.0 to 9.5 percent of iron are found to be suitable for trees like Teak, Ain Dhavada etc. It has also been observed that such regions have a great potential and scope for developing forests. It is concluded on the basis of soil analysis that areas having 8.5 percent iron in soil are not suitable for plantation of Teak and Eucalyptus but are very much suitable for planting Sal trees. The central portion of Konkan, where soils have a favourable percentage of calcium is found to be suitable for Teak and Eucalyptus trees. The region extending from central part of Kolaba to southern part of Ratnagiri district have all conditions favourable for sal trees because the area is characterized by high iron content in the soil. The consideration of ion exchange capacity of soil revealed that, except Ratnagiri district, the region has a moderate
ly fertile soil. The soils in Ratnagiri district have low percent of humus and clay. But an increase in humus and clay percentage is feasible by conserving the soil and by reducing the rate of soil erosion. Besides this, various types of grass may be allowed to grow so as to minimize the rate of erosion.

**Forest Economy Facts and suggestions**

It has been observed that Teak trees in Thana, Kolaba, Ratnagiri and Peint region have attained a greater height and larger volume as compared to those grown in eastern part sof Western Ghat i.e. areas in Poona Satara and Kolhapur district. This can be attributed to high rainfall and high temperatures in the former regions. Thus it makes one conclude and suggest that the later region may be given to trees like Khair, Palas etc. which can thrive in low rainfall conditions, instead of Teak. Such plantations in Poona, Satara, eastern part of Nasik and Dhulia districts would be economic and would provide firewood and charcoal.

Heavy erosion is witnessed in areas having a dissection index of more than sixty percent. Similarly, regions receiving more than 2500 mm. of rainfall also experience high soil erosion. The plantation of agave specie for cross bunding can be sugge-
stood as a suitable measure to check soil erosion, in these areas.

Forests situated in the vicinity of large settlements should be specially given attention from the point of protection, because illicit cutting and hacking are very commonly experienced in these forests since long. Excessive cutting has been responsible for an increase in the rate of soil erosion in the recent past. Therefore it becomes highly essential to protect these forests. The attempts to develop homogeneous forests near major cities like Poona, Nasik, Thana, Kalyan which have numerous saw mills and hardwood factories, would prove to be advantageous from the point of reduction in transport cost and this would increase the returns.

The high frequency of forest fire could be attributed to insufficient forest ranger service, difficulties in communication and other inadequacies. This frequency of fire could be reduced by providing adequate forest ranging services, preparing fire tracts and constructing towers at suitable sites, considering altitude and intervisibility.

The services of forest watchmen and forest jumpers could be utilized intensively during fire
probability season i.e. February and May. During the wet season, their services could be utilized for studying the causes responsible for occurrence of fire and for preparing maps showing past occurrences of forest fires.

The above facts lead us to the conclusion that an independent branch of forest department should be formed to prevent occurrence of forest fires and stop illicit cutting of trees. Such a branch would be named as Forest Protection Branch (F.P.B.).

Besides these, a number of other measures could be taken for conservation of forests in Western ghats. One of these would be to propagate the advantages of forests to local people, which could be done by placing boards at suitable places, by means of film shows and oral explanations. The laws, rules and regulations regarding forests should be implemented more strictly than what are observed at present. The reduction in the working ranges of guards from five-seventeen villages to two-three villages would increase the efficiency and effectiveness of function.

Besides the above major measures, attempts may be made to develop recreational forested areas near major settlements in which trees like sawar, palas and others can be planted. Trees like eucalyptus, banyan etc.
can be planted along rivers, streams and roads with the view of increasing their number.

Historical records clearly indicate the existence of thick vegetative cover in many parts of this region. But excessive cutting, since the last century has adversely affected the ecological balance. The illicit cutting, overgrazing has accelerated the process of soil erosion and has reduced the process of soil development and also the spatial growth of vegetative cover. Because of the reduction in the litter the humus content and consequently the soil fertility has been decreasing. In other works the carbon cycle has also been disturbed. Thus steps like bunding, planting trees, depending upon the environment, stoppage of illicit cutting would help in restoring the ecological balance to some extent in near future.

Scope for further study

Many neglected problems were detected while analysing the region under present work and while analysing the relationships between biological factors & other factors, namely, physiography, climate and human influence. Some of these problems deserve special mention in the lines of which further studies can be undertaken.
The study of foliage and litter in forest areas would be of considerable significance. Attention may be mainly concentrated on analysing the impact of foliage on soil development. Such studies may be done for different types of forests and various species. It would also include finding out species, which add a greater amount of humus in the soil in a short period. Further, the determination of the inorganic constituents like K, Ca, Mg and N of leafage and litter may prove to be useful in explaining the processes of weathering and soil formation. The analysis of inorganic elements of foliage would also give information regarding the areas in which such species could be planted.

The geological structure of substrata is reflected in the type of vegetation. Therefore, in order to establish the exact relationships, detailed studies can be undertaken.

The survey of soil associations is essential for developing grazing grounds and forest areas. Such studies would aid in the estimation of water intake.

Cross bunding is always suggested as an effective measure to prevent soil erosion. The angle of the bunds along different types of slope can be studied. These angles can be decided by considering total runoff,
the velocity of surface flow, the rate of infiltration etc.

There is a need to study the areal distribution of medicinal plants. Medicine industry would benefit from such studies. Moreover, identification of species, which may be used for manufacturing pulp and paper could be also done.

Study of the eco-system of different types of forest communities, with particular reference to the association of species is one of its significant aspect. Apart from the study of forest communities, the ecology of grass areas should be studied separately. Ecological conditions of bare areas particularly in Ratnagirie district could be studied at micro-level. Such micro-level studies, considering various environmental factors, would be of great help in planning further plantations in different areas of Western Ghat region.

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