

Ratnai college of agriculture akluj

Biruraj shendage

Introduction to Forest in India

Total geographical area of India is 32, 80,500 sq. km (328.8M ha)

Total forest area 7, 50,500.00 sq. km (75.06 M ha)

Agricultural area is about 46.4%

The second National Forest Policy was enunciated (decided) in 1952 as per which 33.33% of land should be under forest for proper ecological balance. In hills 60% area should be covered under tree cover. During last tow decades 2 million ha forest was diverted for non-forest purpose, Agro-industry, power and irrigation projects, housing etc. **Government has enacted the Forest Conservation Act. 1980** to ensure that no reserve forest can be diverted to any other type of forest and that no forest and that no forest land can be used for any non forest purpose.

Out of total area under forest, 45.6 million ha (60%) area is in use and another 14.8 million ha (20%) area potentially exploited and remaining unexploited area as on Himalayan states, North Eastern regions and Andaman Nicobar islands.

Sources of energy consumption in India are: Coal, 16.5% Oil 10.0% Electricity 15.7% wood 37.6% Cowdung 8.7% and Vegetation waste 11.5%

Forest:

The word is derived from the Latin word "Eairs" means "outside' Therefore forests are areas covering practically all uncultivated or untended lands covered with rather tall and dense tree growth.

Forestry and Its Branches

The word "Forest" is derived from Latin word 'foris' means meaning outside the village boundary or away from inhabited land. It is a large tract covered with trees and under growth some-times mixed with pasture. Generally, forest is referred to an area occupied by different kinds of trees shrubs, herbs, and grasses and maintained as such. In a general sense, forest is a large uncultivated tract of land covered with trees and Underwood, woody ground and rude pasture a preserve for big game. Technically, forest is an area set aside for the production of timber and other forest produce, or maintained under woody vegetation for certain indirect benefits which it provides, e.g. climatic or protective (Anon. 1966). Ecologically, it is defined as a plant community, predominantly of trees and other woody vegetation, usually with a closed canopy. Legally, forest is an area of land proclaimed to be a forest under a forest law. FAO classifies all such lands into forest.

The forests made / composed / constituted / dominated from almost entirely one single species, to the minimum extent of 50 per cent are called Pure Forest Constitute.

From the above definition, it is clear that the forest has five components, namely;

1. It is an uncultivated land area

2. The land area should be occupied by different kinds of natural vegetation essentially by trees or it is proposed to establish trees and other forms of vegetation
3. The trees should form a closed or a partially closed canopy
4. The trees and other forms of vegetation should be managed for obtaining forest produce and / or benefits and
5. It should provide shelter to wildlife, birds-and other fauna. (Animals)

Branches of Forestry

Mainly, the forestry has been grouped as follows:

1. Basic Forestry
2. Applied Forestry

1. Basic Forestry: Basic Forestry deals with the theory and practice of constitution and management of forests and utilization of their products. Agriculture is the study of science and art of production of plants and animals used by man. In India, the geographical area is about 32,80,500 km². The forests occupy about 7,50,000 km². (22.9% approximately) whereas agricultural (cultivated) area is about 46%. However, agriculture is the largest enterprise in India. Nearly, 70% of the population is employed in this profession. But unfortunately, in spite of this, it is not able to meet the requirements of ever-increasing population. Forestry, just like agriculture, is a good profession with the difference of long life-span.

Basic Forestry has the following Branches:

A) Silviculture: This refers to certain aspects to theory and practice of raising forest, crops, methods of raising tree, their growth and after-cares up to the time of final harvesting. However, in simple words, it is the cultivation of forest trees.

B) Forest Mensuration: In simple language, it is the measurement of forest produce. However, it is defined as the determination of dimensions (e.g. height, diameter, volume, etc.) from, volume, age and increment of single trees, stands or whole woods, either standing or after felling. It concerns with linear area, volume and weight measurements.

C) Silvicultural Systems: A Silvicultural system can be defined as a method of Silvicultural procedure worked out in accordance with accepted sets of Silvicultural principles by which crops constituting forests are tended, harvested and replaced by new crops of distinctive forms.

D) Forest Management: It is the practical application of science, technique, and the economics to a forest estate for the production of some wanted results. In actual sense, it is the application of business methods to the operation of a forest estate. The Society of American Foresters (SAF) has described it as an application of business methods and technical forestry principles to the operation of a forest property.

E) Forest Utilization: It is a branch of forestry concerned with the harvesting, conversion, disposal and use of forest produce (British Common Wealth Forest Terminology,

1953.).According to SAF (1983) it is a branch of forestry concerned with the harvesting, any necessary processing, and delivery to the consumer of forest produce.

F) Forest Law: Law includes any rule of action. The rules and law imposed by the state up on the actions of its citizens for the breach of which they are punishable. Forest law is classified as:

- a) Constitutional laws
- b) Public laws
- c) Private laws; Very essential for protection of forest; Some terms - Forest offence / Forest right / Forest settlement
- d) Forest wild life Act WL (protection) Act 1972 Animals / bird.

G) Forest Policy: Branch of forestry concerned essentially, with social and economic aims underlying forest management and forestry development (SAF - 1983)

2. Applied Forestry: This includes those subjects which have the references to other subject but make the essence of, forestry

- a) Dendrology
- b) Forest Ecology
- c) Forest Economy
- d) Forest Entomology
- e) Forest Fire
- f) Forest Genetics
- g) Forest Pathology
- h) Forest Seed technology
- i) Forest soils
- j) Forest statistics
- k) Forests surveying
- l) Remote sensing
- m) Social Forestry-Social Resent
- i. Agroforestry
- ii. Forestry Extension
- iii. Afforestation
- iv. Recreation Forestry etc.

Some Other Forestry Branches:

- 1. Aesthetic forestry
- 2. Commercial Forestry
- 3. Community Forestry
- 4. Extensive Forestry
- 5. Farm Forestry
- 6. Extensive Forestry
- 7. Multiple use Forestry.

Functions & Types of Forest in India

Function of forests:

Sr.No.	Particulars	Functions
1	Productive	They provide timber, fuel, charcoal, beedi, leaves, wax and resins, fruits, tanning, materials, manure leaves, grass, bamboo, gums, lac etc.
2.	Protective	Forests protect water sheds, catchments of rivers and streams against erosion.
3.	Aesthetic	Forests add good appearance, landscaping and a thrilling atmosphere to the locality.
4	Recreational	Forest provides picnic resorts and opportunities for sport like hiking, trekking, wild life watching, bird watching.
5	Scientific	Study of ecological process can be made
6	Ameliorative	Forests improve climate and reduce pollution
7	Hygienic	Forests improve the environment and help in reduction of noise, purify the air and give out oxygen to the atmosphere.
8	Industrial developments	Forest meet the need for raw material for industrial development such as Paper pulp, rayon grade pulp, saw mill ply wood, hard board etc.

Forest types of Indian:

1. Tropical wet ever green forest
2. Tropical semi evergreen forest
3. Tropical moist deciduous forests (Southern and northern types)
4. Littoral and Swamp forests
5. Tropical dry deciduous forest
6. Tropical thorn forest
7. Tropical dry ever green forest
8. Sub tropical broad leaved hill forest
9. Sub tropical dry evergreen forest
10. Mountain wet temperate forest
11. Himalayan moist temperate forest
12. Sub alpine forest
13. Himalayan dry temperate forest
14. Sub alpine forest
15. Most alpine scrub

16. Dry alpine

The above types are called natural ecosystems. Ecosystems are the natural climax forests, resulting from a long process of ecological succession of plants and associated animals life, undisturbed by man.

Branches of Forestry

Forestry has five different branches:

1. Silviculture:

It refers to certain aspects of theory and practices of raising forest crops, methods of raising tree crops, their growth and after care up to the time of final harvesting.

2. Mensuration:

It deals with the measurement of forest produce ex. Dimension from volume, age and increment of individual trees and forest crop.

3. Silviculture system:

Process by which the crops constituting a forest are tended, removal and replaced by new crops

4. Management:

Practical application of sequence technique and economics to forest estate for the production of certain desired results

5. Utilization:

Branch of forestry which deals with harvesting, marketing conservation and applying the forest produce to a variety of uses eg. Timber, fuel, charcoal, pulp wood, ply wood.

Forestry:

The theory and practice of all that constitutes the creation conservation and scientific management of forest and the utilization of their resources, based on the aims or objectives, the forestry may be:

1. **Protection of Environmental forestry:** Protection of land, regulation of water cycle, Wild life conservation Modernization of climate conditions, combination of above. Ex. Buddha Jayanti Park at New Delhi.
2. **Commercial or Production forestry:** Timber and other raw materials.
3. **Social Forestry:** Raising forests outside the traditional forest with the involvement of society.
4. **Farms Forestry:** Raising forest trees on farms lands. It is further classified as:
 - **Non commercial farm forestry:** raising of trees by individuals for domestic needs (usually by the farmers)
 - **Commercial farms forestry:** Farmers grow trees on commercial basis on farmlands.
5. **Community forestry:** Raising of forests of public or community land
6. **Urban forestry:** Management of public and private owned lands in and adjacent to urban centres. They have more aesthetic value.
7. **Agro Forestry:** Cultivating forest trees along with agricultural crops.

Definations and Terms used in Forestry

1. **Forestry:** Forestry has been defined as 'the theory and practice of all that constitutes the creation, conservation and scientific management of forests and the utilization of their resources.
2. **Silviculture:** The terms silviculture, commonly refers only to certain aspects of theory and practice of raising forests crops. **OR** Silviculture pertains to the establishment, development, are and reproduction of forests crops.
3. **Pollarding:** This is a process in which the branch of a plant is cut off in order to produce a flush of new shoots. Pollarding is carried out at a height which is above the reach of browsing animals. It has been widely adopted on salix trees in Kashmir Valley. (Willow), *Hard-wickia binata* in A.P. (Anjan), *Grewia oppositifolia* in U.P. Hills (Silver oak type)
4. **Lopping:** It pertains to the cutting of branches or even young stems. This leads to the development of new shoots. It is carried out on Diospyros (Temburni) for bidi industry, also in number of broad leaved species for fuel and fodder and as *Quercus incana* (Indiana oak), morus etc, for rearing silkworm.
5. **Pruning:** Means the cutting of branches from the bole in order to maintain the quality of timber.
6. **Taungya system:** It was first evolved in Burma in 1850 as a mode of replanting vast teak areas. Taungya is a Burmas word. (Toung hill, ya - cultivation). This is a modified from of shifting cultivation of which the labour has permission to raise crop on the land, but, with this, they are responsible for planting, of the forest species, also for protection and well being of the plantation. After about five years or so, they are required to move to another patch of land.
7. **Coppice:** When certain plants or seedling are cut from near ground level, they produce a flush of fresh shoots. This is known as coppicing
8. **Seed orchards:** are plantations which may raised exclusively with the aim of producing seed.
 1. **Seed Production areas or seed stands:** Which are area set aside exclusively for the purpose (i) to produce seed of high quality from genetically superior trees available in the stand (ii) to concentrate seed collecting operation in a small sphere or area. The seed stands are established by removal of the inferior frees, seed orchards are plantation of genetically superior trees isolated to reduce pollination from genetically inferior once. Seeds orchards may be of two types: (i) Clonal: raised by grafting clones of superior trees on 2-3 year old seedlings (2) Seedling raised from obtained from seeds of superior trees.
9. **Pricking out:** When the seedlings have to be kept in the nursery for more than a year, it must be transferred to beds, other than the seedling beds. This is known as pricking out or to transplant small seedlings individually in to nursery beds or boxes.
10. **Wind breaks:** Is a protective plantation in a certain area, against strong winds. It is usually comprised of a few rows of trees (or shrubs) spaces at 0.5 to 2.5 m apart.)
11. **Shelter belts:** is a wide zone of trees, shrubs and grasses, planted in rows, usually at right angles to the direction of the prevailing winds. Its aims are:
 - a. To deflect the air current.

- b. To reduce the velocity of prevailing winds
 - c. To provide general protection
 - d. To protect the leeward area from the desiccating effects of hot winds.
12. **Tending:** Tending is a board terms given to operation which are carried out for the well being of forest crops, at any stage of it life, involving operation both on the crop itself and on its competing vegetation e.g. weeding, cleaning, thinning, improvement feeling etc. However, tending does not include operation concerning, regeneration such as regeneration feeling, soil working, control burning etc.
 13. **Felling:** Felling comprise of removal of trees either singly or in small groups scattered all over the forest.
 14. **Afforestation:** Establishing a forest by artificial means on an area on which not forest vegetation has existed for a long time in the past.
 15. **Reforestation:** Re-establishing a forest, by artificial means on an area which previously bore forest vegetation, and which may have been felled or otherwise cleared in the recent past.
 16. **Age crop:** The age of a regular crop corresponding to its crop diameters.
 17. **Age classification:** The division of a crop according to difference in age **OR** the allotment of woods to age classes.
 18. **Alpine:** Zone of vegetation where winter is server, slow fall heavy, the mean annual temperature is 450F and the mean January temperature below 300F. In India Himalayan at the altitude above 10,000 ft.
 19. **Basal area:** The area of the cross section of a stem at breast height, when applied to a crop, the sum of basal areas of all the stems or the total basal areas per unit area.
 20. **Bole:** The main stem of a tree.
 21. **Breast height:** Almost universally adopted as the standard height for measuring the girth, diameter and a basal areas of standing trees. India 4'6" (1.37m). In U.K. and most commonwealth countries 4'.3" (1.30m)
 22. **Coupe:** A felling area, usually one of an annual series unless otherwise stated. Preferable numbered with Roman numbers as, I, II, III etc.
 23. **Crown:** The upper branchy part of the tree above the bole.
 24. **Dendrology:** The identification and systematic classification of trees.
 25. **Reserved forests:** an area so constituted under the Indian Forest Act or other Forests law.
 26. **Protected forests:** A legal terms for an area subjected to limited degrees of protection under the provision of Chapter IV of the Indian Forest Act.
 27. **Unclassed forest:** Forest land owned by Government but not constituted in to a reserved, village or protected forest.
 28. **Log:** The stem of a tree or a length of stem or branch after felling and trimming.
 29. **Logging:** Operation comprising felling of trees, limbing, bucking and transportation of the resulting product out of the forest timber harvesting (Bucking-Act of being)
 30. **Pole:** A young tree from the time when the lower branches begin to fall off to the time when rate of height growth begins to slow down and crown expansion becomes marked.
 31. **Raft:** An assemblage of logs, timbers or bamboos tied together or enclosed within a boom for transport by floating.
 32. **Scrub:** Inferior growth consisting chiefly of small or stunted trees and shrubs.
 33. **Stand:** An aggregation of trees or other growth possessing sufficient uniformity in composition, constitution, age arrangement or condition, to be distinguished from adjacent crops and forming a silvicultural unit.
 34. **Succession:** The gradual replacement of one community by another in the development of vegetation towards a climax

Silviculture

Introduction:

Silviculture pertains to the raising, development, care, reproduction and overall management of forest crops.

Definition: It has been defined variously as follows:

- **By Toumey and Korstain:**

Silviculture is that branch of forestry which deals with the establishment, development, care and reproduction of stands of timber.

- **By Champion and Seth:**

The terms silviculture, in English refers only to certain aspects of the theory and practices of raising of forest crops.

- **By Iffert (IFR Dehradun)**

The art and science of cultivated forest crops. On the other hand, silvics is the study of trees and forests and biological entities, the laws of their growth and development, and impact of environment on them. Thus, silviculture can be described to include all practical and theoretical aspects of silvics.

Objects of Silviculture:

Study of silviculture helps to attain the following objects:

1. **To derive environmental benefits:** Soil and water conservation, control of air and noise pollution, wild life conservation, regulation of climatic condition, regulation of water cycle.
2. **Raising species of more economic value:** Industrial and economic growth through.
3. **Production of high-quality timber:** Silviculture techniques help to avoid the problem of crooked, malformed, diseased or defective timber and thus help to produce goods quality timber.
4. **Production of more volume per unit area:** Unmanaged forests may be too dense or too open, less production, premature death of trees silviculture helps to solve these problems.
5. **Reduction of rotation period:** In unmanaged forests the rotation tends to be longer.
6. **Afforestation of blank areas:** Waste lands can be used for forests
7. **Creation of plantation:** Man made forests or plantations may be created in place of natural forests.
8. **Introduction of exotics:** Successful introduction of exotic species is possible.
9. **Employment potential:** In any plantation operation, the labour component accounts for 60 to 70% of the total financial input.
10. **Increase in the production of fuel and fodder:** In developing countries like India it is an important aspect.
11. **Forest Industries:** Resin for resin and turpentine industry, pulp wood for paper industry, industrial wood for match and timber industry, railway, etc, minor forest products based industries.

12. Foundation of Silviculture

13. The closest foundation of silviculture in the natural sciences is the silvics. It deals with the principles underlying the growth and development of single tree and of the

forest as a biological unit. It can be defined in the following ways:

14. 1. The study of life history and general characteristics of forest trees and crops, with particular reference to environment factors, as the basis for the practice of silviculture.
15. 2. The study of requirements and the processes of tree growth and the environment under which it takes place is called silvics. Stodard and Stodard (1987)
16. Therefore, intelligent management of the forest must depend upon a solid foundation of knowledge of silvical processes.
17. The practice of silviculture is related to the social as well as the biological aspects of forestry. It is regarded as the crown of the forestry. It helps in achieving the five F's. Viz,
 18. 1. Food / Fruit
 2. Fodder
 3. Fuel Wood
 4. Fibre
 5. Fertilizer
19. These are immediate (primary) needs of the society particularly in the rural areas. In addition to these primary needs, some other needs, which are called secondary need, are also fulfilled by silviculture. Following are the secondary needs:
20.
 1. Nitrogen Fixation
 2. Soil Conservation
 3. Mulch Farming
 4. Windbreaks and Shelterbelts
 5. Commercial Timber, etc.

Therefore, study of silviculture is very important now days. In actual sense, it is the base of forestry. It has good relations with various branches of forestry.

Object of Silviculture

Silviculture is improved limitation of nature. In nature, we find a large number of species coming up at one place. Some individuals die out of competition, some attain top canopy while others remain at lower levels. Silvicultural factors are usually controlled by economic considerations. If there are a large number of species, perhaps a forester would select some of them which are economically more important. Also the forester may remove the trees which are likely to die out of suppression. Since our knowledge of economic and natural factor is not perfect, it is not always possible to determine how far to divert from purely natural course. In nature, succession is a process in which one species or group of species is replaced by another species or group of species and a stage comes when more stable species appears. The study of silviculture enables the foresters to know the whole course of natural succession on a given site and also the manner and the speed of existing crop being replaced or altered. This knowledge helps the foresters to determine where and how to control the succession. The important objectives of silviculture can be summarised as under:

1. Control of Crop Composition and Production of Species of More Economic Value:

Under natural conditions, a large number of species form the crop inferior or less valuable species may flourish at the expense of the desirable species. The control is exercised by two ways:

- i. By removing or cutting inferior species
- ii. By creating more favourable conditions for the regeneration and growth of desirable species.

2. Control of Stand Density, for Production of Maximum Volume:

In the natural forests, trees are likely to grow either too dense or too open. If the trees are too dense-the wood production is distributed over large number individuals and none of them grow to the optimum size. If the trees are too less, the production would be less, though individual trees may grow sufficiently with higher dimensions. If the trees are too less, they will not be able to utilise the site, effectively and may be even inadequate to regenerate the area. Both these conditions are not good for maximum wood production. Silviculture helps to maintain or retain sufficient number of trees per unit area so that by optimum use of soil, maximum wood production is ensured. Substantial increase in production can be ensured by thinning dense prop through salvaging the trees otherwise these trees would have died.

3. Afforestation of Blank and Under Stocked Areas:

There is a large area of forests which is blank or under stocked due to fire, encroachments, illicit fillings, or some natural causes. These areas are however, suitable to bear tree growth. Silviculture helps us to afforest these areas with suitable trees by planting or by seedling. Silviculture guides to know the best period of seed collection, nursery technique, plantation details, etc. to complete afforestation.

4. Production of Quality Timber:

In unmanaged forests, because of intense competition or little competition, quality timber is not produced. A large number of trees are malformed, defective and sometimes diseased. Proper control of damaging agencies can increase the production. Insects, fungi, fire, wind, grazing, lopping, etc. which affect the quality of the timber are controlled by suitable Silvicultural techniques and methods.

5. Control on Rotation Period:

Rotation is counted period in years from regeneration to harvesting. In unmanaged forests, if there are more number of trees, the growth of individual tree is slow consequently, they take longer period to reach to harvestable size. The knowledge of silviculture helps to regulate the density of the crop at various sizes / ages which helps to reach exploitable size much faster. Thus, rotation of a crop can be reduced by regulating the density of the crop. It also helps in identifying short rotation crops.

6. Facilitate Management and Use of Forests:

In unmanaged forests, good forests exist in difficult areas, where it is difficult to manage and harvest the timber. In managed forests, it is easy to plant the growth and distribution of

forests so that the produce is used efficiently and economically. It is possible to arrange the forest in different localities in such age classes and species composition that management becomes easy.

7. Creation of Man Made Forests and Introduction of Exotics:

Silvicultural techniques help us to replace wholly or partly, natural forests by man made forests of the same species or by other species. If the existing, forest does not contain valuable and the desirable species. It can be planted with such important species. If the forest consists of desirable species but it is not regenerating properly, it can be harvested and regenerated artificially. Identification of suitable exotics depending upon geographical location, raising seedlings, plantations, selection of suitable exotics species, perfecting the nursery and plantation techniques of the exotics are some of the silvicultural techniques which help in introduction of exotic species on a large scale.

8. Protection of Site and Intangible Returns:

The main object of silviculture is to provide maximum protection to the site so that intangible returns from the forests are ensured. Important intangible returns include, moderating climate, increasing precipitation, reducing soil erosion and floods conserving soil and water increasing water yields providing shelter to a large number of wild animals, etc. Silviculture helps to understand the requirement of a tree and its effect on the site. The species, which are likely to deteriorate the site, are discarded. Only such species which afford complete protection to the site and ensure continuous flow of intangible benefits are preferred.

Classification of Forests

Forests can be classified on the basis of:

1. Age,
2. Method of regeneration,
3. Composition,
4. Ownership,
5. Object of Management,
6. Growing Stock.

1. Classification of Forest On the Basis of Age: Forest is classified into:

A) Even Aged Forest:

Even-aged forests, also called regular forests are those consisting of even - aged woods. Even - aged wood means trees of approximately the same age. True even - aged forests can be only man - made forests. In case of forests, which regenerate naturally, some age difference is often allowed. Differences up to 25% of the rotation are usually allowed in cases where forest is not harvested for 100 years or more.

B) Un-Even Aged Forests:

A forest is called uneven - aged or irregular when trees vary widely in age.

2. Classification of Forest On the Basis of Regeneration: Forests are identified into

A. High Forest: When regeneration is obtained from seed

B. Coppice Forest: When regeneration is through coppice or some vegetative part of the tree.

1. Natural Forest: When the regeneration is obtained naturally, the forests are called natural forests

2. Man Made Forest: When it is obtained artificially, the forests are called Man-made forests or Plantations.

3. Classification of Forest On the Basis of Composition: Forests are classified into

A. Pure Forests: Pure forests are composed almost entirely of one species, usually to the extent of not less than 50 per cent.

B. Mixed Forests: Mixed forests are defined as forest composed of trees of two or more species intermingled in the same canopy.

4. Classification of Forest On the Basis of Management: Forests are classified into

A. Protection Forests: Protection forests are those which are managed primarily for ameliorating climate, checking soil erosion and floods, conserving soil and water, regulating stream flow and increasing water yields and exerting other beneficial influences.

B. Production Forests: Production forests are those which are managed primarily for their produce.

C. Social Forests: Social forests where the produce is utilised by neighbouring society.

5. Classification of Forest On the Basis of Ownership: Forests can be classified as

A. Government Forests:

On the basis of Legal status, Government forests are further classified into:

a. Reserved Forests: A Reserved forest is an area with complete protection, constituted according to chapter II of the Indian Forests Act. 1927.

b. Protected Forests: A Protected forest is an area subject to limited degree of protection constituted under the provisions of chapter IV of the Indian Forest Act., 1927.

c. Village Forests: A Village forest is a state forest assigned to a village community under the provisions of chapter III of Indian Forest Act.

B. Private Forests

C. Forests owned by Corporations, Panchayats, Societies and other Agencies.

6. Classification of Forest On the Basis of Growing Stock: A forest can be classified into

A. Normal Forest: A Normal forest is an ideal forest with regard to growing stock, age class distribution and increment and from which the annual or periodic removal of produce equals to the increment and can be continued indefinitely without endangering future yields.

B. Abnormal Forest: Abnormal forest is one which is not normal, i.e. growing stock, age, class, distribution of stems, increment, etc. are either in excess or more usually in deficit than the normal forest.

Functions of Forests

Forests are world's air-conditioners and earth's blankets. Without forests, this world would be an inhospitable place to live in. Forests are the most valuable natural renewable resources of the earth. Forests help life on earth by performing various functions. Some of these functions are:

- (A) Productive,
- (B) Protective,
- (C) Ameliorative,
- (D) Developmental

Productive Functions of the Forests

1. Forests are valuable natural resources. The goods provided by the forests are of immense importance to animals and mankind. Wood is a major forest produce and it is extensively used for various purposes. In India, most of wood produced is used for construction of house, agricultural implements, bridges, sleepers, etc. In India about 12.5 million cubic metres of timber is produced from the forest. Many species e.g. teak, sal, deodar, sissoo, babul, chir, haldu, axlewood, rosewood, dipterocarps, etc yield valuable timber.

2. Wood is a universal fuel, Approximately 175 million cubic meters of wood is used as fuel in the country, most of which is obtained from the forests.

3. Forest provides raw material to a large number of industries e.g. paper and pulp, plywood and other board, saw mills, furniture making, packing cases, match boxes and toys.

4. A large number of non-wood products are also available from forests.

These are commonly called Minor Forest Products (M.F.P.) not because these are of minor significance but since they are harvested in smaller quantities. Some of the important minor forest products are as under:

(i) Fibres and Flosses: Fibres are obtained from bast tissues of certain woody plants which are used for making ropes. Flosses are obtained from semal (*Dombax ceiba*) and kapuk (*Ceiba pentandra*).

(ii) Grasses and Bamboos: A large variety of grasses are found in the forests. About 20 per cent of 419 million livestock graze in the forests. Among valuable grasses, sabazi (*Eulaliopsis binate*) is harvested annually to the tune of about 80,000 tonnes. About 5.5 million tonnes of bamboo is harvested from our forests every year.

(iii) Essential Oils: India produces about 1500 tonnes of essential oils from forests every year. It utilizes in making soaps, perfumes, detergents and chemicals. Many species e.g. *Eucalyptus spp.*, *Bursera spp.*, *Cymbopogon spp.*, *Santalum album*, etc. produce these oils.

(iv) Oil Seeds: Many tree species, e.g. *Madhuca indica*, *Pongamia pinnata*, *Shorea robusta*, *Azadirachta indica*, *Schleichera oleosa*, *Vateria indica*, etc. produce oil bearing seeds which are commercially important. Some of these oils can be made fit for human consumption. Presently these seeds are used in soap industry. Tribals use these oils for various purposes. There is a potential of production of about 1 million tonnes of oil every year from forest tree seeds.

(v) Tans and Dyes: A variety of vegetable tanning materials are produced in the forests. Important vegetable tanning materials are the myrobalan nuts and bark of wattles (*Acacia mearnsii*, *A. decurrens*, *A. nilotica* and *Cassia auriculata*, etc. Katha and cutch are obtained from *Acacia catechu* trees.

(vi) Gums and Resins: Gums and resins are executed by trees as a result of wound or injury to the bark of wood. Gums are collected from several tree. Species, viz. *Sterculia urens*, *Anogeissus latifolia*, *Lannea coromandelica*, *Acacia nilotica*, *Cochlospermum religiosum*, *Pterocarpus marsupium*, *Butea monosperma* etc. Resin is obtained from *Pinus roxburghii* (Chirpine)

(viii) Tendu Leaves and Other Leaves: Tendu leaves are used to produce bidi and therefore, these are also called bidi leaves. Annual collection of tendu (*Diospyros melanoxylon*) leaves is about 90,000 tonnes in the country. Madhya Pradesh alone contributes about 45 per cent of this quantity. Leaves of trees such as, *Bauhinia spp.*, *Butea spp.*, etc. are used for making plates, drona, etc.

(ix) Edible Products: Fruits, flowers, seeds, tubers, etc. of several forest species are eaten. *Anacardium occidentale*, *Tamarindus indica*, *Syzygium cumini*, *Embllica officinalis*, *Buchanania lanzan*, flowers of *Madhuca indica*, green pods of *Moringa oleifera*, new shoots of bamboo, etc. are in great demand.

(x) Lac and Other Products: Lac is a resinous secretion of the lac insects which feed on forest trees, particularly of *Butea monosperme*. Similarly, silk is another important product from forests. It is obtained from the cocoons of silk worm. Silk worm is raised on *Terminalia alata* and *Morus alba* plantations for obtaining silk. Honey is another product which is obtained from forests.

(xi) Fodder and Grazing: Forests provide fodder leaves and grazing facility to the rural animals. About 20 per cent livestock population depends upon forest grazing and leaf fodder supply. Leaf fodder of several tree species is almost as nutritious as that of agricultural fodder crops. Good fodder yielding tree species include; *Ailanthus excelsa*, *Moringa leifera*, *Sesbania spp.*, *Morus alba*, *Albizia excelsa*, *Moringa leifera*, *Sesbania spp.*, *Morus alba*, *Albizia lebeck*, *Leucaena leucocephala*, *Pongamia pinnata* *Hardwickia binata*, etc.

Protective and Ameliorative Functions

1) Forests play a significant role in maintaining the CO₂ balance in the atmosphere. Without sufficient forest cover, the CO₂ which is released in the atmosphere will not be utilized completely resulting higher per cent of the CO₂ in the atmosphere. The CO₂ per cent in the atmosphere has already reached 0.042 per cent against the normal of 0.030 per cent. If this increases continuously higher temperature and other disturbances on the earth may bring

about un-imaginable miseries to the mankind.

2) Forests increase local precipitation by about 5 to 10 per cent due to their Geographic and micro-climatic effects. These create condition favorable for the condensation of the clouds.

3) Forests reduce temperature and increase humidity. Temperature in the forests is 3° to 8° less than the adjoining open area.

4) Forests maintain the productivity of the soil by adding a large quantity of organic matter and recycling of nutrients. The leaves of trees are used as manure. Supply of firewood from forests releases dung for the use as manure.

5) Tree crowns reduce the violence of rain and check splash (sound) erosion. Forests, increase infiltration and water holding capacity of the soil resulting in much lower surface run-off. This in turn results in checking of soil erosion.

6) Forests check floods. They intercept 15 to 30 per cent of the total rainfall. They increase infiltration rate and water holding capacity of the soil. This results in reduced surface run-off and checks erosion. Mostly floods are caused due to siltation of river channels, caused due to erosion and higher peak discharges caused due to greater surface run-off.

7) Forests conserve soil and water both.

8) Forests and trees reduce wind velocity considerably. Reduction of wind velocity causes considerable reduction in wind erosion, checks shifting of sand dunes, and halts the process of desertification.

9) Forests, by reducing erosion check the siltation of irrigation and hydal reservoirs.

10) Forests are the store-house of genetic diversity. Several unknown plants may have potential for medicines and food.

11) Forests protect from physical, chemical and noise pollution. Dust and other particulate and gaseous pollutant cause serious problems, forests protect us from such pollutants.

12) Forests and trees provide shelterbelt and windbreak effect which is beneficial to agricultural crops, particularly in arid and semi-arid areas. Shelterbelt and windbreak increase agricultural production.

Recreation and Educational Functions

1) Forests provide recreational facilities to the people. A large variety of trees and shrubs, animals and birds attract a large number of people towards them. National parks and sanctuaries, which are rich in flora and fauna, are visited by a large number of people.

2) Environment to Birds/Birds songs.

3) Aesthetic value

4) Forests provide experimental field and laboratory for learning to college and university students.

5) Forests provide a natural healing effect for a number of diseases. We have a number of sanatoriums established in well wooded areas.

Developmental Functions

- 1) Forests provide employment to a large number of people.
- 2) Forests and various forest activities help tribal to improve their socio-economic condition through collection, processing and marketing of various forest products and by providing gainful employment.
- 3) Forests help to earn a good sum of revenue to the government which is used for various developmental works. During every year forests gives revenue worth of about more than Rs. 20,000 million.
- 4) Development of ponds / conservatories for fisheries.

Problems and Constrains in Forest Development

- i. Loss of forest areas for different purposes.
- ii. Encroachment of people on forest land.
- iii. Cutting due to heavy demand for wood, industry, home fuel
- iv. Excessive grazing of animals
- v. Fires - incidences / attacks / problems
- vi. Shifting cultivation - Tonguya etc.
- vii. Inadequate finance
- viii. Non - involvement of people
- ix. Different projects - irrigation / power / thermal / canals
- x. Ecological balance
- xi. Man hindrance

Forest Types in India

The better defined and more stable units of forest vegetation are referred to as Forest Types or Unit of vegetation which possesses characteristics in physiognomy and structure to permit its differentiation from such other units is called as Forest types.

Champion and Seth have Differentiated 16 Climatic Forest types are as below

- 1) Tropical wet ever green forests
- 2) Tropical Semi ever green
- 3) Tropical Moist deciduous
- 4) Tropical- Literal and swamp
- 5) Tropical Dry deciduous
- 6) Tropical Thom Forest
- 7) Tropical Dry evergreen
- 8) Sub T. Broad leaved will F
- 9) Sub Tropical Pine Forest
- 10) Sub Tropical Dry evergreen
- 11) Montane wet temperate

- 12) Himalayan moist temperate
- 13) Himalayan Dry temperate
- 14) Subalpine
- 15) Moist subalpine
- 16) Dry subalpine

Natural Ecosystems: Forest types are called as Natural ecosystems.

Artificial Ecosystems: These are created by introducing of species -through plantation. Teak, Nilgiri, Poplar

Exotics: The forest tree species brought in to country, from their natural habitat (foreign country) Eucalyptus, Cashew nut, Australian, Babul, Silver oak, Pines, and Poplar

Indotic: Plant species having Indian origin, Neem, Babul.

The basis for Classification of Forest Types

1. Physiognomy: Evergreen / deciduous habit, very dry, wet
2. Structure: Covers stratification, dimensions, ht/spaci
3. Function: Morphological characters
4. Floristic: Families, genus, sps.
5. Dynamics: Vegetation change, Force in motion
6. Habitat: Climatic and edaphic factors
7. Physiography: Aspect / altitude
8. History: Past History of site.

• Classification of Silvicultural System

- There are number of ways for classification, but most common is on the basis of Mode of Regeneration and further classified according to pattern of felling carried out in the crop.
- **Two Main Categories or Groups:**
 - 1) High Forest Silvicultural Systems
 - 2) Coppice Silvicultural Systems
- **1) High Forest Silvicultural Systems:**
 - Silvicultural systems in which regeneration is normally of seedling origin either natural or artificial or combination of both and where rotation is generally long
 - A) System of Concentrated Regeneration
 - **a) Clear Felling System:**
 - i) The clear felling system
 - ii) The clear strip system
 - iii) The alternate strip system
 - **b) Shelter Wood System:**
 - i) The Uniform System
 - ii) The Group System
 - iii) The shelter wood strip system
 - iv) Anger's Blender system
 - v) Eberbird's Wedge System
 - vi) The Strip and Group System
 - vii) The irregular Shelter wood system
 - viii) The Indian Irregular Shelter wood System

- B) System of Diffused Regeneration:**
 - a) The Selection System
 - b) The Group Selection System
 - C) Accessory System:
 - a) Two Storeyed High Forest System
 - b) High Forest with Reserves System
 - c) Improvement Fellings
 - **Silvicultural System of Concentrated Regeneration**
 - **a) Clear Felling System:**
 - **i) Clear Felling System:**
 - Defined as 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.
- Regeneration:**
- **1) Artificial:**
 - a) Deptt. plantation
 - b) Taungya i) Deptt. ii) Leased iii) Villages
- **2) Natural:**
 - a) Seed stored in the area
 - b) Received from outside.
- **Advantages of Clear Felling System:**
 - 1) Simple and not require a high degree of skill in marking for felling.
 - 2) Yield / Unit area is more, cost of felling and extractions is less.
 - 3) Increasing the proportion of valuable species and introducing fast growing exotics.
 - 4) Easy supervision of all operations / regeneration felling, conservation, extraction.
 - 5) Does not involve any damage to new crops.
 - 6) Reduces cost of regeneration operations and shortening the rotation.
 - 7) The coupe (area) can be opened up for growing soon.
 - 8) More cleaner and cylindrical boles and trees.
 - 9) Ideal for mechanization.
 - 10) Success or failure for regeneration work is absolutely clear by the end of second year.
- **Disadvantages of Clear Felling System:**
 - 1) Most Artificial
 - 2) Great danger of deterioration soil and the soil erosion increases due to exposure and area till the canopy closes
 - 3) Problems of invitation of weeds and grasses / fire hazards
 - 4) Less resistant to damages by wind (even aged crop)
 - 5) Devastated appearance of large clear felled areas
 - 6) It sacrifices all the immature trees when applied first
- **ii) The Clear-Strip System:**
- It is defined as a Silvicultural system in which clear felling is done in the form of strip which progress successively in one direction (against prevailing direction of wind) across the regeneration area. It is also known as Progressive strip system.
- **Advantages of the Clear-Strip System:**
- In addition of Clear Felling It does not deteriorate the site and maintains the aesthetic beauty of the area, while it is difficult for protection against fire, grazing etc.
- **iii) The Alternate Strip System:**

- It is defined as a Silvicultural System in which clear felling is done in the form of strip and the clean filled strips alternate with un-felled strips of similar width though sometimes these may be narrower or wider also.
- **b) Shelter Wood Systems:**
- As the regeneration is obtained under shelter of the over wood is called Shelter Wood System and as over wood is removed in two or more operations, these are called as systems of successive regeneration forestry.
- In other word shelter wood systems involves gradual removal of the entire stand in two or more successive feelings which extend over a part of rotation.
- **i) The Uniform System:** Defined as silvicated systems in which canopy is opened up for regeneration uniformly over the whole compartment in one operation.

Advantages of the Uniform System:

- 1) Little risk of soil deterioration and erosion
- 2) Marking and feeling of trees is simple
- 3) Invitation of weed is not their
- 4) Young plants are protected against adverse conditions e.g. frost, cold, wind
- 5) Good establishment of superior species
- 6) Insects injuries are reduced considerably
- 7) New crop appears before the old one is harvested, rotation is shortened
- 8) Little loss of potential wood production
- 9) Easy supervision
- **Disadvantages of the Uniform System:**
- 1) Damages may cause to regenerated seedlings while feeling of retained trees
- 2) Required knowledge to maintain canopy / shade
- **ii) The Group Systems:**
- Silviculture Systems in which regeneration felling, instead of being done uniformly all over the compartment are carried out in scattered groups
- **Advantages the Group Systems:**
- 1) Young crop develops in a more natural way than it does in Uniform Systems
- 2) Protection against frost and insolation
- 3) Damage by felling to regeneration is avoided during the earlier stages by regulating the fall of trees towards the un-filled frost.
- **Disadvantages the Group Systems:**
- 1) In hilly terrain area it is difficult
- 2) Marketing of feeling trees is difficult
- 3) Supervision and control becomes difficult
- 4) Considerable losses in hilly areas to regeneration due to rolling/ sliding logs of timber
- 5) Requires intensive working
- 6) Not possible in India 30 years on one place

iii) The Sheltered Wood Strip System:

- Silviculture System in which regeneration, felling is done in the form of strips successively from one side of the compartments progressing against direction of wind.
- **iv) Strip and Group System:**
- Modification of sheltered wood strip system in which fellings done in strips confirm in the group system instead of the uniform systems
- **v) The Irregular Sheltered wood System:**
- Silviculture System in which regeneration felling's on the pattern of group system but as the regeneration period is long, the crop produced is uneven aged or irregular.
- **vi) Indian Irregular Shelter Wood:**
- Defined as Silviculture System in which the crop to be regenerated is opened up

irregularly and the resultant crop is uneven-aged. It provides for retention of groups of well-grown poles and immature trees as part of future crop and it permits the adoption of selection felling on step or rugged portions of compartment being-worked under uniform systems.

- **vii) Agner's Blender System :**
- Silviculture System in which regeneration felling is carried out in narrow strips extending in east west direction and developing from north south object. Offered side protection to regeneration, modification of sheltered strip systems

vii) Wedge Systems:

- Silviculture System in which the strip instead of being one end, is located in the middle of its length coming in the wind direction.

• **Silvicultural Systems of Diffused Regeneration**

a) The Selection System:

Silviculture System in which felling and regeneration are distributed over the whole area and the resultant crop so uneven-aged that trees and all ages are found mixed together over every part of the area.

- 1) Distributed over whole area
- 2) All age classes are mixed together on every unit and area
- 3) Regeneration operations are carried out throughout the life of the crop and thinning are done simultaneously for improving the growth and form of trees.
- **b) The Group Selection System:**

Selection system in which trees are felled in small groups and not as scattered single trees of the typical system employed on a part of the whole forest each year under a felling cycle.

- **Advantages the Group Selection System:**
- 1) Maintains continuous canopy
- 2) Consumes soil and moisture to the fullest extent possible
- 3) Most resistant to injuries by insect pests and adverse climatic factors
- 4) Prevents invitation of grass and weed
- 5) Natural regeneration comes up without difficulty
- 6) More growing stock of all ages trees under each-others and
- 7) Best systems for production of large size trees
- 8) It produces a forest which is superior biologically, as well in its aesthetic and scenic values.
- **Disadvantages the Group Selection System:**
- 1) Skill in marking and felling to ensure regeneration to come up in the gaps
- 2) Cost of logging and extraction is more as mature trees are scattered
- 3) Inherent quality timber, natural regeneration
- 4) Grazing problems
- 5) Protection is difficult to achieve
- 6) Success or failure of regeneration difficult to assess
- 7) Growing stock progressively degenerates with every felling by regeneration of less valuable species.

• **Silvicultural Accessory Systems**

- Silviculture System in which irregular felling or two storeyed high forests is observed.
- **a) Two Storied High Forest:**
- Silviculture System which result in the formation of a two storeyed forest with specific objectives
 - 1) Protection of soil
 - 2) For increasing the proportion of valuable species in the moist deciduous and semi-evergreen forests
 - 3) For propagation of species which cannot be raised in open.
- **Reason:**
- - 1) Protection of soil
 - 2) Increasing production by growing two crops on same area
 - 3) Protection for tender regenerated plants
 - 4) To change the species gradually
 - 5) To provide for a vertical mixture in species composition
 - 6) To obtain early returns
- **Disadvantages of Two Storied High Forest:**
- - 1) Under planting is difficult task
 - 2) Damages to under storey during felling of upper one
 - 3) Under storey crop may affect growth of upper storey
- **b) High Forest with Reserves System:**
- Silviculture System in which selected trees of the crop being regenerated is retained for part or whole of the second rotation, in order to produce large sized timber.
- **c) Improvement Felling:**
- As the method of treatment involving essentially the removal of inferior growing stock in the interest of better growth and the more valuable individuals. It is usually applied to mixed uneven aged forests.
- Felling of dead, dying and diseased trees, Un-saleable unsound over mature trees removal, badly shapes or unsound tree felling, Felling and congested groups of fallen trees, Removal of undesirable undergrowth/inferior trees, Climber cuttings.

Coppice System of Silviculture

Defined as that Silviculture System in which the new crop originates mainly from shoot / stool coppice and where the rotation of the coppice is short.

Various Methods of Coppice System are followed as

- 1) Simple Coppice
- 2) The Coppice of Two Rotations System
- 3) Sheltered Coppice
- 4) Coppice with Standard Systems
- 5) Coppice with Reserves System
- 6) Coppice Selection System
- 7) The Pollard System.

1) Simple Coppice: Defines as Silviculture System based on stool coppice, in which the old crop is, clear filled completely with no reservation for sheltered wood or any other purpose.

Advantages of Simple Coppice:

- 1) Very simple / no skill
- 2) Regeneration is more certain
- 3) Grows fast - so cost of weeding / cleaning and protection is less,
- 4) Reduces rotation period as growth is very fast
- 5) Net returns are more even small sized wood produced

Disadvantages of Simple Coppice:

- 1) Small sized low price timber
- 2) Exhaust more mineral substances as more shoots produced
- 3) Not permanent / after every coppice some shoots dies
- 4) Great damage by frost and wind
- 5) Not desirable from aesthetic point of view

2) Coppice of Two Rotations Systems: Modification of Simple coppice system which at the end of the first rotation of coppice, a few selected poles are left scattered singly over the coupe in the second rotation to attain bigger size.

3) The Sheltered Wood Coppice System: Another modification on Simple coppice system in this system even in the first clear felling, some sheltered (125 to 150 trees/ha) trees are retained for frost protection.

Applied in Following Circumstances:

- 1) Where forest is of common occurrence
- 2) Where locality is good.
- 3) Where the species to be worked can coppice up to a longer age.
- 4) Where in addition to small sized timber, demand for large timber also.
- 5) Where a rotation longer.

4) Coppice with Standards: Defined as Silviculture System. based on coppice in which an over wood of standards usually seedlings origin and composed of trees of various ages as kept over coppice for periods which may be multiples of coppice rotation and a permanent feature of the crop throughout two peculiarities which differentiate it from the simple coppice.

5) Coppice with Reserves: Felling is done only in suitable areas likely to benefit, after reserving all financially immature growth of principal as well as other valuable miscellaneous species, either singly or in optimally spaced groups, tree yielding products of economic importance and entire crop for protective reasons.

6) Coppice Selection System: Silviculture System in which felling is carried out on the principles of selection system but regeneration is obtained by coppice.

7) The Pollard System: Pollard is defined as a tree whose stem has been cut off in order to obtain a flush of shoots, usually above the height to which the browsing animals can reach. Thus, the Pollard system consists in Pollarding trees periodically to obtain exploitable material.

Regeneration of Forest

The renewal of a forest by some means (e.g. natural or artificial) is known as regenerations. The regeneration has been defined in a number of ways by several workers.

- 1) "The renewal of a forest crops by natural or artificial means; also the new crop so obtained".
- 2) Regeneration as, "The renewal by self-sown seed or by vegetative means." It is of two types viz., Natural regeneration and Artificial regeneration.

Methods of Regeneration:

There are following methods of regeneration of forest:

- A) Natural Regeneration,
- B) Artificial regeneration and
- C) Natural regeneration supplemented by Planting.

However, first two methods are most important in regeneration of forests.

A) Natural Regeneration:

The renewal of a forest crop, by self-sown seed, or by coppice or root-suckers, also the crop so obtained or also it can be defined as Reforestation of a stand by natural seeding.

B) Artificial Regeneration:

It is defined as the renewal of a forest crop by sowing, planting, or other artificial methods; also the crop so obtained or the renewal of a tree crop by direct seeding, or planting.

Site Preparation for Regeneration of Forest

The site preparation is used to create an environment suitable for establishing the desired tree species

- 1) To get rid-off logging slash or other debris
- 2) Reducing competition and animal habitat
- 3) To prepare a mineral soil seedbed
- 4) To improve drainage of surface and upper soil horizons and reduce the compaction
- 5) To create a more favorable micro site on harsh sites
- 6) To take measure to control disease.

Site Preparation Methods:

Following four methods of the site preparation are commonly used all over the world:

- i) Mechanical
- ii) Prescribed Burning
- iii) Chemical and
- iv) Combinations of the three.

i) Mechanical Method of Site Preparation for Regeneration: There are several methods employed for carrying out the site preparation mechanically. Following are some of the common mechanical methods:

a) Logging: This is the most common practiced method of site preparation. In this method, logging equipment is used for removing the vegetation and slash.

b) Scalping: This is nothing but the site preparation by hand cleaning.

c) Mechanical Cleaning: In this method self-propelled or the tractor drawn equipment are used.

ii) Prescribed Burning: Fire is a nature's principal method of preparing sites for a new stand.

iii) Chemical Method: The herbicides may be used in new burns and the cuttings, non or poorly stocked parts of plantations, or in existing bushy fields.

Factors Affecting the Choice of Forest Regeneration Method

It is very important to make a choice of method of site preparation. In this case, there are, a number of factors influencing the choice of site preparation method. Following are the seven factors which play a vital role in the choice of method:

- 1) The nature of existing ground cover,
- 2) Physical site factors,
- 3) Site preparation requirement,
- 4) Available labour and equipment
- 5) External constraints,
- 6) Environmental impacts and
- 7) Cost incurred in the operation.

Natural Regeneration of Forest

Regeneration from seed or vegetative parts may observe in Natural Regeneration.
Reforestation of a stand by Natural seedlings

1) Natural Regeneration from Seed: Successful natural regeneration from seed depends upon Seed production, Seed dissemination, Seed germination, Establishment and seedlings.

a) Seed Production: Seeds are cultured ovules, which contain the embryo. An embryo is a miniature plant consisting of seed leaves (cotyledons) attached to rudimentary stem (hypocotyl) with a growing tip (Plumule) and a root tip (radicle) at the other end. Seed production depends upon various factors such a species, age of tree, site, weather conditions, season of maturity, alternate bearing, attack of pests and diseases and birds.

b) Seed Dissemination: For the continued existence of a species, it is necessary that seeds are carried away from the parent plant, because seeds germinating immediately below the parent tree commonly do not get established. Seed dissemination gives young seedlings a better chance of survival for they are saved to a large extend from competition with the parent plant. The means of dispersal adopted by the seeds of different species vary widely. The four important agencies by which seed dispersal is secured are i) Wind, ii) Water, iii) Animals, iv) Explosive mechanism or ejection mechanism in fruit itself.

c) Seed Germination: Germination of seed depends upon several internal and external factors such as Permeability of seed coat, Availability of moisture in seed, Oxygen, Nature of embryo (dormancy), Temperature, Moisture in soil, Oxygen and light. Besides this some factors,

- 1) Age of Tree,
- 2) Flowering Phase,
- 3) Sound or health of seed condition,
- 4) Coppice origin trees,
- 5) Size of seed,

- 6) Plant per cent,
- 7) Type of dissemination,
- 8) Soil type / nutrition,
- 9) Pest and disease,
- 10) Non insect pests.

d) Seedlings Establishment: Successful establishment of newly germinated seedlings in sufficient number as a member of forest crop is undoubtedly, the weakest link in the whole chain of process (a to c) which make up the regeneration of forest crops.

The Factors Responsible, for Seedlings Establishment are as:

- 1) Climate: Light / moisture rainfall / temperature / frost
- 2) Edaphic - Soil / nutrient / aeration / texture / structure.

II) Natural Regeneration by Coppice and Root Suckers: Coppice : Stool shoots generally arise from the adventitious buds formed between the wood and the bark of the stump and are comparatively short lived than those produced by dormant buds. These shoots are called coppice shoots.

Classification of Coppice Regeneration:

- 1) Seedlings Coppice
- 2) Stool Coppice and
- 3) Root collar Shoots
- 4) Pollard Shoots

Natural Regeneration by Root Suckers: Shoots arises from the roots, may occur naturally or artificially.

Regeneration by Artificial Method

The deforestation is still continuing and takes a heavy toll of forest wealth. This not only affects the forests but the wildlife and the whole ecosystem also. Deforestation is on alarmic rate (1.5 million hectare every year). For carrying out artificial regeneration, there are some preliminary considerations which are urgently needed.

Basic Steps in Artificial Regeneration:

1) Choice of Species:

- i) The choice of species is very important in artificial regeneration. Therefore, before choosing the tree species, the purpose of growing the trees has to be specified.
- ii) Climate and microclimate: The choice of species depends upon the prevailing climatic and micro-climatic conditions.
- iii) Soil requirements: a) Wet soils - Salix species, Populus species, etc. b) Water - logged soils, Eucalyptus robusta, E. saligna etc. c) Sandy loam - Albizia procera, Acacia nilotica, Dalbergia sissoo, etc. iv) Market facilities :
- v) Growth rate: Fast growing tree species - Acacia nilotica (Babul), Leucaena leucophala (Subabool), Melia azedarach (Bakain), P. deltoides (Poplar), Salix species (Willow)
- vi) Availability of Exotics: In simple it meaning pertains to, not native to the area of question. The exotic can be described as "an organism in an area which is not native of the area but has its origin in some other region. For example, Eucalyptus species, Leucaena leucocephala,

Robinia pseudacacia, Populus deltoides etc.

vii) Base of establishment.

viii) Management objectives. The artificial regeneration depends upon the objectives of management.

ix) Site conditions: The site is the complex of physical and biological factors of an area that determine what forest of other vegetation may ^arry.

x) Succession: The succession is the gradual replacement of one community by another in the development of vegetation towards a climax.

xi) Cost of growing: This is also very important factor affecting the choice of species.

xii) Availability of seed /propagation material : The seed source should be sound.

2) Choice of Method: The success of artificial regeneration depends, to a great extent upon the choice of method. There are mainly two methods of this regeneration, viz. i) Sowing and, ii) Planting.

i) Sowing: Sowing, in the simplest words, is the process of scattering the seeds in a particular place e.g. nursery bed, field etc.

Advantages of Sowing:

- a) It is the cheapest method and costs less,
- b) Sowing is direct method and no other complications,
- c) It takes less time and thus the work is completed soon,
- d) In sowing method, there is no question of disturbances of roots.
- e) Sometimes, sowing is done directly in the field (in forests), and hence it does not require any nursery.
- f) The sowing being the simple method, is supposed to be less cumbersome.

ii) Planting: Planting is another method of artificial regeneration. However, planting is described as the transferring nursery stock to the planting site as contrasted with transplanting in the nursery.

Advantages of Planting:

- a) More Success, b) Less seed needed c) No damage, d) Cheaper weeding

Disadvantages of Planting:

- a) Need of nursery
- b) Disturbance of roots
- c) Time consuming,
- d) Need of skilled labour
- e) Incurred high costs

3) Site Selection: The selection of site is also a crucial factor in artificial regeneration. There are several factors which affect the site preparation.

Following are the factors which are essential to carry out the preparation:

- 1) Ground Cover:
- 2) Physical Factors: a) Topography, b) Exposure, c) Soil type, d) Erosion hazards, e) Size of treatment area and f) Access
- 3) Preparation requirement: To create a suitable environment for establishment of desirable

species.

4) Man Power and Equipment: The site selection and preparation methods require good skill and useful equipment.

5) External Constraints: a) Legal responsibilities, b) Smoke management guidelines, c) Proximity to sensitive areas and d) The attitude of adjacent farmers / land owners.

6) Spatial Arrangement: This is also called as Spacing.

Artificial Regeneration by Vegetative Method:

Planting material besides seeds for e.g. Bare root seedlings, containerized seedlings, cuttings, layering, rhizomes, suckers, offsets, bulbs, corms are also used for vegetative propagation material.

Propagation by Cuttings: Cuttings are of two types, 1. Stem cutting 2. Root cutting

1. Stem Cutting: Very few species response well for this method. The species, which easy to root are suitable for this method of planting. Particularly species of di-cotyledons group having active cambium layer e.g. Shisam, Nimbara Drumstick, Mulberry Inga dulsis, Dhaman, Pangara, Pimpal, and Banyan Tree etc.

Depending upon the maturity of stem cutting are grouped into:

i) Hard Wood Cutting: Mature woody branches are used.

ii) Soft Wood Cutting: Recently mature branches are used e.g. mulberry-Inga dulsis.

iii) Root-cutting: Roots are used for preparation of cutting e.g. Sandalwood, Pangara.

2. Stumps: In few species, stumps are used for planting e.g. Teak, Shivan, Shisam, Cassia spp. Stumps are easy to transport, require less space and can be transported to long distance. These are prepared at the time of planting operation or just before planting operation. Fresh uprooted seedlings are used to transplant easily. 20% stem portion and 80% taproot is kept while preparing the stump. Fine edge knife or implement is to be used so as to avoid the damage, stem portion is cut 5 to 6 cm above the collar region is kept intact and remaining portion or roots are cut to prepare stump. The stumps are then packed in bundles, keeping stem portion on one side and roots on another side, the stumps should be transported immediately. For transportation stumps are covered with moist gunny bag cloth to avoid desiccation. They can be transported within 2-3 days without much loss.

These stumps are planted on start of monsoon after 3-4 rain showers when soil becomes sufficiently moist and soil temperatures are warm. Stumps are planted by preparing small holes in slating portion with the help of crowbar so that new shoot will rise straight. Then the stumps are inserted inside and soil is pressed firmly so as to avoid water stagnation in the hole. The cooler region is kept just near to the soil surface.

3. Root Suckers: Root suckers can also be used for planting purpose e.g. Pomegranate, Kokum, Salaim Anjan, Shisam, Nimbara, Pangara, Erythrona etc. The layers, grafted plants, budded plants can be used to prepare planting material. These all are only used in forestry for conservation of superior genotype. It is used for commercial plantation as they are short lived, spreading and not develop long straight (trunk), particularly suitable for timber purpose.

Planting by root cuttings in sandal wood, pangara. Planting by root suckers e.g. Pala, Anjan, Pomegranate, Kokum, Salai, Shisam, Nimbara, Erythrina Supersa.

Methods of Seed Collection

Following are the important methods of Seed Collection:

a) Seeds from Standing Trees: The collection of seeds from marked standing trees is done by collecting the seeds by bamboo hooks or by specialized labourers employed for climbing and collecting the seeds.

b) Seeds Collected from Fallen Trees: In addition to collection seed during normal felling operation special felling of trees may be done for seed purposes for e.g. *Terminalia tomentosa*, *Tectona grandis*, *Eucalyptus* spp. the seeds are collected from the fallen trees. Drawback of special felling is that tree is killed in the process of harvesting and only the very best trees need to be felled.

c) Collection from the Ground Floor: Ground collection of natural seed fall is done for the species which produce large heavy seeds or fruits which normally fall to the ground can be collected by spreading tarpauling or polyethylene sheet under tree for e.g. *Gmelir arborea*, *Shorea* species, *Mangifera*, *Azadirachta*, *Tamirindus*.

d) Lopping of Branches: By directly, climbing on trees some of the seed bearing branches are cut down by lopping, that is selectively cutting the branches without damaging the tree. For ex. *Babul* (*Acacia nilotica*), *Delonix regia*, *Bahuna*.

Flowering Habit, Time of Seed Collection, Seed Extraction and Cleaning of Trees

Flowering Habit of Trees:

It is essential to know that the flowering habit, flowering time of different trees to know the exact time and method of seed collection for ex. *Bombax* flowers profusely after 30-40 years and the seeds fall on the ground during seeding years should be collected in the species like *Pinus strobus*. The trees flower profusely but only for short duration some trees are dioeciously, some trees are monoecious. The production of seed depends upon a good seed years that is the years in which the good seeds are produced. Nagi (1983) reported the seed habit for *Abies pindrow* six years, *Citrus deodara* three years, *Pinus roxburghii* three years etc. The seed production also depends upon size of crown that is big size of crown is preferred over other sizes, open canopy of the tree are regarded as store houses of cones and seeds. Some trees like *Eucalyptus* and *Silveroak* can keep seeds on trees in capsules for long time, the seeds from *Casuarina* are to be collected when the capsules are ripe, and before opening the capsules by bagging them otherwise, the seeds may not be collected because they are very minute.

Time of Seed Collection:

The seeds of *Casuarina*, *Babul*, *Shivan*, *Arjun*, *Neem*, *Salai* are collected in the month of April to June. The seeds of *Sissoo*, *Shisam*, *Teakwood*, *Vilayti babul* and *Eucalyptus* are collected from November to February. The seeds of *Ain*, *Australian babul*, *Kashid*, *Amaltas* are collected in the month of March April.

The Seed Extraction and Cleaning:

The seed extraction is done from cones, capsules, pods carefully; pulpy fruits of *Neem*,

Mango, Shivan, Kandamba are extracted by

- a) Sundering and removing pulp mechanically by hand
- b) Soaking to allow the fleshy part to separate from the seed

The seed from the dry, legumes and pods is done by drying the legume pods and seeds in the sun light to stimulate opening and then separating seeds from Chaff and other impurities. Sun drying time may vary from species to species for ex. Pinus patula for one day, Eucalyptus for 4-5days

Tending Operations in Silviculture

For establishment of the regeneration and subsequent development of the forest crop up to harvesting, several operations are carried out. These operations are carried out in the forest crop at different stages of growth in order to provide a healthy environment for their development. These operations are called tending operations includes:

- i) Weeding
- ii) Cleaning
- iii) Thinning,
- iv) Improvement Felling,
- v) Pruning
- vi) Climber Cutting

i) Weeding:

Weeds may be controlled by following methods:

- a) Mechanical Methods
- b) Biological Methods
- c) Chemical Methods

ii) Cleaning:

Cleaning is carried out in a crop which has not crossed the sapling stage and is defined as the cutting made in order to face the best individuals from undesirable one of the same age which interfere or are likely to interfere with the growth of the desired individuals. The greatest advantage offered by cleaning is the-proper regulation of the composition of the crop, particularly in mixed crops.

Methods of cleaning may be mechanical, biological and chemical as described under weeding.

iii) Thinning:

Thinning is defined as a felling made in an immature stand for the purpose of improving the growth and form of the trees that remain, without permanently breaking the canopy. Thinning is a tending operation carried out in a crop beyond the sapling stage and up to the beginning of regeneration period. Thinning principles are so formulated that these are applicable only to pure even aged or relatively even, aged crop or even aged groups of the trees in a crop.

Thinning principles have been developed on the basis of natural development of the stand. Thus, thinning, takes place naturally in a density stocked forest under the law of Survival of the fittest.

Objectives of Tending Operation - Thinning

1) To Improve the Hygiene of the Crop:

By removing dead, dying and diseased trees, hygiene or health of tree can be maintained well.

2) Salvage of Anticipated Losses of the Merchantable Volume:

A large number of trees die of suppression. This amount contributes of about 20 per cent of the merchantable volume. Thinning contributes a substantial amount in the total yield of crop. Thinning helps in shortening of the rotation. Reduction in number of trees in thinning increases the diameter of the remaining trees.

3) To assure the Best Physical Conditions of Growth:

The objective of the thinning is to keep growing stock somewhere within the range. The effect of extreme competition is reflecting by decline in the rate of growth with increasing density in crops which are very dense. Thinning increase the diameter of the crops. Thus thinning may be essential tool for shortening the rotation of a crop.

4) To Obtain Desired Crop:

Thinning helps to improve the stand structure. It ensures a uniform and proper distribution of trees all over the area. This enables the trees to tap water and nutrients from a larger area. The composition of the crop can also be improved. The less valuable species may be removed in thinning and the important and valuable species may be retained for future.

5) Improvement of Stand Composition, Regeneration and Protection:

If an undesirable species is not eliminated during regeneration stage it can be done during thinning to a certain extent. Thinning helps in obtaining suitable seed bearers for obtaining successful regeneration. The dead, drying and diseased trees are removed to afford protection from insect pest, disease and fire because these trees may serve as a source of infection.

6) Improvement in Wood Quality:

Thinning may also improve the quality of wood because trees with higher diameter are likely to be of better quality than smaller ones.

7) To Increase Net Yield and Financial out turn from a Stand:

Thinning help to obtain returns early. The sale of thinning material helps to reduce investment burden because of early returns from thinning and shortening of rotation.

8) To Help Decomposition of Raw Humus:

In temperate forests, thinning increases light and temperature on the forest floor and causes mechanical disturbance which help the decomposition of raw humus and release of nutrients, etc.

Introduction to Agroforestry

Social forestry pertains to those areas and forest which are manmade. Agroforestry is conspicuously and important part of Social forestry and is it a dual system of production i.e.

production of forest crops and food crops, fodders or medicinal plant becomes possible. It meets simultaneously at least two requirements of the participating persons. Agroforestry is defined as a sustainable land management system which increase the overall yield of land, combined with the production of crops (including tree crops) and forest plants and animal simultaneously or sequentially on the same unit of applies management practices that are compatible with the cultural practice of the local population. Thus in Agroforestry co-existence of farm and forestry is adopted on a scientific basis and consequently, the total yield of land is raised significantly. Present status of forest in India is as follows:

Total land area	329 m. ha.
Area under Agriculture	143 m. ha. (47%)
Area under Forest	75 m. ha. (22.7%)
Barren Land	21 m. ha.
Under non Agriculture	18 m. ha.
Illegally occupied	24 m.ha.
Population	1000 M.
Cattle production	400 m

- Half of the Forests in India are denuded, various degrees due to increased human activities.
- India's fast growing population stands at a count of more than 1000 in. and cattle population about 400 m, in which demands for huge amount of food, fodder, timber, fuel, Medicines, employment etc. It has been internationally acknowledged that 30 to 33% of the total geographical area must be under good forest cover.
- For balance environment and ecosystem
- All the above situation calls for massive programme of Afforestation and planting with people's participation. This programme should attempt is restore ecological balance and meet the various needs of rural people. This is feasible only if tree growing become a people's programme which brought to be combined with agriculture.
- The forest land area of 75 in ha under forest cover was not adequate to maintain good environment. It was therefore, rightly resolved through a National Policy Resolution in the year 1952 to add 35 m ha to the forest cover and to bring 33% of our land under forests. The decision though wise, timely and far-sighted, was never implemented with the same spirit.

Against this background Agroforestry should become an important land use system, conventionally which was duly recognized by planners while preparing the seventh plan document. At this stage a recommendation was also made that Agroforestry might be included as core subject in the curriculum by all the State Agricultural Universities.

Objective of Agro-forestry

- 1) To manage land efficiently so that its productivity is increased and restored.
- 2) To use available resources efficiently and economically
- 3) To generate employment opportunities for rural peoples.
- 4) To provide raw material for small cottage industries in rural areas.
- 5) To raise the supply of fuel in the rural areas at convenient distance for consumer. In India 70 million tons of dried cow dung is used every year, which can be diverted for natural organic fertilizer moreover undue pressure is on traditional forest for obtaining fuel wood.
- 6) Agro-forestry aims to raise the supply for small timber used by villages for agricultural implements, house construction and other domestic purposes. In this way Agroforestry can meet this requirement of the rural population and reduce pressure on forest.
- 7) One of the main objectives of Agroforestry is to raise the production of food crops, legumes and tuber to meet the rapidly growing food requirements of the Indian population.
- 8) Agroforestry aims at promoting production of, vegetables, pulses, milk and meat. Thus it can raise the Nutritional value of food, which is urgently, require for mankind in our country. Average Indian gets 2000 calories when 3000 calories require per day.
- 9) Agro-forestry program helps in obtaining an ecological balance in rural areas and thus it may be consider a matter of great significance for a country like India.
- 10) Preservation of humidity in cultivable lands and check soil erosion. Increase productivity of land. In drought prone areas Agroforestry reduces insecurity of the agriculture; in such areas the dual system of production of tree and grasses ensures stability with productivity of land.
- 11) Supply of fodder for vast population of livestock. For proper feeding to livestock increase supply of fodder is urgently required. Large supply of milk and meat is achieved from livestock and poultry when fodder and feeding is proper.

Classification of Agro-forestry System

Different types of Agroforestry systems exist in different parts of the world. These systems are highly diverse and complex in character and functions. To evaluate understand and seek to improve them requires their classification into different categories. Several criteria can be used in classifying them, but the most common include the system's structure, functions, and socio-economic scale of management and ecological spread. According to Nair (1987), Agro-forestry systems can be classified according to following sets of criteria.

1. Structural Basis:

Consider the composition of the components; specially refer including spatial admixture of the woody component, vertical stratification or the component mix and temporal arrangement of different components.

2. Functional Basis:

This is based on the major function or role of the system; mainly of the woody components (This can be productive or protective).

3. Socio-economic Basis:

Consider the level of inputs or management (low input, high input) or intensity/scale or management and commercial goals.

4. Ecological Basis:

Take into account the environmental conditions on the assumption that certain types of systems can be more appropriate for certain ecological conditions.

Classification of Structural Basis Agro-forestry System:

In these systems the type of component and their arrangement are important. On the basis of structure, Agroforestry systems can be grouped into two categories

- I. Nature of components
- II. Arrangement of components.

I. Nature of Components:

- (A) Agri-silvicultural Systems
- (B) Silvipastoral Systems
- (C) Agro Silvipastoral Systems
- (D) Other Systems

II. Arrangement of Components:

- (A) Spatial Arrangement
- (B) Temporal Arrangement

Kinds of Land and Site for Agro and Farm Forestry

The following type of land and sites can be assigned for Agroforestry

- (I) Field boundaries
- (II) Along with farm roads
- (III) Along with nala sites
- (IV) Land on which cultivation is difficult
- (V) Old fallow lands
- (VI) Cultivable wasteland
- (VII) Site of cattle shade, kitchen farm, farms of house etc.

Choice of Species for Agro and Farm Forestry

Following considerations mainly motivate the selection of species in social forestry.

- (1) Rapid growth
- (2) No competition with field crop.
- (3) Fixation of Nitrogen
- (4) Easy decomposition of litter or leaves
- (5) Fast growth and easy establishment
- (6) Ability to regenerate
- (7) High yield of wood and fodder
- (8) Multiple use of wood like Subabul
- (9) Plant with deep tap root system
- (10) Plant yielding small timber
- (11) Easy in establishment and ability to coppice
- (12) Capacity to grow under wide range of environment, soil types, rainfall etc.
- (13) For recreation and shade plants with quick growing and give shade and pleasing colour like Spathodia, Gulmohar, Cassia, Jakaranda are selected.

Socio-economic Aspect of Agroforestry

1. Requirement for more labor inputs, which may cause search at times in other farm activation.
2. Competition between food or fore crops which could cause aggregate field, to be grown than those of single crop.
3. Longer period required for trees to grow to mature and acquire an economic value.
4. Resistance by farmers to displace food crops with trees especially where land is scarce.

Benefits from Agro-forestry

Combining trees with food crops on cropped farms yield certain environmental benefits such as,

1. Reduction of pressure on Forrest.
2. More efficient recycling of nutrients by deep rooted trees on the site.
3. Better protection of ecological systems.
4. Reduction of surface run-off, nutrient leaching and soil erosion.
5. Improvement of microclimate, such as lowering of soils surface temperature and reduction of evaporation of soil moisture due to mulching and shading.
6. Increment in soil fertility through addition and decomposition of litter fall.

Economical Benefits:

Agro-forestry brings significant economic benefits to the farmers, the community, the region and the nation such as:

1. Increment in outputs of food, fodder, fuel wood, timber and organic matter.
2. Reduction in incidence of total crop failure.
3. Increase in levels of farm incomes due to improved and sustained productivity.

Social Benefits:

1. Improvement in rural living standards from sustained employment and higher income.
2. Improvement in nutrition and health due to increased quality and diversity of food.
3. Provides stability to rural peoples.
4. Ecological balance.
5. Pollution reduction.

Scope of Agro-forestry In India

There is tremendous scope for Agroforestry because India has achieved self-sufficiency in food production. Now its attention is becoming more focused on the ecological problems and shortage of fuel, fodder and other outputs as well as unemployment. Agroforestry has vast scope in meeting this requirement through multipurpose tree species as:

- (I) large area is available in the form of farm boundaries, bunds, waste lands where this system can be adopted
- (II) This system permits the growing suitable tree species in the field where most annual crops are growing well
- (III) By growing trees and crops on Agricultural or forest land, Resources are utilized efficiently
- (IV) System has potential generate employment.

- (V) Provides raw material for the cottage industries
- (VI) Helps in maintaining ecological balance
- (VII) Soil and water conservation, soil improvement.
- (VIII) Helps in meeting various needs of growing population.

Improved Fallow Species in Shifting Cultivation

Fallow are cropland left without crops for a period ranging from one season to several years.

The objective of improved fallow species in shifting cultivation is to recover depleted soil nutrients. Once the soil has recovered crops are reintroduced for one more seasons.

Shifting cultivation as the term implies, is a pattern of land use and a system of production of crops under which plots of land are cleared, cultivated for a short period for raising crops, after which the land is allowed to rest longer than the period of cultivation. It is a system of production almost without capital inputs.

This system is practiced extensively in the north-eastern hill region comprising the states of Assam, Meghalaya, Manipur, Nagaland and Tripura (Arunachal Pradesh and Mizoram). To some extent in Andhra Pradesh, Bihar, Madhya Pradesh, Orissa and Karnataka. It is called as JHUM in the north eastern hill region and PODU, in A.P. and Orissa and considered most destructive for forest areas.

The main features of the improved fallow system of Agroforestry is that trees and shrubs.

Are not grown with crops on the same land, the best species for the fallow system should be include good N fixation in the soil.

The main function of the fallow is to maintain or restore soil fertility and reduce erosion some plants can be introduced primarily for their economic value.

Establishment:

Improved fallow can be established in a variety of ways and at various stages of the fallow methods. Direct seeding of clean filled harvest plots and Selective cutting of bush followed by enrichment planting with tall plants. Introducing tall seedlings and cutting into poor quality fallows.

Multipurpose Trees, Forest tree Combination with Plantation Crops and Agroforestry Fuel Wood Production

Multipurpose Trees / Shrubs on Farm:

In this system multipurpose tree species like Azadirachta indica, Cocos nutifera, Bamboo, Acacia species. Mango are scattered haphazardly or according to certain pattern on bunds terraces or bounders. The primary role of this system is to meet various needs of grower for food, fodder, timber, soil conservation or protection of farm.

Forest tree Combination with Plantation Crops:

Perennial trees and shrubs such as tea, coffee, coconut, and cocoa are combined into intercropping systems in numerous ways including;

- a) Integrated multi story cropping of plantation crops.
- b) Shade trees for plantation crops coffee and silver oak and *Erythrina* spp. Betel vine + *sesbania* spp. + *Erythrina* spp.
- c) Intercropping with Agril. crops: Ginger/cardamum/ pepper/ are grown with trees.
- d) Mixture of plantation crops in alternate arrangement.

Agroforestry Fuel Wood Production:

In this system, various multipurpose fuel wood / fire wood species are interplanted, on or around agricultural lands. The primary productive role as fencing, boundary demarcation tree spp. commonly used *Acacia nilotica*, *Cassia siamea*, *Casuarina equisetifolia*, *Prosopis julifera*, *Eucalyptus* spp.

Shelter Belt and Wind Break

Shelter Belt:

These are belts / blocks consisting of several rows of trees established at right the purposes are:

- (a) To deflect air currents
- (b) To reduce the velocity of winds.
- (c) To provide general protection to the leeward areas against the effects of wind erosion.
- (d) To protect the leeward areas from desiccating effects of hot wind.
- (e) To provide fuel, fodder timber etc.

Characteristics of Shelter Belts:

- a) Shape and Composition: Shelterbelts have a spiracle, triangular shape by raising tall trees in the centre.
- b) Density and Width: Shelterbelts up to 50m width are considered ideal under Indian conditions. A certain degree of penetration by wind is planned.
- c. Orientation: Orientation depends on the direction and velocity of the winds.
- 4. Length: The minimum length of a shelterbelt should be about 25 times its height.

Dodonaea viscosa, *Cassia* sp., *Clerodendron*, *Acacia arabica*, *Dalbergia*, *Eucalyptus*, *Parkinsonia*, *Prosopis* etc.

Wind - Break:

Wind-breaks are strips of trees and or shrubs planted to protect fields, homes canals or other areas from wind and blowing soil or sand.

Purpose of Raising Wind Breaks:

- 1) To protect field crops / livestock from cold / hot wind.
- 2) To prevent soil erosion.
- 3) To reduce evaporation from farmlands.
- 4) To improve the microclimate.
- 5) For fencing and boundary demarcation.

6) For productive role-fuel, fodder, etc.

Main Features of Wind Break:

a) Permeability:

The primary purpose of raising windbreaks is to filter and break up the force of the wind. Permeable windbreaks, which allow some wind to pass through, are the most suitable. The desired permeability can be obtained by carefully selecting trees and shrub species. Species such as Eucalyptus and Casuarina will form dense wind break but most native species are more permeable.

b) Orientation:

For best results, wind-breaks should be raised at right angles to the direction of wind. N - S direction is good compromise. They should give better shading of adjacent crops and pastures.

Soil Conservation Hedges

Trees can be planted on physical soil conservation works (grass strips, bunds, risers and terraces), wherein they play two roles to stabilize the structure and to make productive use of the land they occupy. Stabilization is through the root system. In some of steeply sloping landscapes of the country, the risers or terraces are densely planted with trees, with multiple uses being made of them for fruit, fodder and fuel wood. In this system the major groups of components are multipurpose and/or fruit trees and common agricultural species. The primary role of multipurpose/ fruit trees and agricultural species is soil conservation and provision of various tree products. In this system the agricultural crop like food grains, pulses and vegetables are taken as intercrop in the forest trees like Shirish, Sal Teak wood, Eucalyptus, Australian babul, Bikan, Anjan, etc. The forest trees are planted in rows of 15-20 m. In lines of forest trees, agricultural crop, grain crop are cultivated as intercrops.

Silvipastoral Systems (Tree+ pasture/animal)

The production of woody plants combined with pasture is referred to as Silvopastoral system. The trees and shrubs used primarily to produce fodder for live stock. This system is needed in dry area to meet the fodder demand throughout the year. In this system forest tree species for fodder purpose like Anjan, Subabul, babul, Hadag, Shevari, Tamrind, Bikan, Neem, Vilayti Chinch etc. are taken at 10-12 m distance in rows in between the lines the grasses like Barseem, Lucerne, Hameto, Stylo etc. are taken as intercrops. This system is suitable for providing the fodder for milch cattle and thus for development of dairy industry.

There are Three Types of this System:

a) Protein Bank:

Protein rich multipurpose trees are raised on and around farm lands like Subabul Anjan Delbergia sissoo, Zizyphus species, Acacia species, Prosopis juliflora, Bombyx mulbericum, Sesbania spp. etc. are planted.

b) Live Fences:

Fodder trees are raised in the form of hedges or fences e.g. *Sisbania gandiflora* (Hadga), *Sisbania egyptica*, *Prosopis juliflora*, *Leucaena leucoloma*, *Carissa carandas*, *Bambusa* species and *Erythrina Indica*.

c) Trees and Shrub on Pasture:

Fodder, trees and shrub are raised scattered the pasture land e.g. *Embllica*, *Tanirindus*, *Ficus*, *Bakan*, *Anjan*, *Khejadi*.

Other Agroforestry System

In which following systems are included,

a) Horti-pastoral System:

Cultivation of Horticultural crops plus pastures.

b) Agri-Horti-Pastoral System:

In this system, in the marginal lands the fruit crops like Mango, Ber, Anona, Jamun, Tamrind, Wood apple etc. are taken along with forest trees and the food grains like, Peas, Gram, Wheat, Rice, Vegetables are taken.

c) Apiculture with Trees:

In this system, the flowering trees like Kanchan Jacaranda Spathodia, *Erythrina*, Krate sawar, Palas are planted for producing the honey in addition to Jamun, Mahuha, *Eucalyptus* like trees are also planted for honey collection.

d) Aqua Forestry:

Plants grown on the boundary around fish ponds like *Casuriana*, Coconut, Arecanut, Kokum, Babhul, Bamboo, etc.

e) Multipurpose Wood Lots:

The specific multipurpose trees are grown mixed or separately on the farm like *Australin* babhul, *Euclayputs*, *Subabhul*, *Bakan*, *Bamboo* etc.

Taungya System

Taungya is Burmas ward meaning hill cultivation, it was introduced into-India by Dr. Brandis in 1890 and the first Taungya plantation was raised in 1896 in north Bengal. It is practiced in Kerala, West Bangal, U.P., and to lesser extent in Tamil Nadu, A. P. Orissa and the north eastern hill regions. In southern India the system is called KUMARI, it is practiced in a areas with an assured annual rainfall of over 1200-1500mm.

This is a modified term of shifting cultivation in which labour is permitted to raise crop in an area but only side by side with the forest species planted by them. The practices consist of land preparation, tree planting, growing agricultural crop for 1 to 3 years until shade becomes

the dense and then moving on to repeat the cycle in a different area.

Traditional Taungya consist of land preparation for tree plantation, growing agricultural crops for 1 to 3 years after the tree plantation and moving on to another area to repeat the cycle. There are three types of Taungya .

a) Departmental Taungya:

Under this, agricultural crops and plantation are raised by the forest department. By employing daily paid labours the main aim of raising agril. crops along with the plantation is to keep along with the land free of unwanted vegetation.

b) Leased Taungya:

The forest land is given on lease to the person who affects the highest money for raising Agril. crop for a specialized number of years and ensure care of tree plantation.

c) Village Taungya:

This is the most successful of all the three Taungya systems. Under this the people who have settled down in a village inside the forest for this purpose raise crops. Usually each family has about 0.8 to 1.7 ha of land has raise trees and cultivate crops for 3 to 5 years.

Advantages of Taungya System:

- i) Artificially regeneration of the forest is done at cheaper rate
- ii) Problem of unemployment is solved to some extent
- iii) Better utilization of land
- iv) Remunerative to forest department

Disadvantages of Taungya System:

- i) Creates certain legal problems
- ii) Exploitation of hum in labour
- iii) Danger of epidemic
- iv) Provision
- v) Loss and soil fertility

Botanical Name, Common Name and Uses of important Forest Plants

Sr. No	Botanical Name	Common Name	Use or Utilities
1	Acacia catechu	Khair	Fodder, fuel, poles, soil conservation and katha
2	Acacia nilotica	Babhul	Fodder, soil conservation; agricultural implements, bark as medicine, tannin products and fule
3	Aladirachta indica	Neem	Planks, tooth brush and medicine (Bark, leaves gum)
4	Bombax ceiba, BombaxMalbaricam	Simal (Kate sawar)	Match Stiks, packing cases, play wood, soil conservation, roots used as medicines
5	Delbergia sissoo	Sissoo	Fodder, Timber, fuel, soil conservation
6	Delbergia latifolia	Rose Wood	Fodder, Timber, fuel
7	Melia aadirachta	Bakan/ Limbara	Avenue tree, fodder, timber
8	Tectona grandis	sag / Teak Wood	Structures and industrial timber, furniture, fuel, tannin, ornamental and medicinal use, KING OF TIMBEER
9	Ternnalia tomentosa	Asan / Ain	Industrial timber, tannin, gum,

			medicinal, tassar
10	<i>Terminalia arjuna</i>	Arjun	Industrial timber, small poles, fodder, timber, ornamental, tassar
11	<i>Acacia auriculiformis</i>	Australin Babhul	Denuded places, tannin, fuel
12	<i>Acacia chundra</i>	Lal khair	Timber, pole, fuel, tannin and soil conservation
13	<i>Aegle marmelos</i>	Bel	Tooth brush, fruits, medicine (Bark, gum)
14	<i>Albizia chinensis</i>	Kala sires	Timber, pole, fuel, tannin and soil conservation
15	<i>Albizia procera</i>	Safed Siris	Timber, medicine, fuel
16	<i>Artocarpus</i>	Jack Fruit	Fruit and timber
17	<i>Anthocephalus chinensis</i>	Kadamb	Fodder, fuel, pulp wood, ornamental
18	<i>Emblica officinalis</i>	Amla	Fruit, fuel, ornamental, medicinal
19	<i>Madhuka latifolia</i>	Mahua	Liquor oil seed, timber, edible flower
20	<i>Mangifera Indica</i>	Mango	Fruit, timber, medicine.
21	<i>Tamarindus indica</i>	Imli	Fruit, fuel, medicinal, timber, leaves, flowers, fodder, poles
22	<i>Ziziphus jujube</i>	Ber	Fruit, fodder, poles, lac
23	<i>Syzygium cumini</i>	Jamun	Fruit, fodder, poles, timber, fuel, medicinal (flowers fruits)

24	<i>Moringa oleifera</i>	Drumstick	Fruit, fodder, hand paper
25	<i>Sesbania grandiflora</i>	Hadga	Flowers, fence poles, tannin fodder, fuel, pulp
26	<i>Saraca indica</i>	Ashok	Ornamental, medicinal
27	<i>Santalum album</i>	Sandal	Industrial timber, oil, ornamental, medicinal
28	<i>Morus alba</i>	Mulberry	Fodder, fruit, sport goods, silk industries
29	<i>Pongamia pinnata</i>	Karanja	Leaves used for green manuring branches used as tooth brush seeds for oil, used for soil conservation.
30	<i>Bauhinia variegata</i>	Kanchan	Fodder, food, timber, leaves and flowers are used as vegetables, medicine
31	<i>Bauhinia racemosa</i>	Jhangora	Medicinal plant, ornamental
32	<i>Bauhinia chinensis</i>	Kanchan	Medicinal and fuel, ornamental
33	<i>Michelia champaca</i>	Chaffa	Pole, industrial timber, fuel, ornamental, soil conservation, medicinal flowers are more valuable for perfume
34	<i>Populus deltoides</i>	Poplar	Pulp wood, fodder, packing cases, soil conservation, fuel match box and splints
35	<i>Pithecolobium dulce</i>	Vilayati Chinch	Fuel, hedge, soil conservation
36	<i>Prosopis chinensis</i>	Kabuli khar	Fodder, fuel. soil conservation

37	<i>Casuarina equisetifolia</i>	Khadsarni or suru	Fuel, timber, good for plantation in coastal area, charco
38	<i>Cupressus cashmiriana</i>	Cypress	Industrial timber, poles, soil conservation sandy area
39	<i>Eucalyptus camatndulensis</i>	Eucalyptus	Gum, oil,tannin, soil conservation, industrial timber, paper, pulp
40	<i>Eucalyptus globules</i>	Blue Gum	Pulp wood, fuel, timber
41	<i>Eucalyptus teriticornis</i>	Mysore Gum	Fuel and pulp wood
42	<i>Ficus religiosa</i>	Pipal	Avenue trees, fuel, fodder
43	<i>Ficus bengalensis</i>	Wad	Avenue trees, fodder, fuel, fruits, soil conservation, timber for packing cases
44	<i>Ficus glornerata</i>	Gular / Umbar	Avenue trees, fodder, fuel
45	<i>Delonix regia</i>	Gulmobar	Ornamental, avenue trees

Forest Tree Species Used for Different Purpose

i) Industrial Needs: Pulp wood, saw-timber, panel products such as, plywood and other boards, match wood, sport goods etc. constitute the industrial needs. Some of the species for meeting some of the industrial needs are given below:

- 1. Construction:** *Acacia catechu*, *Cedrus deodara*, *Dalbergia sissoo*, *Dipterocarpus macrocarpus*, *Eucalyptus* spp., *Hopea parvifolia*, *Mesua ferrea*, *Pterocarpus santalinus*, *Shorea robusta*, *Tectona grandis*.
- 2. Tool handles:** *Acacia catechu*, *A. nilotica*, *Dalbergia latifolia*, *Diospyros melanoxylon*, *Mesua furrea*, *Pterocarpus inarsuipium*, *Shorea robusta*, *Terminalia alata*.
- 3. Packin Cases:** *Abies densa*, *A. pindrow*, *Acrocarpus* spp., *Ailanthus excelsa*, *Bombax ceiba*, *Boswellia serrata*, *Fiscus* spp., *Mangifera indica*, *Kydia calycina*, *Melia azedarach*, *Pinus* spp.
- 4. Plywood:** *Acrocarpus fraxinifolius*, *Adinacord flora*, *Dalbergia latifolia*, *D. sissoo*, *Dipterocarpus macrocarpus*, *Gmelina arborea*, *Mangifera indica*, *Michelia champaca*, *Schima wallichii*, *Shorea assamica*, *Tectona grandis*, *T myriocarpa*.
- 5. Doors and Windows:** *Tectona grandis*, *Cedrus deodara*, *Adina cordifolia*, *Dalbergia latifolia*, *D. sissoo*, *Dipterocarpus* spp., *Gmelina arborea*, *Pterocarpus dalberhioides*.
- 6. Matches:** *Aillanthus excelsa*, *Alstonia scholaris*, *Anthocephalus chinensis*, *Bombax ceiba*, *Populus deltoides*, *Elaecarpus* spp.
- 7. Lorrboyodies:** *Aerocarpus fraxinifolius*, *Albizia libbeck*, *Artocarpus chaplasha*, *Dalbergia sissoo*, *D. latifolia*, *Dipterocarpus mecrocarpus*, *Pterocarpus dalbergioides*, *P. marsupium*, *Shores robusta*, *Tectona grandis*, *Terminalia alata*, *T myriocarpa*.
- 8. Furniture:** *Tectona grandis*, *Dalbergia latifolia*, *D. sissoo*, *Pterocarpus santalinus*, *Adina cordifolia*, *Gmelina arborea*, *Dipterocarpus macrocarpus*, *Pterocarpus marsuipium*, *Cedrus deodara*, *Juglans regia*.
- 9. Pulp Wood:** *Pinus* spp., *Abies pindrow*, *Picea smithiana*, Bamboos, *Eucalyptus* spp. and other fast grown hardwoods.
- 10. Sport Goods:** The species for various items of sport goods.

ii) Social Needs:

Firewood, fodder, small .timber and poles constitute the social needs. Almost all tree species yield firewood. The important species used for supply of firewood include *Acacia nilotica*, *Leucacaena*, *Prosopis juliflora*, *Lagerstroemia* spp., *Anogeissus latifolia*, etc. Fodder yielding species include *Leucanea leucocephala*, *Acacia nilotica*, *Ficus* spp., *Azadirachta*, *Ziziphus* spp., *Grewia optiva*, *Celtis australis*, *Prosopis cineraria*, *Ailanthus excelsa* etc.

iii) Environmental Protection:

Checking water and wind erosion, stabilize soil surface, windbreaks and shelter-belts road, rail and canal side afforestation, rehabilitation of wastelands and industrial sites constitute environmental protection e.g. *Acacia catechu*, *Acacia nilotica*, *Morus alba*, *Pupulus delfoids*, *Swietania Mahagoni*.

iv) Land Use Needs:

Tree planting is an integral part of land use for amenity shade, shelter, food, wood, soil productivity, etc. e.g. *Artocarpus heterophyllus*, *Embilca officinalis*, *Ficus glomerata*, *Bambusa arundicaciae*, *Hardwickia*

