

**Course Title: Principles of Forestry and Watersheds**

**Course Code: FRW-501**

**Course Credit Hours: 3(2-1)**

**Course Incharge: Mr. Muhammad Safeer**

### **THEORY**

Basic concepts and terminology of Forestry. Relationship with allied fields especially with farm crop production, horticultural crop production, grazing and poultry husbandry etc. Introduction to tree crop morphology and physiology. Principles of Forestry with emphasis on choice of suitable species with respect to site factors such as sunburn, low frost, salinity, water logging, soil erosion, shade, grazing pressure, and market needs etc. artificial regeneration, Tree classification, Tending operations such as thinning, pruning and protection measures such as weeding, cleaning. Intermediate and final yields. Basics of Forest Mensuration and Management Concept of Normal Forest. Harvesting, transportation and marketing of Forest produce. Importance of Watershed, their principles, Basic Terms of Watersheds, Role of trees in Watershed Management.

### **PRACTICALS**

Practice of various forestry operations. Measuring tree height and diameter. Visits to various forests. Seasoning and preservation plants and timber markets. Preparation of forest maps. Study of working plan of a forest. Soil and water conservation practices. Visit to Dam sites. Concept of precipitation recording.

### **BOOKS RECOMMENDED**

- Andreson, D.A. and I.I. Holland. 1982. Forest and forestry. The Interstate printers and publishers Inc. Illinois U.S.A.
- Husch, B., et al. 1982. Forest mensuration. John Wiley and sons New York, USA.
- Quraishi, M.A.A. 2003. Watershed management in Pakistan. University of Agriculture, Faisalabad, Pakistan.
- Quraishi, M. A.A. and M.T. Siddiqui. 2003. Practical manual of watershed management. University of Agriculture, Faisalabad, Pakistan.
- Quraishi, M. A. A. 1999. Basics of forestry and allied sciences. A-One Publishers, Urdu Bazar, Lahore, Pakistan.
- Sharpe G.W., Chare W. Hendee and Wenonah F. Shaibe. 1986. Introduction to forestry. McGraw Hill Book Co., New York, USA.

### **THEORY**

Basic concepts and terminology of Forestry.

**Absciscic acid:** Absciscic acid (ABA) is a naturally occurring compound ubiquitously found in plants. It is a sesquiterpenoid (15 carbons) which is partially produced via the mevalonic pathway in chloroplasts and other plastids. The production of ABA is enhanced by stresses such as water loss and freezing temperatures.

**Account:** In context of bookkeeping, refers to the ledger pages upon which various assets, liabilities, income, and expenses are represented.

**Active transport:** the movement of ions or molecules across a cell membrane into a region of higher concentration, assisted by enzymes and requiring energy.

**Adaptation:** Genetically control physiological, behavioral and structural adjustment of an organism to maximize its performance in an environment.

**Adventitious root:** These are roots in an unusual place, that originates from stem or leaf tissue rather than from another root, often where a branch or other part contacts soil or damp material. Adventitious roots are not ordinarily expected, and often they are the result of stress or injury.

**Afforestation:** It refers to planting of new trees on lands which, historically, have not contained forests.

**Agricultural soils:** The soils which are ploughed several times, fertilized and irrigated according to crop requirements that result in subsoil compaction and leaching of dissolved nutrients.

**Agri-silviculture:** It is a production technique which combines the growing of agricultural crops with simultaneously raised and protected forest crops.

**Agri-silvi-pastoral system:** Land use system in which woody perennials are grown with agricultural crops, forage crops, and livestock production.

**Agroforestry system:** An agroforestry system is a specific local example of a practice, characterized by environment, plant species and their arrangement, management, and socioeconomic functioning.

**Agroforestry:** It is the purposeful growing or deliberate retention of trees with crops, pastures and/or animals in interacting combinations for multiple products or benefits from the same land unit.

**Albuminous seeds:** These are the seeds which have food stored in the special nourishing tissue called as endosperm that remains persistent till maturity. Cotyledons only act as food sucking organs and not food storage organs.

**Alley cropping:** Fast growing, leguminous or fodder trees are grown between crops or as hedges.

**Alluvial plain:** It is a largely flat landform created by the deposition of sediment over a long period by one or more rivers coming from highland regions, from which alluvial soil forms.

**Amenity:** Any feature that provides comfort, convenience, or pleasure.

**Anatomy:** The branch of science concerned with the bodily structure of humans, animals, and other living organisms, especially as revealed by dissection and the separation of parts.

**Angiosperms:** A group of plants that have flowers and produce seeds enclosed within ovary, including herbaceous plants, shrubs, grasses, and most trees.

**Annual plants:** Plants that grow, produce seed, and expire during one season.

**Apiculture:** Trees are grown for honey production.

**Apoplastic pathways:** Within a plant, the apoplast is the space outside the plasma membrane within which material can diffuse freely.

**Arboreal:** Inhabiting or frequenting trees.

**Arboretum:** An arboretum in a narrow sense is only a collection of trees.

**Ascent of sap:** The ascent of sap in the xylem tissue of plants is the upward movement of water and minerals from the root to the crown. Xylem is a complex tissue consisting of living and non-living cells.

**Atmosphere:** Atmosphere is a protecting blanket of air around the earth without which the temperature variations in day and night would be very high.

**ATP:** A phosphorylated nucleotide  $C_{10}H_{16}N_5O_{13}P_3$  composed of adenosine and three phosphate groups that supplies energy for many biochemical cellular processes by undergoing enzymatic hydrolysis especially to ADP —called also adenosine triphosphate.

**Autecology:** Autecology is the study about individual organism like its life history, adaptation and behavior.

**AVHRR:** Advanced very high resolution radiometer.

**Barrage:** Head works of irrigated system with gates to restrict flow of water downstream.

**Biennial plants:** Plants that complete their biological lifecycle in two years.

**Biodiversity:** The variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.

**Biogeochemical cycle:** Cycling of nutrients in different forms from nonliving environment to living organisms and then back to nonliving environment e.g. oxygen, nitrogen, carbon, and hydrological cycles etc.

**Biological Diversity:** Biological diversity is often used to refer to the total number of different species on Earth.

**Biomass:** The total mass of living matter within a given unit of environmental area. or material produced by living organisms.

**Biome:** General class of ecosystems occupied by certain types of life particularly vegetation e.g. deserts, grasslands, and forests.

**Biosphere:** Biotic zone of the earth where all living organisms and ecosystems inhabit.

**Biotic:** Biotic refers to living organisms. Compare with abiotic.

**BOD:** The abbreviation used to describe "Biochemical or biological oxygen demand (BOD)" It is the amount of dissolved oxygen present in water at given temperature that is needed to microbes to break down organic material during a specific time interval.

**Boundary layer:** It is a thin layer of still air enfolding the leaf surface. When transpiration occurs, water vapors leaving the stomata diffuse through this layer to reach the atmosphere where vapor will be removed by moving air. Boundary layers increase as leaf size increases, reducing rates of transpiration.

**Broadleaved:** A tree or plant having relatively wide flat leaves rather than needles having hard wood

**Cambium:** A thin layer of living parenchymatous cells surrounding sapwood, responsible for growth cells division tangentially as well as radially.

**Cambium:** It is a plant tissue located between the xylem and the phloem in the stem and root of a vascular plant, and is the source of both the secondary xylem growth (inwards, towards the pith).

**Canopy:** Roof of forest crop made up of tree crowns.

**Carnivore:** Carnivores are organisms that eat living animals.

**Cash:** Use of this term includes coins, currency and checks (e.g. petty cash fund, checking account).

**Cavitation:** The rupture of the water column in the xylem, when tension surmounts the cohesive nature of water.

**Cell division:** It is the process by which a parent cell divides into two or more daughter cells. Cell division usually occurs as part of a larger cell cycle.

**Cheque:** A bill of exchange drawn on a bank by the holder of a current account; payable into a bank account, if crossed, or on demand, if uncrossed.

**Clear felling system:** It is a silvicultural system in which equal or equi-productive areas of mature crop are successively clear-felled in one operation to be regenerated most frequently, artificially but sometimes naturally also.

**Cleistothecium:** (*Plural Cleistothecia*) closed spore-bearing structure of some fungi from which spores are released only by decay or disintegration.

**Climate:** Long term environmental conditions of an area is called climate. The key factors defining an area's climate are its temperature and precipitation.

**Climax species:** These are plant species that will remain essentially unchanged in terms of species composition for as long as a site remains undisturbed.

**Cohesion and transpiration pull:** The theory assumes that water is pulled from up, but not pushed from below. The theory has two essential features such as (i) cohesion of water and adhesion between water and xylem tissues, (iii) Transpiration pull.

**Cohesive forces:** These are the intermolecular forces (such as those from hydrogen bonding and Van der Waals forces) which cause a tendency in liquids to resist separation. These attractive forces exist between molecules of the same substance.

**Community:** It is defined as populations of all species existing and cooperating in an ecosystem at a particular time.

**Competition:** Competition is when two or more organisms of a single species (intraspecific competition) or two or more individuals of different species (interspecific competition) trying to utilize the same resources in an ecosystem.

**Conifer:** A tree which bears cones and needle-like or scale-like leaves that are typically evergreen and have soft wood.

**Consumer:** Organisms that fulfill their life and dietary requirements by eating other living organisms.

**Consumers:** Accounting information is needed by the consumers for establishing good accounting control so that cost of production may be reduced with the resultant reduction of the prices for some goods are fixed by the Government, so it needs accounting information to fix reasonable prices so that consumers are not exploited.

**Coppice:** It's a traditional woodland management technique in which new growth appears from the stumps or roots after the cutting of tree trunks.

**Cortex:** an outer layer of tissue immediately below the epidermis of a stem or root.

**Cost Accounting:** It ascertains the cost of a product and to help the management in the control of cost.

**Cotyledon:** Acotyledon is a significant part of the embryo within the seed of a plant. Upon germination, the cotyledon usually becomes the embryonic first leaves of a seedling.

**Creditors:** Persons who supply goods on credit or bankers or lenders of money are called creditors. They want to know the financial position of a concern before giving loans or granting credit. They want to be sure that the concern will not have trouble in making their payments in time i.e. Liquid position of the concern is satisfactory. To know the liquid position, they need accounting information.

**Cuticle:** A plant cuticle is a protecting film covering the epidermis of leaves, young shoots and other aerial plant organs without periderm.

**Cytoplasm:** The material or protoplasm within a living cell, excluding the nucleus.

**Damping off:** Damping off is the early decay and death of seedlings with soft and succulent stem, caused by excessive moisture and soil-inhabiting fungi that are facultative parasites like *Pythium*, *Rhizoctonia* and *Fusarium*.

**DBH:** Diameter at breast height.

**Deciduous plants:** Plants shed their leaves in reaction to specific environmental stress especial during cold or dry seasons such as maples and oaks.

**Decomposer:** Decomposers are organisms that break down the dead organic material and utilize the resultant nutrients and energy for their survival.

**Defoliation:** Loss of leaves in trees caused by insects, diseases etc.

**Deforestation:** Cutting of trees from a forest and converting into a non-forest ecosystem.

**Desert:** Desert is a biome where evaporation goes beyond precipitation and annual average precipitation is less than 10 inches. Such areas have scanty and low vegetation.

**Desertification:** Conversion of rain-fed or irrigated croplands to desert-like lands with a lower productivity. It might be caused by soil erosion, deforestation, prolonged droughts, climate change and overgrazing.

**Detritivore:** Organisms that feed on detritus, dead organisms, and wastes of living organisms e.g. termites, earthworms, and crabs.

**Diastema:** A space in the tooth row between the incisors and cheek teeth.

**Dibbler:** A wooden or metallic implement used to make planting holes.

**Dieback:** Dieback and decline of trees is the loss of vigor caused by biotic and abiotic stresses. Normally trees begin to die from top to backward.

**Diffusion pressure deficit (DPD):** It is reduction in the diffusion pressure of water in solution or cell over its pure state due to presence of solutes in it and forces opposing diffusion.

**DNA:** deoxyribonucleic acid, a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information.

**Drought:** It is a condition in which an area fails to get sufficient water due to less precipitation than normal or higher-than-normal temperature that enhances evaporation.

**Early wood:** The softer more porous portion of an annual ring of wood that develops early in the growing season. It is also termed as spring wood.

**Echard:** The water which is available to plant.

**Ecological diversity:** The diversity of deserts, grasslands, forests, oceans, and other biological communities interacting with one another and with their environment.

**Ecological restoration:** Careful modification of a degraded ecosystem to restore its ecological structure and function as much as possible.

**Ecologist:** It defines as biological scientist who studies the relationships of living organisms with their environment.

**Ecology:** Ecology is a biological science that deals with the relationships between living organisms and their environment;

**Ecosystem:** A permanent and stable community of all organisms (plants and animals) in an area and the physical environment with which they interact. It is functionally an independent unit to study ecology.

**Employee:** The demand for wage rise, bonus, better working condition, etc depends upon the profitability which in turn depends upon the financial position of a firm. For these reason, this group is interested in accounting information.

**Enamel:** The hard, brittle and shiny outer covering of a mammal's teeth.

**Endangered species:** Species with few individual survivors and could soon become extinct in most of its natural areas.

**Endemic species:** Endemic species native or restricted to a certain place and are found in only one area and more exposed to extinction.

**Endodermis:** It is the central, innermost layer of cortex in some land plants. It is made of compact living cells surrounded by an outer ring of endodermal cells that are impregnated with hydrophobic substances (Casparian Strip) to restrict apoplastic flow of water to the inside.

**Endosperm:** The part of a seed which acts as a food store for the developing plant embryo, usually containing starch with protein and other nutrients.

**Environment:** Sum of all external factors, matter, and energy, living and nonliving, that affect a living organism constitute environment.

**Epidermis:** The outer layer of tissue in a plant, except where it is replaced by periderm.

**Epigeal germination:** The germination of a plant takes place above the ground called Epigeal germination.

**Ethylene:** Ethylene is a gaseous hormone and it is the only member of its class. It has simplest plant growth substance and has the simplest structure. It is produced in all higher plants and is usually attributed with fruit ripening and the other physiological response.

**Evapotranspiration:** (ET) is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies.

**Evergreen plants:** Plants that retain their leaves throughout the year e.g. conebearing trees (conifers)

**Extinction:** It means complete vanishing of a species from the earth. It occurs when a species fail to adapt under new environmental circumstances.

**Financial Accounting:** It is the original or pioneer form of accounting. It is mainly confined to the preparation of financial statements for the use of outsiders like creditors, banks and financial institutions, etc. The chief purpose of financial accounting is to calculate profit or loss made by the business during the year and exhibit financial position of the business as on a particular date.

**Flora:** the plants of a particular region, habitat, or geological period.

**Food chain:** Series of organisms that are connected by the linear transfer of nutrients and energy from one organism to another.

**Food web:** Food web is a complex system of numerous interconnected food chains and feeding relationships that originates from same source.

**Forest ecology:** It is scientific study of interrelated patterns, processes, fauna, flora and ecosystems found in forest.

**Forest ecosystem:** The group of forest entities (trees, animals, microorganisms, and peoples) along with their environment (soil, water, air, and organic matter) cooperating inside a distinct boundary.

**Forest floor or O horizon:** The top layer is of organic matter of forest soil is called "Forest floor".

**Forest Pest:** Any insect, disease or other close related organism which can harm, injure or can destroy forest or timber.

**Forest soils:** The soils developed under forest cover or a forest canopy.

**Forest type:** Group of Plants living together under similar ecological conditions and having similar plant succession trends.

**Forest:** A forest is a biotic community of fauna and flora predominated by trees and woody vegetation that cover a large area.

**Fossorial:** Living underground in burrows or dens.

**Fungicide:** A substance or preparation, as a spray or dust, used for destroying fungi.

**Fusiform:** It is wide in the middle and tapers at both ends. Spindle-shaped.

**Geophyte:** A perennial plant that bears its overwintering buds below the surface of the soil.

**Germination Tray:** Equipment used to produce seedlings made up of expanded polystyrene or polythene.

**Germination:** Germination is the process by which a plant grows from seed OR the resumption of a seed or spore.

**Gibberellins:** Gibberellins are the class of hormones which are categorized on the basis of structure as well as function. All gibberellins are synthesized from the ent-gibberellane skeleton. Generally, gibberellins are diterpenes which was synthesized initially from acetyl CoA via the mevalonic acid pathway.

**Global warming:** Warming of the earth atmosphere due to rise in the level of one or more greenhouse gases. It may cause climate change that can persist for decades.

**Grasses:** Short herbaceous plants with long, narrow leaves, growing wild or cultivated on lawns and pasture, and as a fodder crop.

**Grassland:** It is biome found in the region where sufficient annual average precipitation promotes the growth of small plants and grasses but fail to support large trees.

**Growth rings:** Growth rings are new layers of wood that are added in each growing season, thickening the stem, existing branches and roots, to form a growth ring. It is also termed as tree rings or annual rings and can be seen in a horizontal cross section cut through the trunk of a tree.

**Gymnosperms:** A group of plants that have seeds unprotected by an ovary or fruit, including the conifers, cycads.

**Habitat:** An area where an organism or population of organisms lives, breed and feed.

**Halophyte:** It refers to plant species which specifically grows on the saline soil.

**Heartwood:** It is the dead, inner wood, which often comprises the majority of a stem's cross-section.

**Heavy metals:** The group of metals having density  $> 5 \text{ g cm}^{-3}$ .

**Herbivore:** Organism that survive by eating live plants.

**Heterotroph:** Organism that uses organic matter formed by other organisms rather than making organic matter itself.

**Holard:** The total soil water that can be divided into Echar and Hygroscopic water.

**Home gardens:** Closed, multistory combination of multipurpose trees preferably fruit trees, vegetable crops around homesteads.

**Humification:** It is the process of humus formation.

**Humus:** Humus is the final product after the decomposition of organic matter.

**Hydrological cycle:** Water cycle which collects, purifies, and distributes the earth water from the environment to living organisms and then back to the environment.

**Hydathodes:** Hydathodes are specialized pores along the margins and apex of the leaf through which the secretion of water (guttation) takes place.

**Hydrosphere:** The hydrosphere refers to discontinuous shell of water on the earth. It contains oceans with connecting rivers, streams, and snow.

**Hygroscopic water:** Nonavailable water that remains stuck to the soil.

**Hypertrophied Lenticels:** A conspicuous pore located on the tree stem for exchange of gases which helps to enhance oxygen in plant roots in saturated (waterlogged/flooded) soils.

**Hypogeal germination:** The germination of a plant takes place below the ground is called hypogeal germination.

**ICSU:** International Council of Scientific Union.

**Imbibition Theory:** It is a special type of diffusion when water is absorbed by solids-colloids-causing them to enormously increase in volume. The classical examples of imbibition are absorption of water by seeds and dry wood.

**Improved fallow:** In this practice, fast growing, leguminous trees are grown during a fallow period.

**Incisors:** A pair of teeth adapted for cutting.

**Indicator species:** Those species which give early indication that an ecosystem or community is being degraded.

**Infiltration:** Lateral, generally slow movement of free water through soil surface and through litter layer under the force of gravity.

**Inorganic pollutants:** These are the substances of mineral nature. Important examples are heavy metals, ceramics, common metals, synthetic plastics, as well as water.

**Investors:** The prospective investors, who want to invest their money in a business, want to know the progress and prosperity of the business, before investing their amount. They can know the profitability and the financial position of the organization given in the financial statement of the organization.

**Khareez:** Underground water channel found in Balochistan.

**Lake:** Precipitation, land runoff, or groundwater flow fills a natural depression in the earth to form a large body of standing fresh water.

**Late wood:** The part of the wood in a growth ring of a tree that is produced later in the growing season. The cells of late wood are smaller and have thicker cell walls than those produced earlier in the season. It is also termed as summer wood.

**Lesion:** Any unusual change in the tissue of an organism which has suffered from disease or stress.

**Loam:** Type of soil with considerable shares of at least two size classes of soil particles.

**Lopping:** Removal of branches to use these without any regard to the health and vigour of standing tree stem.

**Mammae:** Modified sebaceous glands, terminating in a nipple, to secrete milk.

**Management:** The art of getting things done through other is termed as management. Accounting information provides the eyes and ears to management and hence it helps the manager in appraising the performance of the subordinates.

**Mangroves Forest:** A group of trees and shrubs that live in the coastal intertidal zone.

**Meristematic cells:** Meristems are the tissue in most plants containing undifferentiated cells (meristematic cells), found in zones of the plant where growth can take place. Meristematic cells give rise to various organs of the plant and keep the plant growing.

**Mg C:** Mega grams of Carbon.

**Migration:** It means movement of organisms into and out of a particular geographic area.

**Mineralization:** It is the process by which an organic substance is converted into inorganic substance.

**Mitigation:** Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters.

**Monogamous:** The state or custom of being married to one animal at a time.

**Monsoon:** Tropical or subtropical system of air flow described by a seasonal shift between usual onshore and offshore winds.

**Mortality:** Relative incidence of death within a specific population categorized according to different factors.

**Multipurpose trees:** Trees which can benefit in terms of timber, fuelwood, fruit and fodder.

**Mutualism:** Symbiotic interaction between two species that benefits both partners.

**Muzzle:** Mouth of an animal with projecting jaws and nose.

**Mycorrhizae:** Mutual relationship between fungal hyphae and plant roots, by which plant get nutrients from fungus.

**Net assimilation rate:** A useful measure of the photosynthetic efficiency of plants.

**Nocturnal:** Occurring in the night or active at night.

**Nucleoplasm:** The substance of a cell nucleus, especially that not forming part of a nucleolus.

**Nursery:** Nursery is a place where seedlings, cuttings and grafts are raised with care before transplanting.

**Obligate parasite:** This is an aparasitic organism that cannot complete its lifecycle without exploiting a suitable host.

**Omnivore:** Organisms that can eat both plants and other animals as food.

**Organic chemical pollutants:** The contaminants produced from organic sources or generated by biological material of some living organisms.

**Osmosis:** A process by which molecules of a solvent tend to pass through a semipermeable membrane from a less concentrated solution into a more concentrated one.

**Owners:** The persons who provide funds or capital for the organization. They need accounting information to know the profitability and the financial position of the concern in which they have invested their funds.

**Parasite:** Organism that lives and feeds on another living organism known as the host.

**Passive transport** is a movement of biochemical and other atomic or molecular substances across cell membranes without need of energy input.

**Pasture:** Land covered with grass and other low plants suitable for grazing animals, especially cattle or sheep.

**Pathogen:** Small living organism that causes infection or disease such as bacterium, virus, fungus etc.

**Perennial plants:** Plants that complete their biological lifecycle in more than two years.

**Pericycle:** The pericycle is a cylinder of parenchyma or sclerenchyma cells that lies just inside the endodermis and is the outer most part of the stele of plants.

**Phenology:** In organisms' time course of periodic events, linked with climate.

**Photosynthesis:** Photosynthesis is the process by which plants, some bacteria, and some protists use the energy from sunlight to produce sugar, which cellular respiration converts into ATP, the "fuel" used by all living things.

**Phytoplankton:** In aquatic ecosystems, small floating plants e.g. algae and bacteria.

**Pioneer species:** First hardy species such as microbes, lichens and mosses that start to inhabiting a specific area as the first stage of succession.

**Pith:** Pith, or medulla, is a tissue in the stems of vascular plants. Pith is composed of soft, spongy parenchyma cells, which store and transport nutrients throughout the plant.

**Plant anatomy:** Plant anatomy is the general term for the study of the internal structure of plants.

**Plant physiology:** It is a sub discipline of botany concerned with the functioning or physiology of plants.

**Pole:** The stage of plant from the fall of lower branches to the time when the rate of increase in height begins to fall off and crown expansion becomes more prominent up to the diameter of 5".

**Population:** Similar organisms from the same species, living at one place at any given time.

**Porcupids:** Young ones of porcupine just after birth.

**ppm:** parts per million.

**Precipitation:** Any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface.

**Predator:** Organism that captures and feeds on another organism.

**Prey:** Organism that is captured and used as feed by another organism.

**Primary succession:** Succession in a bare area that has never been remains under the community of organisms.

**Pristine Forest:** An ancient forest that is saved from logging or any other damage caused by anthropogenic activities.

**Producer:** Organisms that use solar energy (green plants) or chemical energy (some bacteria) to manufacture the organic compounds.

**Protein banks:** Plantation of protein rich and nutritious trees on agriculture land/pastures/ rangelands for cut-and-carry fodder production.

**Pruning:** Removal of branches from lower 1/3rd portion to improve the timber quality of standing tree.

**Pycnidium:** (Plural pycnidia) A globose or flask shaped fruiting body bearing conidia on conidiophores.

**Rangelands:** Rangelands are grasslands, shrub lands, woodlands, wetlands, and deserts that are grazed by domestic livestock or wild animals.

**Receipts:** Includes all cash received, whether it is “revenue” for the Association or not. Non-revenue items can include NEA and state dues, security and damage deposits for rental space and expense reimbursement from outside sources.

**Reforestation:** It refers to the establishment of trees on land that has been cleared of forest within the relatively recent past.

**Regeneration:** To renew a forest crop by natural or artificial means; also the new crop so obtained.

**Relative humidity:** The amount of water vapors present in air expressed as a percentage of the amount needed for saturation at the same temperature.

**Remittance:** The sum of money sent to someone at the distance.

**Revenue:** Receipt of cash (or a promise to pay) in exchange for an item or a service delivered to someone within a fiscal year. Typical items included are local association dues, NEA and state projects, and related funds and interest earned on investments. Please note that NEA and state dues are “pass through” amounts that are recorded as Revenue at the organizational level where the dues are owed, not at the local.

**Ribosomes:** A minute particle consisting of RNA and associated proteins found in large numbers in the cytoplasm of living cells. They bind messenger RNA and transfer RNA to synthesize polypeptides and proteins.

**Riverine forests:** These are tall flood plain forests along flowing waters such as tidal rivers and creeks.

**RNA:** Ribonucleic acid, a nucleic acid present in all living cells. Its principal role is to act as a messenger carrying instructions from DNA for controlling the synthesis of proteins, although in some viruses, RNA rather than DNA carries the genetic information.

**Root Hair:** Each of many elongated microscopic outgrowths from the outer layer of cells in a root, absorbing moisture and nutrients from the soil.

**Root pressure:** It is osmotic pressure within the cells of a root system that causes sap to rise through a plant stem to the leaves. Root pressure occurs in the xylem of some vascular plants when the soil moisture level is high either at night or when transpiration is low during the day.

**Rotation age:** Age when trees will be felled after fulfilling the precise objective.

**RSC:** Residual sodium carbonates

**Runaway water:** The left-over amount of water after soil saturation, getting itself drained into rivers, ponds and streams.

**Runoff:** Lateral, generally fast movement of free water on ground surface and through litter layer under the force of gravity.

**Sapling:** Sapling refers to a small tree between one and five inches in diameter.

**Sapwood:** It is the living, outermost portion of a woody stem or branch.

**Scavenger:** Organisms that feed and survive on other dead organisms e.g. vultures and crows.

**Sclerenchyma cells:** Any of various kinds of hard, woody cells that serve the function of support in plants. Mature sclerenchyma cells are dead cells that have heavily thickened walls containing lignin.

**Secondary growth:** Increase in thickness of plant body due to formation of secondary tissue by activity of vascular cambium and cork cambium is known as secondary growth.

**Secondary succession:** Ecological succession which takes place on previously vegetated area after a disturbance in which there are remaining effects of organisms present before the disturbance.

**Seed:** Seed is an embryonic plant enclosed in a protective outer covering.

**Seedling:** Seedling is a tree which is less than one inch in diameter. A typical young seedling consists of three main parts: the radicle (embryonic root), the hypocotyl (embryonic shoot), and the cotyledons (seed leaves).

**Seepage:** The slow escape of a liquid or gas through porous material or small holes out of root zone.

**Selectively permeable membrane:** It is also termed as semipermeable membrane or a differentially or partially permeable membrane. It is a type of biological or synthetic, polymeric membrane that will allow certain molecules or ions to pass through it by

**Sericulture:** Preferably, *Morus alba* is grown for silk worm rearing.

**Shelter wood Silvicultural System:** A silvicultural system in which the over wood is removed gradually in two or more successive felling depending on the progress of regeneration.

**Shrub:** A woody plant which is smaller than a tree and has several main stems arising at or near the ground.

**Sieve cells:** a sieve element of a primitive type present in ferns and gymnosperms, with narrow pores and no sieve plate.

**Silvi-pastoral system:** The production of woody plants combined with pasture is referred to as Silvopastoral system.

**Snowline:** It is the altitude in a particular place above which some snow remains on the ground throughout the year.



**Sorption:** This term is collectively used for the processes of absorption and adsorption. Absorption is the incorporation of a substance in one state into another of a different state (e.g., liquids being absorbed by a solid or gases being absorbed by water).

**Species evenness:** Relative abundance of individuals within each species in a community.

**Species richness:** It is defined as number of different species in a community.

**Species:** Species is a very frequently used term in ecology which is defined as group of similar organisms that can mate and produce offspring successfully.

**Stele:** The part of the stem inside of the cortex is known as the stele. The stele consists of 3 regions-the pericycle, the vascular bundles region and the pith.

**Steppe:** Discontinuous grassland having scattered shrubs or stunted trees.

**Stomata:** Stomata are small breathing pores in the leaf that allow gaseous exchange where water vapour leaves the plant and CO<sub>2</sub> enters. Guard cells control each pore's opening or closing.

**Succession:** Succession is the natural replacement, in time, of one plant community with another. Conditions in the existing plant community create conditions favorable for establishing the next stage.

**Symplastic pathways:** The symplast of a plant is the inner side of the plasma membrane in which water and low-molecular-weight solutes can freely diffuse.

**Synecology:** Synecology deals with the study of groups of organisms which are associated together as a unit e.g. study of a forest.

**Taungya:** Growing agricultural crops with young trees either on borders or in between, a common practice in West Africa and Savannas.

**Thorn forest:** It is a dense, scrub like vegetation characteristic of dry subtropical and warm temperate areas with a seasonal rainfall averaging 250 to 500 mm. It consists of thorny plants.

**Threatened species:** Wild species that is still abundant in its natural area but is expected to become endangered because of decrease in number.

**Timber line:** A geographic boundary beyond which trees cannot grow. It is also called tree line.

**Topography:** The detailed mapping or charting of the features of a relatively small area, district, or locality.

**Tracheid:** A type of water-conducting cell in the xylem which lacks perforations in the cell wall.

**Transition zone:** A transition zone is an area where the predominant species changes from one to another form.

**Transpiration pull:** The cohesion of water explains only maintenance of the sap column; the explanation for the upward movement of the water is accounted for by a mechanism, called transpiration pull that involves the evaporation of water from leaves.

**Transpiration:** Process, in which water is absorbed by roots of a plant, passes through stomata in leaves or other parts, and evaporates into the atmosphere as water vapor.

**Tree crown:** The crown of a woody plant (tree, shrub, liana) is the branches, leaves, and reproductive structures extending from the trunk or main stems. Shapes of crowns are highly variable.

**Tree:** Refers to a woody perennial plant having a single usually elongated stem or trunk, generally with few or no branches on its lower part.

**Tundra:** It is a type of ecosystem that is too cold to support the tree growth.

**Vascular tissue:** It is a complex conducting tissue, formed of more than one cell type, found in vascular plants. The primary components of vascular tissue are the xylem and phloem.

**Vegetation Cove:** Refers to trees, perennial bunch grasses and grasslands, legumes, and shrubs with an expected life span.

**Vibrissae:** Stiff hairs located about the nostrils or on other parts of the face in mammal.

**Vital force theories:** "Vital force theory" is a proposed mechanism for the ascent of sap through the xylem tissue of plants. According to the vital force theory, the conduction of water up the xylem vessel is a result of vital action of the living cells in the xylem tissue.

**Viviparous germination:** Germinating or producing seeds that germinates before becoming detached from the parent plant, as in the mangrove.

**Water Erosion:** The removal thin layer of soil through water is called water erosion.

**Watershed:** A sloppy area that drains surplus water into a river, stream or a water body.

**Weather:** Short-term fluctuations in the temperature, pressure, humidity, precipitation, sunshine, cloud, wind and other conditions in the troposphere at a given time and place.

**Wetland:** Land that is covered all or partially with salt or fresh water except streams, lakes, and ocean.

**Wilderness:** Area where the earth and its ecosystems have not been disturbed by humans.

**Windbreak:** A row of trees or a fence, wall, or screen, that provides shelter or protection from the wind.

**Wood:** It refers to the hard-fibrous material made up of cellulose and lignin, forms the main substance of the trunk or branches of a tree or shrub, used for fuel or timber.

**Xerophytes:** Species that can survive in water scarcity.

**Xylem Tissue:** the vascular tissue in plants which conducts water and dissolved nutrients upwards from the root and helps to form the woody element in the stem.

**Zooplankton:** They are small floating herbivores which depend for feed on plant planktons.

### **Introduction to tree crop morphology and physiology.**

**Plant physiology** is a sub discipline of botany concerned with the functioning, or physiology, of plants. Closely related fields include plant morphology (structure of plants), plant ecology (interactions with the environment), phytochemistry (biochemistry of plants), cell biology, genetics, biophysics and molecular biology.

Fundamental processes such as photosynthesis, respiration, plant nutrition, plant hormone functions, tropisms, nastic movements, photoperiodism, photomorphogenesis, circadian rhythms, environmental stress physiology, seed germination, dormancy and stomata function and transpiration, both parts of plant water relations, are studied by plant physiologists

Principles of Forestry with emphasis on choice of suitable species with respect to site factors such as sunburn, low frost, salinity, water logging, soil erosion, shade, grazing pressure, and market needs etc.

## Chapter 4

# PRINCIPLES OF FORESTRY

Like other land uses such as Horticulture, Agronomy, Range or Watershed Management, Forestry too has its principles. If Forestry operations are organized and conducted in the light of these principles, one can expect to grow trees of desirable species successfully in the shortest possible period at minimum cost and with maximum income.

### 1. Precise objectives of Forestry for a specific site.

It is extremely important to determine the precise objective(s) of Forestry for any specific site. This is the first thing which has to be accomplished. The entrepreneur should consider and weigh one's own preferences and likings and should then visit the concerned site and study the environmental conditions (site potential), needs of the people and marketing potential very carefully. Although any one site may have more than one objectives which are to be achieved by Forestry, but all these are not equally important. Our job is to prepare a priority list of different objectives of Forestry. The main objective of Forestry is generally either (1) to moderate the climatic extremes and thus tender shelter to farm residents, animals and crops (2) to conserve and ameliorate soil, (3) to provide forage during cold and dry periods, or (4) to produce fire wood and timber etc. on commercial basis. Almost all possible objectives of Forestry can be classified into above mentioned four classes. Once we have defined the objective(s) of Forestry for a specific site precisely, all our activities are geared towards achieving this objective(s).

### 2. Selection of suitable site:

Due considerations regarding selection of a suitable forest site provide a sound foundation for undertaking a successful Forestry enterprise. The site in question should be either highly productive or at least potentially productive. A site is considered highly productive when all the important environmental factors are favourable for tree growth. Sites of quality class IV and V are considered best forest sites. Sites of quality class VI and VII are considered good to moderate forest soils. A potentially productive site on the other hand



refers to a site where all factors are more or less favourable except one factor which is either limiting or in excess and is effectively depressing tree growth; such factor, however, is generally easily amendable to correction and improvement.

A correct decision regarding site selection at this early stage will ensure success and one can easily overcome minor weaknesses and deficiencies that might come up at later stages. A failure in making right decision about site selection, however, will lead us nowhere, no matter what we do later on. A team of Forest Ecologists and Soil Scientists should be asked to visit the proposed site for obtaining their considered opinion before making any final decision. A stitch in time at this occasion will save nine at later stages.

### 3. Selection of suitable species

This is an other extremely important principle. We should select such species which are suitable for a given set of soil and climatic conditions and which are in great demand in the market. A tree must be able to grow upto a certain size before it can render any service. The selected species must also meet the specific needs of the market such as forage fire wood, timber, etc. and should be readily saleable. The selected species must not be a breeding place for any insect pest and it must not be an alternate host for any serious disease. Lot of effort must go in the search of suitable species for the concerned area.

### 4. Establishment of woody vegetation

Although trees and shrubs come in through natural regeneration but the process is generally painfully slow and the species such selected are not always desirable. In view of increasing competition between Forestry and other land uses for more and more land and other resources, slow establishment (regeneration) of trees is not acceptable to foresters any more. Another disadvantage of natural regeneration is the lack of control as to where a tree should grow. Hence it is the artificial regeneration which has very important role in future Forestry. Artificial regeneration speeds up the process of tree establishment tremendously. There is complete control of choice of species to be planted and of location of each and every plant. Hence it is clear that artificial regeneration has very important role in present day Forestry.

### Regeneration of Forests:

It generally means raising a new forest crop after or during the final felling of the old crop.



When regeneration is obtained from the seeds that naturally fall from the standing mother trees and young seedlings develop and establish under the shelter of standing mother tree it is called natural regeneration. On the other hand if seed is collected manually, sown in well prepared fine seed beds in nurseries and transplants are later planted out in the field whether under shelter or without shelter is called artificial regeneration. It has the added advantage of freedom of choice of species and location of transplants in the field. With the passage of time artificial regeneration is becoming more and more important.

#### Afforestation:

It generally means establishing a totally new forest on treeless areas. It is always achieved through artificial means. Seed of suitable species is collected or purchased, transplants raised in the nursery and planted out in the field. Field is protected from all climatic or biotic stresses as far as possible. Water is provided. Weeds are suppressed. Stakes are fixed besides tender saplings if necessary.

#### 5. Cultural operations and protection •

Trees and shrubs are living organisms. Although these are much more tolerant of environmental extremes than most green plants but these too pass through a stage in their life history when these are very tender and are easily susceptible to damage by extreme environmental conditions. Once the trees are through the early susceptible stage of their life safely, these can well take care of themselves in later age. However, during the forest's early tender (susceptible) stage, trees do need external help from the forester/farmer in the form of cultural operations. It should be remembered that some of the cultural operations may be required from early age right upto later part of the life cycle. Some of the examples of cultural operations are as follows: Watering, staking, weeding, interplanting, thinning, pruning, pollarding, topping, etc.

Protection is also very important in present dry Forestry. This is so because the trees/shrubs are frequently planted individually as single trees or in separate lines (of single tree width) or in narrow shelter-belts in combination with crops. Such trees/shrubs are, therefore, more exposed to all kinds of hazards. If trees/shrubs are planted in compact blocks they will require comparatively less protection. Important hazards may include grazing and browsing, trampling, damage due to various farm operations carried out carelessly, willful uprooting by children, frost, exposure to excessive light and temperature, lack of drainage, and faulty Forestry

6. Timely felling, proper conversion and skillful marketing:

Removal of trees at the proper time is also very important principle. Once the trees / shrubs have performed their functions and have achieved its objectives as determined earlier (in principle No. 1) these should be felled, properly converted to desired end products, marketed and new plants planted in their place. As long as a tree or a forest stands on the ground it always yields some production although it may not do so most efficiently. The criteria of felling a tree or a tree crop is the efficiency and vigour with which it performs its functions i.e. growth. Once it slows down in growth it should be removed, sold and replaced with a young and vigorous tree or tree crop.

In order to maximise our benefits from trees or tree crops, these should be felled, cut to appropriate size, seasoned and preserved properly before marketing and ultimate utilization.

The profitability of a Forestry enterprise depends upon planting suitable (fast growing and high value) tree species, timely carrying out of various cultural operations and selling at favourable market prices.



## Importance of Watershed, their principles,

### Watershed management

Ninety percent of the water in Pakistan originates from the northern upland watersheds. With the construction of dams and reservoirs to generate hydropower and supply water to the massive irrigation works that support the national agricultural economy, watershed management in the mountains has become a national priority. Loss of vegetation cover in the watershed areas seriously impairs the hydrological cycle resulting in landslips and flashfloods, causing damage to infrastructure, settlements and loss of human and animal lives. The main causes of watershed degradation are forest conversion, improper agricultural practices and fragmentation of land, complex land tenure arrangements and poverty. During the last three decades, watershed management has assumed special significance and received attention in federal and provincial governments. A number of integrated watershed rehabilitation projects with a focus on community organization and participation have been implemented with considerable success. Experience has shown that the sectoral approach to mountain development has to be replaced by an integrated NRM approach with multi-stakeholder participation to address the special environmental values of mountain watersheds. Prolonged drought and a reduced amount of snowfall in the mountainous areas have decreased water availability in major rivers considerably, creating water scarcity in the country. Since water-related issues and conflicts are expected to worsen due to the effects of climate change, the management of upland watersheds will become the policy thrust area during this century. Pakistan, like other countries, is celebrating the International Year of Mountains 2002 under Agenda 21. There is a need to prepare a strategic plan for sustainable mountain development in partnership with local communities and the private sector.

The 1955 policy recommended coercive measures to control land use. However, plans to construct dams in the late 1950s brought the need for large-scale watershed management programs to the fore. Recommendations on watershed management have been an integral component of forest policies since 1962. Large-scale afforestation, planting of fruit trees, and soil and water conservation measures have been major recommendations. The policies also recommended the provision of incentives to farmers and subsidies on cooking stoves and kerosene to reduce the use of fuelwood. The 1991 policy recommended watershed planning and coordination as a federal function, with implementation continuing to be the responsibility of the provinces.