



A Manual on Miyawaki Plantation



**ICFRE - Tropical Forest Research Institute
Indian Council of Forestry Research
& Education**

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Preface

Living in harmony with nature is essential in this rapidly expanding era of urbanisation. The preservation of the environment shouldn't be sacrificed for economic growth. Efforts should be made in nature-friendly ways to protect the environment.

The major environmental challenges faced by urban areas are air, water and soil pollution and the large volume of garbage production, including hazardous waste. The metropolitan areas are stretching the limits of their ability to support human existence and are suffering from serious environmental degradation.

Tree plantations with the Miyawaki Plantation Method, offer multiple benefits such as conservation of species, reducing the time of forest establishment and development, high plant diversities, augmenting the avian population through meeting basic needs for food and shelter, acting as a big sink for carbon storage, and enhancing the monetary as well as scenic beauty values of the landscape. To generate green employment for local people with its tangible and intangible benefits, it creates a positive impact on human health and the environment in densely populated urban societies.

Keeping these facts in mind, it is essential to educate and create awareness about this method with easily understandable knowledge source.

I hope that the enthusiastic tree planters, students, researchers, forest departments, NGOs, and forestry professionals would find the publication to be a convenient source of information on the Miyawaki Plantation Technique.

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Plantation of forest tree species is being promoted continuously in our country through various government schemes, organizations and state forest departments. The National Forest Policy (1988) aims at bringing 33% of the geographic area under forest and tree cover. The present total forest and tree cover of the country is 8, 09, 537 sq km, which is 24.62% of the geographical area of the country (FSI, 2021). As the population is increasing rapidly, there is an urgent need for sound planning and sustainable management to prevent over-use and degradation of India's forest resources.

In India, out of a total population of 1210.2 million as of March 1, 2011, about 377.1 million people live in urban areas. Over the past decade, there has been a net increase of 91.0 million people in urban areas (MoHUF, 2021). The proportion of people living in cities within the total population of the country is 31.6%. To serve a large proportion of the country's population with a healthy environment, fresh air, water, a stress-free life, etc., there is a need for sound management of natural resources and also a need to increase the tree cover of the country. Keeping in view the necessity to increase forest cover, urban greening and achieve the goal of sustainable development, a plantation technique proposed by Dr. Miyawaki for increasing green cover by developing multitier system comprising trees (Upper storey), shrubs (Middle storey) and herbs (Lower storey). The selection of trees shrubs and herbs is based on the availability of species in particular region are that holds native plant diversity. It provides a beautiful landscape element; a buffer against extreme heat, polluted air, flooding and drought; an educational opportunity; and part of an antidote to the global climate crisis.



Dr. Akira Miyawaki was born in Okayama, Japan, on January 29, 1928. In 1952, he received his bachelor's degree in biology from Hiroshima University with a specialisation in weed ecology. He served as a visiting researcher at the Federal Institute for Vegetation Mapping in West Germany from 1958 to 1960. Hiroshima University conferred on him the degree of Doctor of Science in 1961. Following that, he continued a professional career in teaching and research. Various prestigious honours have also been bestowed upon him, including the Asahi Shimbun Prize (1990), the Reinhold Tüxen Prize, Germany (1995), the Order of the Sacred Treasure, Gold and Silver Star, Japanese Government (2000), the Blue Planet Prize (2006), and others.

The Akira Miyawaki Plantation Techniques, i.e., reforestation of "Native Forest by native trees" is based on traditional Japanese "Chinju—No-Mori" and ecology, a new synthetic science that integrates biocoenoses and the environment. Dr. Akira Miyawaki developed the "Miyawaki Method" to repair and recreate forests using native species appropriate to the habitat based on intensive field assessment of local vegetation and ecological theories (Fig.1). In this method, main tree species and their companionspecies are chosen from the potential natural vegetation of the area, the seeds of selected species are collected, grown in pots until a complete root system develops collected, mixed and planted closetogether by adopting the system of natural forests.

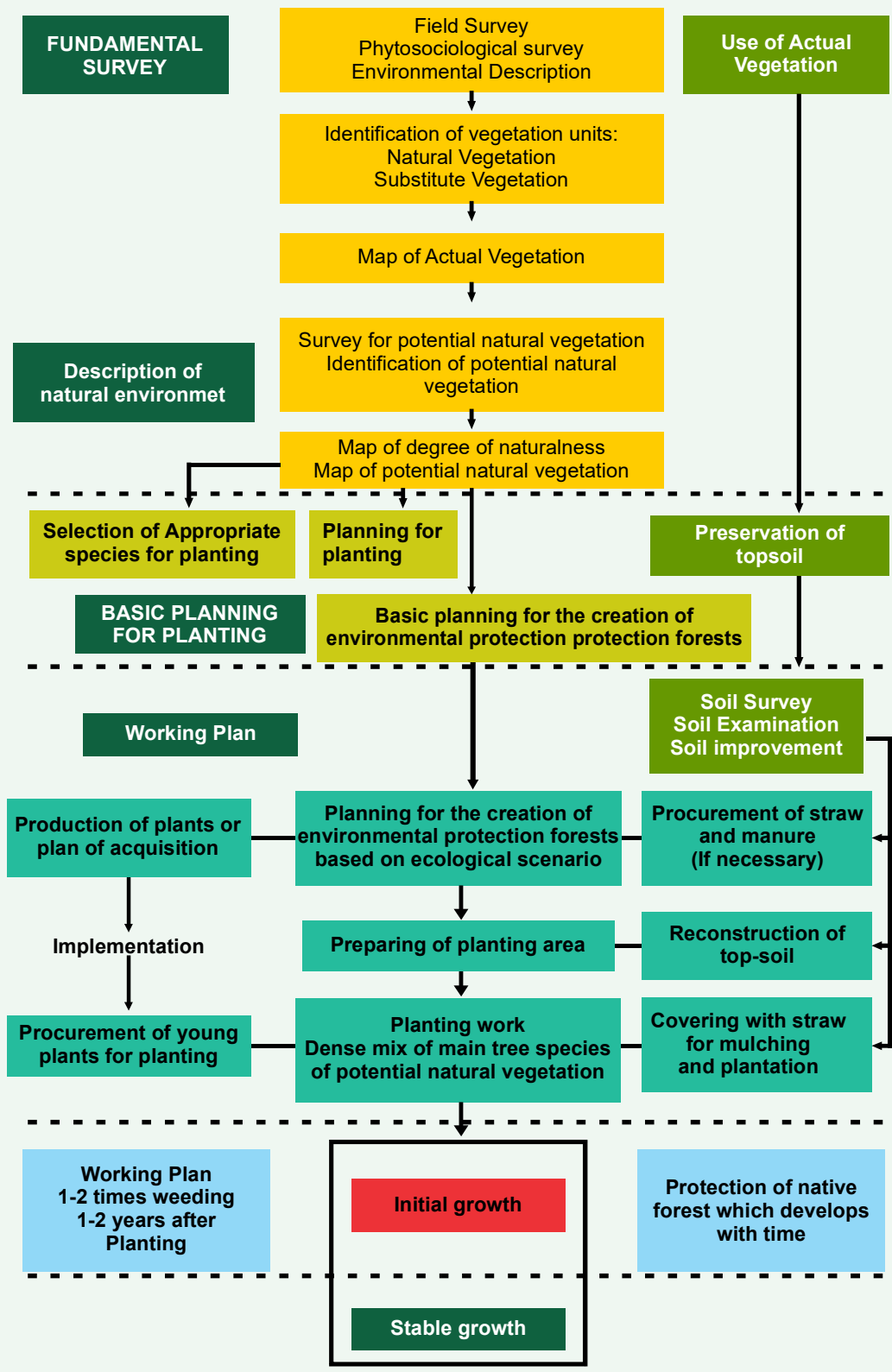


Fig. 1 : Flow Chart for the restoration and creation of native forest
(Source: Miyawaki, 1999)

Trees play an associate's degree critical position in the elimination of carbon dioxide. They dispose of (sequester) carbon from the environment via photosynthesis and convert it to oxygen. As bushes grow, they dispose of CO₂ from the environment during the photosynthesis (Kiran *et al.*, 2011). Each species has different capacity to sequester carbon. Tree canopies offer a cooling impact on the microclimate immediately with the help of shading the floor and in a roundabout way via transpiration. Therefore, selection of suitable tree species having high carbon sequestration potential is of prime importance.

Miyawaki plantation techniques offer the benefits of a mixture of diverse types of tree species in plantations. This method of plantation allows creation of a mature natural forest in a comparatively small amount of time, is based on a careful selection of the plant species that are best suited to local environment. This plantation technique will provide multiple benefits in a rapidly expanding urban area. Miyawaki method is to create a permanent canopy of climax tree species directly, without going through successional stages.

The Miyawaki Method is also unique because it can be applied to area of any size and develops mini-forest with tangible and intangible benefits for urban and rural population *vis a vis* country as well.

Chapter 2 Method of site preparation for establishment of plantation

- **Selection of site:** The site selection is an important step in the plantation programme, which leads to the establishment of successful forest tree plantations. The suitable selection of site helps in taking the following decisions :
 - I. To select species for site specific planting.
 - II. To determine required ground preparations.
 - III. To plan internal layouts of roads, rides, firebreaks and location of water points.

Pre-planting of survey			
S. No.	Type	Desired information	Management value
1	Terrain	Elevation (m)	Overcome the limits of economical harvesting, reduce the risk of erosion, limit of mechanization. Selection of species, ground preparation etc., ground configuration may affect location of firebreaks, nursery, roads etc.
		Aspect	
		Slope	
		Steepness	
		Ground configuration	
2	Drainage	Risk of flooding	This is purely a feature of the terrain, but it plays a crucial role in locating nurseries, fire protection dams, watering sites, and extraction systems, as well as in creating bridges and culverter sizes.
		Periods when beds are dry	
		Distance from nearest natural waterbodies	
3	Soils	Soil types	The selection of tree and shrub species, ground preparation work, fertiliser requirements, need for erosion control, the potential supply of materials for building roads, etc.
		Soil chemical and physical status	
		Erodability	
		Underlying geology and outcrops	

4	Vegetation cover	Vegetation type	Utilising current vegetation as an index of the fertility of the site, identifying regions that need to be preserved, and the necessity of clearing vegetation
		Density	
		Species composition	
		Area or species of special ecological values	
5	Communication and services	Location of public roads and right of way	Assist with infrastructure development, identify unusable land (below) and decide where rights must be preserved.
		Telephone and electricity line	
		Other easement	
6	Special factors which may preclude planting	Area of special scientific interest	Land with significant biological, ecological, geological, cultural and historical values
		Areas or vegetation of religious or cultural significance	Local tradition will determine this. Land or existing trees may have spiritual significance or serve as a food source.
		Area of landscape significance	Land should be excluded or the boundary should be changed to accommodate the landform.
		Easements-power line, telephones etc,	Tree planting is valuable because of the limitations on tree height growth.
		Rights of access, grazing , hunting etc.	In order to avoid conflicts of interest and antipathy, it is crucial that they be clearly acknowledged and that local residents be included in the planning stage.

Source: Evans, J. (1992).

Contact to Expert during/before initiating the planting process	
Subject Expert	Management Role
Silviculturist/ Forestry Expert	Help in species combination selection according to associate species and site conditions, planning and management of forests
Soil Scientist	Soil health analysis and nutrient management requirement
Ecologist	To study the impact on environment and site

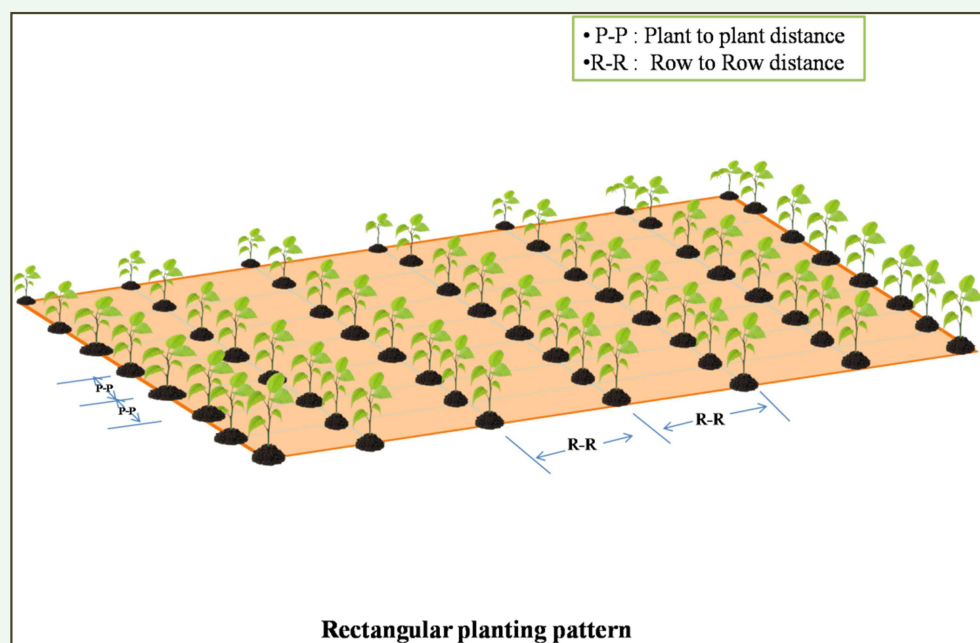
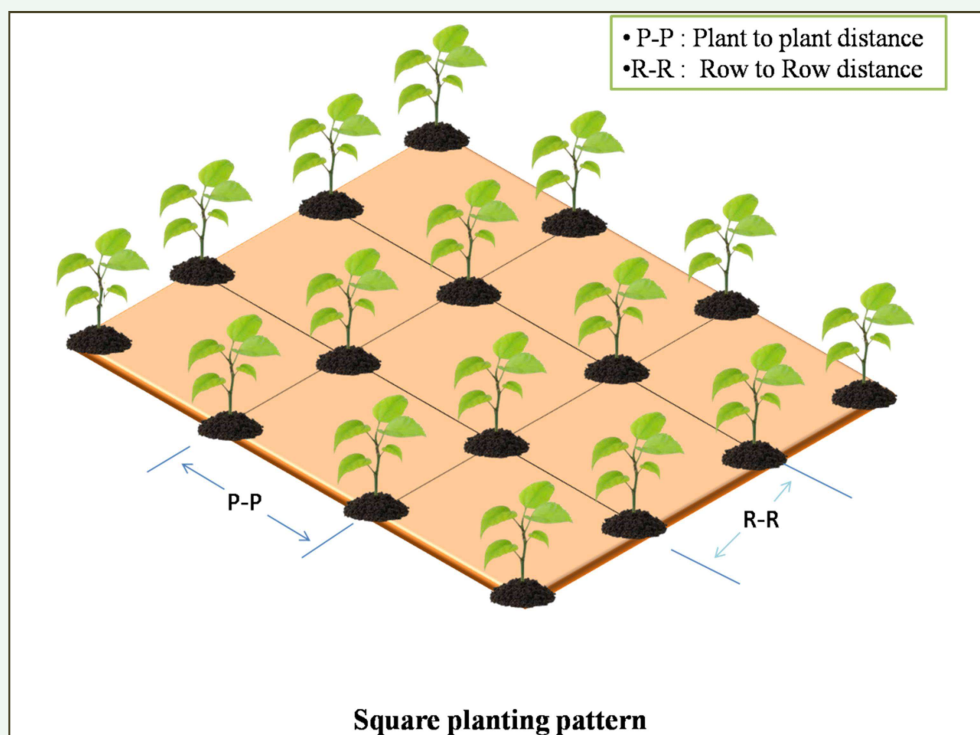
- **Soil condition:** Soil fulfills three essential requirements for tree growth: **supply of moisture, nutrients and mechanical support.** Good soil fertility, physical condition and rootable depth are the primary consideration.
- **Cleaning of site:** Removal of weed, grasses, and stone from the site.
- **Layout of site:** Design of layout according to availability of area and site condition. General availability of area of land for plantation purpose particularly in the urban area i.e., 100 sq. m to 1000 sq. m size plot. Based on previous studies, following spacing for plantation may be adopted:

S. No.	Spacing	No. of plants per 100 sq. m
1	30 cm×30 cm	1111
2	30 cm ×40 cm	833
3	30 cm ×50 cm	666
4	30 cm × 60 cm	555
5	40 cm × 40 cm	625
6	40 cm × 50 cm	500
7	40 cm×60 cm	417
8	50 cm × 50 cm	400
9	50 cm × 60 cm	333
10	60 cm× 60 cm	277

For successful establishment, minimum spacing 60 cm × 60 cm may be adopted for good growth of plantation, to avoid/reduce mortality with increasing age of plantation due to competition among the plants for nutrients and space in long term.

Considering the canopy growth, height of trees and root spread of main species and associate species will be appropriate while deciding the spacing.

- Diagram of layout :



Miyawaki Forest (Field Design)

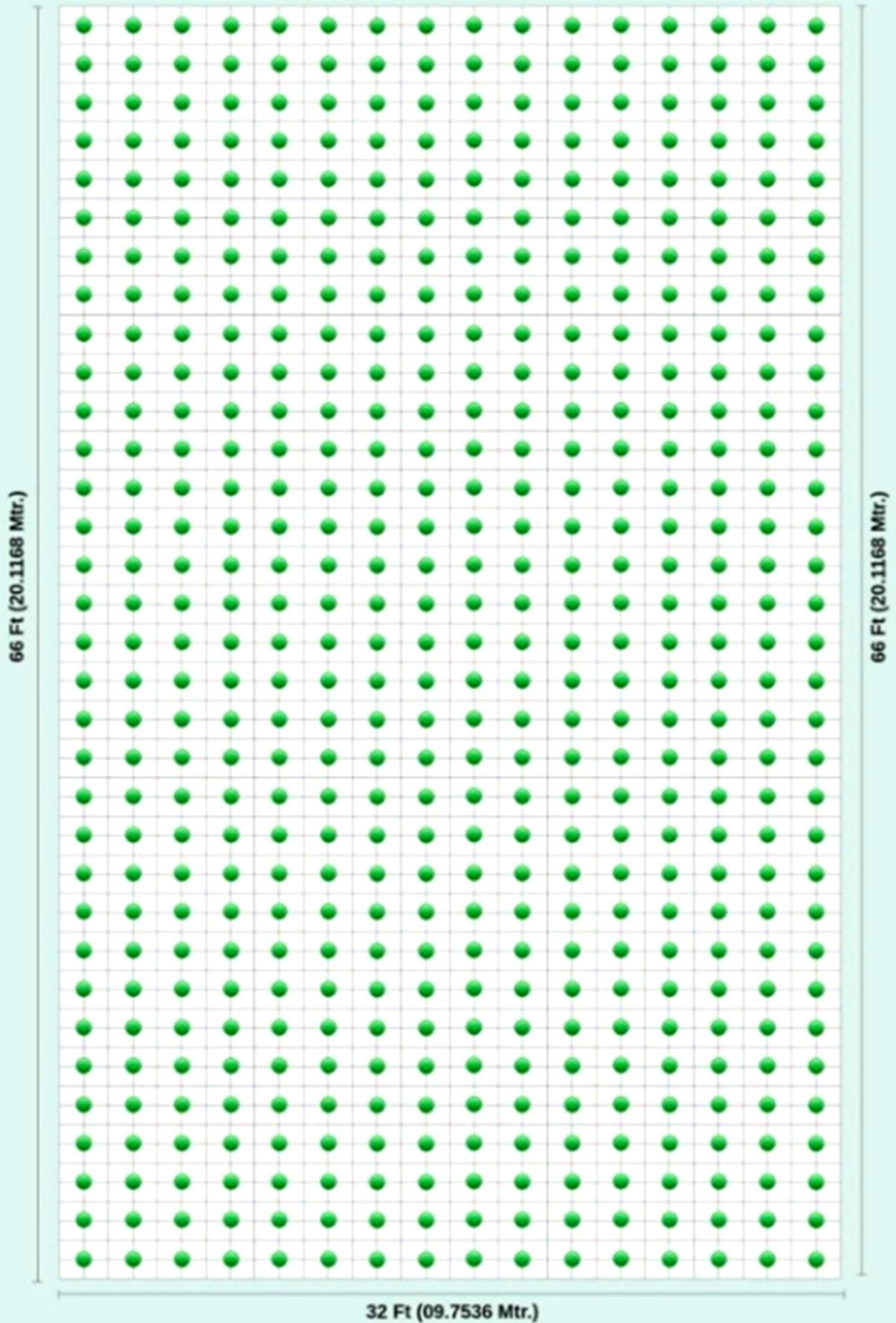
Area

Length :- 66 Ft. (20.1168 Mtr.)

Width :- 32 Ft. (09.7536 Mtr.)

Total Trees:

● In 1 Row :- 16 x 33 = 528

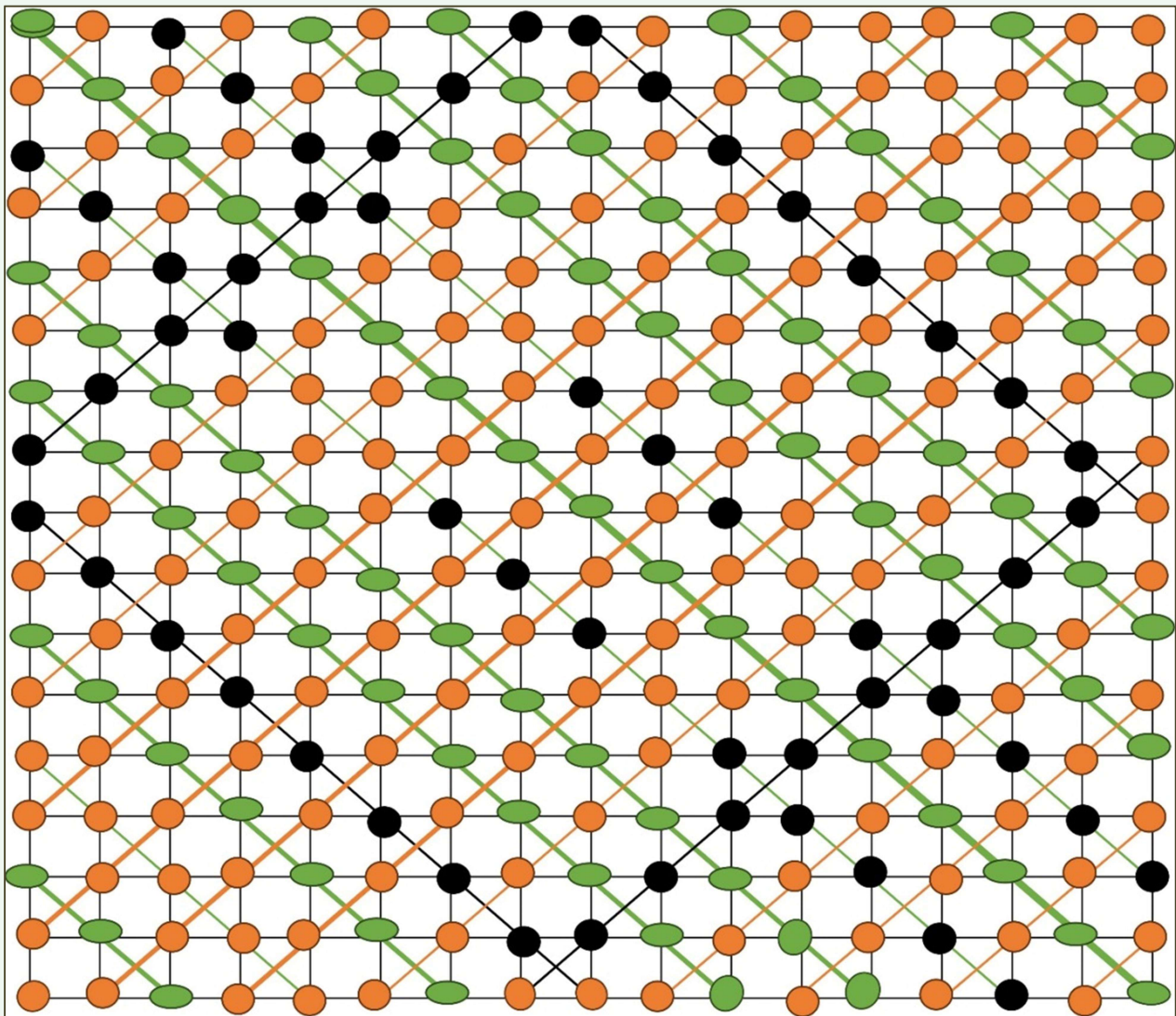





Note :- Space between two dots (2 Ft.)

(Source: Mission Miyawaki Group)

Proposed plan for Miyawaki Plantations

Design of Layout: This layout is proposed to provide optimum light and reduce root competition for nutrients among the different storey species by arranging tree species in a systematic manner according to light requirements or shade tolerance levels. The proportion of top storey, middle storey and lower storey density may vary according to objectives, site soil, and climatic conditions.



Details of Layout	
	Top storey (TS)
	Middle Storey (MS)
	Lower Storey (LS)
Spacing	0.60 m × 0.60 m
Plot Size	10 × 10 m
Total area	100 m ²
Total Number of Plants	278
Ratio	TS: 30%, MS: 50%, LS: 20% (the % of TS, LS & MS may be changed as per the site conditions)

- **Marking and staking:** The following items are required:



Rope



Lime Powder



Bamboo sticks

Field photographs:



Marking



Staking

- **Preparation of Pits**



(Photographs Source: Mission Miyawaki Group)

- **Addition of fertilizer**

- **Organic:** Farmyard manure, Oil cakes (Groundnut cake, Coconut cake, Castor cake, Neem cake, Mahua cake).
- **Inorganic:** Urea, DAP (Di-ammonium Phosphate)

- **Selection of plants:** Select the one year old seedling, which is free from disease and healthy root and shoot development.

- **Planting of trees**

- **Steps of planting**



(Photographs Source: Mission Miyawaki Group)

- **Irrigation:** Proper irrigation with good quality of water is required for plant establishment, growth and development.

View of Irrigation Method:



Flood irrigation



Drip Irrigation

- **Fencing of site:** The choice of fencing depends on the type of terrain, soil depth and the kind of soil and degree of protection required to avoid grazing and browsing animals.

Type of fence:



Barbed wire fencing with cemented poles



Fencing with bamboo poles + agro net + plastic wire mesh



Fencing with plastic wire mesh with iron pole



Fencing with bamboo

- **Pruning operation:** Pruning operation is necessary in 2nd and 3rd years in the plantation to improve the growth and development of plants. Also help in reduction light competition and promote straight growth of plants.

Pre-planting / Post Planting process

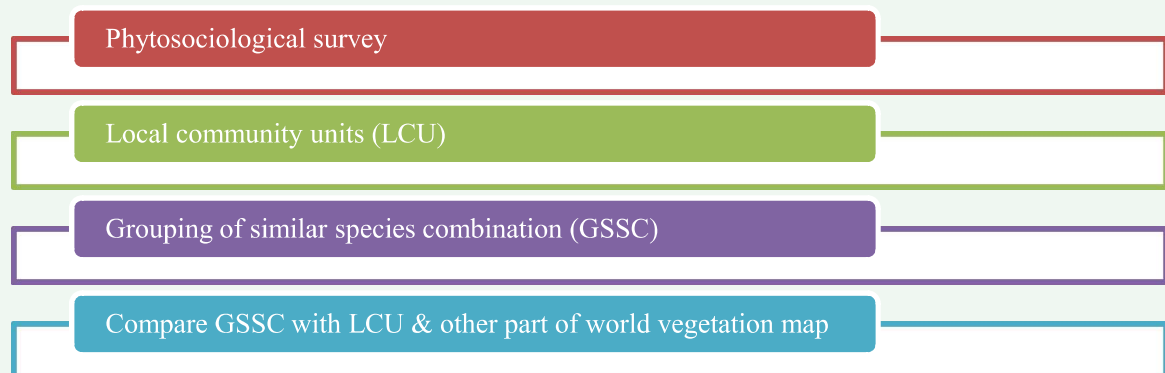
- Registered the established plantation with details of area, number of plants, and list of species planted, at least 2 photographs with the local forest department or government-authorized body.

The selection of tree species in the Miyawaki Plantation plays an important role. The tree species must be chosen from the forest communities of the region in order to restore multi-stratal natural or quasi-natural forests.

The growth and development of individual trees in later stages are directly related to the canopy development of planted species. The canopy of trees controls many factors such as light penetration, moisture, humidity, temperature, rainfall, etc. that directly affect the growth of tree species in different canopy layers.

If the main tree species are wrongly chosen, it will be difficult to regenerate native forests successfully. In the plant communities, if the top is authentic, the followers are also real, just like in human society.

1. Methods species selection:



- **Phytosociological survey:**

For the proper choice of species, we first make a list of species available in the native area through field vegetation survey including temple or religious places, old house forests, natural forests established on slopes and substitute vegetation changed by various human impacts. This method is called releves, which are equivalent to a census of green environments/phytosociological survey (Miyawaki, 1999).

- **Local community units (LCU):**

By comparing releves and prepare grouping of similar species combinations.

- **Grouping of Similar Species Combination (GSSC):**

For the selection of species combination identify high-fidelity species for particular communities. Selected species will be known character species. Then compare phytosociological units widely from natural forests to secondary communities and decide “associations” basic unit of a plant community system.

2. **Potential Natural Vegetation (PNV):**

The Potential Natural Vegetation indicates the potential capacity of land, theoretically considered as sustainability potential of vegetation. To decide the PNV, assess natural vegetation and compare it with various secondary vegetation types from the factors of time and space. The amount of soil profile topography and land utilization should also be considered.

PNV is the “vegetation cover in equilibrium with climate that would exist at a given location non-impacted by human activities” (Hengl *et al.*, 2018). “The concept of potential natural vegetation (PNV) was introduced by Faber (1937) and afterward promoted by Tuxen (1956). According to the definitions given by these authors, PNV is an imagined state of the vegetation that would exist without the influence of man. To put it briefly, PNV expresses the site conditions in terms of phytosociology (Fischer 2003). In this way, “PNV is a scientific construct reflecting the site conditions of a certain place or area (Fischer *et al.*, 2013). Therefore, a forester needs to understand the interaction between species and site conditions before the species selection for the establishment of Miyawaki plantation according to this principle. The potential patterns give the ecological engineer an endpoint or a design goal to guide reconstruction” (Miyawaki, 1993). From a forester's point of view PNV is defined as a collection of small patches of forest where plants maintain a balance with climate factors for their development on a specific site in the absence of anthropogenic disturbance.

PNV maps are essential for each ecological study field and are significant as ecological diagnoses for restoration of green environment. It is recorded that it is possible to restore native green environments, multi-stratal forests, by choosing the main species from the potential natural vegetation of the area and planting them mixed and densely with as many companion species as possible.

Characteristic of Main species in NPV:

- Deep and straight –rooted
- Belongs to top canopy layer
- Minimum plant allelopathy effects on associated species
- Best suitable species for associated species

Field Survey Form:

S. No.	Top storey (Dominant trees)	Middle storey (Intermediate)	Lower storey (Suppressed)
1.			
2.			
3.			
4.			
5.			

- Top storey/Dominant trees: Trees which form the upper most leaf canopy and have their leading shoots free.
- Middle storey/Intermediate: Trees which do not form part of the upper most leaf canopy
- Lower storey/Suppressed: Trees which reach only about 0.50 to 0.63% of the height of predominant, with their leading shoot definitely over topped by their neighbours or at least shaded on all sides by them.

Based on forest type classification by Champion & Seth (1968) and major three forest types in the states/UT as per forest cover percentage, a list of plant species for selection of tree/shrubs/herbs in different canopy layers (TS, MS & LS) for different regions is given below:

List of suggested tree/shrubs/herbs species according to different canopy layers existed in the top three forest types (based on area) in different states of India.			
Sl. NO.	State & Union territories	Forest types	Forest cover (%)*
1.	Andhra Pradesh	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Chirodi R. F., Andhra Pradesh-</p> <p>Top Storey: <i>Terminalia tomentosa, Bauhinia racemosa, Acacia arabica, A. catechu, Boswellia serrata, Buchanania lanzan, Azadirachta indica, Ougeinia oojeinensis, Flacourtia indica.</i></p> <p>Middle Storey: <i>Gymnosporia spinosa, Ziziphus mauritiana, Z. xylopyrus, Morinda tinctoria.</i></p> <p>Lower storey: <i>Mimosa hamata, Terminalia tomentosa, Grewia hirsuta.</i></p> <p>Cuddalore Nallamalais, S. Kurnool Division, A.P.-</p> <p>Top Storey/ Middle Storey: <i>Anogeissus latifolia, Cleistanthus collinus, Terminalia tomentosa, Pterocarpus marsupium, P. santalinus, Hardwickia binata, Tectona grandis.</i></p> <p>Middle Storey: <i>Dendrocalamus strictus.</i></p> <p>S. Cuddapah Division, A. P</p> <p>Top Storey/ Middle Storey: <i>Terminalia pallida, Shorea talura, S. tumbergaia, Eugenia alternifolia, Mangifera indica, Albizia odoratissima</i></p> <p>Lower storey: <i>Phoenix acaulis.</i></p>	42.97
		<p>5B/DS1 Dry Deciduous Scrub</p> <p>Mansurabad, Andhra Pradesh</p> <p><i>Acacia leucophloea, Bauhinia racemosa, Dalbergia paniculata, Wrightia tinctoria, Ziziphus xylopyrus, Cassia fistula, Randia, Annona spp.</i></p>	31.58

		<p>3B/C2 Southern Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Pterocarpus marsupium</i>, <i>Salmalia malabarica</i>, <i>Terminalia bellirica</i>, <i>Anogeissus latifolia</i>, <i>Dalbergia latifolia</i>, <i>Terminalia tomentosa</i>, <i>Lannea coromandelica</i>, <i>Madhuca indica</i>, <i>Garuga pinnata</i>.</p> <p>Middle Storey: <i>Miliusa tomentosa</i>, <i>Polyalthia cerasoides</i>, <i>Lagerstroemia parviflora</i>, <i>Emblica officinalis</i>, <i>Xylocarpus xylocarpa</i>, <i>Grewia tiliifolia</i>, <i>Schrebera swietenoides</i>, <i>Cleistanthus collinus</i>, <i>Diospyros montana</i>, <i>Flacourtia indica</i>, <i>Dendrocalamus strictus</i>.</p> <p>Low Storey: <i>Ziziphus oenopolia</i>, <i>Casearia graveolens</i>, <i>Helicteres isora</i>, <i>Desmodium gangeticum</i>.</p> <p><i>Terminalia tomentosa</i> predominating accompanied by <i>Pterocarpus</i>, <i>Adina</i>, <i>Salmalia</i>, <i>Grewia</i>.</p>	5.20
2.	Arunachal Pradesh	<p>8B/C1 East Himalayan Sub-Tropical Wet Hill Forest</p> <p>Top storey: <i>Lithocarpus elegans</i>, <i>Quercus fenestrata</i>, <i>Quercus lamellosa</i>, <i>Quercus griffithii</i>, <i>Castanopsis</i> spp., <i>Schima</i>, <i>Cinnamomum</i>, <i>Saurauia</i> spp., <i>Litsea</i> spp., <i>Machilus</i>, <i>Syzygium</i>, <i>Cedrela toona</i>, <i>Phoebe lanceolata</i>, <i>Beilschmiedia</i>, <i>Cinnamomum cecicodaphne</i>, <i>Schima</i>, <i>Lauraceae</i> (many spp.), <i>Litsea</i> spp., <i>Magnolia</i> spp., <i>Alnus</i> spp., <i>Betula</i> spp., <i>Cinnamomum</i>, <i>Pinus wallichiana</i></p> <p>Middle/ Lower storey: <i>Elaeagnus</i> spp., <i>Berberis wallichiana</i>, <i>Maesa indica</i>, <i>Strobilanthes</i> spp., <i>Zanthoxylum</i> spp., <i>Gaultheria</i> spp., <i>Rhododendron</i> spp., <i>Psychotria</i>, <i>Flacourtia</i>, <i>Symplocos</i>, <i>Crateva nurvala</i>, <i>Emblica</i>.</p> <p>Middle storey: <i>Quercus</i> spp., <i>Lithocarpus</i>, <i>Schima</i>, <i>Castanopsis</i> spp., <i>Betula alnoides</i>, <i>Acer oblongum</i>, <i>Engelhardia</i>, <i>Symplocos</i>.</p> <p>Lower storey: <i>Pittosporum</i> spp., <i>Myrsine</i>, <i>Debregeasia</i>, <i>Rubus</i>.</p>	24.35

		<p>11B/C1 East Himalayan Wet Temperate Forest</p> <p>Top Storey : <i>Magnolia, Manglietia, Michelia, Quercus, Acer, Prunus, Pyrus, Symingtonia (Bucklandia) populnea, Alnus nepalensis, Betula alnoides, Carpinus viminea, Alnus nepalensis, Betula alnoides, Carpinus viminea, Abies densa, Berberis spp., Pinus wallichiana, Schima, Litsea spp., etc.</i></p> <p>Middle Storey : Bamboo in the east.</p> <p>Lower storey: Evergreen shrubs</p>	22.92
		<p>14/C2 East Himalayan Sub-Alpine Birch/Fir Forest</p> <p>Top Storey : <i>Abies densa, Juniperus wallichiana</i></p> <p>Middle Storey: <i>Rhododendron wightii, Betula utilis, Rhododendron spp., Pyrus aucuparia, Salix wallichiana.</i></p> <p>Lower storey: <i>Spiraea spp., Juniperus recurva, Cassiope fastigiata, Rhododendron lepidotum, Potentilla fruticosa, Polygonum spp.</i></p>	13.46
3.	Assam	<p>2B/C2 Cachar Semi-Evergreen Forest</p> <p>Cachar, Assam</p> <p>Top Storey/ Middle Storey: <i>Artocarpus chaplasha, Dipterocarpus turbinatus, Palaquium polyanthum, Cynometra polyandra, Eugenia spp., Vitex peduncularis, Pterospermum acerifolium, Pterygota alata, Chukrasia velutina, Tetrameles nudiflora, Adina cordifolia, Protium serratum, Albizia procera, Premna bengalensis, Gmelina arborea, Salmalia insignis, Stereospermum personatum</i> and many others.</p> <p>Middle Storey: <i>Melocanna bambusoides.</i></p> <p>Lower Storey: Evergreen shrubs.</p>	37.75
		<p>3C/C3b East Himalayan Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Lagerstroemia parviflora, Terminalia bellirica, Sterculia villosa, Salmalia malabarica, Schima wallichii.</i></p> <p>Middle Storey: <i>Careya arborea, Bauhinia purpurea, Amoora spp.</i></p>	17.92

		<p>1B/C1 Assam Valley Tropical Wet Evergreen Forest (Dipterocarpus)</p> <p>Top Storey: <i>Dipterocarpus macrocarpus</i>, <i>Shorea assamica</i>, <i>Mesua ferrea</i>, <i>Altingia excelsa</i>, <i>Dysoxylum procerum</i>, <i>Artocarpus chaplasha</i>, <i>Michelia</i> spp., <i>Stereospermum personatum</i>, <i>Canarium</i> spp., <i>Amoora wallichii</i>.</p> <p>Middle Storey: <i>Vatica lanceifolia</i>, <i>Eugenia</i> spp., <i>Garcinia cowa</i>, <i>Talauma</i> spp., <i>Myristica</i> spp., <i>Dendrocalamus hamiltonii</i>, <i>Bambusa pallida</i>, <i>Pseudostachyum polymorphum</i>, <i>Linistona jenkinsiana</i>.</p> <p>Lower storey: <i>Clerodendron</i>, <i>Ixora</i>, <i>Pinanga</i>, <i>Laportea</i> spp.,</p>	3.56
4.	Bihar	<p>5B/C2 Northern Dry Mixed Deciduous Forest Singhbhum, Bihar (Cochlospermum-Euphorbia association)</p> <p>Top Storey & Middle Storey: <i>Lannea coromandelica</i>, <i>Gardenia latifolia</i>, <i>Cochlospermum religiosum</i>, <i>Sterculia urens</i>, <i>Chloroxylon swietenia</i>, <i>Buchanania lanzan</i>, <i>Aegle marmelos</i>, <i>Anogeissus latifolia</i>, <i>Morinda tinctoria</i>, <i>Canthium dicoccum</i>, <i>Emblica officinalis</i>, <i>Euphorbia nivulia</i>, <i>Protium serratum</i>, <i>Lagerstroemia parviflora</i>, <i>Erythrina suberosa</i>, <i>Stereospermum suaveolens</i>, <i>Ficus</i> .</p> <p>Lower Storey: <i>Woodfordia fruticosa</i>, <i>Nyctanthes arbor-tristis</i>, <i>Petalidium barlerioides</i>, <i>Murraya paniculata</i>, <i>Sarcostemma acidum</i>, <i>Eranthemum purpurascens</i>, <i>Justicia</i> spp., <i>Rungia</i>, <i>Dicliptera</i> spp., <i>Butea superba</i>, <i>Olax scandens</i>, <i>Jasminum</i>, <i>Erycibe</i>.</p> <p>Singhbhum, Bihar (Anogeissus-Mitragyna-Dendrocalamus-Daedalacanthus association)</p> <p>Top & Middle storey: <i>Anogeissus latifolia</i>, <i>Adina cordifolia</i>, <i>Mitragyna parvifolia</i>, <i>Hymenodictyon excelsum</i>, <i>Aegle marmelos</i>, <i>Chloroxylon swietenia</i>, <i>Schleichera oleosa</i>, <i>Lannea</i></p>	30.70

		<p><i>coromandelica</i>, <i>Schrebera swietenioides</i>, <i>Lagerstroemia parviflora</i>, <i>Bridelia retusa</i>, and occasional <i>Shorea</i>, <i>Cochlospermum</i>, <i>Sterculia</i>, <i>Boswellia</i>, <i>Buchanania</i>, <i>Ougeinia oojeinensis</i>, <i>Erythrina</i>, <i>Bauhinia malabarica</i>, <i>Madhuca</i>, <i>Diospyros montana</i>, <i>Stereospermum</i>, <i>Vitex peduncularis</i>.</p> <p>Lower Storey: <i>Petalidium barlerioides</i>, <i>Helicteres isora</i>, <i>Strobilanthes auriculatus</i>, <i>Symphorema polyandrum</i>.</p>	
		<p>5B/C1c Dry Peninsular Sal Forest</p> <p>Singhbhum, Bihar</p> <p>(1) <i>Shorea-Anogeissus-Woodfordia</i> association</p> <p>Top & Middle Storey: <i>Shorea robusta</i>, <i>Anogeissus latifolia</i>, <i>Boswellia serrata</i>, <i>Cochlospermum religiosum</i>, <i>Dillenia aurea</i>, <i>Ziziphus xylopyrus</i>, <i>Gardenia gummifera</i>.</p> <p>Lower Storey: <i>Woodfordia fruticosa</i>, <i>Wendlandia tinctoria</i>, <i>Grewia hirsuta</i>, <i>Phoenix acaulis</i>.</p> <p>(2) <i>Shorea-Gardenia-Eulaliopsis</i> association.</p> <p>Top & Middle Storey: <i>Shorea robusta</i>, <i>Buchanania lanzan</i>, <i>Eugenia caryophyllifolia</i>, <i>Gardenia gummifera</i>, <i>Madhuca indica</i>, <i>Diospyros tomentosa</i>, <i>Emblica officinalis</i>. <i>Cephalostachyum pergracile</i>.</p> <p>Lower Storey: <i>Wendlandia tinctoria</i>, <i>Phoenix acaulis</i>.</p>	21.13
		<p>5B/C1a Dry Siwalik Sal Forest</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Anogeissus latifolia</i></p> <p>Middle Storey: <i>Buchanania lanzan</i></p> <p>Lower Storey: <i>Woodfordia fruticosa</i>, <i>Indigofera pulchella</i></p>	5.14
5.	Chhattisgarh	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top & Middle Storey: <i>Terminalia tomentosa</i>, <i>Anogeissus latifolia</i>, <i>Mitragyna parvifolia</i>, <i>Schrebera swietenioides</i>, <i>Madhuca indica</i>, <i>Diospyros tomentosa</i>, <i>Buchanania lanzan</i>, <i>Lagerstroemia parviflora</i>, <i>Emblica officinalis</i>, <i>Cassia fistula</i>, <i>Aegle marmelos</i>, <i>Butea monosperma</i>, <i>Santalum album</i>, <i>Albizia</i></p>	27.37

	<p>spp., <i>Boswellia serrata</i>, <i>Chloroxylon swietenia</i>, <i>Syzygium cumini</i>, <i>Hardwickia binata</i>, <i>Acacia arabica</i>, <i>Prosopis juliflora</i>, <i>Sterculia urens</i>.</p> <p>Lower Storey: <i>Nyctanthes arbor-tristis</i>, <i>Ziziphus</i> spp., <i>Helicteres isora</i>, <i>Vitex negundo</i>, <i>Adhatoda vasica</i>, <i>Gymnosporia spinosa</i>, <i>Randia dumetorum</i>, <i>Flacourtia indica</i>, <i>Grewia</i> spp., <i>Woodfordia fruticosa</i>, <i>Balanites aegyptiaca</i>, <i>Carissa</i> spp., <i>Holarrhena antidysenterica</i>, <i>Lantana camara</i>.</p>	
	<p>3C/C2e (ii) Moist Peninsular Low Level Sal Forest</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Terminalia tomentosa</i>, <i>Pterocarpus marsupium</i>, <i>Anogeissus latifolia</i>, <i>Madhuca indica</i>.</p> <p>Middle Storey: <i>Emblica officinalis</i>, <i>Buchanania lanzan</i>, <i>Diospyros melanoxylon</i>, <i>Terminalia chebula</i>, <i>Kydia calycina</i>, <i>Ougeinia oojeinensis</i>, <i>Bridelia retusa</i>, <i>Bauhinia retusa</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Indigofera pulchella</i>, <i>Moghania semialata</i>, <i>Phoenix acaulis</i>, <i>Grewia</i> spp., <i>Woodfordia fruticosa</i>, <i>Embelia arborea</i>, <i>Ixora tsjeriam-cottam</i>.</p>	16.64
	<p>3B/C2 Southern Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Pterocarpus marsupium</i>, <i>Salmalia malabarica</i>, <i>Terminalia bellirica</i>, <i>Anogeissus latifolia</i>, <i>Dalbergia latifolia</i>, <i>Terminalia tomentosa</i>, <i>Lannea coromandelica</i>, <i>Madhuca indica</i>, <i>Garuga pinnata</i>.</p> <p>Middle Storey: <i>Miliusa tomentosa</i>, <i>Polyalthia cerasoides</i>, <i>Lagerstroemia parviflora</i>, <i>Emblica officinalis</i>, <i>Xylia xylocarpa</i>, <i>Grewia tiliifolia</i>, <i>Schrebera swietenoides</i>, <i>Cleistanthus collinus</i>, <i>Diospyros montana</i>, <i>Flacourtia indica</i>, <i>Dendrocalamus strictus</i></p> <p>Lower Storey: <i>Ziziphus oenopolia</i>, <i>Casearia graveolens</i>, <i>Helicteres isora</i>, <i>Desmodium gangeticum</i>.</p>	15.68

6.	Delhi	6B/C2 Ravine Thorn Forest Top & Middle Storey: <i>Acacia senegal</i> , <i>A. leucophloea</i> , <i>Prosopis spicigera</i> , <i>Salvadora oleoides</i> Lower Storey: <i>Capparis decidua</i> , <i>Ziziphus mauritiana</i> , <i>Z. nummularia</i> , <i>Calotropis procera</i> .	45.37
		5B/C2 Northern Dry Mixed Deciduous Forest Top Storey: <i>Acacia catechu</i> , <i>Anogeissus latifolia</i> , <i>Lannea coromandelica</i> , <i>Aegle marmelos</i> , <i>Feronia limonia</i> , <i>Ehretia laevis</i> , <i>Kydia calycina</i> , <i>Ougeinia oojeinensis</i> , <i>Mitragyna parvifolia</i> , <i>Flacourtia indica</i> . Middle Storey: <i>Mallotus philippensis</i> , <i>Nyctanthes arbor-tristis</i> , <i>Dendrocalamus strictus</i> Lower Storey: <i>Carissa opaca</i> , <i>Dodonaea viscosa</i> , <i>Woodfordia fruticosa</i> , <i>Adhatoda vasica</i> .	21.73
7.	Goa	3B/C2 Southern Moist Mixed Deciduous Forest Top Storey: <i>Adina cordifolia</i> , <i>Grewia tiliifolia</i> , <i>Madhuca indica</i> , <i>Dillenia pentagyna</i> , <i>Cinnamomum</i> spp., <i>Litsea</i> spp., <i>Olea dioica</i> , <i>Terminalia paniculata</i> , <i>Tectona grandis</i> , <i>Grewia tiliifolia</i> , <i>Careya arborea</i> . Middle Storey: <i>Emblica officinalis</i> , <i>Xylia xylocarpa</i> etc., <i>Bambusa arundinacea</i> , <i>Dendrocalamus strictus</i> . Lower Storey: <i>Tabernaemontana</i> spp., <i>Ziziphus rugosa</i> , <i>Cyclea</i> , <i>Acacia concinna</i> spp.,	42.55
		1A/C4 West Coast Tropical Evergreen Forest Top Storey: <i>Dipterocarpus indicus</i> , <i>Poeciloneuron indicum</i> , <i>Mesua ferrea</i> , <i>Hopea parviflora</i> , <i>Dysoxylum malabaricum</i> , <i>Calophyllum elatum</i> , <i>Machilus macranthus</i> , <i>Palaquium ellipticum</i> and many others. Middle Storey: <i>Myristica</i> spp., <i>Euphoria longana</i> , <i>Unona pannosa</i> , <i>Humboldtia brunonis</i> , <i>Aglaia odoratissima</i> , <i>Hopea wightiana</i> , <i>Oxytenanthera</i> spp.	22.40

		<p>Lower Storey: <i>Rubiaceae, Strobilanthes, Pinanga dichsoni, Arenga wightii, Pandanus, Calamus spp.</i></p>	
		<p>2A/C2 West Coast Semi-Evergreen Forest</p> <p>Top Storey: <i>Terminalia paniculata, Diospyros spp., Lagerstroemia lanceolata, Holigarna arnottiana, Lophopetalum wightianum, Machilus macranthus, Cinnamomum spp., Hopea parviflora, Artocarpus hirsutus.</i></p> <p>Middle Storey: <i>Elaeocarpus serratus, Mallotus philippensis, Diospyros assimilis, Ixora arborea.</i></p> <p>Lower Storey: <i>Webera, Strobilanthes spp., Ixora malabarica.</i></p> <p>Climbers and canes numerous</p>	21.35
8.	Gujarat	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top Storey/ Middle Storey: <i>Sterculia urens, Lannea coromandelica, Salmalia malabarica, Moringa oleifera.</i></p> <p>Lower Storey: <i>Euphorbia tirucalli, Capparis decidua, Lawsonia inermis.</i></p>	12.75
		<p>5A/C1b Dry Teak Forest</p> <p>Top Storey: <i>Tectona grandis, Boswellia serrata, Lannea coromandelica, Anogeissus latifolia, Diospyros tomentosa, Terminalia tomentosa, Butea monosperma, Hymenodictyon excelsum, Cochlospermum religiosum, Cassia fistula, Bauhinia racemosa, Bridelia retusa, Ougeinia oojeinensis, Dalbergia latifolia, Schrebera swietenoides.</i></p> <p>Middle Storey: <i>Wrightia tinctoria, Flacourtia indica, Ziziphus xylopyrus, Dendrocalamus strictus.</i></p> <p>Lower Storey: <i>Holarrhena antidysenterica, Nyctanthes arbor-tristis, Ziziphus nummularia.</i></p>	11.77
		<p>6B/C1 Desert Thorn Forest</p> <p>1. Kutch, Saurashtra, Gujrat</p> <p>Top Storey: <i>Acacia senegal, A. leucophloea, Cordia rothii, Azadirachta indica.</i></p>	9.22

		<p>Middle Storey & Lower Storey: <i>Euphorbia neriifolia</i>, <i>E. nivulia</i>, <i>Balanites aegyptiaca</i>, <i>Salvadora</i>, <i>Commiphora mukul</i>, <i>Capparis</i> spp. <i>Grewia tenax</i>, <i>G. villosa</i>, <i>Premna integrifolia</i>.</p> <p>2. Sasan, Saurashtra, Gujrat</p> <p><i>Acacia planifrons</i>, <i>A. arabica</i>, <i>A. catechu</i>, <i>Balanites aegyptiaca</i>, <i>Ziziphus</i> spp.</p>	
9.	Haryana	<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Acacia catechu</i>, <i>Anogeissus latifolia</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Feronia limonia</i>, <i>Ehretialaavis</i>, <i>Kydia calycina</i>, <i>Ougeinia oojeinensis</i>, <i>Mitragyna parvifolia</i>, <i>Flacourtia indica</i>.</p> <p>Middle Storey: <i>Mallotus philippensis</i>, <i>Nyctanthes arbor-tristis</i>, <i>Dendrocalamus strictus</i></p> <p>Lower Storey: <i>Carissa opaca</i>, <i>Dodonaea viscosa</i>, <i>Woodfordia fruticosa</i>, <i>Adhatoda vasica</i>.</p>	30.20
		<p>6B/C2 Ravine Thorn Forest</p> <p>Top Storey & Middle Storey: <i>Acacia senegal</i>, <i>A. leucophloea</i>, <i>Prosopis spicigera</i>, <i>Salvadora oleoides</i></p> <p>Lower Storey: <i>Capparis decidua</i>, <i>Ziziphus mauritiana</i>, <i>Z. nummularia</i>, <i>Calotropis procera</i>,</p>	14.32
		<p>6/1S1 Desert Dune Scrub</p> <p>Top Storey: <i>Prosopis spicigera</i>, <i>Acacia arabica</i>, <i>Tamarix aphylla</i>, <i>Salvadora oleoides</i>.</p> <p>Middle Storey/Lower Storey: <i>Calotropis gigantea</i>, <i>C. procera</i>, <i>Ziziphus nummularia</i>, <i>Z. mauritiana</i>, <i>Calligonum polygonoides</i>, <i>Balanites aegyptiaca</i>, <i>Capparis decidua</i>, <i>Leptadenia pyrotechnica</i>, <i>Aerva javanica</i>, <i>Crotalaria burhia</i>.</p>	6.40
10.	Himachal Pradesh	<p>12/C1d Western Mixed Coniferous Forest (Spruce, Blue Pine, Silver Fir)</p> <p>Top Storey: <i>Picea</i> spp., <i>Cedrus deodara</i>, <i>Abies pindrow</i>, <i>Pinus wallichiana</i>.</p>	14.03

		<p>Middle Storey: <i>Quercus dilatata</i>, <i>Quercus incana</i>, <i>Quercus semecarpifolia</i>, <i>Acer acuminatum</i>, <i>A. caesium</i>, <i>A. pictum</i>, <i>Euonymus lacerus</i>, <i>Taxus baccata</i>, <i>Betula alnoides</i>, <i>Arundinaria falcata</i>, <i>Thamnocalamus spathiflorus</i>.</p> <p>Lower Storey: <i>Deutzia corymbosa</i>, <i>Ribes rubrum</i>, <i>Viburnum nervosum</i>, <i>Skimmia</i>, <i>Strobilanthes</i> spp. Va. <i>Fragaria</i>, <i>Viola</i>, <i>Valeriana</i>, <i>Pteridium</i>, <i>Adiantum venustum</i>, <i>Aspidium aculeatum</i>.</p>	
		<p>15/C3 Alpine Pasture</p> <p><i>Agropyron longearistatum</i>, <i>A. semicostatum</i>, <i>Brachypodium sylvaticum</i>, <i>Bromus asper</i>, <i>B. japonicus</i>, <i>Dactylis</i> spp., <i>Danthonia</i> spp., <i>Festuca</i> spp., <i>Milium effusum</i>, <i>Oryzopsis</i>, <i>Phleum</i>, <i>Poa</i> spp. etc.</p>	13.96
		<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Acacia catechu</i>, <i>Anogeissus latifolia</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Feronia limonia</i>, <i>Ehretialaervis</i>, <i>Kydia calycina</i>, <i>Ougeinia oojeinensis</i>, <i>Mitragyna parvifolia</i>, <i>Flacourtia indica</i>.</p> <p>Middle Storey: <i>Mallotus philippensis</i>, <i>Nyctanthes arbor-tristis</i>, <i>Dendrocalamus strictus</i></p> <p>Lower Storey: <i>Carissa opaca</i>, <i>Dodonaea viscosa</i>, <i>Woodfordia fruticosa</i>, <i>Adhatoda vasica</i>.</p>	12.70
11.	Jammu & Kashmir and Ladakh (combined)	<p>12/C1d Western Mixed Coniferous Forest (Spruce, Blue Pine, Silver fir)</p> <p>Top Storey: <i>Picea</i>, <i>Cedrus deodara</i>, <i>Abies pindrow</i>, <i>Pinus wallichiana</i>.</p> <p>Middle Storey: <i>Quercus dilatata</i>, <i>Quercus incana</i>, <i>Quercus semecarpifolia</i>, <i>Acer acuminatum</i>, <i>A. caesium</i>, <i>A. pictum</i>, <i>Euonymus lacerus</i>, <i>Taxus baccata</i>, <i>Betula alnoides</i>, <i>Arundinaria falcata</i>, <i>Thamnocalamus spathiflorus</i>.</p>	12.82

		<p>Lower Storey: <i>Deutzia corymbosa</i>, <i>Ribes rubrum</i>, <i>Viburnum nervosum</i>, <i>Skimmia</i>, <i>Strobilanthes</i> spp. Va. <i>Fragaria</i>, <i>Viola</i>, <i>Valeriana</i>, <i>Pteridium</i>, <i>Adiantum venustum</i>, <i>Aspidium aculeatum</i>.</p>	
		<p>9/C1a Lower or Siwalik Chir Pine Forest</p> <p>Top Storey: <i>Pinus roxburghii</i>.</p> <p>Middle Storey: <i>Terminalia chebula</i>, <i>Mallotus philippensis</i>, <i>Pyrus pashia</i>, <i>Syzygium cumini</i>, <i>Albizia chinensis</i>, <i>Emblica</i>, <i>Acacia catechu</i>.</p> <p>Lower Storey: <i>Carissa opaca</i>, <i>Dodonaea viscosa</i>, <i>Rubus ellipticus</i>, <i>Crataegus crenulata</i>, <i>Flacourtia</i>, <i>Myrsine africana</i>, <i>Woodfordia fruticosa</i>, <i>Colebrookia</i>, <i>Berberis</i>, <i>Indigofera pulchella</i>, <i>Murraya koenigii</i>.</p> <p>NOTE- In moister sites, <i>Quercus incana</i>, <i>Quercus glauca</i>, <i>Pyrus</i>, <i>Rhododendron</i> etc.</p>	10.86
		<p>12/C1c Moist Deodar Forest (<i>Cedrus</i>)</p> <p>Top Storey: <i>Cedrus deodara</i>, <i>Pinus wallichiana</i>.</p> <p>Middle Storey: <i>Quercus incana</i>.</p> <p>Lower Storey: <i>Rosa macrophylla</i>, <i>Berberis lycium</i>, <i>Lonicera angustifolia</i>, <i>Strobilanthes wallichii</i>, <i>Boenninghausenia</i> spp., <i>Deutzia staminea</i>.</p>	8.93
12.	Jharkhand	<p>5B/C1c Dry Peninsular Sal Forest</p> <p>(1) Shorea-Anogeissus-Woodfordia association</p> <p>Top Storey & Middle Storey: <i>Shorea robusta</i>, <i>Anogeissus latifolia</i>, <i>Boswellia serrata</i>, <i>Cochlospermum religiosum</i>, <i>Dillenia aurea</i>, <i>Ziziphus xylopyrus</i>, <i>Gardenia gummifera</i>.</p> <p>Lower Storey: <i>Woodfordia fruticosa</i>, <i>Wendlandia tinctoria</i>, <i>Grewia hirsuta</i>, <i>Phoenix acaulis</i>.</p> <p>(2) Shorea-Gardenia-Eulaliopsis association.</p> <p>Top & Middle Storey: <i>Shorea robusta</i>, <i>Buchanania lanzan</i>, <i>Eugenia caryophyllifolia</i>, <i>Gardenia gummifera</i>, <i>Madhuca</i></p>	53.77

	<p><i>indica, Diospyros tomentosa, Emblica officinalis, Cephalostachyum pergracile.</i></p> <p>Lower Storey: <i>Wendlandia tinctoria, Phoenix acaulis.</i></p>	
	<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>(i) Cochlospermum-Euphorbia association</p> <p>Top & Middle Storey: <i>Lannea coromandelica, Gardenia latifolia, Cochlospermum religiosum, Sterculia urens, Chloroxylon swietenia, Buchanania lanzan, Aegle marmelos, Anogeissus latifolia, Morinda tinctoria, Canthium dicoccum, Emblica officinalis, Euphorbia nivulia, Protium serratum, Lagerstroemia parviflora, Erythrina suberosa, Stereospermum suaveolens, Ficus spp.</i></p> <p>Lower Storey: <i>Woodfordia fruticosa, Nyctanthes arbor-tristis, Petalidium barlerioides, Murraya paniculata</i></p> <p>(ii) Anogeissus-Mitragyna-Dendrocalamus- Daedalacanthus association</p> <p>Top & Middle Storey: <i>Anogeissus latifolia, Adina cordifolia, Mitragyna parvifolia, Hymenodictyon excelsum, Aegle marmelos, Chloroxylon swietenia, Schleicheria oleosa, Lannea coromandelica, Schrebera swieteniioides, Lagerstroemia parviflora, Bridelia retusa, and occasional Shorea, Cochlospermum, Sterculia, Boswellia, Buchanania, Ougeinia oojeinensis, Erythrina, Bauhinia malabarica, Madhuca, Diospyros montana, Stereospermum, Vitex peduncularis.</i></p> <p>Lower Storey: <i>Petalidium barlerioides, Helicteres isora, Strobilanthes auriculatus, Symphorema polyandrum.</i></p>	35.01
	<p>5/DS1 Dry Deciduous Scrub</p> <p><i>Acacia catechu, Butea monosperma, Randia dumetorum, Carissa opaca, Acacia pennata, Flacourtia indica, Euphorbia, Ziziphus, Carissa, Mimosa.</i></p>	2.36

13.	Karnataka	<p>1A/C4 West Coast Tropical Evergreen Forest</p> <p>Top Storey: <i>Dipterocarpus indicus</i>, <i>Poeciloneuron indicum</i>, <i>Mesua ferrea</i>, <i>Hopea parviflora</i>, <i>Dysoxylum malabaricum</i>, <i>Calophyllum elatum</i>, <i>Machilus macranthus</i>, <i>Palaquium ellipticum</i> and many others.</p> <p>Middle Storey: <i>Myristica</i> spp., <i>Euphoria longana</i>, <i>Unona pannosa</i>, <i>Humboldtia brunonis</i>, <i>Aglaia odoratissima</i>, <i>Hopea wightiana</i>, <i>Oxytenanthera</i> spp.</p> <p>Lower Storey: <i>Rubiaceae</i>, <i>Strobilanthes</i>, <i>Pinanga dichsoni</i>, <i>Arenga wightii</i>, <i>Pandanus</i>.</p>	12.65
		<p>3B/C2 Southern Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Adina cordifolia</i>, <i>Grewia tiliifolia</i>, <i>Madhuca indica</i>, <i>Dillenia pentagyna</i>, <i>Cinnamomum</i>, <i>Litsea</i>, <i>Olea dioica</i>.</p> <p>Middle Storey: <i>Embllica officinalis</i>, <i>Xylia xylocarpa</i>, <i>Bambusa arundinacea</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Tabernaemontana</i>, <i>Ziziphus rugosa</i>, <i>Cyclea</i>, <i>Acacia concinna</i></p>	11.70
		<p>2A/C2 West Coast Semi-Evergreen Forest</p> <p>Top Storey: <i>Terminalia paniculata</i>, <i>Diospyros</i> spp., <i>Lagerstroemia lanceolata</i>, <i>Holigarna arnottiana</i>, <i>Lophopetalum wightianum</i>, <i>Machilus macranthus</i>, <i>Cinnamomum</i> spp., <i>Hopea parviflora</i>, <i>Artocarpus hirsutus</i>.</p> <p>Middle Storey: <i>Elaeocarpus serratus</i>, <i>Mallotus philippensis</i>, <i>Diospyros assimilis</i>, <i>Ixora arborea</i>.</p> <p>Lower Storey: <i>Webera</i>, <i>Strobilanthes</i> spp., <i>Ixora malabarica</i>.</p>	10.52
14.	Kerala	<p>1A/C4 West Coast Tropical Evergreen Forest</p> <p>1. High Level Evergreen Forests of Wynaad, Kerala-</p> <p>These forests are characterised by a high proportion of <i>Mesua ferrea</i>, <i>Palaquium ellipticum</i>, <i>Cullenia excelsa</i> and <i>Calophyllum elatum</i>. The absence of <i>Dipterocarpus indicus</i>, <i>Filicium</i>, <i>Kingiodendron pinnatum</i> and <i>Hopea</i> is noteworthy;</p>	15.13

these species are met with at lower elevations in the adjoining Kannoth block, where Merua is absent.

Top Storey: *Palaquium ellipticum*, *Vateria*, (especially near water courses), *Calophyllum elatum*, *Cullenia excelsa*, *Dysoxylum malabaricum*, *Artocarpus hirsutus*, *Cedrela toona*, *Machilus macranthus*, *Mesua ferrea*, *Elaeocarpus tuberculatus*, *Bischofia*, *Eugenia* spp., *Canarium*.

Middle Storey: *Palaquium ellipticum*, *Moristica* spp., *Vateria*, *Eugenia munroi*, *Actinodaphne hirsuta*, *Ostodes*, *Euphoria longana*, *Litsea* spp. *Meliosm simplicifolia*, *Polvalthia coffeoides*, *Cinnamomum zeylanicum*, *Elaeocarpus serratus*, Bamboos appear mainly as *Ochlandra* brakes along the larger streams but occasionally spread out on the slopes.

Lower Storey: *Leea indica*, *Rubiaceae*, *Apama*, *Areca*, *Strobilanthes* spp., *Psychotria*, *Lasianthus*, *Pandanus* spp., *Glycosmis*, *Calamus* spp., *Laportea crenulata*, large ferns.

2. High Level Evergreen Forests of Nilambur (Kerala)--

Top Storey: *Palaquium ellipticum*, *Cullenia excelsa*, *Calophyllum elatum*, *Terminalia bellirica*, *Machilus macranthus*, *Dysoxylum malabaricum*, *Elaeocarpus tuberculatus*, *Artocarpus hirsutus*.

Middle Storey: *Eugenia gardneri*, *Cinnamomum zeylanicum*, *Bischofia javanica*, *Cedrela toona*, *Elaeocarpus* spp., *Xylopia parviflora.*, *Ochlandra* spp.

Lower Storey: *Strobilanthes*, *Rubiaceae*, *Pinanga dicksonii*, *Arenga wightii*.

NOTE. Here *Palaquium* is the commonest species. *Hopea* is found sparsely, scattered below 750 m. *Mesua ferrea* is abundant from 900 m. to 1,200 m. *Calophyllum* tends to be gregarious in patches. *Dipterocarpus* is absent.

	<p>2A/C2 West Coast Semi-Evergreen Forest</p> <p>i) Wynaad and Palghat, Kerala-</p> <p>Top Storey: <i>Artocarpus hirsutus, Salmalia malabarica, Vitex altissima, Tetrameles nudiflora, Acrocarpus fraxinifolius, Hopea parviflora, Lagerstroemia lanceolata, Vateria indica, Anthocephalus cadamba, Xylia xylocarpa, Terminalia tomentosa, Cedrela toona, Grewia tiliifolia, Dalbergia latifolia, Pterospermum rubiginosum, Radermachera xylocarpa, Mesua ferrea, Adina cordifolia, Holoptelea integrifolia, Pterocarpus marsupium, Sterculia guttata.</i></p> <p>Middle Storey: <i>Hydnocarpus laurifolia, H. alpina, Bischofia javanica, Mallotus philippensis, Kydia calycina, Schleicheria oleosa, Evodia lunuankenda, Bambusa arundinacea, Ochlandra spp.</i></p> <p>(ii) Trivandrum, Kerala-</p> <p>Top Storey: <i>Artocarpus hirsutus, Hopea parviflora, Adina cordifolia, Lagerstroemia lanceolata, Terminalia paniculata, T. tomentosa, Salmalia malabarica, Tetrameles nudiflora, Vitex altissima, Holoptelea integrifolia, Vateria indica, Lophopetalum, Pterocarpus marsupium, Calophyllum elatum, Machilus macranthus, Grewia tiliifolia, Terminalia bellirica.</i></p> <p>Middle Storey: <i>Polyalthia fragrans, Canarium strictum, Cinnamomum zeylanicum, Aporosa lindleyana, Mallotus philippensis, Xanthophyllum flavescens, Emblica officinalis, Bridelia retusa, Albizia odoratissima.</i> Bamboos and reeds very common.</p> <p>Lower Storey: <i>Clerodendron, Glycosmis pentaphylla, Strobilanthes spp.</i></p>	13.79
	<p>3B/C2 Southern Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Terminalia paniculata, T. tomentosa, T. bellirica, Pterocarpus marsupium, Albizia procera, Alstonia scholaris,</i></p>	8.80

		<p><i>Dillenia pentagyna, Bridelia retusa, Salmalia malabarica, Grewia tiliifolia.</i></p> <p>Middle Storey: <i>Xylia xylocarpa, Careya arborea, Callicarpa lanata, Cassia fistula, Strychnos nux-vomica.</i></p> <p>Lower Storey: <i>Croton reticulatus, Anisomeles heyneana, Carissa carandas.</i></p> <p>Ranni, Kerala-</p> <p>Top & Middle Storey: <i>Terminalia paniculata, T. tomentosa, Pterocarpus marsupium, Anogeissus latifolia, Careya arborea, Buchanania lanzan, Emblica officinalis, Dillenia pentagyna, Salmalia insignis, Sterculia villosa, Albizia odoratissima, Cassia fistula, Gmelina arborea, Taberaemontana heyneana, Bauhinia malabarica, Wrightia tinctoria.</i></p>	
15.	Madhya Pradesh	<p>5A/C1b Dry Teak Forest</p> <p>Top Storey /Middle Storey: <i>Tectona grandis, Anogeissus latifolia, Diospyros tomentosa. Pterocarpus marsupium, Dalbergia latifolia, Cassia fistula, Butea monosperma, Adina cordifolia, Mitragyna parvifolia, Bridelia retusa, Aegle marmelos, Lagerstroemia parviflora, Wrightia tinctoria, Bauhinia spp., Alangium salviifolium, Dendrocalamus strictus.</i></p> <p>Lower Storey: <i>Nyctanthes arbor-tristis, Woodfordia fruticosa, Helicteres isora, Grewia hirsuta, Gymnosporia spinosa, Indigofera pulchella, Adhatoda vasica, Carissa spp., Holarrhena antidysenterica, Lantana camara.</i></p>	26.40
		<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top Storey /Middle Storey: <i>Terminalia tomentosa, Anogeissus latifolia, Mitragyna parvifolia, Schrebera swietenoides, Madhuca indica, Diospyros tomentosa, Buchanania lanzan, Lagerstroemia parviflora, Emblica officinalis, Cassia fistula, Aegle marmelos, Butea monosperma, Santalum album, Albizia spp., Boswellia serrata,</i></p>	24.55

		<p><i>Chloroxylon swietenia, Syzygium cumini, Hardwickia binata, Acacia arabica, Prosopis juliflora, Sterculia urens.</i></p> <p>Lower Storey: <i>Nyctanthes arbor-tristis, Ziziphus spp. Helicteres isora, Vitex negundo, Adhatoda vasica, Gymnosporia spinosa, Randia dumetorum, Flacourtia indica, Grewia spp., Woodfordia fruticosa, Balanites aegyptiaca, Carissa spp., Holarrhena antidysenterica, Lantana camara.</i></p>	
		<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey & Middle Storey: <i>Anogeissus pendula, Acacia catechu, Anogeissus latifolia, Diospyros melanoxylon, Madhuca indica, Butea monosperma, Emblica officinalis, Feronia limonia, Albizia spp., Acacia leucophloea, A. arabica, Soyimida febrifuga, Miliusa tomentosa, Bauhinia spp., Dendrocalamus strictus.</i></p> <p>Lower Storey: <i>Carissa spp., Flacourtia indica, Ziziphus xylopyrus, Ziziphus nummularia, Capparis decidua, Calotropis procera, Falanites aegyptiaca, Holarrhena antidysenterica, Grewia spp., Adhatoda vasica, Gymnosporia spinosa.</i></p>	18.55
16.	Maharashtra	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top Storey /Middle Storey: <i>Boswellia serrata, Acacia leucophloea, Bauhinia tomentosa, Rhus mysorensis, Lannea coromandelica, Flacourtia indica, Cochlospermum religiosum, Anogeissus latifolia, Terminalia tomentosa, Gymnosporia spinosa, Ziziphus mauritiana, Ziziphus oenopolia, Ziziphus xylopyrus, Azadirachta indica, Santalum album, Osyris wightiana, Tectona grandis, Heterophragma quadriloculare, Stereospermum personatum, Dolichandrone falcata.</i></p>	26.30

	<p>3B/C2 Southern Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Tetrameles nudiflora</i>, <i>Stereospermum personatum</i>, <i>Dysoxylum binectariferum</i>, <i>Ficus nervosa</i> (all occasional).</p> <p>Middle Storey: <i>Syzygium cumini</i>, <i>Olea dioica</i>, <i>Pouteria tomentosa</i>, <i>Bridelia retusa</i> var. <i>squamosa</i>, <i>Mangifera</i>, <i>Actinodaphne angustifolia</i>, <i>Ficus glomerata</i>, <i>Memecylon umbellatum</i>, <i>Mallotus</i>, <i>Ixora</i>, <i>Flacourtia</i>, <i>Randia</i>.</p> <p>Lower Storey: <i>Callicarpa</i>, <i>Lasiosiphon</i>, <i>Phayloopsis</i>, <i>Leea</i>, <i>Pogostemon</i> etc.</p> <p>(ii) Chanda, Maharashtra-</p> <p>Top Storey: <i>Pterocarpus marsupium</i>, <i>Salmalia malabarica</i>, <i>Terminalia bellirica</i>, <i>Anogeissus latifolia</i>, <i>Dalbergia latifolia</i>, <i>Terminalia tomentosa</i>, <i>Lannea coromandelica</i>, <i>Madhuca indica</i>, <i>Garuga pinnata</i>.</p> <p>Middle Storey: <i>Miliusa tomentosa</i>, <i>Polyalthia cerasoides</i>, <i>Lagerstroemia parviflora</i>, <i>Emblica officinalis</i>, <i>Xylia xylocarpa</i>, <i>Grewia tiliifolia</i>, <i>Schrebera swietenoides</i>, <i>Cleistanthus collinus</i>, <i>Diospyros montana</i>, <i>Flacourtia indica</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Ziziphus oenopolia</i>, <i>Casearia graveolens</i>, <i>Helicteres isora</i>, <i>Desmodium gangeticum</i>.</p>	21.01
	<p>5A/C1b Dry Teak Forest</p> <p>Top Storey: <i>Tectona grandis</i>, <i>Terminalia tomentosa</i>, <i>Lannea coromandelica</i>, <i>Diospyros tomentosa</i>, <i>Madhuca indica</i>, <i>Miliusa tomentosa</i>, <i>Anogeissus latifolia</i>, <i>Soymida febrifuga</i>, <i>Mitragyna parvifolia</i>, <i>Boswellia serrata</i>, <i>Hardwickia binata</i>, <i>Dalbergia paniculata</i>, <i>Dillenia pentagyna</i>.</p> <p>Middle Storey: <i>Butea monosperma</i>, <i>Buchanania lanzan</i>, <i>Emblica officinalis</i>, <i>Cassia fistula</i>, <i>Acacia catechu</i>, <i>Bauhinia</i></p>	17.40

		<p><i>racemosa</i>, <i>Holarrhena antidysenterica</i>, <i>Flacourtia indica</i>, <i>Randia dumetorum</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Helicteres isora</i>, <i>Calotropis gigantea</i>, <i>Grewia</i> spp., <i>Woodfordia fruticosa</i>, <i>Nyctanthes arbor-tristis</i>.</p>	
17.	Manipur	<p>8B/C1 East Himalayan Sub-Tropical Wet Hill Forest</p> <p>a) Langool Reserve. <i>Quercus-Laurus-Schima hylium</i>, 800, to 1,000 m. or more.</p> <p>Top Storey: <i>Lithocarpus spicatus</i>, <i>Quercus vercus (fenestrata)</i>, <i>Quercus serrata</i>, <i>Castanopsis</i>, <i>Schima</i>, <i>Cinnamomum</i>, <i>Saurauia</i> spp., <i>Litsea</i> spp., <i>Machilus</i>, <i>Syzygium</i>, <i>Cedrela toona</i>.</p> <p>Middle Storey/Lower Storey: <i>Psychotria</i>, <i>Flacourtia</i>, <i>Symplocos</i>, <i>Crateva nurvala</i>, and <i>Emblica</i>.</p> <p>(b) Ukhrul and Shugnu. <i>Pinus-Quercus hylium</i>, 1,200 to 1,500 m., 1,750 mm. rainfall, volcanic rock.</p> <p>Top Storey: <i>Pinus insularis</i> (khasya) dominant.</p> <p>Middle Storey: <i>Quercus</i> spp., <i>Lithocarpus</i>, <i>Schima</i>, <i>Castanopsis</i> spp., <i>Betula alnoides</i>, <i>Acer oblongum</i>, <i>Engelhardia</i> spp., <i>Symplocos</i>.</p> <p>Lower Storey: <i>Pittosporum</i> spp., <i>Myrsine</i>, <i>Debregeasia</i>, <i>Rubus</i> spp., etc.</p> <p>(c) Koupru and Maohing. <i>Saurauia-Phoebe-Beilschmiedia hylium</i>, 900 to 1,800 m., 3,000 to 4,000 mm. rainfall.</p> <p>Top Storey/Middle Storey: <i>Saurauia</i> spp., <i>Phoebe lanceolata</i>, <i>Beilschmiedia</i>, <i>Cinnamomum cecicodaphne</i>, <i>Schima</i>, <i>Lauraceae</i> (many spp.), <i>Ostodes</i>.</p> <p>Lower Storey: Abundant shrub layer.</p>	33.69
		<p>3C/C3b East Himalayan Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Lagerstroemia parviflora</i>, <i>Terminalia bellirica</i>, <i>Sterculia villosa</i>, <i>Salmalia malabarica</i>, <i>Schima wallichii</i></p>	24.48

		<p>Middle Storey: <i>Careya arborea</i>, <i>Bauhinia purpurea</i>, <i>Amoora</i> spp.</p>	
		<p>2B/C2 Cachar Semi-Evergreen Forest</p> <p>Kabaw Valley, Manipur. 100 m. (DEB)-</p> <p>Top Storey: <i>Dipterocarpus tuberculatus</i>, <i>D. turbinatus</i>, <i>Melanorrhoea usitata</i>, <i>Duabanga grandiflora</i>, <i>Xylia dolabriformis</i>, <i>Dillenia pentagyna</i>, <i>Lagerstroemia parviflora</i>, <i>Terminalia tomentosa</i>, <i>Gmelina arborea</i>.</p> <p>Middle Storey: <i>Terminalia citrina</i>, <i>Emblica officinalis</i>, <i>Engelhardia spicata</i>, <i>Saurauia nepaulensis</i>, <i>Symplocos racemosa</i>, <i>Mallotus philippensis</i>, <i>Melocanna bambusoides</i>.</p> <p>Lower Storey: <i>Wendlandia grandis</i>, <i>Woodfordia fruticosa</i>, <i>Buddleia asiatica</i>, <i>Indigofera pulchella</i>, <i>Leea</i> spp., <i>Desmodium</i> spp., <i>Licuala peltata</i>.</p>	15.39
18.	Meghalaya	<p>3C/C3b East Himalayan Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Lagerstroemia parviflora</i>, <i>Terminalia bellirica</i>, <i>Sterculia villosa</i>, <i>Salmalia malabarica</i>, <i>Schima wallichii</i></p> <p>Middle Storey: <i>Careya arborea</i>, <i>Bauhinia purpurea</i>, <i>Amoora</i> spp.</p>	47.73
		<p>8B/C2 Khasi Sub-Tropical Wet Hill Forest</p> <p>Top Storey: <i>Quercus</i> spp., <i>Manglietia insignis</i>, <i>Beilschmiedia</i> spp., <i>Cinnamomum</i> spp., <i>Machilus</i> spp., <i>Schima khasiana</i>, <i>Bucklandia</i>, <i>Ficus nemoralis</i>.</p> <p>Middle Storey: <i>Lindera</i> spp., <i>Ilex</i> spp., <i>Ligustrum</i> spp., <i>Litsea</i> spp., <i>Prunus</i> spp., <i>Pyrus</i> spp., <i>Symplocos</i> spp., <i>Myrica sapida</i>, <i>Lyonia</i> spp., <i>Chimonobambusa callosa</i>.</p> <p>Lower Storey: <i>Myrsine semiserrata</i>, <i>Daphne</i> spp., <i>Euonymus</i> spp., <i>Hypericum</i> spp., <i>Viburnum</i> spp., <i>Zanthoxylum</i> spp., <i>Rosa</i> spp., <i>Rubus</i> spp.</p>	20.43

		1B/C3 Cachar Tropical Evergreen Forest Top Storey & Middle Storey: <i>Palaquium, Diospyros topiosa, Cynometra polyandra, Dipterocarpus turbinatus, Mesua, Eugenia spp., Euphoria longana, Sapium baccatum, Vatica lanceifolia, Canarium spp., Hydnocarpus kurzii, Heritiera acuminata, Kayea floribunda.</i>	8.52
19.	Mizoram	2/2S1 Secondary Moist Bamboo Brakes <i>Melocanna bambusoides.</i> <i>Bambusa tulda</i> <i>Dendrocalamus hamiltonii</i>	37.42
		3C/C3b East Himalayan Moist Mixed Deciduous Forest Top Storey: <i>Lagerstroemia parviflora, Terminalia bellirica, Sterculia villosa, Salmalia malabarica, Schima wallichii.</i> Middle Storey: <i>Careya arborea, Bauhinia purpurea, Amoora spp.</i>	30.79
		2B/C2 Cachar Tropical Semi-Evergreen Forest Top Storey & Middle Storey: <i>Palaquium, Diospyros topiosa, Cynometra polyandra, Dipterocarpus turbinatus, Mesua, Eugenia spp., Euphoria longana, Sapium baccatum, Vatica lanceifolia, Canarium spp., Hydnocarpus kurzii, Heritiera acuminata, Kayea floribunda.</i>	30.70
20.	Nagaland	3C/C3b East Himalayan Moist Mixed Deciduous Forest Top Storey: <i>Lagerstroemia parviflora, Terminalia bellirica, Sterculia villosa, Salmalia malabarica, Schima wallichii</i> Middle Storey: <i>Careya arborea, Bauhinia purpurea, Amoora spp.</i>	38.44
		2B/2S2 Eastern Alluvial Secondary Semi-Evergreen Forest Top Storey: <i>Ailanthus grandis, Pterospermum, Albizia lucida, Stereospermum, Terminalia citrina, T. bellirica, Dipterocarpus macrocarpus, Anthocephalus.</i>	17.55

		<p>Middle Storey: <i>Macaranga</i>, <i>Mallotus albus</i>, <i>Zanthoxylum</i>, <i>Alstonia</i>, <i>Actinodaphne</i>, <i>Litsea monopetala</i>, <i>Bambusa pallida</i>, <i>Pseudostachyum</i>, <i>Dendrocalamus hamiltonii</i>.</p> <p>Lower Storey: <i>Laportea</i>, <i>Melastoma</i></p>	
		<p>8B/C2 Khasi Sub-Tropical Wet Hill Forest</p> <p>Top Storey: <i>Quercus</i> spp., <i>Manglietia insignis</i>, <i>Beilschmiedia</i>, <i>Cinnamomum</i> spp., <i>Machilus</i> spp., <i>Schima khasiana</i>, <i>Bucklandia</i>, <i>Ficus nemoralis</i>.</p> <p>Middle Storey: <i>Lindera</i> spp., <i>Ilex</i> spp., <i>Ligustrum</i> spp., <i>Litsea</i> spp., <i>Prunus</i> spp., <i>Pyrus</i> spp., <i>Symplocos</i> spp., <i>Myrica sapida</i>, <i>Lyonia</i> spp., <i>Chimonobambusa callosa</i>.</p> <p>Lower Storey: <i>Myrsine semiserrata</i>, <i>Daphne</i> spp., <i>Euonymus</i> spp., <i>Hypericum</i> spp., <i>Viburnum</i> spp., <i>Zanthoxylum</i> spp., <i>Rosa</i> spp., <i>Rubus</i> spp.</p>	16.09
21.	Odisha	<p>3C/C2e (ii) Moist Peninsular Low Level Sal</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Terminalia tomentosa</i>, <i>Adina cordifolia</i>, <i>Mitragyna parvifolia</i>, <i>Lagerstroemia parviflora</i>, <i>Anogeissus latifolia</i>, <i>Bridelia retusa</i>, <i>Albizia procera</i>, <i>Hymenodictyon excelsum</i>, <i>Pterocarpus marsupium</i>, <i>Salmalia malabarica</i>, <i>Gmelina arborea</i>.</p> <p>Middle Storey: <i>Cleistanthus collinus</i>, <i>Dalbergia latifolia</i>, <i>Dalbergia paniculata</i>, <i>Syzygium cumini</i>, <i>Dillenia pentagyna</i>, <i>Careya arborea</i>, <i>Diospyros</i> spp., <i>Mallotus philippensis</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Cipadessa fruticosa</i>, <i>Woodfordia fruticosa</i>, <i>Clerodendrum viscosum</i>, <i>Ziziphus oenopolia</i>.</p>	22.06
		<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Adina cordifolia</i>, <i>Lagerstroemia parviflora</i>, <i>Anogeissus latifolia</i>, <i>Terminalia tomentosa</i>, <i>Mitragyna parvifolia</i>, <i>Dalbergia latifolia</i>, <i>Hymenodictyon excelsum</i>, <i>Bridelia retusa</i>, <i>Albizia</i> spp., <i>Salmalia malabarica</i>, <i>Shorea</i></p>	21.29

		<p><i>robusta</i>, <i>Pterocarpus marsupium</i>, <i>Dalbergia paniculata</i>, <i>Protium serratum</i>, <i>Stereospermum suaveolens</i>, <i>Terminalia bellirica</i>, <i>Melia composita</i>, <i>Cleistanthus collinus</i>, <i>Diospyros tomentosa</i>, <i>Lannea coromandelica</i>.</p> <p>Middle Storey: <i>Ougeinia oojeinensis</i>, <i>Cassia fistula</i>, <i>Alangium salviifolium</i>, <i>Careya arborea</i>, <i>Holarrhena antidysenterica</i>, <i>Casearia tomentosa</i>, <i>Mallotus philippensis</i>, <i>Randia</i> spp., <i>Feronia limonia</i>, <i>Acacia leucophloea</i>, <i>Ziziphus xylopyrus</i>, <i>Chloroxylon swietenia</i>, <i>Gardenia latifolia</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Helicteres isora</i>, <i>Strobilanthes</i> spp., <i>Moghania</i>, <i>Gardenia gummifera</i>.</p>	
		<p>5B/C1c Dry Peninsular Sal Forest</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Terminalia tomentosa</i>, <i>Pterocarpus marsupium</i>, <i>Anogeissus latifolia</i>, <i>Lagerstroemia parviflora</i>, <i>Adina cordifolia</i>, <i>Terminalia bellirica</i>, <i>Acacia catechu</i>, <i>Buchanania lanzan</i>.</p> <p>Middle Storey: <i>Cleistanthus collinus</i>, <i>Chloroxylon swietenia</i>, <i>Emblica officinalis</i>, <i>Cassia fistula</i>, <i>Terminalia chebula</i>, <i>Wendlandia tinctoria</i>, <i>Symplocos racemosa</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Indigofera pulchella</i>, <i>Phoenix acaulis</i>.</p>	17.79
22.	Punjab	<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Acacia catechu</i>, <i>Anogeissus latifolia</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Feronia limonia</i>, <i>Ehretialaervis</i>, <i>Kydia calycina</i>, <i>Ougeinia oojeinensis</i>, <i>Mitragyna parvifolia</i>, <i>Flacourtia indica</i>.</p> <p>(i) Kangra Division, Punjab-</p> <p>Middle Storey: <i>Mallotus philippensis</i>, <i>Nyctanthes arbor-tristis</i>, <i>Dendrocalamus strictus</i></p>	67.29

		Lower Storey: <i>Carissa opaca</i> , <i>Dodonara viscosa</i> , <i>Woodfordia fruticosa</i> , <i>Adhatoda vasica</i>	
		6B/C2 Ravine Thorn Forest Top Storey & Middle Storey: <i>Acacia senegal</i> , <i>A. leucophloea</i> , <i>Prosopis spicigera</i> , <i>Salvadora oleoides</i> . Lower Storey: <i>Capparis decidua</i> , <i>Ziziphus mauritiana</i> , <i>Z. nummularia</i> , <i>Calotropis procera</i> , <i>Tephrosia purpurea</i>	4.17
		5/E9 Dry Bamboo Brakes <i>Dendrocalamus strictus</i>	1.62
23.	Rajasthan	5B/C2 Northern Dry Mixed Deciduous Forest (i) Chittorgarh Division, Rajasthan- Top Storey: <i>Anogeissus latifolia</i> , <i>Boswellia serrata</i> , <i>Terminalia tomentosa</i> , <i>Sterculia urens</i> , <i>Lannea coromandelica</i> , <i>Diospyros melanoxylon</i> , <i>Albizia odoratissima</i> , <i>Soymida febrifuga</i> , <i>Cassia fistula</i> , <i>Bridelia retusa</i> , <i>Bauhinia racemosa</i> , <i>Mitragyna parvifolia</i> , <i>Butea monosperma</i> , <i>Ficus</i> spp., <i>Dalbergia paniculata</i> . Middle Storey: <i>Acacia catechu</i> , <i>Acacia leucophloea</i> , <i>Nyctanthes arbor-tristis</i> , <i>Ziziphus mauritiana</i> , <i>Prosopis spicigera</i> , <i>Wrightia tinctoria</i> , <i>Flacourtia indica</i> , <i>Dendrocalamus strictus</i> . Lower Storey: <i>Carissa spinarum</i> , <i>Ziziphus nummularia</i> , <i>Grewia</i> spp. (ii) Udaipur Division, Rajasthan- Top Storey & Middle Storey: <i>Anogeissus latifolia</i> , <i>Boswellia serrata</i> , <i>Lannea coromandelica</i> , <i>Sterculia urens</i> , <i>Terminalia arjuna</i> , <i>Salmalia malabarica</i> , <i>Soymida febrifuga</i> , <i>Albizia odoratissima</i> , <i>Acacia leucophloea</i> , <i>Emblica officinalis</i> , <i>Wrightia tinctoria</i> , <i>Mitragyna parvifolia</i> . Lower Storey: <i>Holarrhena antidysenterica</i> , <i>Vitex negundo</i> , <i>Woodfordia fruticosa</i> , <i>Jatropha</i> spp.	40.07

		<p>5/E1 <i>Anogeissus pendula</i> Forest</p> <p>Top Storey & Middle Storey: <i>Anogeissus pendula</i>, <i>Boswellia serrata</i>, <i>Acacia catechu</i>, <i>A. rupestris</i>, <i>Albizia odoratissima</i>, <i>Dalbergia lanceolaria</i>, <i>Dichrostachys cinerea</i>, <i>Bauhinia racemose</i>, <i>Grewia</i> spp.</p>	15.21
		<p>5/E1/DS1 Dry Deciduous Scrub</p> <p>Top Storey & Middle Storey: <i>Nyctanthes arbor-tristis</i>, <i>Dodonaea viscosa</i>, <i>Woodfordia fruticosa</i>, <i>Carissa opaca</i>, <i>Flacourtia indica</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Cassia fistula</i>, <i>Acacia catechu</i></p>	10.96
24.	Sikkim	<p>14/C2 East Himalayan Sub-alpine birch/fir forest</p> <p>Gompatung Chu, Sikkim, 2,800 m.-</p> <p>Top Storey: <i>Abies densa</i>, <i>Juniperus wallichiana</i>.</p> <p>Middle Storey: <i>Rhododendron wightii</i>, <i>Betula utilis</i>, <i>Rhododendron</i> spp., <i>Pyrus aucuparia</i>, <i>Salix wallichiana</i>.</p> <p>Lower Storey: <i>Spiraea</i> spp., <i>Juniperus recurva</i>, <i>Cassiope fastigiata</i>, <i>Rhododendron lepidotum</i>, <i>Potentilla fruticosa</i>, <i>Polygonum</i> spp.</p>	24.01
		<p>8B/C1 East Himalayan Sub-tropical wet hill forest</p> <p>Top Storey: <i>Phoebe paniculata</i>, <i>P. attenuata</i>, <i>Beilschmiedia roxburghiana</i>, <i>Engelhardtia</i>, <i>Nyssa javanica</i>, <i>Schima wallichii</i>, <i>Chinnamomum cecicodaphne</i>, <i>Morus laevigata</i>, <i>Syzygium cumini</i>, <i>Quercus fenestrata</i>, <i>Calophyllum polyanthum</i>, <i>Wightia</i> etc.</p> <p>Middle Storey: <i>Drypetes venusta</i>, <i>Talauma hodgsonii</i>, <i>Gynocardia odorata</i>, <i>Nyssa javanica</i>, <i>Garcinia paniculata</i>, <i>Eugenia kurzii</i>, <i>Dendrocalamus patellaris</i>, <i>Chimonobambusa griffithiana</i>.</p> <p>Lower Storey: <i>Daphne</i>, <i>Cyclea</i>, <i>Glycosmis</i>, <i>Strobilanthes</i> spp., <i>Phlogacanthus</i> etc.</p>	23.89

		<p>11B/C1b Buk Oak Forest</p> <p>Top Storey: <i>Quercus lamellosa, Castanopsis tribuloides, Acer campbellii, Michelia doltsopa, Alcimandra cathcartii, Sloanea dasycarpa.</i></p> <p>Middle Storey: <i>Machilus spp., Litsea spp., Arundinaria spp.</i></p> <p>Lower Storey: <i>Rubus spp., Strobilanthes spp.</i></p>	23.04
25.	Tamil Nadu	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Shorea talura, Dalbergia latifolia, Terminalia tomentosa, T. chebula, T. paniculata, Pterocarpus marsupium, Albizia odoratissima, Anogeissus latifolia, Cassia fistula, Hardwickia binata, Santalum album.</i></p> <p>Middle Storey: <i>Dendrocalamus strictus.</i></p> <p>Top Storey and Middle Storey: <i>Hardwickia binata, Anogeissus latifolia, Chloroxylon swietenia, Erythroxylon monogynum, Acacia catechu</i></p>	22.43
		<p>5/2S1 Secondary Dry Deciduous Forest</p> <p>Top Storey: <i>Salmalia malabarica, Buchanania lanzan, Grewia tiliifolia, Elacodendron glaucum, Schleicheria oleosa, Lannea coromandelica, Semecarpus anacardium, Tectona grandis.</i></p> <p>Middle Storey: <i>Feronia limonia, Aegle marmelos, Ziziphus xylopyrus, Careya arborea, Gardenia spp., Dolichandrone atrovirens, Santalum album.</i></p> <p>Lower Storey: <i>Dodonaea viscosa, Carissa spinarum, Holarrhena antidysenterica, Lantana</i></p>	9.91
		<p>6A/C1 Southern Thorn Forest</p> <p>Top Storey & Middle Storey: <i>Chloroxylon swietenia, Albizia amara, Acacia chundra, A. ferruginaca, Azadirachta indica, Canthium dicoccum, Erythroxylon monogynum, Ziziphus mauritiana, Z. xylopyrus, Cleistanthus collinus, Dichrostachys cinerea, Atalantia monophylla</i></p>	6.85

26.	Telangana	<p>5A/C3 Southern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Terminalia tomentosa</i>, <i>Bauhinia racemosa</i>, <i>Acacia arabica</i>, <i>A. catechu</i>, <i>Boswellia serrata</i>, <i>Buchanania lanzan</i>, <i>Azadirachta indica</i>, <i>Ougelnia oojeinensis</i>, <i>Flacourtia indica</i>.</p> <p>Middle Storey: <i>Gymnosporia spinosa</i>, <i>Ziziphus mauritiana</i>, <i>Z. xylopyrus</i>, <i>Morinda tinctoria</i>.</p> <p>Lower Storey: <i>Mimosa hamata</i>, <i>Terminalia tomentosa</i>, <i>Grewia hirsuta</i>.</p>	60.52
		<p>5B/DS1 Dry Deciduous Scrub</p> <p>Scattered <i>Acacia leucophloea</i>, <i>Bauhinia racemosa</i>, <i>Dalbergia paniculata</i>, <i>Wrightia tinctoria</i>, <i>Ziziphus xylopyrus</i>, <i>Cassia fistula</i>, <i>Randia</i>, <i>Annona</i>, <i>Heteropogon contortus</i>, <i>Eragrostis</i> spp.</p>	19.21
		<p>5A/C1b Dry Teak Forest</p> <p>Top Storey: <i>Tectona grandis</i>, <i>Pterocarpus marsupium</i>, <i>Anogeissus latifolia</i>, <i>Dalbergia latifolia</i>, <i>Terminalia tomentosa</i>, <i>Chloroxylon swietenia</i>, <i>Lannea coromandelica</i>, <i>Dalbergia paniculata</i>, <i>Salmalia malabarica</i>, <i>Terminalia bellirica</i>, <i>Madhuca indica</i>, <i>Lagerstroemia parviflora</i>, <i>Boswellia serrata</i>, <i>Sterculia urens</i>.</p> <p>Middle Storey: <i>Diospyros tomentosa</i>, <i>Buchanania lanzan</i>, <i>Acacia chundra</i>, <i>Acacia leucophloea</i>, <i>Aegle marmelos</i>, <i>Soymida febrifuga</i>, <i>Wrightia tinctoria</i>, <i>Butea monosperma</i>, <i>Cleistanthus collinus</i>, <i>Ziziphus xylopyrus</i>.</p> <p>Lower Storey: <i>Randia dumetorum</i>, <i>Cassia auriculata</i>, <i>Nyctanthes arbor-tristis</i>, <i>Helicteres isora</i>, <i>Ziziphus</i> spp.</p>	14.84
27.	Tripura	<p>3C/C3b East Himalayan Moist Mixed Deciduous Forest</p> <p>Top Storey: <i>Lagerstroemia parviflora</i>, <i>Terminalia bellirica</i>, <i>Sterculia villosa</i>, <i>Salmalia malabarica</i>, <i>Schima wallichii</i></p>	39.89

		Middle Storey: <i>Careya arborea</i> , <i>Bauhinia purpurea</i> , <i>Amoora</i> spp.	
		2B/C2 Cachar Semi-Evergreen Forest Top Storey & Middle Storey: <i>Palaquium</i> , <i>Diospyros topiosa</i> , <i>Cynometra polyandra</i> , <i>Dipterocarpus turbinatus</i> , <i>Mesua</i> , <i>Eugenia</i> spp., <i>Euphoria longana</i> , <i>Sapium baccatum</i> , <i>Vatica lanceifolia</i> , <i>Canarium</i> spp., <i>Hydnocarpus kurzii</i> , <i>Heritiera acuminata</i> , <i>Persea owdenii</i> , <i>Kayea floribunda</i> .	27.47
		2/2S1 Secondary Moist Bamboo Brakes <i>Dendrocalamus hamiltonii</i>	7.55
28.	Uttar Pradesh	5B/C2 Northern Dry Mixed Deciduous Forest Top Storey: <i>Anogeissus latifolia</i> , <i>Boswellia serrata</i> , <i>Acacia catechu</i> , <i>Shorea robusta</i> , <i>Bauhinia</i> spp., <i>Cochlospermum religiosum</i> , <i>Terminalia tomentosa</i> , <i>Buchanania lanzan</i> , <i>Diospyros tomentosa</i> , <i>Terminalia bellirica</i> , <i>Hymenodictyon excelsum</i> , <i>Garuga pinnata</i> , <i>Kydia calycina</i> , <i>Sterculia pallens</i> , <i>Mitragyna parvifolia</i> , <i>Bridelia retusa</i> . Middle Storey: <i>Nyctanthes arbor-tristis</i> , <i>Gardenia turgida</i> , <i>Ougeinia oojeinensis</i> , <i>Ehretia laevis</i> , <i>Aegle marmelos</i> , <i>Emblica officinalis</i> , <i>Feronia limonia</i> , <i>Holarrhena antidysenterica</i> , <i>Cordia dichotoma</i> , <i>Ziziphus xylopyrus</i> , <i>Wendlandia exserta</i> , <i>Cassia fistula</i> , <i>Casearia tomentosa</i> , <i>Butea monosperma</i> , <i>Flacourtia indica</i> , <i>Ziziphus mauritiana</i> , <i>Dendrocalamus strictus</i> Lower Storey: <i>Woodfordia fruticosa</i> , <i>Nyctanthes arbor-tristis</i> , <i>Indigofera pulchella</i> .	34.90
		3C/C2d (i) Western Light Alluvium Plains Sal (i) North Kheri Division, Uttar Pradesh- Top Storey: <i>Shorea robusta</i> , <i>Terminalia tomentosa</i> , <i>T. bellirica</i> , <i>Lagerstroemia parviflora</i> , <i>Adina cordifolia</i> , <i>Kydia</i>	10.06

		<p><i>calycina</i>, <i>Stereospermum suaveolens</i>, <i>Schleichera oleosa</i>, <i>Ficus</i> spp.</p> <p>Middle Storey: <i>Syzygium cumini</i>, <i>Miliusa velutina</i>, <i>Semecarpus anacardium</i>, <i>Bauhinia malabarica</i>, <i>Grewia</i> spp., <i>Mallotus philippensis</i>, <i>Butea monosperma</i>, <i>Holarrhena antidysenterica</i>.</p> <p>Lower Storey: <i>Helicteres isora</i>, <i>Ardisia solanacea</i>, <i>Moghania</i>, <i>Clerodendrum viscosum</i>, <i>Murraya koenigii</i>.</p> <p>(ii) South Kheri Division, Uttar Pradesh-</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Terminalia tomentosa</i>, <i>Lagerstroemia parviflora</i>, <i>Diospyros tomentosa</i>, <i>Stereospermum suaveolens</i>, <i>Madhuca indica</i>.</p> <p>Middle Storey: <i>Buchanania lanzan</i>, <i>Bridelia retusa</i>, <i>Syzygium cerasoideum</i>, <i>Mallotus philippensis</i>, <i>Holarrhena antidysenterica</i>, <i>Ehretia laevis</i>, <i>Casearia tomentosa</i>, <i>Bauhinia malabarica</i>, <i>Aegle marmelos</i>.</p> <p>Lower Storey: <i>Carissa spinarum</i>, <i>Ziziphus mauritiana</i>, <i>Ziziphus oenopolia</i>, <i>Helicteres isora</i>.</p>	
		<p>6B/C2 Ravine Thorn Forest</p> <p>Top Storey: <i>Acacia leucophloea</i>, <i>Prosopis spicigera</i>, <i>Azadirachta indica</i>, <i>Holoptelea integrifolia</i>, <i>Acacia arabica</i>, <i>Salvadora oleoides</i>, <i>Balanites aegyptiaca</i>, <i>Flacourtia indica</i>.</p> <p>Middle Storey: <i>Capparis decidua</i>, <i>C. sepiaria</i>, <i>C. zeylanica</i>, <i>Carissa opaca</i>, <i>Ziziphus</i> spp., <i>Dichrostachys cinerea</i>, <i>Calotropis procera</i>, <i>Adhatoda vasica</i></p>	5.11
29.	Uttarakhand	<p>9/C1b Upper or Himalayan Chir Pine Forest</p> <p>Top Storey: <i>Pinus roxburghii</i></p> <p>Middle Storey: <i>Ficus roxburghii</i>, <i>Syzygium cumini</i>, <i>Engelhardtia colebrookiana</i>, <i>Lyonia ovalifolia</i>, <i>Quercus incana</i>, <i>Rhododendron arboreum</i>, <i>Symplocos crataegoides</i>, <i>Myrica sapida</i>.</p>	27.97

		<p>Lower Storey: <i>Indigofera dosua</i>, <i>Flemingia fruticulosa</i>, <i>Lespedeza sericea</i>, <i>Rubus ellipticus</i>, <i>Viburnum coriaceum</i>, <i>Glochidion velutinum</i>, <i>Leptodermis lanceolata</i>, <i>Aechmanthera tomentosa</i>.</p>	
		<p>3C/C2a Moist Siwalik Sal Forest</p> <p>Top Storey: <i>Shorea robusta</i>, <i>Anogeissus latifolia</i>, <i>Terminalia tomentosa</i>, <i>Adina cordifolia</i>, <i>Pinus roxburghii</i>, <i>Lannea coromandelica</i>, <i>Garuga pinnata</i>, <i>Terminalia bellirica</i>, <i>Diospyros tomentosa</i>.</p> <p>Middle Storey: <i>Ougeinia oojeinensis</i>, <i>Buchanania lanzan</i>, <i>Semecarpus anacardium</i>, <i>Ehretia laevis</i>, <i>Bauhinia</i> spp., <i>Cassia fistula</i>, <i>Casearia tomentosa</i>, <i>Emblica officinalis</i>, <i>Olea glandulifera</i>, <i>Engelhardia colebrookeana</i>, <i>Machilus odoratissima</i>, <i>Dendrocalamus strictus</i>.</p> <p>Lower Storey: <i>Colebrookia oppositifolia</i>, <i>Murraya koenigii</i>, <i>Woodfordia fruticosa</i>, <i>Berberis asiatica</i>, <i>Indigofera pulchella</i>, <i>Clerodendrum viscosum</i>, <i>Pogostemon plectranthoides</i>.</p>	14.05
		<p>12/C1a Ban Oak Forest (<i>Q. incana</i>)</p> <p>Top Storey: <i>Quercus incana</i>, <i>Carpinus viminea</i>, <i>Cedrela serrata</i>.</p> <p>Middle Storey: <i>Rhododendron arboreum</i>, <i>Lyonia ovalifolia</i>, <i>Euonymus pendulus</i>, <i>Ilex dipyrena</i>, <i>Betula alnoides</i>, <i>Lindera pulcherrima</i>, <i>Litsea umbrosa</i>.</p> <p>Lower Storey: <i>Viburnum cotinifolium</i>, <i>Desmodium tiliaefolium</i>, <i>Indigofera gerardiana</i>, <i>Rubus niveus</i>, <i>Boenninghausenia</i> spp., <i>Myrsine africana</i>, <i>Deutzia staminea</i>.</p>	13.86
30.	West Bengal	<p>5B/C1c Dry Peninsular Sal Forest</p> <p>1) <i>Shorea-Anogeissus-Woodfordia</i> association</p> <p>Top Storey & Middle Storey: <i>Shorea robusta</i>, <i>Anogeissus latifolia</i>, <i>Boswellia serrata</i>, <i>Cochlospermum religiosum</i>, <i>Dilleniaaurea</i>, <i>Ziziphus xylopyrus</i>, <i>Gardenia gummifera</i>.</p>	16.31

		<p>Lower Storey: <i>Woodfordia fruticosa</i>, <i>Wendlandia tinctoria</i>, <i>Grewia hirsuta</i>, <i>Phoenix acaulis</i>.</p> <p>(2) Shorea-Gardenia-Eulaliopsis association.</p> <p>Top Storey & Middle Storey: <i>Shorea robusta</i>, <i>Buchanania lanzan</i>, <i>Eugenia caryophyllifolia</i>, <i>Gardenia gummifera</i>, <i>Madhuca indica</i>, <i>Diospyros tomentosa</i>, <i>Emblica officinalis</i>. <i>Cephalostachyum pergracile</i>.</p> <p>Lower Storey: <i>Wendlandia tinctoria</i>, <i>Phoenix acaulis</i>.</p>	
		<p>4B/TS2 Mangrove Forest</p> <p>(i) W. Sunderbans-</p> <p>Top Storey/Middle Storey: <i>Rhizophora candelaria</i>, <i>Kandelia candel</i>, <i>Avicennia alba</i>, <i>Bruguiera conjugata</i>, <i>Xylocarpus moluccensis</i> (Carapa), <i>Ceriops tagal</i>, <i>Lumnitzera racemosa</i>, <i>Xylocarpus granatum</i>, <i>Excoecaria agallocha</i>, <i>Ceriops roxburghiana</i>, <i>Sonneratia apetala</i>.</p> <p>(ii) Krishna and Godavari deltas</p> <p>Top Storey/Middle Storey: <i>Avicennia officinalis</i>, <i>Rhizophora mucronata</i>, <i>R. candelaria</i>, <i>Ceriops roxburghiana</i>, <i>Bruguiera</i> spp., <i>Sonneratia apetala</i>.</p> <p>Lower Storey: <i>Acanthus ilicifolius</i>, <i>Clerodendrum inerme</i>.</p>	5.89
		<p>4B/TS3 Salt Water Mixed Forest (<i>Heritiera</i>)</p> <p>Top Storey/Middle Storey: <i>Heritiera minor</i>, <i>Excoecaria agallocha</i>, <i>Ceriops roxburghiana</i>, <i>Xylocarpus moluccensis</i>, <i>Bruguiera conjugata</i>, <i>Avicennia officinalis</i>, <i>Amoora cucullata</i>, <i>Aegialitis rotundifolia</i></p> <p>Lower Storey: Nipa relatively uncommon</p>	2.80
31.	Andaman & Nicobar Islands	<p>1A/C2 Andamans Tropical Evergreen Forest</p> <p>(i) Andamans.</p> <p>Top Storey: <i>Dipterocarpus grandiflorus</i>, <i>D. pilosus</i>, <i>Artocarpus chaplasha</i>, <i>A. gomezianus</i>, <i>Calophyllum soulattri</i>,</p>	43.70

	<p><i>Planchonia andamanica</i>, <i>Hopea odorata</i>, <i>Endospermum chinense</i>, <i>Sideroxylon longipetiolatum</i>.</p> <p>Middle Storey: <i>Xanthophyllum andamanicum</i>, <i>Myristica andamanica</i>, <i>M. glaucescens</i>, <i>Baccaurea sapida</i>, <i>Croton argyratus</i>, <i>Pterospermum aceroides</i>, <i>Caryota mitis</i>, <i>Cryptocarya</i>, <i>Memecylon</i> spp., <i>Euphorbia epiphyllodes</i>, <i>Pseuduvaria prainii</i>, <i>Actephila excelsa</i>.</p> <p>Lower Storey: <i>Anaxagorea luzonensis</i>, etc.</p> <p>(ii) Gopalkabang valley, South Andamans-</p> <p>Top Storey: <i>Dipterocarpus kerrii</i>, <i>D. grandiflorus</i>, <i>D. gracilis</i>.</p> <p>Middle Storey: <i>Artocarpus</i>, <i>Planchonia</i>, <i>Hopea odorata</i>, <i>Pterospermum aceroides</i>, <i>Myristica andamanica</i>, <i>Elaeocarpus</i> spp.</p> <p>Middle Storey: <i>Oxytenanthera nigrociliata</i>, <i>Macaranga andamanica</i>, <i>Mussaenda macrophylla</i>, <i>Leea</i> spp., <i>Evodia glabra</i>, <i>Licuala peltata</i>, <i>Pandanus</i>, <i>Clinogyne grandis</i>.</p>	
	<p>2A/C1 Andamans Semi-Evergreen Forest</p> <p>Top Storey: <i>Dipterocarpus alatus</i>, <i>D. pilosus</i>, <i>Pterygota alata</i>, <i>Pterocymbium tinctorium</i>, <i>Sterculia campanulata</i>, <i>Terminalia bialata</i>, <i>T. procera</i>, <i>Albizia chinensis</i>, <i>A. lebbek</i>, <i>Calophyllum soulattri</i>, <i>Salmalia insignis</i>, <i>Artocarpus lakoocha</i>, <i>A. chaplasha</i>, <i>Pterocarpus dalbergioides</i>.</p> <p>Middle Storey: <i>Lagerstroemia hypoleuca</i>, <i>Dillenia pentagyna</i>, <i>Dracontomelum mangiferum</i>, <i>Pometia pinnala</i>, <i>Myristica irya</i>, <i>Pisonia excelsa</i>, <i>Litsea panamonja</i>, <i>Xanthophyllum andamanicum</i>, <i>Fagraea morindaefolia</i>, <i>Talauma andamanica</i>, <i>Garcinia andamanica</i>, <i>Aporosa villosula</i>, <i>Licuala peltata</i>, <i>Caryota mitis</i>, <i>Areca triandra</i>.</p> <p>Middle Storey: Usually no bamboos. <i>Oxytenanthera</i> spp.</p>	29.30


		<p>Middle Storey: <i>Saprosma ternata</i>, <i>Maesa andamanica</i>, <i>Micromelum pubescens</i>, <i>Clerodendrum viscosum</i>, <i>Leea indica</i>, <i>Clinogyne grandis</i>.</p>	
		<p>4B/TS2 Mangrove Forest</p> <p>Andaman Islands</p> <p><i>Rhizophora mucronata</i>, <i>R. candelaria</i>, <i>Bruguiera conjugata</i>, <i>B. parviflora</i>, <i>Avicennia officinalis</i>, <i>Ceriops tagal</i>, <i>Kandelia candel</i>, <i>Xylocarpus moluccensis</i>, <i>Sonneratia caseolaris</i>, <i>Excoecaria</i> spp., etc.</p> <p>Great Nicobar Islands</p> <p><i>Bruguiera conjugata</i>, <i>Carallia brachiata</i>, <i>Sonneratia caseolaris</i>, <i>Nipa fruticans</i>, <i>Areca triandra</i>.</p>	10.96
32.	Chandigarh	<p>5B/C2 Northern Dry Mixed Deciduous Forest</p> <p>Top Storey: <i>Acacia catechu</i>, <i>Anogeissus latifolia</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Feronia limonia</i>, <i>Ehretialaervis</i>, <i>Kydia calycina</i>, <i>Ougeinia oojeinensis</i>, <i>Mitragyna parvifolia</i>, <i>Flacourtia indica</i>.</p> <p>Middle Storey: <i>Mallotus philippensis</i>, <i>Nyctanthes arbor-tristis</i>, <i>Dendrocalamus strictus</i>, <i>Carissa opaca</i>, <i>Dodonara viscosa</i>, <i>Woodfordia fruticosa</i>, <i>Adhatoda vasica</i></p>	48.33
		<p>5B/DS1 Dry Deciduous Scrub</p> <p>Top Storey: <i>Nyctanthes arbor-tristis</i>, <i>Dodonaea viscosa</i>, <i>Woodfordia fruticosa</i>, <i>Carissa opaca</i>, <i>Flacourtia indica</i>, <i>Lannea coromandelica</i>, <i>Aegle marmelos</i>, <i>Cassia fistula</i>, <i>Acacia catechu</i>.</p>	0.09
33.	Dadra & Nagar Haveli	<p>3B/C2 Southern Moist Mixed Deciduous</p> <p>Top Storey: <i>Adina cordifolia</i>, <i>Grewia tiliifolia</i>, <i>Madhuca indica</i>, <i>Dillenia pentagyna</i>, <i>Cinnamomum</i>, <i>Litsea</i>, <i>Olea dioica</i>.</p> <p>Middle Storey: <i>Emblica officinalis</i>, <i>Xylocarpus xylocarpa</i>, <i>Bambusa arundinacea</i>, <i>Dendrocalamus strictus</i>, <i>Tabernaemontana</i> spp. etc.,</p>	77.66




		<p>3B/C1b Moist Teak Forest</p> <p>Top Storey: <i>Tectona grandis</i>, <i>Terminalia tomentosa</i>, <i>Adina cordifolia</i>, <i>Dalbergia latifolia</i>, <i>Madhuca indica</i>, <i>Pterocarpus marsupium</i>, <i>Mitragyna parvifolia</i>, <i>Lagerstroemia parviflora</i>, <i>Albizia</i> spp., <i>Salmalia malabarica</i>, <i>Diospyros tomentosa</i>, <i>Careya arborea</i>, <i>Stereospermum personatum</i>, <i>Tamarindus indica</i></p> <p>Middle Storey: <i>Xylia xylocarpa</i>, <i>Grewia tiliifolia</i>, <i>Cleistanthus collinus</i>, <i>Emblica officinalis</i>, <i>Schleichera oleosa</i>, <i>Diospyros montana</i>, <i>Ixora arborea</i>.</p> <p>MIDDLE STOREY: <i>Dendrocalamus strictus</i>, <i>Helicteres isora</i>, <i>Petalidium barlerioides</i>, <i>Pogostemon plectranthoides</i>, <i>Indigofera</i> spp.</p>	9.44
		<p>5A/C3 Southern Dry Mixed Deciduous</p> <p>Top Storey/Middle Storey: <i>Boswellia serrata</i>, <i>Acacia leucophloea</i>, <i>Bauhinia tomentosa</i>, <i>Rhus mysorensis</i>, <i>Lannea coromandelica</i>, <i>Flacourtia indica</i>, <i>Cochlospermum religiosum</i>, <i>Anogeissus latifolia</i>, <i>Terminalia tomentosa</i>,</p> <p>Middle Storey: <i>Gymnosporia spinosa</i>, <i>Ziziphus mauritiana</i>, <i>Ziziphus oenopolia</i>, <i>Z. xylopyrus</i>, <i>Azadirachta indica</i>, <i>Santalum album</i>, <i>Osyris wightiana</i>, <i>Tectona grandis</i>, <i>Heterophragma quadriloculare</i>, <i>Stereospermum personatum</i>, <i>Dolichandrone falcata</i>.</p>	4.31
34.	Daman & Diu	<p>4B/TS2 Mangrove Forest</p> <p><i>Rhizophora mucronata</i>, <i>R. candelaria</i>, <i>Bruguiera conjugata</i>, <i>B. parviflora</i>, <i>Avicennia officinalis</i>, <i>Ceriops tagal</i>, <i>Kandelia candel</i>, <i>Xylocarpus moluccensis</i>, <i>Sonneratia caseolaris</i>, <i>Excoecaria</i> spp., etc.</p>	14.79
		<p>6B/C1 Desert Thorn Forest</p> <p>Top Storey: <i>Acacia senegal</i>, <i>A. leucophloea</i>, <i>Cordia roth</i></p>	14.45




		<p>Middle Storey: <i>Azadirachta indica</i>, <i>Euphorbia nivulia</i>, <i>Balanites aegyptiaca</i>, <i>Salvadora</i>, <i>Commiphora mukul</i>, <i>Capparis</i> spp., <i>Grewia tenax</i>, <i>G. villosa</i>, <i>Premna integrifolia</i>.</p>	
		<p>4A/L1 Littoral Forest</p> <p>Top Storey: <i>Casuarina equisetifolia</i>, <i>Calophyllum inophyllum</i>, <i>Terminalia catappa</i>.</p> <p>Middle Storey: <i>Barringtonia asiatica</i>, <i>Erythrina variegata</i>, <i>Guettarda speciosa</i>, <i>Pongamia pinnata</i>, <i>Heritiera littoralis</i>, <i>Cerbera manghas</i>, <i>Ochrosia oppositifolia</i>.</p> <p>Middle Storey: <i>Ixora</i> spp., <i>Cycas rumph</i>, <i>Asplenium nidus</i>, <i>Dendrobium</i> spp., <i>Bulbophyllum</i> spp.</p> <p>Top Storey/Middle Storey: <i>Hibiscus tiliaceus</i>, <i>Thespesia populnea</i>, <i>Erythrina variegata</i>, <i>Ixora arborea</i>, <i>Vitex negundo</i>, <i>V. trifolia</i>, <i>Trewia nudiflora</i>, <i>Dolichandrone spathacea</i></p>	6.69
35.	Puducherry	<p>4B/TS2 Mangrove Forest</p> <p><i>Rhizophora mucronata</i>, <i>R. candelaria</i>, <i>Bruguiera conjugata</i>, <i>B. parviflora</i>, <i>Avicennia officinalis</i>, <i>Ceriops tagal</i>, <i>Kandelia candel</i>, <i>Xylocarpus moluccensis</i>, <i>Sonneratia caseolaris</i>, <i>Excoecaria</i> spp. etc.</p>	3.19




Source: Champion, & Seth (1968); FSI (2019)*

IMPORTANT TREES SPECIES AS UPPER STORY



Botanical Name & Common name Family/ Maturity Period	Active ingredients (Useful parts)	Varieties available /source	Gross production /income	Major Medicinal properties/Uses	Photographs
<p><i>Aegle marmelos</i> L. (Bael) Family- Rutaceae Maturity period- After 4-5 year</p>	<p>Carotenoids, Phenolics, alkaloids, Coumarins, flavonoids, terpenoids, and other antioxidants (Fruit, Bark)</p>	<p>Goma Yashi (Source-ICAR-CIAH, Bikaner) Narendra Bael (NB-5, Narendra Bael -7, Narendra Bael-9, Narendra Bael -16 and Narendra Bael -17 (Source- N.D. University of Agriculture and Technology, Kumarganj, Faizabad, U.P.) Pant Aparna, Pant Sujata, Pant Urvashi and Pant Shivani (Source-G. B. Pant University of Agriculture and Technology, Pant Nagar, Uttarakhnad) CISHB-1 and CISHB-2 (Source: Central Institute for Sub-tropical Horticulture, Lucknow, Uttar Pradesh) Thar Divya, Thar Neelkanth, Thar Gaurav and Thar Srishi (ICAR-CIAH, Bikaner)</p>	<p>Dhar Divya- Average yield/plant is 85.20 kg in 9th year. Thar Neelkand-Yield: 70-75 kg per plant (8th Year) Yield: 58.58 kg/plant (7th year) and 124.36 kg/plant (12th year) NB-5-28.78 kg par plant (6th year) NB-9-56 kg/plant (6th year) NB-7- (starts fruiting in the 4th year, 32.10 kg/plant (6th year) Pant Aparna- 40.25 kg/plant (6th year) CISHB-1-42.64 kg/plant (6th year and fruiting starts in the 4th year) CISHB-2-3845 kg/plant (6th year) Goma Yashi-51 kg/plant (6th year)</p>	<p>Diarrhea, Dysentery, Constipation</p>	



<p><i>Azadirachta indica</i> A. Juss., (Neem) Family- Meliaceae Maturity period- After 3-5 years</p>	<p>Azadirachtin, Nimbolinin, Nimbin, Nimbidin, Nimbidol, Salannin, and Quercetin. (Leaf, Seed)</p>	<p>6 cultivars -FRI-IFFCO-1, FRI-IFFCO-2, FRI-IFFCO-3, FRI-IFFCO-4, FRI-IFFCO-5, FRI-IFFCO-6 Recommended for eastern plateau (Bundelkhand Uphill), Northern plains (Rajasthan) then upland and Gujrat plains) and Deccan plateau hot semi-arid region.</p>	<p>Seeds 10-12 kg/tree/yr</p>	<p>Various skin disorders, diabetes, Ulcer, and worm</p>	
<p><i>Buchanania lanzan</i> Lour. (Chironji) Family- Anacardiaceae Maturity period- After 10 years</p>	<p>Fatty oil, Seed cake contains fibres, carbohydrates, mineral, fats, vitamin B₁, B₂, B₃, C, calcium, chlorine copper, iron, magnesium, phosphorus, potassium, sodium, sulfur, fatty oil, β-amyrin</p>	<p><i>Buchanania lanzan</i> var. Palodensis (Source- Kumar <i>et al.</i>, 2020) Thar Priya (Source: ICAR, CIAH, Bikaner, Rajasthan)</p>	<p>Thar Priya - 11.90 kg /plant (Start bearing in 4th year of planting)</p>	<p>Useful in the treatment of diarrhoea, leaves are used in the treatment of skin diseases and fruits are used in treating coughs and asthma</p>	
<p><i>Emblia officinalis</i> L. (Ampla) Family- Euphorbiaceae Maturity period-After 4th year</p>	<p>Vitamin – C (Fruit)</p>	<p>Banarasi, Chakaiya, Francis, NA-4 (Krishna), NA-5 (Kanchan), NA-6, NA-7 (Promising variety), NA-10, BSR-1 (Bhavaniagar). (Source) Goma Aishwarya (ICAR-CIAH, CIAH, Bikaner, Rajasthan)</p>	<p>NA- 7-51 kg/tree Chakaiya- 34 Kg/tree NA- 628 Kg/tree</p>	<p>Cough, diabetes, cold, laxative, hyper acidity.</p>	

<p><i>Moringa oleifera</i> Lam. (Sahajan) Family- Moringaceae. Maturity period- 9 months</p>	<p>Flavonoids, alkaloids, phenols, vitamins, minerals, proteins, glycosides, glucosinolates, Isothiocyanates, terpenes, saponins, and tannins (Fruit, Leaf)</p>	<p>Periyakulam 1 and 2 (PKM1 and PKM2) (Source- Horticulture Research Station of Tamil Nadu Agricultural University (TNAU) Thar Harsha (Source: ICAR-CIAH, Bikaner, Rajasthan)</p>	<p>Average yield 200-220 kg fruits/tree/yr 138 ton/ha (Spacing 1.2m*1.2m, approx. 19.87 kg/tree) Thar Harsha- 45-48 kg/plant</p>	<p>Arthritis and other joint pain (rheumatism), asthma, cancer, constipation, diabetes, diarrhea, stomach and intestinal ulcers.</p>	
<p><i>Morus alba</i> L. White mulberry) Family--Moraceae Maturity period-after 3rd year</p>	<p>Rutin (293.5 µg/g), chlorogenic acid (226.9 µg/g), caffeic acid (17.2 µg/g), quercetin (15.2 µg/g), gallic acid (8.9 µg/g), kaempferol (5.8 µg/g), and apigenin (3.5 µg/g), Rutin, chlorogenic acid, caffeic acid, quercetin, gallic acid, kaempferol, and apigenin</p>	<p>Kanva-2, S-36, S-54, Victory-1, S-13, S-34, MR-2 (Source: CSRTI, Mysore) Anantha (Source: Regional Sericulture Research Station in Andhra Pradesh) Vishala (Source: Central Silk Board, Bangalore) Thar Lohit and Thar Harit (Source: ICAR-CIAH, Bikaner, Rajasthan)</p>	<p>Fruit yield Thar Lohit- 12.4 kg to 26.5/tree/yr Thar Harit- 32.6 kg /tree/yr plant</p>	<p>The treatment of dizziness, insomnia, premature aging, atherosclerosis, liver and kidney disorders, and inflammation.</p>	
<p><i>Syzygium cumini</i> L. (Jamun) Family- Myrtaceae Maturity period- Fruit bearing start in 3rd year</p>	<p>Phenolic acids, Flavonoids and Anthocyaninsetc (Fruits)</p>	<p>Ram Jamun Jamun GJ-2, Jamun GJ-8, CISH J-37, CISH J-42 (Source: Central Institute for Subtropical Horticulture, Lucknow) Konkan Bahadoli (RFRS, Vengurla) Goma Priyanka- (ICAR-CIAH, Bikaner) Narendra Jamun 6-Narendra dev University of Agriculture and Technology, Faizabad, U.P. Rajendra Jamun-1 – Bihar Agriculture Collage Bhagalpur Thar Krantiand Goma Priyanka (Source: ICAR-CIAH, Bikaner, Rajasthan)</p>	<p>Thar Kranti- 65.00 kg/tree/yr Goma Priyanka- 30 kg/tree/yr</p>	<p>Antihyperglycemic, Hypolipemiant, Anti-inflammatory, Cardioprotective, and Antioxidant activities.</p>	




<p><i>Terminalia chebula</i> Retz. (Harad) Family- Combretaceae Maturity period- After 6 years</p>	<p>Glycosides, Gallic acids, Ellagic acid, Chebulinic acid, Tannic acid (Fruits)</p>	<p><i>Vijaya, Rohini, Putana, Amrita, Abhaya, Jivanti and Chetaki</i> (Chattopadhyay and Bhattacharyya, 2007)</p>	<p>Approximately 40–50 kg/tree/yr dry fruits</p>	<p>Ingredient of Triphala, Laxative.</p>	
<p><i>Terminalia bellirica</i> Gaertn. (Bahera) Family- Combretaceae Maturity period- After 10 years</p>	<p><i>Arjunenin, Bellericacid and Bellericosides</i> (Fruits)</p>		<p>20-25 kg/tree from mature tree</p>	<p>Ingredient of Triphala</p>	
<p><i>Tamarindus indica</i> L. (Tamarind, Tamarindo, Tamarin, Sampalok) Family- Fabaceae Maturity period- within three to four years</p>	<p>β-amyirin, compesterol, β-sitosterol and seven hydrocarbons. (Fruits)</p>	<p>Goma Prateek (Source: ICAR-CIAH, Bikaner, Rajasthan) PKMI (Source: Tamilnadu University (HCRI, Periakulam) Tumkur Parthithan (Source: FRS, Aurangabad, Maharashtra) Urigam DTS-1 (Source: UAs, Dharwad) Yogeswari (Source: Forest Deptt. Karnataka)</p>	<p>Average yield – 150-200 kg/tree/yr PKMI Yield – 250 kg from 9th year</p>	<p>It is used in wound healing, abdominal pain, diarrhea, dysentery, parasitic infestation, fever, malaria and respiratory problems.</p>	




IMPORTANT SHRUBS SPECIES AS MIDDLE STORY

Botanical Name & Common name Family/ Maturity Period	Active ingredients (Useful parts)	Varieties available /source	Gross production /income	Major Medicinal properties/Uses	Photographs
<i>Annona reticulata</i> L. (Custard apple) Family- Annonaceae Maturity period-5 th year	Tannins, alkaloids, phenols, glycosides, and flavonoids and steroids. (Fruit)	Arka Neelanchal Vikram and Arka Sahan (Source: SVRC, Govt. of Odisha) Arka Sahan- HR Bangalore	Arka Neelanchal Vikram - 69 fruits/plant); fruit weight (211g) Arka Sahan- 45Kg/tree (5 th year and Fruits starts at 3 rd year)	As anthelmintic, analgesic, Anti- inflammatory, Anti- Antipyretic, wound Healing and cytotoxic effects	
<i>Citrus limon</i> L. (Nimbu) Family- Rutaceae Maturity period- Starts bearing from 3 rd year after planting	Flavonoids, limonoids, phenolic acids, carboxylic acids, coumarins, and vitamins and their metabolites (Fruit)	Eureka, Allen, Cascade, Cook, Meek, Thorton, Lisbon, Bradbury, Cavors, Deavor, Hall, Jameson, Ledig, Limoneira, -8A, Monore, Prior, Prospect, Strong, Femminelo, Oval, Genoa, Brena	50-60 fruit/tree (after 3 rd yr) 1000-1500 (after 8 th yr) fruit/tree	Meniere's disease, Kidney stones, Treating scurvy, The common cold and flu. Decreasing swelling. Increasing urine.	




<p><i>Punica granatum</i> L. (Pomegranate) Family- Puniceaceae Maturity period-</p>	<p>Flavonoids, Ellagitannin, Punicalagin, Eellagic vitamins and minerals. (Fruit)</p>	<p>Ganesh, Mardula, Bhagwa, PhuleBhagwa Super, Phule Arakta and G 137 (Source: MPKV, Rahuri) CO-1 and Yercaud-1 (TNAU, Coimbatore), Ruby and Amlidana (Source: HR, Bengaluru) YCD-1 Pomegranate- (Source: Horticultural Research Station, Yercaud) Goma Khatta (Source: ICAR-CIAH, Bikaner, Rajasthan) CAZRI Vishal (Source: Singh and Meghwal, 2020) Jyoti (UAS, Dharwad)</p>	<p>Goma Khatta - 6.59 kg/tree and anardana yield is 1.18 kg/tree CAZRI Vishal- 12-15 t/ha (3.5m*4m, approx. 16.8-21 kg/tree) YCD-1- 60-70 fruits/plant/yr</p>	<p>Treatment for Cancer, Osteoarthritis and Other Diseases. The Pomegranate has been used in natural and holistic medicine to treat sore throats, coughs, urinary infections, digestive disorders, skin disorders, arthritis, and to expel tapeworms.</p>	
<p><i>Ziziphus mauritiana</i> Lam. (Ber) Family- Rhamnaceae Maturity period-</p>	<p>Proteins & amino acids, flavonoids, alkaloids, glycosides, terpenoides, saponins, fibers, tannins and phenolic compounds. (Seed)</p>	<p>Thar Sevika, Thar Bhubharaj, Goma Kirti and Thar Malti (Source: ICAR-CIAH, Bikaner, Rajasthan) Goma Keerthi (Source: ICAR-II:HR, Bengaluru)</p>	<p>Thar Sevika -30-32 kg/tree. Thar Bhubharaj- 30-36 kg/tree Thar Malti- 65-70 kg/tree Goma Keerthi- 35.6 kg/tree</p>	<p>Eye diseases, leukorrhea, as an astringent tonic to the heart and brain. The seeds also help to relieve thirst, and have a sedative and hypnotic effect, which is helpful in insomnia, pain, physical weakness, and rheumatic symptomology.</p>	




IMPORTANT HERBS AS UNDERSTORY





Botanical Name & Common name, Family/ Maturity Period	Active ingredients/ Parts used	Varieties available /source	Gross production /income	Medicinal Uses	Photographs
<i>Andrographis paniculata</i> Burm.f. (Kalmegh/Bhuneem) Family- Acanthaceae Maturity period- Within one year	Andrographolide (Whole Plant)	CIM-Megha (Source: CSIR-CIMAP Lucknow Uttar Pradesh)	CIM-Megha-2.5-3.0 t/ha. of dried herb Net Income- 45,000/ha (from 3 rd month) (Bahl <i>et al.</i> , 2018)	Fever, weakness, gastric problems.	
<i>Aloe vera</i> Miller (Grit-kumari) Family- Liliaceae Maturity period- 2 nd -5 th yr	Aloin (Leaves)	CIM-Sheetal (Source: CSIR-CIMAP Lucknow, Uttar Pradesh) IC11127 IC111269 IC111280 IC111273 (Source-NBPGR, ICAR, Delhi)		Laxative, Wound Healing, & Skin burns	
<i>Acorus calamus</i> L. (Buch) Family- Acoraceae Maturity period- Within one year	β -asaron, Flavonoid, monoterpene, quinone, sesquiterpene, and phenylpropanoid (Root)	Jor Lab AC-1 (Source: CSIR- NEIST Jorhat, Assam and Lal <i>et al.</i> , 2019)	Rs -36602.5/ha /yr 50-70 gram/plant	Depression, Mental ailments, As an insecticide, aediatric, cough and colicky problems.	



<p><i>Bacopa monnieri</i> L. (Brahmi) Family- Scrophulariac eae Maturity period- One year</p>	<p>Bacoside A & B (Whole plant)</p>	<p>Subodhak, Pragyashakti, and CIM-Jagriti. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>As a pure crop, fresh yield is 22.5 tonnes/ hectare, reduced to approximately 5.5 tonnes/hectare on drying.</p>	<p>Memory enhancer, mental disorders.</p>	
<p><i>Cassia angustifolia</i> L. (Senna) Family- Liliaceae Maturity period- Within 1 year</p>	<p>Sennosides (Dry tubers)</p>	<p>Sona CSIR-CIMAP's (Source: CSIR-CIMAP Lucknow Uttar Pradesh)</p>	<p>Sona CSIR-Dry leaf yield: 11 q/ha, seed yield: 4 q/ha. Net profit- 27,000- 30,000 Rs/ha/yr.</p>	<p>Rheumatism, general debility tonic, aphrodisiac.</p>	
<p><i>Coleus barbatus</i> Andrews Benth. ex G. Don (Pashan Bheda / Pathar Chur) Family- Lamiaceae Maturity period- One year</p>	<p>Bergenin, and Afzelechin (Root)</p>	<p>Manganiperu (commercially cultivated in Tamil Nadu). Garmai (cultivated in Gujarat state). Maimul</p>	<p>Fresh tubers: 15 – 20 t/ha Dry tubers: 2000 – 2200 kg/ha</p>	<p>Kidney stone, Calculus.</p>	


<p><i>Cymbopogon flexuosus</i> Nees ex Steud. W. Watson (Cochin grass, East-Indian lemon grass) Family- Poaceae Maturity period- after 4 to 6 months</p>	<p>Myrcene, citral, limonene, geraniol, citronellol, geranyl acetate, nerol, terpenes, alcohols, ketones, aldehyde and esters. (leaves)</p>	<p>Cim -Pragti, Nima, Chirharit, Krishna, CIM-Swarna and CIM -Shikhar, which gives more herb and oil yield. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>Krishna- 230-250kg oil/ha. Nima- 25-260kg/ha Essential oil CIM-Shikhar- More 280kg/ha. Oil yield Net profit of about Rs 60,000 and 1,00,000/ha/yr depend on irrigation (Bahl <i>et al.</i>, 2018)</p>	<p>Antispasmodic, Hypotensive, Anticonvulsant, Analgesic, Antiemetic, Antitussive, Antirheumatic, Antiseptic and treatment for Nervous and Gastrointestinal disorders and Fevers.</p>	
<p><i>Cymbopogon martini</i> Roxb. Wats. (Palmarosa) Family-Poaceae Maturity period- after 4 to 6 months</p>	<p>Motia (palmarosa oil), Mentha x piperita (peppermint) and Eugenia caryophyllus (clove). (Flower)</p>	<p>PRC-I, Trishna, Tripta, Vaishnavi, CIM-Harsh. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>PRC-I- 125-150 kg oil/ha. Net Return- 60,000-1,00,000/ha/yr CIM-Harsh- 175-200 kg/ha. (Bahl <i>et al.</i>, 2018)</p>	<p>Aromatherapy as a skin tonic due to its antimicrobial properties. It has also used in Ayurvedic medicine for skin problems and to relieve nerve pain.</p>	
<p><i>Cymbopogon winterianus</i> Jowitt ex Bor. (Java citronella) Family-Poaceae Maturity period- After 4 months</p>	<p>Citronellol, citronellal, geraniol. (leaves)</p>	<p>Manjusha, Mandakini, Bio13, Jalpallavi and CIM. (Source: CSIR-CIMAP Lucknow Uttar Pradesh)</p>	<p>20 - 30 t/ha/year (Spacing of 60 x 45 cm) Citronellal 38.61% (Manjusha)</p>	<p>Anti-Inflammatory, Antinociceptive, and central Nervous system (CNS) disorders.</p>	

<p><i>Curcuma longa</i> L. (Turmeric) Family- Zingiberaceae Maturity period- 7-9 months after planting</p>	<p>Three curcuminoids; curcumin (diferuloylmethane, the primary constituent responsible for yellow color of turmeric)</p>	<p>Suvarna, Suguna, Sudarsana, SR Prabha, SR Prathibha., Co- 1, BSR-L, Krishna, Sugandham, Roma, Sutoma, Ranga, Rasmi, Rajendra, Sonia, SR Kedaram, Sobha, Sona, Varna, Kanthi. (Source: Department of spices and plantation crops, faculty of horticulture Tamil Nadu Agriculture university, Coimbatore, Tamil Nadu) CIM-Pitamber (source- CSIR-CIMAP)</p>	<p>CIM-Pitamber- 60-65 tonnes fresh rhizomes/ha Net profit 1.25 –1.50 lakhs/ha (Bahl <i>et al.</i>, 2018)</p>	<p>A cough, diabetes, dermatological conditions, respiratory problems, and cardiovascular diseases, hepatobiliary diseases, arthritis, irritable bowel disease (IBS), peptic ulcers, psoriasis, and atherosclerosis.</p>	
<p><i>Desmodium gangeticum</i> L. DC. (Salparni) Family- Fabaceae Maturity period- six to seven months</p>	<p>Gallic, protocatechuic, salicylic, chlorogenic, caffeic acids, rutin, quercetin and kaempferol in both parts of plant. (Root, whole plant)</p>		<p>The total herb yield per hectare is estimated to be 50-55 quintals dry weight, while the dry weight yield of roots is estimated to be 11-15 quintals/hectare.</p>	<p>Febrifuge, aphrodisiac, analgesic, diuretic, antiinflammatory, and haemorrhagic properties. It is used in postnatal complaints, diarrhoea, chronic fever, biliousness, cough, vomiting, and asthma. It is an important ingredient of dasmoolarishta and chyavanprash.</p>	
<p><i>Embelia ribes</i> Burm.f. (Vidanga) Family- Primulaceae Maturity period- After 5-6 months</p>	<p>Embelin; quercitol, fatty ingredients and alkaloid schristermbine, a resinoid, tannins (Seed)</p>			<p>Relieving Headache, Rhinitis, Haemorrhage, Epilepsy, Insomnia.</p>	




<p><i>Gloriosa superba</i> L. (Kalihari) Family- Liliaceae Maturity period- Five years</p>	<p>Cholchicin, Alkaloid gloriocine (Seed, tuber)</p>		<p>Seeds 200-250 kg/ha. tubers 300 kg/ha.</p>	<p>Skin Diseases, Abortion, General debility.</p>	
<p><i>Mentha piperita</i> L. (Peppermint) Family- Lamiaceae Maturity period- Perennial</p>	<p>Menthol, Essential oil (Leaves, Flower, Oil)</p>	<p>Menthone, menthol rich: Kukrail: menthol (34.5%), menthone (27.9%), Tushar: menthol (33.3%), menthone (27.3%) Pranjai: menthol (52%), menthone (13.5%) CIM- madhuras: menthol 31.2%, menthone 24.3%. Menthofuran rich: -V CIM- indus; menthofuran (27%) and pulegone (15%), CIMAP- patra: menthofuran content:35- 46%. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>Tushar- 85-90 kg/ha (Bahl <i>et al.</i>, 2018) Oil yield (kg/ha)-120 Cost of cultivation (Rs./ha)- 75,000 Value @ Rs.2400/kg- 2,88,000 Net Return Rs./ha- 2,13,000 CIM-Madhuras- High oil yielding (120-125 kg/ha)</p>	<p>Carminativ, Antiseptic and Gastro-stimulant</p>	
<p><i>Mentha arvensis</i> L. (Japani mint) Family- Lamiaceae Maturity period- after 100-120 days</p>	<p>Menthol, menthone, menthyl acetate, isomenthone, limonene and neomenthol. (leaves)</p>	<p>Menthol mint- CIM- kranti, CIM- saryu, Kosi Peppermint- CIMAP- patra, CIM- madhuras, kukrai, Pranjai Spearmint- MSSS, arka, Neera, Neerkalka Bergamot mint- kiran. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>CIM-saryu- 140-150 kg/essential/ha. containing 78-80% menthol. CIM- Vishisht- 60 kg/ha of essential oil (Bahl <i>et al.</i>, 2018) Menthol mint: Rs.125000/ha Peppermint: Rs.70000- 80000/ha Spearmint: 70000-80000/ha</p>	<p>Hypertension and in patients with ischemic heart disease. The infusion of these leaves is used in indigestion, rheumatic pains, arthritis, and as remedy for inflamed joints.</p>	


<p><i>Ocimum sanctum</i> Linn. (Tulsi) Family Lamiaceae Maturity period 3 months</p>	<p>Oleanolic acid, rosmarinic acid, ursolic acid eugenol, linalool, carvacrol (Leaves/Seed)</p>	<p>CIM-Ayu, CIM- Angna. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>CIM-Ayu- 16 q/ha. dry leaf yield or 110 kg/ha. Oil CIM- Angna-14 q/ha. or 90 kg/ha essential oil (Bahl <i>et al.</i>, 2018)</p>	<p>Cough, Cold, Bronchitis, used as expectorant.</p>	
<p><i>Ocimum basilicum</i> L. (Indian basil) Family Lamiaceae Maturity period 26-50 days</p>	<p>Methyl chavicol- rich, linalool- rich, methyl eugenol- rich, methyl cinnamate-rich, (leaves)</p>	<p>CIM- Saumya, CIM- Snigdha, CIM- Surabhi, CIM- Shishir, CIM- Sharda. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>Average herb yield of basil is about 20-25 ton and oil yield are about 80-100 kg per hectare</p>	<p>Headaches, coughs, diarrhea, constipation, warts, worms, and kidney malfunctions.</p>	
<p><i>Phyllanthus amarus</i> Schumacher. & Thonn. (Bhumi Family Euphorbiaceae Maturity period Within one year</p>	<p>Phyllanthin (Whole Plant)</p>	<p>CIM- Jivan (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>Yield- 15-20 q/ha dry herb</p>	<p>Anemic, jaundice, Dropsy.</p>	
<p><i>Plumbago zeylanica</i> L. (Chitrak) Family Plumbaginaceae Maturity period- 10-12 months after transplanting</p>	<p>Plumbagin (Root)</p>		<p>Yield varies from 12- 18 quintals/hectare Dry root. The cost of cultivation is approximately Rs 8000/hectare/yr</p>	<p>Stubborn chronic Rheumatoid arthritis, Skin diseases and tumorous growths, chronic menstrual disorders, viral warts and chronic diseases of nervous system.</p>	

<p><i>Piper longum</i> L. (Long piper / Pipali) Family- Piperaceae Maturity period- After first year</p>	<p>Alkaloids (Fruit, Root)</p>	<p>Calicut, Assam and Viswam (Source: Philip <i>et al.</i>, 2000)</p>	<p>Yield of dry fruits in first year is about 100- 150 kg/ha and it attains up to 0.75-1.0 t/ha in third to fourth year. The yield of dry spike during first year is around 0.5 t/ha. It increases up to 1.2 t/ha in the 3rd year.</p>	<p>Appetizer, enlarged spleen, Bronchitis, cold, antidote.</p>	
<p><i>Rauvolfia serpentina</i> L. Benth. ex Kurz (Sarpa Gandha) Family- Apocynaceae Maturity period- After 2 year</p>	<p>Alkaloids (Root)</p>	<p>CIM-Sheel (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>CIM-Sheel- Average root from-1200 kg/ha (2nd year) Yield of root- 100-140 gm/plant Net return (Rs/ha)- 150,000/- (Bahl <i>et al.</i>, 2018)</p>	<p>Hyper tension, insomnia.</p>	
<p><i>Rosa damascena</i> Mill. (Damask rose) Family- Rosaceae Maturity period-</p>	<p>Phenylethyl alcohol (78.4%), citronellol (9.9%), nonadecane (4.4%) and geraniol (3.7%) (flower)</p>	<p>Noorjahan, Rani Sahiba. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>Noorjahan- 600g rose oil/ha. Valued at 3 lakh/ha. Geraniol 30%, Citronellol 24%, Nerl-12% and Rose oxide- 1.3%, Rani Sahiba-40 q/ha, Flower biomass Geraniol 35% Geranyl acetate-7% Citronellol-5% and trans-rose oxide-10% (Bahl <i>et al.</i>, 2018)</p>	<p>Abdominal and chest pains, strengthening the heart, menstrual bleeding, digestive problems and constipation.</p>	

<p><i>Vetiveria zizanioides</i> L. Nash. (Vetiveria, Vetiver grass) Family- Poaceae Maturity period- at 18 months</p>	<p>Sesquiterpenes (3-4 %), sesquiterpenols (18-25 %) and sesquiterpenones (7-8 %). (leaves)</p>	<p>KS 1, Dharini (khus odour), Gulabi (rosr odour), Kesari (saffaron odour), CIM-Vriddhi, CIM- Khus – 15, CIM – Khus -22, CIM – Khusnolika and CIM – samraddhi, khus -40 etc. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>KS 1-18-20kg/ha CIM-Vriddhi-20-25kg/ha (10-12 months) Net profit-1,50,000/ha. (Bahl <i>et al.</i>, 2018)</p>	<p>For relieving stress, It is also used for arthritis, stings, and burns. Vetiver is sometimes inhaled as aromatherapy for nervousness, insomnia, and joint and muscle pain.</p>	
<p><i>Withania somnifera</i> L. Dunal (Ashwagandha) Family- Solanaceae Maturity period- One year</p>	<p>Alkaloids (Root, leaf)</p>	<p>NIMITLI-101, Poshita, NIMITLI-118, Pratap, Chetak. (Source: CSIR-CIMAP Lucknow, Uttar Pradesh)</p>	<p>NIMITLI- 118-15 q/ha (dry root yield) NIMITLI- 101-23 q/ha (dry root yield) Expenditure per hectare = 30,000/- Gross Return/ hectare = 96,000/ Net income per hectare = 66,000/-</p>	<p>Restorative tonic, stress, nerves disorder, aphrodisiac.</p>	

IMPORTANT SUGGESTED CLIMBER SPECIES

Botanical Name & Family/ Maturity period	Active ingredients/ Parts used	Varieties available /source	Gross production /income	Medicinal Uses	Photographs
<i>Asparagus racemosus</i> Willd. (Satavari) Family- Liliaceae Maturity period- After 2-3 year	Saponin glycosides (Sataverin I-IV) (Tuber, root)	CIM- Shakti, CIM- Sunehari (CSIR-CIMAP, Uttar Pradesh), Lucknow,	CIM-Shakti – 5-6 t/ha Dried root yield from a 2 year old crop. Net profit- 3,50,000 Rs/ha. CIM- Sunehari- 9 t/ha Dried root yield	Enhance lactation, general weakness, fatigue, and cough.	
<i>Dioscorea bulbifera</i> L. (Air potato, Air yam, Aerial yam, Bitter yam) Family- Dioscoreaceae Maturity period- After two to three years.	Flavonoids, clerodane diterpenoids, and steroidal saponins and phenolic compounds. (tubers)	Peruvalli (<i>D. alata</i>): Co 1, Sree Roopa, Sree Keerthi, Sree Shilpa Siruvalli (<i>D. esculenta</i>): Sree Latha, Sree Kala	20 – 25 t/ha in 240 days of tubers.	Piles, Dysentery, Syphilis, Ulcers, Cough, Leprosy, Diabetes, Asthma, and Cancer.	
<i>Gymnema sylvestre</i> R. Br. (Gurmar) Family- Asclepiadaceae Maturity period- After Four year	Gymnemic acids (Leaves)		About 1250 kg/ha. dried leaves (every three months). or 5-6 kg/ha. dried leaves/plant (after 3 rd year and about 10,000-15,000 kg/ha. of dried leaves.)	Diabetes, Hydrocele, Asthma.	

<p><i>Mucuna pruriens</i> L. DC. (Kaunch) Family- Fabaceae Maturity period- Within 5 months</p>	<p>Levodopa (Seed)</p>		<p>Seed yield is high between 2.5 to 3.0 t/ha on large scale cultivation.</p>	<p>Male infertility, Nervous disorders, and also as an aphrodisiac.</p>	
<p><i>Tinospora cordifolia</i> Thunb. Miers (Guduchi/Giloe) Family- Menispermaceae Maturity period- Within one year</p>	<p>Alkaloids, Diterpenoid Lactones, Glycosides, Steroids, Sesquiterpenoid, Phenolics, Aliphatic Compounds and Polysaccharides (Stem)</p>		<p>The plant yields about 1500 kg of fresh woody stem, reduced to 300 kg of dry weight per hectare in about two years.</p>	<p>Gout, Pile, general debility, fever, Jaundice.</p>	

4.1 Miyawaki Plantation Established by ICFRE Institutes

4.1.1. Institute of Forest Productivity (IFP), Ranchi

Introduction of Miyawaki Plantation at Rajrappa OCP Mines under the CCL funded project entitled “Top soil conservation and Eco-rehabilitation of selected degraded coal mines of Central Coalfields Ltd., Jharkhand through forestry interventions”.

The institute has taken up 1.74 hectare in the Rajrappa OCP Mines area. A total of 155 plots each size of 100 sqm were laid down in the given area.

- Size of the plot = 100 sqm.
- No. of Plants planted in each plot = 225
- No. of Species of High canopy = 3
- No. of Species of Medium canopy = 3
- No. of Species of Shrub = 3
- Total number of plants planted $225 \times 155 = 34875$ plants

The factorial design was taken with five treatments as below:

Sl. No.	Treatments	Amendments (AM)
1.	T1	Soil + Bonemeal + FYM
2.	T2	Soil + FYM + VAM tablets
3.	T3	Soil + Cocopeat + Vermicompost + Bonemeal
4.	T4	Soil + Cocopeat + Vermicompost + VAM tablets
5.	T5	Soil + Bonemeal + FYM + Cocopeat + VAM tablets

Based on the biodiversity survey carried out in the 10 km of the buffer area, the species shortlisted are as below:

Details of species selected for plantation			
Sl. No.	High Canopy	Medium Canopy	Shrubs
1.	<i>Albizia lebbek</i>	<i>Bauhinia variegata</i>	<i>Adhatoda zeylanica</i>
2.	<i>Dalbergia sissoo</i>	<i>Cassia fistula</i>	<i>Ipomoea fistulosa</i>
3.	<i>Melia azedarach</i>	<i>Acacia catechu</i>	<i>Ricinus communis</i>

Miyawaki Design (15 PIT X 15 PIT)

Sl. No.	Treatments	Amendments (AM)
1.	AM 1	Soil + Bonemeal + FYM
2.	AM 2	Soil + FYM + VAM tablets
3.	AM 3	Soil + Cocopeat + Vermicompost + Bonemeal
4.	AM 4	Soil + Cocopeat + Vermicompost + VAM tablets
5.	AM 5	Soil + Bonemeal + FYM + Cocopeat + VAM tablets

Plot Design

Replication 1			Replication 2			Replication 3			Replication 4			Replication 5		
T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1
S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2
M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3
T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1
S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2
M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3
T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1
S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2
M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3
T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1
S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2
M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3
T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1	T1	M1	S1
S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2	S2	T2	M2
M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3	M3	S3	T3

(Source: ICFRE-IFP, Ranchi)

Glimpses of The Miyawaki Plantation at IFP, Ranchi



Field Site Preparation



View of Field Plots



Plantation of trees



View of newly established Plantation

4.2. Miyawaki Plantation established in North Eastern States of India

A. Assam

- i. Assam Science Society created first man-made micro-forest in Goalpara district's Lakhipur College. The plantation is based on Japanese ecologist Akira Miyawaki's model.

Environment, Forest & Wildlife Minister Parimal Suklabaidya launched a Miyawaki method afforestation programme at Amingaon on 28th August 2010. As part of the initiative, Guwahati Refinery planted 5,000 saplings of indigenous plants at the site with an aim to build a small forest resonating with Indian Oils theme Lungs of Guwahati City.

Guwahati Refinery carries out Akira Miyawaki method of afforestation as a mark of support to Indian Oil's commitment towards the cause of environment protection and conservation, at Amingaon in the city on 1st January 2020. A total of 4,000 saplings of around 48 species of indigenous plants were planted near the Saraighat Lake to build 'the lungs of Guwahati city'.

- ii. On the 5th June 2021 during World Environment Day, the State Environment and Forest Department of Assam, Aie Valley Division organized an event of the plantation where the initiative of Miyawaki Method was inaugurated.



- iii. Young Indians (Yi) Guwahati Chapter launched Miyawaki Forest Project in Assam on 11th October 2021 in the premises of Assam Down Town University, Panikhaiti. This project aims to restore landscapes, aid in soil conservation and help build the natural ecosystem of the region.



B. Meghalaya

RNB Cements, one of the most modern cement makers in North East India, embarks on a new innovative initiative. In a plantation program carried out on 25.06.2013, at their plant in Barapani Industrial Area, Umiam, in Ri Bhoi district, they introduced an innovative eco-development system. Under the guidance of Dr Shantanu Kumar Dutta, Environment Engineer, Central Pollution Control Board, they planted 375 native species trees by adopting Akira Miyawaki Method of Environment Forest Plantation.

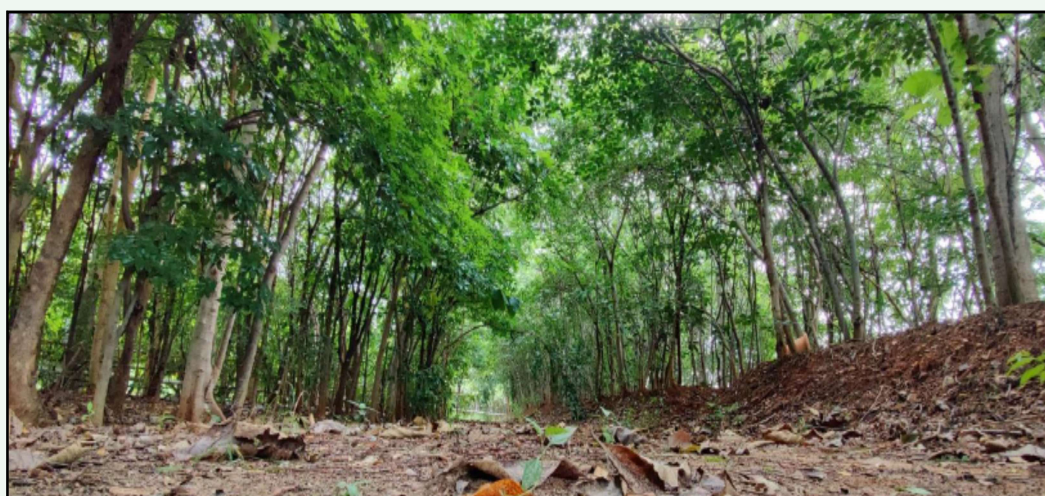
4.3. Miyawaki Plantation established in southern Indian states

4.3.1. Bengaluru:

A. Miyawaki – as mixed forest plantation (State Forest Department, Ramnagara)

B. Miyawaki forest – natural acoustic barrier (TKM, Bididi)

Toyota Kirloskar Motor Private Limited (TKM) was the first organisation in India to introduce Miyawaki method of forestry during a mass afforestation movement on 21st June 2009 at Bididi, where 36,000 saplings were planted involving 5600 stakeholders including employees and their family members, local community members, local regulators (CII, 2019). TKM, Bididi recorded the benefits of Miyawaki plantation viz., control of soil erosion, increasing water holding capacity, reduction of ambient temperature in premises, especially the reduction in noise of the vehicle during test drive. The gradual reduction of noise level (76.8 dB to 63.1 dB) up to 18% and only 10% noise reduction (76.8 dB to 69.0 dB) from source location to 15 m in the Miyawaki and in the non-plantation area (CII, 2019). Otherwise also, studies had focused in increasing the performance of noise barriers by adding vegetation in the form of urban forest along highways (Ow and Ghosh, 2017). In case of highways, closer (<15m) the noise barrier forest, better the performance and ultimately, Miyawaki forest is one of the favorable combinations with its medium to high density vegetation thereby place the forest in optimal conditions to reduce noise pollution (Urban Forest Company, 2020).



Dense trees of mound plantation of Miyawaki method, TKM Bididi

C. Miyawaki forest – as Live / Bio-fence (BIAL, Bengaluru):

Bio-fencing, also referred to live-fencing, is one of the old concept and long-lasting alternative practice to different kinds of mechanical fencing. The structure of a bio-fence involves lines of bushes or trees that are planted closely spaced at field boundaries against wind, soil erosion and insect pests and diseases. They also enrich the soil, function as carbon sinks, and improve microclimatic conditions (Villanueva-López *et al.*, 2016, Vadeo *et al.*, 2018).

The basic idea behind the bio-fence at BIAL (Bangalore International Airport Limited) project office campus is to maintain temperature and reduce dust particles from the surrounding area and aesthetic urban view, apart from other micro-ecological benefits of Miyawaki plantation.



(Clockwise) Aerial (Google location) view of the Bio-fence surrounding BIAL Office, followed by field photographs of Miyawaki Plantation, BIAL, Bengalure

D. Miyawaki – as an alternative for green cover in Urban Fragments (Saytrees, Bengaluru)

Small Forest Fragments or Urban green spaces (UGS) are considered as “lungs of city” and reservoirs of “carbon stock” as the vegetation in and around the urban areas sequester and store large amount of carbon (Nowak *et al.*, 2008; Strohbach *et al.*, 2012), thereby contribute towards mitigation of climate change impacts (Nero *et al.*, 2017). The modern civilization created an imbalance in the environment where many natural forests have been removed or fragmented in urban and its periphery for various developmental purposes, thereby, dwindling the urban space. On the other hand, day-by-day rapid expansion of the grey infrastructure (infringing the tree protection area) becomes a threat to existence and upkeep of large trees (with vast canopy), especially in all metro cities of our country. Miyawaki forests are the best alternative for restoring green space and maintenance in urban areas.



Biodiversity Park at Manyata Tech Park (Saytrees, Bengaluru)



Biodiversity Park at IRIDM (SWR), RR Nagar (Saytrees, Bengaluru)

E. Miyawaki forests in Bengaluru City - Revival of degraded land (Municipal Solid Waste Quarry area)

The top soil filling of 4 to 5 feet may be suitable for vegetation cap. Their purpose of vegetation cap is to increase evapotranspiration from the surface of the landfill and enhance bioremediation through suitable plantation. A further advantage of the alternative vegetative cap is more rapid “stabilization” of the wastes, decrease gas production gradually after 5–20 years, and earlier access to the site for alternative uses (Schnoor, 2002).



Google extract of Bellahalli quarry area (left hand side) and right hand side) Quarry after covered with soil creating a vegetation cap of 4 to 5 feet (Courtesy - BMRCL)

Nevertheless, Karnataka Forest Department followed traditional planting method for reclamation of a MSW dump yard located near Hesaraghatta, Karnataka



Vegetation cap at MSW dump yard (KFD, Hesaraghatta)

4.3.2. Mumbai

Establishment of city forests using the Akira Miyawaki plantation technique is an emerging city forest plantation concept in our country. In Mumbai, this type of plantation has been established by Maharashtra State Forest Department and various NGOs in the city. The preliminary study was carried out by ICFRE-TFRI, Jabalpur (M.P.), for Miyawaki plantations established by Keshav Srushti. Keshav Srushti, a NGO based in

Thane, Maharashtra, has established Miyawaki plantations in 19 sites using Akira Miyawaki Plantation techniques. The established plantations were one month to two years of age.

Table 1: Details of Miyawaki Plantation sites

S. No.	Name of study sites	Date of Establishment	No. of Plant Planted	No. of species	Area (sq. m)
1	Keshav Srushti, UTTAN, Bhayander (west), 401 106	7-Jun-2018	2104	150	278.70
2	Ismail Yusuf college, Hardevi Society, Natwar Nagar, Jogeshvari –(East), Mumbai, 400 060	14-Aug-2019	1200	32	185.80
3	Veer Abdul Hamid Garden, Kandivali- East, Mumbai, 400 101	23-Aug-2019	1200	30	185.80
4	SRPF Ground, NH 8, Goregaon, Mumbai, Maharashtra, 400065	27-Oct-2020	1000	23	557.41
5	Posha Nakhwa BMC Garden, Versova, Andheri, Mumbai	9-Mar-2021	945	55	185.80
6	Plot No. 230, Ramdev park, Mira Road, Mumbai- 4	1-Apr-2021	1650	53	383.22
7	Sanjay Gandhi National Park, WEH, Borivali East, Mumbai	13-Nov-2020	1620	35	371.61
8	Sanjay Gandhi National Park, Site near pine forest	17-Aug-2021	1500	54	297.28

Source: Rathod D.U., Saravanan, S and Rao, G. (2022)

Based on study observed that *Bauhinia spp.*, *Terminalia spp.*, *Ficus benghalensis*, *Mimusops elegi*, *Syzygium cumini*, *Pongamia pinnata* species with the highest number of individuals were planted.

Microclimate condition of Miyawaki Plantation was also studied during the survey includes temperature, humidity and light condition. Based on field data observed that In terms of temperature, the difference in temperature between inside and outside the plantation ranged from 0.5°C to 2.4°C between all sites during the month of August. This difference may be more pronounced during the summer season. This microclimate difference in plantations can attract birds to shelter, especially during hot summers. The Miyawaki plantation site can be helpful in increasing the number of birds in the city area. The data on humidity indicated that the value of

increasing the number of birds in the city area. The data on humidity indicated that the value of humidity ranged between 74% and 98% inside the plantation and 66% to 98% outside the plantation. A higher value of humidity was recorded inside the plantation than outside the plantation. Due to the monsoon season, the humidity rate was higher inside the plantation and lower outside the plantation. This scenario may vary during the summer season. Plantation creates a favourable microclimate for the bird population. The data on light showed that the intensity of the light ranged between 300 lux and 1533 lux, and 1467 lux and 2000 lux on the inside and outside of the plantation, respectively. The value of light is low inside the plantation site as compared to outside the plantation. This difference in light intensity was due to the dense canopy at all plantation sites. Such low light penetration inside the plantation may lead to a plantation site free of weeds. During the survey, we observed that most sites were free from weed. It may reduce the management cost of a plantation. But proper companion species selection with the main species is required; otherwise there may be chances of lower-storey plantation failure. The light condition data will also be helpful in species selection for future successful establishment of plantations and reducing the species mortality rate through an appropriate selection of species based on light requirements.



3 years and 2 months old plantation at
Keshav Srushti Uttan



2 Years old Miyawaki Plantation in the
Public Garden



10 Months old Miywaki Plantation at SRPF Ground, NH 8, Goregaon, Mumbai



5 Months old Miywaki Plantation at Poshanakhwa BMC Garden, Andheri, Mumbai



2 week old Miywaki Plantation at Sanjay Gandhi National Park



Miywaki Plantation at SGNP established by Maharashtra State Forest Department

List of Species for Miyawaki Plantation		
*Note: Based on field observation recorded at Mumbai in established Miyawaki Plantation by Keshav Srushti (NGO)		
Top storey (Dominant and Co-Dominant)	Middle storey (Intermediate)	Lower storey (Suppressed)
<i>Gmelina arborea</i> , <i>Ceiba pentandra</i> , <i>Albizia</i> spp., <i>Melia dubia</i>	<i>Adenanthera pavonina</i> , <i>Albizia procera</i> , <i>Azadirachta indica</i> , <i>Lagerstroemia</i> spp., <i>Putranjiva roxburgh</i>	<i>Syzygium cumini</i> , <i>Terminalia arjuna</i>
<i>Albizia procera</i> , <i>Cassia siamea</i> , <i>Lagerstroemia</i> spp., <i>Bauhinia</i> spp., <i>Terminalia catappa</i> , <i>Melia azedarach</i> , <i>Accacia</i> spp., <i>Acacia nilotica</i> .	<i>Cassia fistula</i> , <i>Cassia</i> spp., <i>Dalbergia sissoo</i> , <i>Ficus benghalensis</i> , <i>Senna surattensis</i>	<i>Mimusops elengi</i> , <i>Tamarindus indica</i> , <i>Terminalia arjuna</i> , <i>Wrightia tinctoria</i> , <i>Tamarindus indica</i>
<i>Melia azedarach</i> , <i>Gmelina arborea</i> , <i>Cassia siamea</i> , <i>Bauhinia</i> spp., <i>Chukrasia tabularis</i> , <i>Khaya senegalensis</i>	<i>Dalbergia sissoo</i> , <i>Terminalia catappa</i> , <i>Largestromis</i> spp.	<i>Syzygium cumini</i> , <i>Terminalia arjuna</i> , <i>Terminalia bellirica</i> , <i>Pongamia pinnata</i>
<i>Gmelina arborea</i> , <i>Ceiba pentandra</i> , <i>Neolamarckia cadamba</i> , <i>Vitex negundo</i> , <i>Melia azedarach</i> , <i>Bauhinia</i> spp., <i>Alstonia scholaris</i>	<i>Cassia fistula</i> , <i>Dalbergia latifolia</i> , <i>Azadirachta indica</i> , <i>Bombex ceiba</i> , <i>Morus alba</i>	<i>Terminalia arjuna</i> , <i>T. bellirica</i> , <i>Pongamia pinnata</i> , <i>Phyllanthus emblica</i> , <i>Alstonia scholaris</i> , <i>Ficus</i> spp. <i>D. latifolia</i> , <i>Sterculia foetida</i> , <i>Adhatoda vasica</i> , <i>Cordia dichotoma</i>
<i>Gmelina arborea</i> , <i>Melia azedarach</i> , <i>Ceiba pentandra</i> , <i>Delonix regia</i>	<i>Terminalia catappa</i> , <i>Combretum indicum</i> , <i>Lagerstroemia</i> spp., <i>Alstonia scholaris</i> , <i>Casuarina equisetifolia</i> ,	<i>Terminalia arjuna</i> , <i>Polyalthia longifolia</i> , <i>Swietenia mahagoni</i>
<i>Bauhinia</i> spp., <i>Pterospermum acerifolium</i> , <i>Largestromia</i> spp., <i>Cassia fistula</i> , <i>Cassia siamea</i> , <i>Swietenia mahagoni</i> , <i>A. cadamba</i> , <i>Caesalpinia pulcherrima</i> , <i>C. siamea</i>	<i>A. pavonina</i> , <i>A. marmelos</i> , <i>Ficus benghalensis</i> , <i>Trema orientalis</i> , <i>Terminalia catappa</i> , <i>Saraca asoca</i> , <i>Mitragyna parvifolia</i> , <i>Millingtonia hortensis</i> , <i>Holoptelea integrifolia</i>	<i>Butea monosperma</i> , <i>Bridelia retusa</i> , <i>Dalbergia sissoo</i> , <i>Terminalia bellirica</i> , <i>Sapindus mukorossi</i> , <i>Dalbergia latifolia</i> , <i>Erythrina</i> spp., <i>Acacia</i> spp.
(Source: Rathod D.U., Saravanan, S and Rao, G. (2022))		

References

- Champion, H. G. and Seth, S. K. (1968). A revised survey of the forest types of India. Manager of publications.
- CII (2019). Investing in Biodiversity for Building Resilient Business - Case Studies from Indian Industry, IBBI Publication, CII-ITC Centre of Excellence for Sustainable Development.
- Clara, M. (2020). The Miyawaki method – Data & concepts, Urban Forest Company ([Urban-Forests-report-The-Miyawaki-method—Data-concepts.pdf](#)).
- Evans, J. (1992). Plantation forestry in the tropic. 2nd Edition, Oxford University Press. Pg. 173.
- Fischer, H. S., Winter, S., Lohberger, E., Jehl, H. and Fischer, A. (2013). Improving transboundary maps of potential natural vegetation using statistical modeling based on environmental predictors. *Folia Geobotanica*, 48(2), 115-135.
- FSI (2019) India state of forest report, Forest Survey of India (MoEF & CC), Dehradun (Uttarakhand). Retrieval link: <https://fsi.nic.in/isfr-volume-ii?pgID=isfr-volume-ii>
- FSI (2021) India state of forest report, Forest Survey of India (MoEF & CC), Dehradun (Uttarakhand). Retrieval link: <https://fsi.nic.in/isfr-2021/acknowledgement-executive-summary.pdf>
- Hengl, T., Walsh, M. G., Sanderman, J., Wheeler, I., Harrison, S. P. and Prentice, I. C. (2018). Global mapping of potential natural vegetation: an assessment of machine learning algorithms for estimating land potential. *Peer Journal*, 6, e5457.
- Kiran, G., Sandhya and Kinnary, S. (2011). “Carbon sequestration by urban trees on roadside of Vadodara city.” *International Journal of Engineering Science and Technology (IJEST)*, 3(4): 3066-3070
- Miyawaki, A. (1993^a) Restoration of native forest from Japan to Malaysia. In: Lieth H, Lohmann M (eds) *Restoration of tropical forest ecosystems*. Kluwer Academic, Dordrecht, pp 5–24.
- Miyawaki, A. (1999) Creative ecology: restoration of native forests by native trees. *Plant Biotechnol* 16(1):15–25.
- MoHUF, (2021). Ministry of Housing and Urban Affairs, Govt. of India. **Retrieval link:** <http://mohua.gov.in/cms/urbangrowth.php#:~:text=Growth%20rate%20of%20population%20in,to%2053%20in%20Census%202011>.

- Nero, B, Callo-Concha, D., Anning, A. and Denich, M. (2017). Urban Green Spaces Enhance Climate Change Mitigation in Cities of the Global South: The Case of Kumasi, Ghana. *Procedia Engineering*, 198, 69–83.
- Nowak, D.J., Crane, D.E., Stevens, J.C., Hoehn, R.E., Walton JT and Bond JA. (2008). Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services. *Arboriculture & Urban Forestry*, 34, 347–358.
- Ow L.F. and Ghosh S. (2017). Urban cities and road traffic noise: Reduction through vegetation. *Applied Acoustics*. 120, 15–20. <https://doi.org/10.1016/j.apacoust.2017.01.007>
- Rathod D.U., Saravanan, S. and Rao, G. (2022). Survey Report on Miyawaki Plantations, TFRI (ICFRE) Jabalpur (M.P.). Pg 1-72.
- Schnoor, J.L. (2002). Phytoremediation of soil and groundwater. Technology Evaluation Report-TE-02-01. Ground-Water Remediation Technologies Analysis Center.
- Strohbach, M.W. and Haase D. (2012). Above-ground carbon storage by urban trees in Leipzig, Germany: Analysis of patterns in a European city. *Landscape and Urban Planning*, 104, 95–104.
- Tüxen, R. (1956). Die heutige potentielle natürliche Vegetation als Gegenstand der Vegetationskartierung. *Angew Pflanzensoziol (Stolzenau)* 13:5–42
- Vadeo, A.D., Hiese, N. and Hiese Z. (2018). Study on traditional method of rearing Mithun (*Bos frontalis*) and application of bio-fencing in Mithun ranges at Porba, Phek District, Nagaland. *Research Journal of Chemical and Environmental Sciences*, 6, 54–58.
- Villanueva-Lopez G., Casanova-Lugo F., Martinez-Zurimendi P, Parsons, D. and Aguilar-Solis L.A. (2016). Effect of live fences of *Gliricidia sepium* on CO₂ fluxes in tropical livestock systems. *Soil Use Management*, 32, 553–564. doi: 10.1111/sum.12311.

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