PRACTICAL MANUAL

ON

Silviculture of Indian Trees

FSA 202 3(2+1)

For B.Sc. Forestry IV Semester students

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Syllabus FSA 202 3(2+1): Study the morphological description and field identification characteristics of trees, seeds and seedlings. Phenology, Collection of seeds. Planting and stand management practices of *Tectona grandis, Dalbergia latifolia, Santalum album, Swietenia macrophylla,* eucalypts, acacias, bamboos, fast growing MPTs etc. Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicing and pollarding, etc. Visit various problem areas and study on species suitability. Visit forest plantations and other woodlots. Study the planting density and stand management regimes for various end uses such as timber, pulpwood, plywood, cottage industries etc.

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Semester .....

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CONTENTS

Practical No.1

Objective: To study morphological description and field identification characteristics of trees.

Morphology is a branch of biology dealing with the study of the form and structure of organisms and their specific structural features. Plant morphology "represents a study of the development, form, and structure of plants, and by implication, an attempt to interpret these on the basis of similarity of plan and origin. Plants can be identified by observing certain distinguishing morphological characteristics. In order to successfully identify woody plants, it is necessary for an individual to have a keen awareness (working knowledge) of taxonomic terminology and concise mental pictures of leaf, bud, stem flower and fruit morphology.

Morphological description and field identification characteristics of trees species.

S. No.	Name of plant		Morphological Characteristics					
	Scientific name	Common Name	Plant type	Leaf type	Flower type	Fruit type	Seed	Other characteristics
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Practical No. 2

Objective: To study morphological description and field identification characteristics of tree seeds.

Seed is a fertilised mature ovule that possesses an embryo. In seed ovule developed into seed and ovary develops into fruit while integuments develop into seed coat. In seed embryo alone/embryo and endosperm occupy larger volume of the seed.

Seeds are used for plant propagation for next generation; use directly as food; for extraction of oil and used as medicines etc.

Morphological features of seed

Seed size: ……

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Shape: ……

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Seed Weight: ……

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Surface Texture: ……

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External Features:

Seed Coat……

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Pericarp……

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Raphae……

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Micropyle……

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Hilum……

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Internal features:

Embryo……

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Endosperm……

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Cyotyledon……

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Scutellum……..……

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Coleoptyle……..……

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Plumule……..……

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Radicle……..……

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Hypocotyl……..……

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Perisperm……..……

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Epicotyl……..……

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Draw Angiosperm and Gymnosperm Seed Structure:

Angiosperm	Gymnosperm

Practical No. 3

Objective: To study morphological description and field identification characteristics of seedlings.

The investigations on seedling morphology have emerged as a taxonomic tool for floristic studies. The seedling characters can also be used to develop artificial key for the identification of taxa at juvenile stage, i.e. much before flowering and fruiting. Based on the seedling features, interrelationships between taxa and phylogenetic interpretations can also be made. The knowledge of seedling morphology assists in conservation work, forestry research, weed control, reintroduction of plants for management of phytodiversity relating to Indian flora.

The term seedling is used for woody plants from the beginning of germination up to a stage where it is 25-30 cm high. When it is over about one meter high, then it is called a sapling. Seedling is "an early developmental stage that contains at least some still functioning structures produced from the initial seed reserves and initial morphology to indicate the form of the seedling at the time the first entirely photosynthetic organs have fully expanded" (Garwood 1996). However, there is a general understanding that seedling is the juvenile stage of a plant after germination from seed. The seedling stage is the most striking and vulnerable phase in a plant's life cycle.

Characteristics and diagram of seedling

Morphological identification Tool	Characteristics	Diagram
Phanerocotylar-epigeal		
	Gymnosperm	
Cryptocotylar – hypogeal		
	Angiosperm	
Phanerocotylar-epigeal with orbicular paracotyledon		
	Ecbolium viride (Acanthaceae)	
Phanerocotylar-epigeal with oblong paracotyledon		
	Blainvillea acmella (Asteraceae)	
Phanerocotylar-epigeal with lanceolate paracotyledon		
	Datura metel (Solanaceae)	

Phanerocotylar-epigeal with flabellate paracotyledon		
	Terminalia chebula (Combretaceae)	
Phanerocotylar-epigeal with ovate paracotyledon		
	Bombax ceiba (Malvaceae)	
Phanerocotylar-epigeal with bilobed paracotyledon		
	Jacaranda mimosifolia (Bignoniaceae)	
Cryptocotylar-epigea		
	Madhuca indica (Sapotaceae)	

Seedling available in RLBCAU Nursery.

S.No	Scientific name	Common name	Family	Use
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3.				
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Importance of studies morphological characteristics of seedling

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Practical No. 4

Objective: To study phenology, collection of seeds, planting and stand management practices of Teak (*Tectona grandis*).

Teak (Tectona grandis) is one of the most well-known timbers of the world. Its timber qualities include attractiveness in colour and grain, durability, lightness with strength, ease of seasoning without splitting and cracking, ease of working and carving, resistance to termite, fungus, and weathering, etc. The species is native to the Indian-Burmese floristic region and found naturally in India, Myanmar and Thailand. Teak has been successfully established as an exotic in many countries, e.g. Sri Lanka, Bangladesh and China in Asia; Ghana, Nigeria, Ivory Coast, Senegal, Togo and Benin in West Africa; Sudan and Tanzania in East Africa; Trinidad, Puerto Rico and Panama in Central America; Brazil and Ecuador in South America.

Phenology of Teak (*Tectona grandis*).

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Silvicultural characteristics of Teak (*Tectona grandis*)

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Seed collection and Pre-sowing treatment given to the teak seed:

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Nursey practices and planting method adopted for Teak (*Tectona grandis*) plantation.

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Stand management practices use in Teak (*Tectona grandis*).

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Practical No. 5

Objective: To study phenology, collection of seeds, planting and stand management practices of Rosewood (*Dalbergia latifolia)*

Dalbergia latifolia Roxb. is a high-quality wood in trade, known as Rosewood. The area of natural distribution is from the Himalayas to the southern tip of India and on the island of Java in Indonesia. It is mainly found in monsoon forests in association with species such as *Tectona grandis*, *Albizia chinensis* and *Cassia fistula*. It grows on deep, well-drained, moist soils, from the low plains to about 1500 m altitude in areas with annual rainfall of 750-5000 mm. It has been introduced to Sri Lanka and in Africa in Nigeria, Tanzania and Kenya.

Phenology of Rosewood (*Dalbergia latifolia).*

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Silvicultural characteristics of Rosewood (*Dalbergia latifolia).*

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Seed collection and Pre-sowing treatment given to the Rosewood (*Dalbergia latifolia)* seed:

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Nursery practices and planting method adopted for Rosewood (*Dalbergia latifolia)* plantation.

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Stand management practices use in Rosewood (*Dalbergia latifolia).*

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Practical No. 6

Objective: To study phenology, collection of seeds, planting and stand management practices of Sandalwood (*Santalum album)*

Sandalwood is the fragrant heartwood of species of genus Santalum. In India, the genus is represented by Santalum album Linn. Its wood, known commercially as “East Indian Sandalwood” and essential oil from it as “East Indian Sandalwood Oil” are among the oldest known perfumery materials. In India Santalum album is found all over the country, with over 90% of the area in Karnataka and Tamil Nadu covering 8300 sq. kms. In Karnataka, it grows naturally in the southern as well as western parts over an area of 5000 sq. kms. In Tamil Nadu, it is distributed over an area of 3000 sq. kms and dense population exists in North Arcot (Javadis and Yelagri hills) and Chitteri hills. The other states where sandal trees are found are Andhra Pradesh, Kerala, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, Bihar and Manipur.

Phenology of Sandalwood (*Santalum album).*

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Silvicultural characteristics of Sandalwood (*Santalum album).*

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Seed collection and Pre-sowing treatment given to the Sandalwood (*Santalum album)* seed:

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Nursey practices and planting method adopted for Sandalwood (*Santalum album)* plantation.

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Stand management practices use in Sandalwood (*Santalum album).*

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Practical No. 7

Objective: To study phenology, collection of seeds, planting and stand management practices of Mahogany (*Swietenia macrophylla)*

Swietenia macrophylla King, also known as bigleaf Mahogany, is a tropical tree species native to Central and South America. *Swietenia macrophylla* has a wide natural distribution, extending from Mexico to Bolivia and central Brazil. In India, mahogany has established in 1795, when it introduced from West Indies to Royal Botanical Garden, Culcutta (Troup, 1921) while *Swietenia macrophylla* and *Swietenia mahagony* was initiated in South Malabar in 1872. Mahogany species is planted 1at Edacode, North Forest Division, Kerala in 1893, it has regarded as an exotic species, planted in scattered small plantations and nowadays, mahogany grown a wide acceptance among the tree growers in Kerala due to its economic importance of timber, moderate growth, adoptability, remarkable wood qualities, better form and higher sown out turn, amenability to stand management practices etc. are some of the features that endear among the tree farmers.

Phenology of Mahogany (*Swietenia macrophylla).*

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Silvicultural characteristics of Mahogany (*Swietenia macrophylla).*

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Seed collection and pre-sowing treatment given to the Mahogany (*Swietenia macrophylla)* seed:

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Nursery practices and planting method for Mahogany (*Swietenia macrophylla)* plantation.

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Stand management practices use in Mahogany (*Swietenia macrophylla)*

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Practical No. 8

Objective: To study phenology, collection of seeds, planting and stand management practices of *Eucalyptus* spp.

Eucalyptus (*Eucapyptus* spp.), is a large genus of the Myrtaceae family, which includes 900 species and subspecies. This evergreen tall tree is native from Australia and is the second largest genera after acacia. In ancient times the eucalyptus plant was used for several purposes by aboriginal people, both as medicine and as food. Nowadays, the plant is used in forestry (timber, fuel, paper pulp), environmental planting (water and wind erosion control), as a source of essential oil (medicinal, perfumery oils), for arts and craft. Among all the species of Australian Eucalyptus, the *E. globulus* was widely introduced overseas, becoming largely cultivated in the subtropical and Mediterranean regions, as well as in Nigeria. *E. globulus* which has different vernacular names (eucalyptus in Bengali and in Hindi; blue-gum eucalyptus in English and Karpuramaram in Tamil is considerably used in the pulp industry, as well as for the production of eucalyptus oil extracted on commercial scale in many countries and adopted in perfumery, cosmetics, food, beverages, aromatherapy and phytotherapy.

Phenology of *Eucalyptus* …….

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Silvicultural characteristics of *Eucalyptus* ….....

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Seed collection and Pre-sowing treatment given to the Eucalyptus seed:

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Nursery practices and planting method adopted for Eucalyptus species plantation.

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Stand management practices use in Eucalyptus species.

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Practical No. 9

Objective: To study phenology, collection of seeds, planting and stand management practices of *Acacia* spp.

The name Acacia comes from the Greek acacia, ace or acis meaning a point or thorn, or from acazo, to sharpen, although this name applies more to African than Australian species (Australian acacia have no thorns or larger prickles, unlike those that are native to Africa). Many species of Acacia, or wattles as they are commonly called in Australia, are valuable for a range of uses, in particular as garden plants. They are also used for amenity plantings, windbreaks, shade trees, groundcovers, erosion and salinity control. Important India Acacia species includes *A. nilotica, A. magnum, A. catechu, A. aruculiformis, A. melanoxylon*

Phenology of *Acacia* ……

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Silvicultural characteristics of *Acacia* ……...

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Seed collection, harvesting, storage and Pre-sowing treatment in *Acacia* …….. seed:

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Nursey practices and planting method adopted for Acacia species plantation.

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Stand management practices use in Acacia species.

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Practical No. 10

Objective: To study phenology, collection of seeds, planting and stand management practices of Bamboo.

Bamboos are one of the fastest growing perennial plants in the world. They belong to the family Poaceae (Graminae) and are found in the in the tropical, sub-tropical and mild temperate regions of the world. As per an FAO report (2007), there are about 1,200 species in 90 genera worldwide. In India, bamboo grows naturally almost throughout the country except in Kashmir region. India is reportedly home to about 125 indigenous and 11 exotic species of bamboo from 23 genera. Bamboos occur in abundance in the deciduous and semi-evergreen forests of the North-eastern region of the country and the tropical moist deciduous forests of Northern and Southern India. The major bamboo genera found in India are *Arundinaria, Bambusa, Chimonobambusa, Dendrocalamus, Dinochola, Gigantochloa* etc.

Bamboo is capable of thriving in an extreme range of climatic and edaphic conditions. With its wide distribution, Bamboo also plays an important role in carbon sequestration, bio-diversity and soil moisture conservation. It is an important non-wood forest product used in making normal and fine quality paper, furniture, flooring, handicrafts, walking sticks, fishing poles etc. Young bamboo shoots are used as vegetables in many cuisines. Raw leaves of many bamboo species are a source of fodder for cattle. The largest stems of bamboo are used as planks for houses and rafts, while both large and small stems are lashed together to form the scaffoldings at construction sites. Bamboo is therefore, called as green gold, poor man's timber, cradle to coffin timber etc.

Phenology of Bamboo species (……).

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Silvicultural characteristics of Bamboo species (……)

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Different species of bamboo introduced in RLBCAU campus.

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Nursey practices and planting method adopted for Bamboo species.

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Stand management practices use in Bamboo species.

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Practical No. 11

Objective: To study the criteria for the selection of multipurpose trees (MPTs).

Multipurpose Trees (MPTs): (बहुउद्देशीय पेड़)

- ✓ Multipurpose trees are trees that are deliberately grown and managed for more than one output (goods & amp; services).
- ✓ The term MPTs refer to all woody perennials that are purposefully grown to provide more than one significant contribution and/or service function of a land use system.
- ✓ They may supply food in the form of fruit, nuts, or leaves that can be used as a vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs.

Characteristics of Multipurpose Trees (MPTs).

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Benefits obtained from MPTS:

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Characteristics of MPT's growing in the Bundelkhand region of Uttar Pradesh.

Sr. No	Scientific Name	Common Name	Fuel	Fodder	Timber	Edible	Soil stabilized
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How MPT's improved the socio-economic status of farmer of Bundelkhand Region of U.P.

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Practical No. 12

Objective: To study silviculture of trees in response to light, fire, drought, frost; root suckering, coppicing and pollarding, etc.

Silviculture is the practice of controlling the growth, composition/structure, and quality of forests to meet values and needs, specifically timber production. The main objective of study the silviculture of trees is to Study its habitat, distribution, soil and climate requirements, phenology and cultivation technique of economically important species of the area.

Silviculture of important tree species in RLBCAU Campus.

Name of Tree species			Distribution/Climate	Silviculture characteristics	Use
Common name	Scientific name	Family			

Practical No. 13

Objective: To visit various problematic areas and study on species suitability.

Soils which set a limit to crop production due to mineral stress, drought, acidity, sodicity, waterlogging, etc. could be considered as problem soils. The alkali soils are largely predominant in the Indo-Gangetic plains. The saline soils are found mainly in the States of Gujarat, Bihar, Haryana, Rajasthan, Maharashtra, Odisha, Andhra Pradesh, Kerala, Tamil Nadu, Uttar Pradesh and West Bengal. The problem of acid soils exists in most of the States except Gujarat, Punjab, Rajasthan and Uttar Pradesh. With the advent of canal irrigation, area under problem soils is increasing day by day, due to which large fertile cultivated lands is losing production potential across the country.

Location of Problematic area…………………………………………………….

Date of visit: ………………………………………………………………………….

Details about reclamation measures use in Problematic areas.

Type of Problematic area	Characteristics	Remedial measures	Species suitability

Practical No. 14

Objective: To visit forest plantations and other woodlots.

In general, forestry plantation establishment is broadly divided into three management phases: seed collection and handling; nursery practices and plantation establishment and management. The initial plantation establishment phase is divided into the following activities: species selection, site preparation and planting operation. The plantation management phase include silvicultural activities as follows: protection, tending (weeding and fertilising), pruning, thinning, felling and regeneration/replanting.

Name and location of plantation area: …………………………………………………

Division: ……………..…………………………………………………………………..

Range: ……………………………………………………………………………………….

Date of visit: ……………………………………………………………………………..

Area (ha): ………………………………………………………………………………

Details information about plantation area.

Name of tree species		Spacing		Purpose of plantation	Other information
Common name	Scientific name	Plant to Plant	Row to Row		

Objective of Plantation:

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How plantation improve the socio-economic status of local people Bundelkhand region of U.P.

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Conclusion:

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Practical No. 15

Objective: To study planting density and stand management regimes for timber.

Important timber species of Bundelkhand region of Uttar Pradesh.

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Presence of prioritized tree species to the plantation sites:

Tree Species		Rotation Period	Distance		Stand management practices
Common Name	Scientific Name		In rows (m^2)	In plants (m^2)	

Criteria adopted by the farmer while selecting the tree species for timber plantation:

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Achievements of Timber plantation to socio-economic status of local people:

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Conclusion:

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Practical No. 16

Objective: To study planting density and stand management regimes for pulpwood.

Pulp is a lignocellulosic fibrous material prepared by chemically or mechanically separating cellulose fibres from wood. Wood is the leading raw material for paper and paperboard production. Pulpwood is basically of three different kinds: softwood, hardwood, and residues from mechanical wood processing (sawmill chips and sawdust). India with a total of 813 pulp and paper mills ranks as 15th largest paper producer and also considered the fastest growing paper market in the world. The paper industry is one of the largest industrial sectors in India with a turnover of Rs. 50,000 crores (equal to 6,5 billion euros) (Central Pulp and Paper Research Institute 2015).It accounts for 3.7% of the total world's production with 14.99 million metric tonnes of paper and paperboard yearly. Indian Paper Industry consumes 8.7 million MT/annum of wood (~13 million cum/annum), and 90% requirement met through farm level plantations.

Important Pulpwood species of Bundelkhand region of Uttar Pradesh

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Presence of prioritized tree species to the specific Pulp and Paper plantation sites:

Tree Species		Rotation Period	Distance		Stand management practices
Common Name	Scientific Name		In rows (m^2)	In plants (m^2)	

Achievements of Pulp and Paper plantation area to socio-economic status of local people:

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Major Tree and their clone used in Pulp and Paper plantation:

S. No.	Tree species	Clone
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Important Paper mills of India:

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Conclusion: ……

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Practical No. 17

Objective: To study planting density and stand management regimes for plywood.

Plywood is a building material consisting of veneers (thin wood layers or plies) bonded with an adhesive. There are two types of plywood: softwood plywood and hardwood plywood. Softwoods generally correspond to coniferous species. The most commonly used softwoods for manufacturing plywood are firs and pines. Hardwoods generally correspond to deciduous species. For hardwood plywood, commonly used wood species include oak, poplar, maple, cherry, and larch. Softwood plywood is manufactured by gluing several layers of dry softwood veneers together with an adhesive. Softwood plywood is used for wall siding, sheathing, roof decking, concrete formboards, floors, and containers. Hardwood plywood is made of hardwood veneers bonded with an adhesive. The outer layers (face and back) surround a core which is usually lumber, veneer, particleboard, or medium density fiberboard. Hardwood plywood may be pressed into panels or plywood components (e.g., curved hardwood plywood, seat backs, chair arms, etc.). Hardwood plywood is used for interior applications such as furniture, cabinets, architectural millwork, paneling, flooring, store fixtures, and doors.

Important plywood species of Bundelkhand region of Uttar Pradesh.

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Presence of prioritized tree species to the specific Plywood plantation sites:

Tree Species		Rotation Period	Distance		Stand management practices
Common Name	Scientific Name		In rows (m^2)	In plants (m^2)	

Achievements of Plywood plantation area to socio-economic status of local people:

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Characteristics of plywood:

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Important Plywood mills of India:

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Question No.6. Conclusion:

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Practical No. 18

Objective: To study forest-based cottage industry.

Forest based cottage industries are run by small machines and tools by the tribals. Theses includes bidi making, fibre and floss extraction, gum and resin collection, wicker works of bamboos etc.

Characteristic of Cottage Industry.

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Important forest based cottage industries of Uttar Pradesh?

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Silvicultural system used to manage the bamboo forests of MP?

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Why Beedi industry is an important forest-based industry in Bundelkhand region?

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Forest based cottage industry to which the species or its parts act as raw material.

Scientific Name	Common Name	Forest based cottage industry
Bauhinia vahlii	Malungar, Pahur Camel's Foot Creeper	Leaf cup and plate
Phoenix acaulis	Dwarf Date Palm	Broom making

APPENDICES

HINTS FOR THE IDENTIFICATION OF THE PLANTS

1. **Habit:** tree, shrub, herb, climber
2. **Leaf:** acuminate, oval, venation, simple, compound, glabrous etc.
3. **Foliage:** lush green, dark brown, colourful etc.
4. **Stem:** straight, crooked, branching pattern etc.
5. **Bark:** rough, smooth, spotted, crocodile, soft, colour etc.
6. **Flower:** arrangement, inflorescence, colour, smell, petals, sepals, calyx etc.
7. **Fruit:** Pod, berry, pome etc, their colour, smell, etc.
8. **Seed:** types, colour, smell, surface, shape etc.
9. **Odour:** leaf, fruit, bark, heartwood flower etc especially for aromatic crops.
10. **Phenology:** leaf shedding and renewal, flowering and fruiting time etc.

Inflorescence: Flowers are borne on structures called inflorescence, which is a collection of individual flowers arranged in a specific order or form e.g., spike, catkin, raceme, corymb, umbel, compound umbel, cyme, panicle, head, solitary flower Basics for Identification of Flowering Plants. To understand the form, function, habitat and essential needs of plants use all your senses (vision, hearing, smell, taste, and touch) to observe plants. A collective understanding of fundamental botanical terms helps us share and discuss our discoveries with each other.

Duration of vegetative parts

Annual: completes life cycle in one year
Biennial: completes life cycle in two years
Perennial: life cycle extends three or more years
Deciduous: plants that shed their leaves at the end of the season and become dormant
Evergreen: plants that are never without leaves attached
Broadleaf evergreens: include all evergreens except conifers which have needle or scale-like leaves

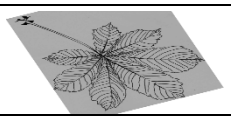
Plant appearance or habit

Herbs (Herbaceous plant): plants with non-woody stems
Shrub: **woody** perennial with more than one main stem
Tree: **woody** perennial with a single main stem
Vine: herbaceous plants with elongate, flexible, non-self-supporting stems
Liana: a woody vine

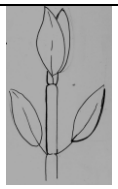
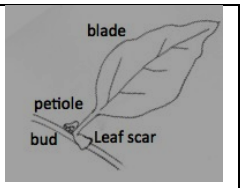
Leaf features

Blade: Flattened part of the leaf
Petiole: stalk supporting the blade
Leaf scar: a heart-shaped scar remains on the stem where the petiole was attached
Bud: forms above leaf scar and contain the beginnings of future growth; size, color, shape and marking of the scales on buds offer identification characteristics.

Arrangement on leaf petiole:

		
Simple leaf is undivided though can be deeply lobed	**Pinnate** compound leaf is feather-like with leaflets attached both sides of central **axis**	**Palmate** compound leaf is hand-like with three or more leaflets radiating from one point

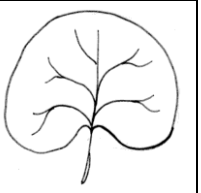
Leaf arrangements on plant stem

				
Alternate leaves 1 per node	Opposite leaves 2 per node	Whorled leaves More than 2 per node	Rosette leaves Radiating cluster at base	Alternate leaves 1 per node

Node: area on stem from which one or more leaves develop

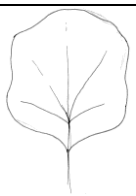
Leaf modifications: Bract: modified leaf often associated with a flower or inflorescence; **Sheath**: basal portion of leaf that surrounds the stem; **Spine**: sharp pointed leaf or portion of a leaf; **Tendril**: twining leaf or portion of a leaf

Leaf blade surface: Glabrous: without hair and **Glaucous**: waxy coating

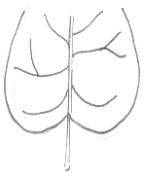
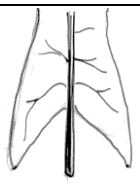
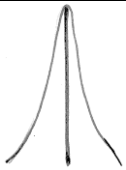
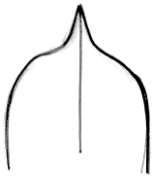
							
Ciliate Fine hairs	**Crenate** Rounded teeth	**Entire** Smooth	**Lobate** Indented/ lobed	**Undulate** Widely wavy	**Dentate** Symmetrical angular teeth	**Denticulate** Fine teeth angular teeth	**Serrate** Coarse teeth curved forward
							
Serrulate Fine teeth curved forward	**Sinuate** Wave-like indentations	**Cuneate** Wedge shaped	**Elliptical** Oval-shaped with small or no tapering	**Lanceolate** Pointed at both ends; base widest	**Oblanceolate** Widest section towards tip	**Spatulate** Spoon shaped	**Rhomboid** Diamond shaped
							
Linear Thin; sides parallel	**Oblong** Wider; parallel sides	**Obovate** Egg shape; widest at tip	**Ovate,** Egg shaped widest at base	**Obcordate** Heart shaped	**Reniform** Kidney shaped		

Pubescent: hairy surface--there are many kinds of hairiness

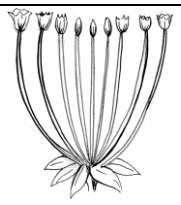
Leaf blade venation

			
Net (Reticulate) veins	Form a complex network	Palmate veins radiate	From a central point at base

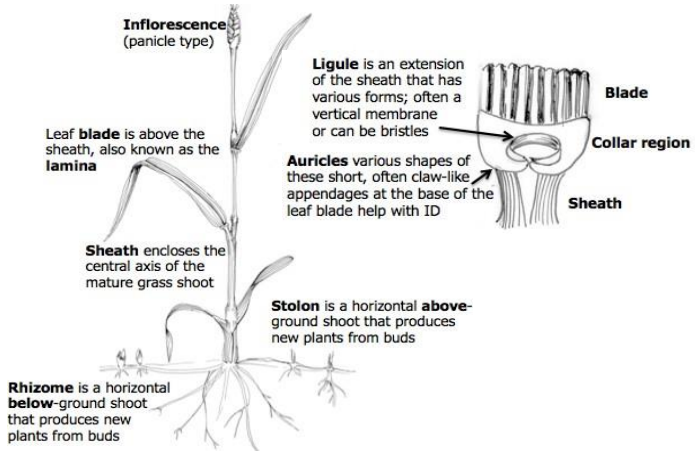
Leaf blade margin

					
Acute Less than 90° angle	**Auriculate** Lobes of a human ear	**Cordate** Heart shaped	**Hastate** Triangular lobes	**Sagittate** Arrow head shaped	**Oblique** Asymmetrical
					
Oblique Asymmetrical	**Obtuse** Greater than 90° angle	**Acuminate** Curving inward; fine point	**Cuspidate** Long, thin, sharp tip	**Emarginate** Notched towards base	**Mucronate** Short abrupt point

Inflorescence type

				
Umbel flowers originating from a common point with floral stalks of equal length	**Corymb** flowers along a central axis with floral stalks of unequal length, all ending at the same height	**Cyme** produces a flat-topped with oldest flowers at the end of main axis	**Spike** has flowers without stalks along a central axis length	**Raceme** has flowers with short floral stalks along a central axis
				
Panicle is a branched or compound raceme	**Head** produce a short dense arrangement ray and disk flowers	**Solitary** is a single flower on a flowering stalk attached to stem	**Catkin** is a spike-like; often pendent and falling as a unit	

Typical Grass Structure



MORPHOLOGICAL AND FIELD IDENTIFICATION CHARACTERISTICS OF TREE SPECIES

Acacia auriculiformis:

- It is moderate sized evergreen, unarmed tree to 10-15 m tall, with compact spread, often multi-stemmed; young growth glaucous.
- Its Leaves are alternate, simple, reduced to phyllodes (flattened leaf stalks), blade-like, slightly curved, 11-20 cm (5-8 in) long, with 3-7 main parallel veins and a marginal gland near the base; surfaces dark green.
- The trunk is crooked and the bark vertically fissured.
- Its flowers are in loose, yellow-orange spikes at leaf axils or in clusters of spikes at stem tips; flowers mimosa-like, with numerous free stamens.
- Its fruits are flat, oblong pod, twisted at maturity, splitting to reveal flat black seeds attached by orange, string like arils.
- Pods are coiled and open-up on maturity to reveal the black *Acacia auriculiformis seeds,* which hang on strings of yellow aril to attract birds. Its Seeds are transversely held in the pod, broadly ovate to elliptical, about 4-6 x 3–4 mm

Azadirachta indica

- Neem is an evergreen tree with medium to large sized, handsome tree with rounded crown of bright green foliage.
- It attains the height of 15 meter, rarely up to 25 m.
- Its leaves are pinnate, crowded near the end of the branchlet; leaflets sub-opposite, obliquely lanceolate, acuminate, serrate and 20-30 cm in length.
- Flowers are white, fragrant, shorter than the leaves.
- The bark on young tree is smooth, soft, and moderate thick.
- Drupe yellowwhenripe,1-seeded.

Albizia lebbeck

- It is a moderate to large deciduous tree with straight short bole and, branching low down with a broad crown
- Its height 20-30m. and a girth of 2-3 m.
- Its bark is brownish-grey, rough with numerous cracks. (d)Its leaves are twice pinnate, axis 3-12-inch-long, with 2 glands; pinnae 2-4 pairs; reflects 3-9 pairs, 1-2 inch long, unequal sided, dark green.
- Its flowers are white with numerous stamens and very fragrant, 1.5-inch-long in large, globose, umbellate heads; Calyx small tubular; corolla glabrous; stamens very long, greenish.
- The fruit pods are 15 to 30 cm long and 2.5 to 5.0 cm broad containing six to twelve seeds

Buchanania lanzan

- It is small to medium sized nearly evergreen tree with a small crown and short trunk.
- Its height is upto 18 m and a girth 1.5 m.
- The colour of bark is grey or black, conspicuously divided in small rectangular plates resembling like a crocodile skin and inside it is redish.
- Its leaves are thick, leathery, oblong, glabrous, shining above, softly hairy beneath and 10-25 cm long.
- Its flowers are small, without stalk, greenish white, in large, dense, many flowered, branched panicles.
- Its drupe black, sub-globose, 0.5 in. long.
- Its seed are hard as stone.

Casuarina equisetifolia

- It is a moderate to large sized tree, attaining the height of 30-35 m and 100 cm (dbh) in favourable condition.
- It is an evergreen tree with straight stem and rough woody branches
- Its branches are bearing 10-15 cm long, slender and jointed needle like shoots. the ends of branches densely bearing numerous, long, filiform (thread like), slender, green, jointed, pendulous branchlets
- The bark is initially smooth and light colour and old bark becomes brownish black and peeling off in long strips.
- Its flowers are unisexual, both sexes borne on the same individual.
- its Fruit ovoid or globose, small.

Eucalyptus tereticornis

- It is tall tree upto 45 m. high with straight bole.
- The nature of bark is smooth, white and mottled form.
- The crown is open.
- The juvenile leaves are alternate, lanceolate and petiolate.
- Adult leaves alternate.
- The fruit is a woody, hemispherical capsule 2-6 mm (0.079–0.236 in) long and 4–8 mm (0.16–0.31 in) wide with the valves prominently protruding
- Inflorescence axillary usually seven flower umbel.

Pongamia pinnata

- A medium sized, almost evergreen tree,
- Bark soft grey, covered with tubercles (rounded nodules); crown rounded.
- Leaves odd-pinnate, glabrous, bright green; leaflets 5-9 opposite, shining on both surfaces, ovate or elliptic.
- Flowers purple and white in axillary racemes.
- Pods woody, glabrous, oval-oblong, with a short decurved lateral beak.
- The seeds are about 1.5–2.5 centimetres (0.59–0.98 in) long with a brittle, oily coat and are unpalatable to herbivores.

Tectona grandis

- A Large deciduous tree up to 30 m high and 100 cm or more dbh.
- Long straight cylindrical bole up to 2/3 of the height of tree.
- Bark light brown or grayish, peeling off in thin layers.
- Leaves large obovate-elliptic, stellately yellowish, tomentose beneath and papery leaves that are often hairy on the lower surface.
- Branch-lets are quadrangular and channelled flowers white, shortly stalked, numerous in terminal large panicles of cymes.
- Fruit sub-globose, enclosed in the inflated calyx.
- Deep tap root system

Shorea robusta

- Sal is moderate to slow growing, and can attain heights of 30 to 35 m and a trunk diameter of up to 2-2.5 m.
- The crown is spreading and spherical. The bark is dark brown and thick, with longitudinal fissures deep in poles, becoming shallow in mature trees, and provides effective fire protection.
- Leaves are 10–25 cm long and 5–15 cm broad and having the broad ovate.
- The sal flowers, whitish in colour, appear in early summer. These are borne in raceme-like panicles in leaf axils, covered with white pubescence

Terminalia arjuna

- Arjuna is a large deciduous tree with spreading crown and drooping branches
- Its bark is thick, grey to pinkish green, smooth, thin, coming off in irregular sheets.
- It usually has a buttressed trunk, and forms a wide canopy at the crown, from which branches drop downwards.
- Leaves are usually sub-opposite, 10–15 cm long, and 4–7 cm broad; base is rounded or heart shaped, often unequal sided; veins are reticulate.
- It has pale yellow flowers which appear between March and June; its glabrous, 2.5 to 5 cm fibrous woody fruit, divided into five wings, appears between September and November.

Dalbergia sissoo

- It is a medium to large sized gregarious and deciduous tree.
- Its bark is thick, rough grey bark, with shallow broad longitudinal fissures exfoliating in irregular woody strips and scales.
- It attains the height up to 30 m. and a girth of 2.4 m.
- The stem is generally crooked.
- Leaves are imparipinnate, alternate, rachis 3.5-8 cm long, swollen at base, leaflet 3-5, and ovate shape.
- Flowers are yellowish-white, 7-9 mm long, sessile and standard petal narrowed at base into low claw, wing and keel petals oblong, clawed.
- Pods are linear oblong strap-shaped and one pod having 1-4 seeds.
- Seeds are brown to brownish-black and 8-10 mm long and 4-5 mm width

Dalbergia latifolia

- It is predominantly a single-stem deciduous tree with a dome shaped crown of lush green foliage.
- On wet sites it may remain evergreen.
- Its height varies from 20-40 meters with a girth of 1.5 - 2.0 meters.
- Leaves are alternate, odd-pinnate with 5-7 unequal-sized leaflets originating from the same rachis. Leaflets are broadly obtuse, dark green above and pale below.
- The bark is grey, thin with irregular short cracks, exfoliating in fibrous longitudinal flakes.
- Flowers are white in axillary panicles, 0.5-1.0 cm long.
- The brown pods are oblong-lanceolate and pointed at both ends.
- They contain 1-4 smooth brown seeds and do not open at maturity.

Santalum album

- Sandalwood is an evergreen tree, partial root parasite, generally grows in the dry, deciduous forests of the Deccan Plateau.
- It attains a height of 12 of 15 meters and a girth of 1 to 2.4 meters with slender drooping as well as erect branching.
- Bark is reddish brown or dark brown in colour, smooth in young trees and becomes rough with deep vertical cracks as the tree matures.
- Its leaves are opposite and decussate, and sometime show whorled arrangement.
- Flowers are unscented straw yellow coloured at initiation but turns to deep purplish brown on maturation. They occur in axillary or terminal cymose panicles.

Swietenia macrophylla

- It is evergreen tree with well shape crown. Its leaves are unipinnate, paripinnate; leaflets 3-4, falcately lanceolate, very oblique at base, acute, glabrous, shinning above, paler beneath; secondary nerves 6-12 on each side.
- Its flowers have a nice smelling, in narrow, supra-axillary panicles. Panicles shorter than leaves, glabrous. Sepals distinct, ovate, minute. Petal greenish-white, oblong. Staminal tube apically 10-lobed, urceolate. Disk red, annular. Ovary 5-locular, with many ovules; almost distinct, ovate-oblong, minute, ciliolate.

Eucalyptus territicornis

- It is a tall tree with stout trunk, attains a height of 50 m.
- It is an evergreen, glabrous tree usually secreting an aromatic gum.
- Its leaves and flowers contain conspicuous oil glands. Leaves of the saplings are generally opposite, sessile, cordate and held horizontal; those of the adult tree as a rule are alternate, petiolate and held vertical.
- Flowers are borne in umbels usually pedunculate. Calyx tube encloses the ovary which is covered with a deciduous operculum. The operculum is much longer than calyx and is formed by the union of the petals and falls off entire when the stamens emerge.
- Flowers are white in colour.
- Its fruit are consisting of the enlarged calyx tube is usually hard and woody, full of resin sacs.
- Seeds are numerous but a large proportion of these is abortive and sterile seeds outnumber fertile ones.
- Bark is grey, exfoliating in long flakes.

SILVICULTURE OF TREES IN RESPONSE TO LIGHT, FIRE, DROUGHT, FROST, ROOT SUCKERING, COPPICING AND POLLARDING

S No	Name of species	Light	Frost	Drought	Fire	Coppice

1.	*Acacia nilotica*	Strong demander	Tender	Resistant	Tolerant	Well
2.	*Anogeissus latifolia*	Strong demander	Resistant	Resistant	Sensitive	Well
3.	*Azadirachta indica*	Demander	Very sensitive in seedling & sapling stage	Hardy	Tender	Fairly well
4.	*Cassia fistula*	Demander	Tender	Resistant	Tolerant	Well
5.	*Casuarina equisetifolia*	Strong demander	Tender	Hardy	Tender	Not
6.	*Dalbergia latifolia*	Moderate Demander	Frost tender	Resistant	Sensitive	Well
7.	*Dalbergia sissioo*	Demander	Hardy	Hardy	Moderate resistant	Free
8.	*Emblica officinalis*	Demander	Tender	Resistant	Tolerant	Not
9.	*Eucalyptus camaldulensis*	Demander	Hardy	Tolerant	Tender	Very Well
10.	*Melia azadarch*	Demander	Hardy	Resistant	Tender	Well
11.	*Prosopis juliflora*	Demander	Resistant	Resistant	Tolerant	Very Well
12	*Tamarindus indica*	Demander	Sensitive	Hardy	Tolerant	Well
13	*Terminalia arjun*	Moderate Demander	Sensitive	sensitive	Tolerant	Well
14	*Terminalia belerica*	Demander	Tender	Resistant	Tolerant	Fairly well
15	*Terminalia chebula*	Demander	Hardy	Resistant	Tolerant	Fairly well
16.	*Santalum album*	Demander	Sesnitive	Sensitive	Sensitive	Well
17.	*Shorea robusta*	Demander	Moderate Hardy	Sensitive	Moderate resistant	Well

GLOSSARY

Silviculture: The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Silvicultural prescription: A planned series of treatments designed to change current forest structure to one meeting the goals and objectives established for an area. A prescription is a written statement or document defining the outcomes to be attained from silvicultural treatments. The outcomes are generally expressed as acceptable ranges of the various indices being used to characterize forest development.

Silvicultural System: A planned process whereby a stand is tended, harvested, and re-established. The system name is based on the number of age classes, and/or the regeneration method used (see Clearcutting, Seed Tree, Shelterwood, Selection, Coppice, and Coppice with Reserves).

Silvicultural treatment: A process or action that can be applied in a controlled manner, according to the specifications of a silvicultural prescription or forest plan, to improve actual or potential benefits).

Stand: A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit (see Even-aged, and Uneven-aged Stands).

Sapling - A small tree, usually between 2 and 4 inches DBH.

Improvement cut: intermediate cutting in stands past the sapling stage to improve their composition and quality. Trees of undesirable species, form or condition are removed from the upper canopy, often in conjunction with an understory thinning.

Liberation cut: intermediate cutting (release treatment) in stands not past the sapling stage to free the favored from competition of older, overtopping trees.

Commercial thinning: intermediate cutting to stimulate growth and development of a residual stand. Commercial thinnings are also made to increase the yield of usable (merchantable) material for a future harvest.

Salvage cut: intermediate cutting to remove trees that are dead or in imminent danger of being killed by insects or other injurious agents. The primary goal is to remove dead trees before they become economically worthless.

Sanitation cut: intermediate cutting to remove dead, damaged or susceptible trees and help prevent or control the spread of insects and diseases. The sanitation and salvage terms are often used interchangeably but this usage is incorrect. For example, removal of dead trees in a root-disease center would be considered sanitation if the harvest helps slow the spread and intensification of root disease; it would be coded as salvage if the harvest has little or no effect on the root disease.

Cohort: A group of trees developing after a single disturbance, commonly consisting of trees of similar age, although one cohort can include a considerable span of ages ranging from seedlings or sprouts to trees that predated the disturbance. Stands are often characterized as single-cohort or multicohort depending on whether they contain one or several cohorts.

Crown class: A categorization or classification of trees based on their crown position relative to adjacent trees within the same canopy stratum; four primary crown classes are recognized:

Dominant – a tree whose crown extends above the general level of the main canopy, receiving full light from above and partial light from the sides.

Codominant – a tree whose crown helps to form the general level of the main canopy, receiving full light from above and limited light from the sides.

Intermediate – a tree whose crown extends into the lower portion of the main canopy but is shorter than the codominants, receiving little direct light from above and virtually none from the sides.

Subcanopy (overtopped) – a tree whose crown is completely overtopped by the crowns of one or more neighboring trees, occurring in a subordinate or submerged position relative to the main canopy.

Rotation: In even-aged systems, the period (in years) between regeneration establishment and final cutting.