Course No. AGRO 302

Course Title: PRINCIPLES AND PRACTICES OF SOCIAL FORESTRY

Lecture No: 1

Problems and Prospects of Indian Forestry :-

INTRODUCTION: Forestry is nature's greatest bounty to mankind. With the depletion and degradation of natural resources by over use we are still lagging far behind in the process of development through modernization. Availability of resources is generally much below the world average and far below the average of developed countries.

The country do not have enough land space and the productivity of the available space as far as the forests are concerned is also very low. Forests in India cover about 22.8 %. Estimates of the area currently classified as forest land in India vary widely from as high as 75 million hectares to as low as less than 40 million hectares. This represents 23 and 12 per cent respectively total land area of the country (327.7 M.ha) of the total geographical area admeasuring 74.72 m.ha as against 33 1/3 % enunciated in the National forest policy 1988 to maintain the ecological balance of forest area in A.P. is 6.3 m.ha covering 23.2 % of the total geographical area (27.7 m.ha). as compared to the world average of 1.6 ha per capita forest area, India has 0.11 ha per capita forest area mainly due to the population increase. The country has lost about 43.4 m.ha of forest area during 1951-52 to 1982 – 83 @ 1.5 m.ha / annum, the main reasons being excessive biotic interference, removal of cut forest exceeding than the forests could produce, diversion of area for agriculture for river valley projects and industries etc. The productivity of Indian forest is also very low 0.5 m/ha when compared to the world average of 2 m/ha because of over exploitation, overgrazing and excess maltreatment of forest area in the past. In India most of the forests (95%) are owned and managed by the government in contrast to the management of forests by private sector in the European countries. Although forests occupy 22.8 % they are reported to contribute not much (1%) towards the National economy when compared to agriculture (35%), many reasons have been attributed to the

low revenue. Removal of large amount of forest produce by the local population in the form of rights and concessions as well as illicit removals being the main ones. Yet another problem faced by the Indian forestry is the lack of proper investment in reforestation and afforestation programmes. (the investments never exceeded 0.75% of the total plan outlay in the public sector).

During the five year plans large scale development and rehabilitation works were launched in the forestry. With the introduction of conservation and forest management the work of demarcation of forest areas and working plan preparation was taken up. At present as a consequence the area covered under working plans constitutes about 66 % of total forest area.

Definition of Forest and Forestry :

The word forest is derived from Latin word 'Foris' means outside. Therefore forests are areas covering practically all uncultivated and untended lands fairly extensive stretch of land covered with rather tall and dense tree growth.

Forests are also defined as an area set aside for the production of timber and other forest produce and is under woody vegetation for certain benefits which it provides.

Forestry :

Forestry stands for the theory and practice of constitution and management of forests and utilization of their products. It also stands for scientific management of forests for the continuous production of goods and services.

Branches of Forestry ;

1. **Silviculture :** Refers to certain aspects of theory and practice of raising forest crops method of raising tree crops, their growth and aftercare upto the time of final harvesting.
2. **Forestry soils :** Refers to the composition, physical and chemical characters and behavior of the soil upon which forest is to be established

3. **Dendrology :** Refers to description, classification and recognition of tree species.
4. **Forest menstruation :** Deals with the measurement of forest produce.
5. **Forest Management :** Is the practical application of science, technique and economics to a forest estate for the production of certain desired results.
6. **Forest utilization :** Branch of forestry dealing with the harvesting, marketing, conversion and putting the forest produce for a variety of uses like timber, fuel, pulp wood etc.
7. **Wood technology :** Deals with the structure, physical, mechanical properties and behaviour of wood under varying conditions.
8. **Forest policy and Administration :** Deals with the rules, regulations, laws and procedures that helps to conserve forests.
9. **Forests protection :** Knowledge of the behaviour of the forest enemies viz., Fire, Insects, Diseases, Wind, Animal and protection from them.
10. **Agroforestry :** Deals with the integration of crops, forest plants or livestock simultaneously or sequentially on the same piece of land for sustainable land management.

FOREST POLICIES:

Although the forest management in India has been on a sound footing since 1864, the condition of the forests continued to deteriorate through over exploitation. Efforts were made to conserve the forest resources. The first effort in this direction was made by enunciating the **first forest policy of India on 19th October 1894**. The important features of this policy were :

1. The state forests are to be administered for the benefit of the public.
2. Forests on hill slopes may be protected.
3. The requirements of people may be met from second class state forest.
4. Whenever an effective demand for cultivable land exists, the needed land can only be supplied from the forest area without habitation.

5. Royalty for the government must be collected for various facilities enjoyed by people.

The main aim of the forest policy of 1894 was to collect revenue from the forests and please the local population by granting them rights and concessions. There was no intention to improve the forestry management in general. After independence the Government of India, Ministry of Agriculture enunciated the **second National Forest Policy** on 12th May 1952. It has been formulated on the basis of 6 paramount needs of the country.

1. The need of evolving a balanced and complimentary land use so that each land allotted should produce most and deteriorate least.
2. The need for checking :- a) Denudation in mountain regions on which depends the perennial water supply of the river system. b) The erosion progressing place along the treeless bank areas of rivers and on vast stretches of undulating wastelands leading to ravine formations. C) Invasions of seasand on coastal tracts and shifting sand dunes.
3. The need for establishing tree lands wherever possible for the amelioration of physical and climatic conditions promoting the general well being of the people.
4. The need for insuring progressively increasing supplies of grazing small wood for agriculture implements and in particulars of fire wood to release the cow dung as a manure.
5. The need for sustained supply of timber and other forest produce required for defense, industry etc.
6. The need for the realization of the maximum annual revenue in perpetuity consistent with the fulfillment of the enumerated above.

This forest policy recommends that India should aim at maintaining the 1/3 rd of its land area under forest. But this policy mainly aims at conservation forestry and there is no emphasis on production forestry. Therefore to make the existing forest with their low

productivity should be converted into plantation forestry of high productivity which is possible only through enunciation of new forest policy of 1988, which has been announced in the parliament by the Minister of Environment, Government of India on 7th December 1988. The main objectives of **New National Forest Policy** are:

1. The national goal should be to have 1/3 rd of the total land area of the country under forest to save fragile ecosystems.
2. The forest should not be looked upon as a source of revenue. Forests that clothe steep slopes, catchments of rivers, lakes, reservoirs should be protected and checking extension of sand dunes.
3. Massive need based and time bound programme of afforestation and tree planting with a particular emphasis on fuel wood and fodder development on all degraded lands in the country are to be promoted whether forests or non-forests as a national imperative.
4. The policy emphatically says that construction of dams, reservoirs, mining and expansion of agriculture should be consistent with the needs for conservation of trees and forests. The policy categorically states that no mining lease should be granted to any party (Private or public).
5. The policy specifies that land laws should be modified wherever necessary as to facilitate or motivate individuals and institutions to undertake tree farming or grow fodder trees, grasses and legumes on their own land.
6. The policy favours the restrictions on grazing, browsing in forest areas by levying grazing fee to discourage people in forests area from raising large heards of essential livestock.
7. The policy envisages to put an end to removal of timber by contractors by replacing bodies like tribal and labour cooperatives and Governments corporations.
8. The new forest policy also invites a special care for the needs of wild life conservation.

Lecture No. 2

FOREST INFLUENCE

Forests cover about 1/4th of the land mass on the earth. In India however they cover only about 1/5th of the area. Forests are one of the most predominant geographic features of this planet and greatest bounty of mankind and influence the lives of human beings in several ways. They moderate the extremes of local climate, reduces wind velocity, intercepts precipitation, reduces impact of rain drops, reduce soil erosion, regulates stem flow in forested area, improves quality and quantity of water supply and finally provides important forest products. The various aspects of forest influences are as follows :

1. **Forests and Climate :** The macro-climate of a given area depends upon its latitude and altitude whereas the micro-climate depends upon topography and vegetation. The various aspects of climate are :

    a. **Temperature and radiation :** Dense forests with heavy foliage have greatest influence on air temperature. On monthly maximum temperatures, the effect is greater than on monthly minimum temperatures. The maximum temperatures are lower and minimum temperature are higher and the net effect of the forest cover is to reduce the range of temperatures at all periods of the year. Studies carried out at New Forest (Dehradun) inside *Pinsu roxburghii* and *Dendrocalamus strictus* showed that temperature in forest and open area varies from 1.4 ^{o} C to 3.1 ^{o}C. Evergreen forests have greater influence than the forests of deciduous foliage.

    b. **Wind Movement :** Forests offer a mechanical obstruction and deflect upwards the moving masses of air and slow down the velocity of that part which enters the forests. Dense forests with greater foliage have more effect. It was reported that velocity of wind in the interior of forests may be 1/10 to 2/3 of that in the adjacent open area. Thus effect is being also

felt to a considerable distance in the leeward side. In a study the reduction in wind velocities at different height are as follows :

1. At the top of canopy - 43 % of that open (21 meters above ground)
2. At the midpoint of canopy - 14 % of that open (9 meters above ground)
3. At bottom of canopy - 20 % of that open (3 meters above ground)

c. **Humidity :** In general the air in a forest is somewhat moist than the open in view of the large amounts of water transpired by the trees. Relative humidity may be about 5-10 % more in the forest than in open area. Forest air being more humid proves to be heavier and sinks down in the neighbouring open areas thus resulting in descending currents of air above the forests and cooling the adjacent tree less areas.

d. **Precipitation :** The influence of forests on rainfall is more controversial, But in India even today it is believed that forests increase rainfall. Precipitation depend upon not only on the amount of moisture content in the clouds but also on the conditions favourable for its release. Forests act as barrier across the horizontal path of wind causing more rainfall. Studies conducted in forest and non-forested area have shown that annual rainfall increased by 173. mm. or 12 % in forested area. Thus it is inferred that forests increase the precipitation. According to some scientists the forests slow the movement of air by oronographic obstacles and cause ascending currents which results in cooling of the air, formation of clouds and additional amount of rainfall.

2. Forests and Soil Conditions :

a) **Soil composition and structure :** Forest soils are more friable and crumby. Forests make lighter soil (sandy) heavier and heavy soils (clay) lighter. The roots loosen the soil mass and when die add organic matter to the soil. Porosity in the forest soils is increased because of effect of organic matter addition through root system.

b) **Soil Temperature :** It is affected by forest cover due to reduction in insulation and radiation by the over head forest cover and partly due to the insulating effect of the leaf litter and humus of forest cover.

c) **Soil Moisture :** Forest tend to decrease the amount of soil moisture by intercepting precipitation, retaining water in the forest floor (litter) and by transpiration. They tend to increase the amount of soil water by reducing surface run off, increasing permeability, decreasing evaporation and by increasing water holding capacity and storage capacity of soil.

d) **Water table :** Forests lower the water table under all soil climatic conditions due to the effect of higher evapotranspiration and greater moisture uptake. It has been reported that trees such as Sal, Teak and oak spread their roots in an area of 100 Sq. meters and go more than 8 meters deep.

e) **Chemical Properties of Soil :** The forest also improves the chemical properties of soil N, Ca, P, K, Mg and other elements which are made available in larger proportions. The C.E.C. of soil is also improved. pH of the forest soil is generally acidic in nature.

f) **Water regime :** Quality of water flowing in forested area is better. It was reported from Deharadun that water flowing out of forest area was of high purity and pH was tending to be slightly acidic. The calcium oxide was the highest among the dissolved chemicals.

3. **Forests and Floods :** Forests play a vital role in controlling floods, hence mass scale afforestation of catchments of major rivers is generally advocated. Forest are capable of checking the occurrence of floods by the following ways.

1. Consuming large amount of moisture by evapotranspiration
2. With holding rain water from reaching soil surface by interception
3. Increasing infiltration capacity of soil.
4. Increasing underground run-off and decreasing the surface run-off
5. Reducing erosion and thus, reducing the silting of river beds.
6. Improving soil characteristics for building underground water reservoirs.

4. **Forests and Erosion :** Forests play an important role in checking the erosion of both water and wind. The main effect of vegetation is in improving the infiltration so that there is less water to run off a source effect. It can also restrict the rate of flow, the channel effect to diminish the more erosive efficiency of the moving water. The impact of rain drop is also being reduced which further reduces the removal of soil particles. Forests with a density of 0.3 is not very effective to control the run-off. Small water sheds after afforestation in fully stocked plantation were effective in total reduction of 28 % in run-off and 73 % in peak rate of run off.

5. **Forests and Human Health :** Noise and pollution of air are some of the reasons for many diseases. Forests generally filter the air. The dust carrying winds invade the forests and deposit the dust on trunks, branches, leaves and needles. Forests also check the wind velocity resulting in increased dust precipitation. According to a scientist the dust filtering capacity of forests is tremendous **a stand of one hectare of spruce collects about 32 tones of dust, pine collects 36.4 tones and beach 68 tones dust per hectare.**

Forests offer protection against CO_2 created by combustion. During the assimilation process of vegetation the CO_2 is taken from the air and release '0_2'

into the air. The SO_2 which is harmful is also kept under control. Radioactive radiation is also being filtered by forests.

Higher noise of industrialization, mechanization and motorization increases the blood pressure. Noise exposure of 90 phones or more create reduction in hearing capacity. The forests absorb certain amount of noise, the denser the forests higher would be the sound absorbing capacity. It has been proved that a park of 50 meter width can reduce traffic noise by 20-30 db (decibels). Forests have natural healing effect for a number of diseases. Coniferous forests are believed to have healing effect against bronchitis **due to the ethereal oils** present in these forests.

6. **Forests and Recreation :** Man's relation with plants is immortal. It is observed that man have always selected forested places for their habitat because they satisfy a number of basic necessities of life. The mild forest climate and quiet nature have favourable effects in the recreational process. Apart from healthy climate in the forests, trees exert certain fascination on human beings, watching of flying birds with their delightful songs in the forested area provides great upliftment of soul.

The following are the main geographical features of the country.

i) **Mountains :** Himalayas, Aravallis, Vindhyas, Satpures Western and Eastern ghats

ii) **Plains :** The indo-gangatic plains the Deccan Plateau Eastern and Western coasts.

iii) **River Basins :** Himalayan rivers, Rivers emanating from central Indian plateau and Rivers arising from western and eastern ghats. Forests are formed in great concentration on all the mountains range. Very little are formed on the Gangatic plain. The river basins of rivers emanating from Himalayas and the ghats have some forests. In A.P. the Godavari and Krishna Basins contain some good forests.

Lecture No.3

SILVICULTURE

Principles of General Silviculture :

The theory and practice of raising forest crops is the silviculture. On the other hand, silvics is the study of trees and forest as biological entities; the laws of their growth and development and impact of environment on them. Thus the silviculture can be described to include all the practical and theoretical aspects of silvics. It is science that combines biology, mathematics, management and economics. Therefore the study of silviculture helps to attain the following objects :

1. To derive environmental benefits.
2. Raising species of more economic value.
3. Production of high quality timber
4. Production of more volume per unit area.
5. Reduction of rotation period.
6. Afforestation of blank areas.
7. Creation of plantations.
8. Introduction of exotics.
9. Employment potential
10. Increase in the production of fuel and fodder.
11. Development of forest industries.

Definition of silviculture :

It is the science that deals with the establishment, development, care and reproduction of stands of trees. Its aim is the continuous production of wood.

It is under silviculture that we learn the growth habit of trees and techniques to raise them naturally and artificially.

Parts of a tree :

1) **Crown :** The upper part of the tree comprising of branches and foliage is called crown. Mode of branching, degree of branching, flexibility, of branches, deciduous and evergreen type, persistence of evergreen leaves, twigs, shedding leaf, are the important features of crown which vary greatly with the species.

2). **Bole :** The lower portion of the stem upto the point where the main branches are given off is known as the bole. Some trees have inherent tendency to form a tall, erect, straight bole with relatively small branches when grown even in open eg: Conifers, Eucalyptus etc.

a) **Taper of Form Factor :** The taper of the bole is commonly expressed as the stem form factor which is proportional to the actual volume, bears to the volume of cylinder of the same height on the same base.

b) **Buttressed stem :** In many species of wet tropical forests and few in drier tropics, the swellings at the base of the stem is far more pronounced and may even extend upto 15ft. or more up the stem. The form it takes is called buttressed.

c) **Fluted stems :** The bole above the basal swell may be smoothly rounded in section or it may show irregular involutions and swellings which are referred as flutings and this is a serious defection for timber production.

Structure : The main stem and the branches of a tree consists of the central wood, the cambium and the bark (phloem). The wood constitutes (xylem) the timber.

Annual rings : In many species the predominant elements of the xylem are the tracheids. The marked differences in size shape and cell wall thickness of the early and late wood tracheids produce growth rings or growth mark. One ring refers to the growth of the whole year. Tracheids are vertical thick walled dead cells of 0.5 – 15 mm length.

3) ROOTS :

a) Taproot : It is derived directly from radical of the seedling. It penetrates to a greter depths. In *Prosopis specigera* and *acacia arabica* tap root reaching down to 100 ft or more is recorded.

b) Mangrove roots : In water logged and submerged soils the Rhizophores are supported on a system of aerial stilt roots, while some species send up peg like projections from their roots consists of sponge soft tissue (pneumatophores).

c) Adventious root system : The roots are emerging in cluster from the base of the stem other than radicle.. The root system generally is shallow and mostly present in coniferous spp. Prop roots, stilt roots, pneumatophores belong to this group.

Stages of development of tree :

Different terms are used for different stages of development of forest trees. Four main stages in growth and development of tree have been recognized.

1. **Seedling** : From germination upto a height of three feet (1m).
2. **Sapling** : From 3feet or /m height till the lower branches begin to fall A sapling is characterized by the absence of dead bark and by vigorous height growth.
3. **Pole** : From the fall of flower branches to the time when the rate of increase in height begin to fall off and crown expansion becomes marked.
4. **Tree** : After passing the pole stage beyond the time the rate of growth begins to slow down and expansion of the crown begins to attain predominance.

TENDING :

Tending is a broad term given to operations which are carried out for the well being of a forest crop at any stage of its life involving operations both on the crop itself and on its competing vegetation. Tending is an important silvicultural operation which helps in the production of high quality timber, maximizing returns per unit area and ensures overall well being of the forest. The various operations of tending are :

1) **Irrigation of Watering :** For avenue plantations watering is advisable to ensure establishment of the plants. In case of block planting on village lands and in forest area it is better to plant a greater number to allow for causality. In forests watering is rarely done as it is a costly operation.

2) **Weeding :** To reduce the root competition and suppression of the plants from weeds and grasses, an area of about 1.5 meters diameter all around the plant is cleared of weed growth. This operation is done once in a month.

3) **Soil working :** This involves loosening the soil and working up the soil around the plant to prevent soil moisture loss. The operation should be carried out with all the weeding and particularly when there is a wide gap in the rains and at the beginning of the hot season. Mulching with twigs, brush wood, paddy husk etc is also carried out to prevent soil from hardening.

4) **Fire Tracing :** A belt of 2 meters diameter cleaned on all sides of the plant will prevent any direct damage from the fires. In case of block plantings a fire line of 4 meters width around the area should be cleared so that no fire enters the area.

5) **Singling :** In case of double or more coppice shoots, it is advisable to remove all retaining the best one so that the establishment is quicker and growth is faster.

6) **Brashing or low pruning :** In the 2^{nd} or 3^{rd} year if there are any lower branches they should be pruned by saw or by a sharp implement without damaging the plant upto a height of 2 meters. This helps for straight and better growth of the tree.

7) **Climber cutting :** The climbers are harmful particularly when the trees are young. In older trees they constrict the stem and deteriorate the value of wood. *Bauhinia Vahlii, Butea parviflora, vitis spp, Ipomeaspp and Acacia spp* are some of the climbers.

ARTIFICAL REGENERATION

Renewal of a forest crop by artificially or man-made means is called artificial regeneration. It is a group of methods which involve sowing and planting etc. Planting usually refers to the transplanting of sapling raised in nursery under protected conditions, where as at certain times the seedlings may also be procured from the forest itself grown under natural conditions and planting such seedlings is called wilding. The artificial regeneration is being carried out to fulfill the objectives mentioned below :

1. **Reforestation** : The artificial regeneration carried out on lands which were originally forested is called reforestation. The purpose of reforestastion is a) supplementing natural regeneration b) replacing natural regeneration c) Introduction of other species.
2. **Afforestation :** Raising of forest crop of land which were not originally forested. This may be under taken for productive, protective and bio-aesthetic purposes.

Steps involved Artificial Regeneration :

1. Choice of species
2. Site selection
3. Choice of method of sowing
4. Spacing
5. Arrangement of staff and labour

1) **Choice of species** : Selection of a suitable species for artificial regeneration is very essential, because it involves high expenditure. Selection of species for artificial regeneration will depend upon

- The habitat conditions and Silvicultural requirements
- Objects of raising plantations (Type of management)
- Effect of species on the habitat
- Resistance to insect pests and diseases
- Silviculture system to be adopted

2). **Site Selection :** Selection of a suitable site for raising the particular plantation is very important. While selection the site the following factors are to be taken into account.

- Climatic conditions of the area.
- Topography.
- Soil conditions

3) **Choice of Methods**: Sowing and planting are the two methods of artificial regeneration. Depending on the species and site, suitable method either for sowing or planting should be selected.

4) **Spacing**: Distance between two plants in a plantation forest is spacing, which depends upon species, site, purpose and management

5) **Arrangement of Staff and Labour:** Trained persons of the forestry department should supervise the work for successful regeneration. Arrangement of labour may be made by engaging daily wage workers through contractors, and labour having permission to raise the agricultural crops in plantation area.

For successful artificial regeneration certain technical aspects of tree species is more essential.

a**) Seed Collection and Storage**: These are very important operations in plantation programme. The seed must be collected from healthy and well-formed trees of proper ecotype. It is important to have seed orchards of each species. In absence of seed orchards good quality neighbouring forest area may be selected as seed stand and seeds must be collected from such areas.

The seed should be collected from good trees which are dominant, middle aged, tall, vigorous, well shaped and straight trees but not from immature, over mature, suppressed branchy, diseased, insect infested or low grade variety.

Land Preparation :

Planting area must be suitably prepared for plantation work. A well prepared plantation site may help in proper growth and development of trees.

a) Soil working : Complete soil working by tractor, bulldozers, sub soilers may be done in case of large plantations as deep soil working has its own advantages of checking weed growth etc.

b**) Digging pits :** Many species are planted in pits of 1x1x1 feet (30 cm x 30 cm x 30cm) and on some special sites and for some species 2 x 2 x 2 (60 x 60 x 60) are dug.

1) **Ordinary pits :** Are recommended for clayey and saline and alkaline soils.
2) **Saucer shape pits :** Are suitable for sandy soils.
3) **Ring pits :** Are dug in scanty rainfall areas and very sandy soils to accumulate maximum rain water at the root zone.
4) **Ridge ditch :** Ridge ditch is partly filled in trench. Sowing or planting is done in the bottom of the trench or sloping area. Ridge ditch system is followed in sloping lands where ridge is made on lower slope and the ditch on upper slope.
5) **Double trenches :** Are also suitable for murramy areas and where hard pan formation exists in sub-soil.
6) **Contour trenches :** Suitable for hilly areas.
7) **Brick planting :** Suitable for sandy coastal areas. In desert sands and mobile sand dunes, the sand dunes should be first stabilized by spreading leaf litter or brush wood etc.
8) **Drainage :** For successful plantation drainage channels should be opened in water logged areas.

Planting Methods :

1) **Planting with roots :** While planting with naked roots, the important considerations are :

a) Collar should beat the level of soil surface.
b) The tap and sinker roots are not doubled up
c) The planting pits should be at least as deep as the length of roots of seedlings.

2) Planting with ball of earth : Many species do not tolerate the exposure of the root system specially when they grow large. For preparation of ball of earth the plant must be uprooted in such a way from the nursery that the roots come out in natural position with ball of earth.

3) Container planting :

a) Dona method of planting : Dona is a cup shaped structure made up of leaves of *Bauhinea vahlii* and *Butea monosperma*. The donas are placed on the ground and watered after sowing seeds until the seedlings are well rooted. The seedlings are then planted out.

b) Mossed transplants : In Eucalyptus and in some other species when the seedlings are very small, they are mossed by embedding them (with some earth) in a cylindrical role of moss about 15 cm long bound with fibre and then kept in a shade. The plants are shifted from one place to another place within week in order to check the growth of the roots outside moss until they are planted. Mossing of seedlings of Eucalyptus is being taken to protect them from frost in ootacamand and other cooler places when seedlings are 7.5 to 10 cm. tall.

c) Brick planting : Bricks are prepared from the mixture of local soil sand or clay and manures are used in planting out. There is a cavity in the centre of the brick which is filled with good soil to receive a seedlings are planted along the bricks in sand dune areas.

d) Planting in Polythene bags : This method is mostly advantages on difficult sites. The plants are developed with minimum disturbance. The bottom of the bags are opened while planting out.

4. Stump Planting : The advantages of stump planting are 1) Practically no damage in transport 2) Handling and planting are easy 3) Lot of reserve food materials in stumps. The stumps should be 20-25 cms. The root portion is about 18-20 cm and 2-5 cm shoot. Tectona, Sissoo, Albizzia spp are planted by this method successfully.

5. Vegetative propagation : Root suckers, branch and stem cuttings, root cuttings, layering, grafting and budding are most commonly used for vegetative propagation of forest plants.

SPACINGS :

One of the advantages of artificial regeneration over natural regeneration is the control of no. of trees per unit area and their uniform distribution over the land area. An optimum spacing will produce the greatest volume in proper size form and quality of trees required. Trees with wider spacing grow more rapidly than those planted in narrow spacing. Trees planted at wider spacing have greater taper, thicker branches with deeper and wider crowns. Closer spacing is adopted in order to facilitate natural pruning for production of clean and straight bole. Too close spacing results in thinner diameter of trees. The spacing depends upon 1) Site 2) purpose 3) Management 4) Species.

Season of Planting :

Planting seasons varies with the species and the commencement of monsoon, Teak and sisso stumps are planted with the onset of rains. casuarina, Eucalyptus and other pot culture plants are planted after the monsoon sets in or advanced to some extent. In the east coast where north east monsoon is dependable, planting is done in September – October. In area of South west monsoon planting is done during June – July.

Lecture No 4

SOCIAL FORESTRY

A growing tree is a living symbol of a progressive nation (Jawaharlal Nehru).

Concept: The forests managed to cater the needs of the local population for small timber, bamboo for agriculture and other domestic requirements like fuel wood, fodder, grazing recreation and aesthetic purpose are usually referred as Social forestry. Social forestry is a forestry having social content achieved through the participation of the people and intended for meeting the various requirements of people and it is for the people of the people and by the people. The concept of social forestry was enunciated in a comprehensive manner by Mahatma Gandhi, the Father of the Nation.

An ideal village should be so conditioned that the villagers could procure all their daily needs and requirements of materials such as bamboos, fuel wood, grazing etc from within a radius of five miles. The credit for coining the social forestry for the first time goes to Mr.Westoby (1968) who defined it as forestry, which aims at producing flow of protection and recreation benefits for the community.

Need of social forestry: The vast human and cattle population of the country need food fuel wood, fodder and small timber. In India, 95 % of the fuel consumption mainly consists of fuel wood, cow dung and agriculture wastes. Through the framers are fully aware of the importance of cow dung, they are compelled to use large quantities (4.58 m.t. of wet dung annually) of cow dung as a fuel due to shortage of fuel wood which otherwise can be diverted to increased agriculture production i.e., ***"We are burning the food to cook the food"*** due to wood famine. The existing forest cover of the country is 11-14% as against 33 1/3 % required to maintain the ecological balance. It is estimated that about 1.5 m.ha of forests are being lost annually due to illegal and indiscriminate during forests, by rural makers for their needs of fuel wood. As a result, extensive areas have suffered denudation causing serious soil erosion. About 144 m.ha of land is being affected by erosion causing displacement of 6000 m.t. of fertile topsoil every year including 5 m.t. of NPK nutrients

alone. Finally the erosion also results in silting of riverbeds and floods. The fast receding forest cover is also causing Green House effect where the CO_2 content of atmosphere is increased affecting not only the "Ozone layer but also increasing the earths temperature by 1-2 ^{o}C which in turn results in drawing of low lying areas by melting snow hills.

In addition the country possess 130 m.ha of wastelands including 30 -35 m.ha of degraded forests and 40-45 m.ha of marginal agril. Lands constituting 41% of the total land area. These lands are very poor in productivity and more or less unproductive. In view of large population, lands remains as scarce and requires effective land use planning i.e., productive capacity of these lands is to be restored.

Therefore the immediate need of the day is creating of new man made forests near the habitations, village waste lands etc. to cater the needs of rural masses besides conserving the ecosystem and restoring the productive capacity of all waste lands.

The enormity of the problem was recognized by the **National Commission on Agriculture in 1976.** Therefore it recommended that each state should reorganize the forest department into two separate wings. One to retain charge of traditional production forestry and one to develop social forestry aimed at the production of fuel wood, fodder and other minor forest products for rural population. Subsequently in 1978 the World Bank undertook a review of forestry prospect in India and identified "Social Forestry Projects is an ideal vehicle for initiating economic development in rural areas. And in 1985 late EX-Prime Minister Sri Rajiv Gandhi set up the National Waste land Development Board (NWDB) with the objective of bringing 5 m.ha. of land under fuel wood and fodder production every year.

Objectives of Social Forestry:

1. To develop tree consciousness and love for tree cultivation amongst the masses
2. To provide fodder, firewood and small timber for the rural population.
3. To provide timber for sustaining and creating village level cottage industries based on wood.

4. To improve the socio-economic level of the village through increased avenues of gainful employment.
5. To optimize the use of agricultural land through agorforestry practices and to stabilize the farmers income.
6. To improve the income from marginal agricultural lands through tree cultivation.
7. To create recreational forests in urban areas.
8. To raise green belts around industrial locations to control atmospheric and noise pollution and also to absorb toxic affluents.
9. To help in planting all available land in the urban areas to improve the urban environment.
10. To help in augmenting the supply of industrial raw material from non-forest areas to bridge the gap between demand and supply and to lessen the pressure on reserved forests.
11. To make vast saline and alkaline lands productive through afforestation.
12. To afforest the eroded and ravine lands.

Scope of Social Forestry: The broad base given to the social forestry by the National Commission on Agriculture (NCA) was extended to urban forestry as well because it is a forestry practice outside the forest areas and designed for the benefit of a community therefore the NCA defined the scope of social forestry as follows:

1). **Community Forestry:** Practice of forestry in community lands in which planting, management, harvesting and marketing of forest products are carried out by rural community members by themselves or by a state forest service on their behalf for benefit the community rather than individuals.

2) **Farm Forestry:** Practice of forestry on farm lands in which individual land owners are encouraged by training and incentives to plant the trees along field boundaries at farm wood lots. Raising of windbreaks and shelterbelts is also included in farm forestry.

3) **Extension Forestry:** Practice of forestry outside the farm lands and outside the reserve forests includes raising of trees on canal banks, railway lines, road sides, under high tension lines, foreshore areas of tanks, reservoirs and on marginal lands not suitable for agriculture.
4) **Recreation and amenity forestry:** Creation and maintenance of trees for recreational purpose and for improvement of local amenity conditions.
5) **Rehabilitation forestry:** Creation of forests or raising of trees in degraded forests and degraded land to have both the benefits of direct productive and indirect social benefits.
6) **Compensatory plantations:** Creation of forestry for supplementing the natural regeneration to conserve the natural forests with the benefits of gene conservation for supplies of medicines and protection.
7) **Agroforestry:** A form of mixed cropping where in the trees are integrated with agricultural crops / pastures / animals on arable lands for sustainable agriculture.
8) **Urban Forestry:** Growing of trees in urban areas for beauty and climatic amelioration.

JOINT FOREST MANAGEMENT (JFM)

The Government of India, Ministry of Environment and Forests and Wild life vide Lr.No. 6-21/89-FB dated: 01.06.90 issued guidelines for implementing forestry programmes by involving people's participation under the concept of "Joint Forest Management (JFM). This concept of JFM was suggested based on many success stories of protecting the forest by the villagers through formation of various committees like Hill Resource Management Societies in Haryana Village forest protection in Orissa and Forest Protection committees in West Bengal.

Salient features of JFM Project: Given the problem of degradation of forests in the vicinity of the villages involvement of local forests would help to regenerate the forests and also protect them from the degradation. From this JFM concept was developed for the Forest Department to jointly manage the forests. Accordingly the local village communities

are constituted into “Vana Samrakshana Samithies” (V.S.S.) to plan and carryout the forest development programmes jointly with forest department. The forest joining to villages will be identified marked a ten-year plan drawn focusing integrating of resources with requirements based on micro-planning. Annual plans will highlight the inputs both inputs and labour. All grass, leaf fencing material, lops and tops are taken free of cost. Reserved items like gum and beedi leaves are collected by V.S.S. and sold to Girijana Cooperative Corporation (GCC). Produce is shared on priority basis V.S.S. is eligible for about 50 per cent of the share of produce based on their performance.

Basic Objectives:

- To create awareness and localize people interest in forest programmes.
- To lay emphasis on places where good local leadership and active voluntary agencies exist.
- To provide for people’s requirement and wishes in the planning process.
- To provide for continuous revenue.
- To associate the forest staffing in grounding and monitoring the programme.

VSS Characteristics :

- 50 house holds
- One man and one woman from each house hold
- Management Committee - Village President
- Forester as member / Secretary
- Forest guard member.

Management and Harvesting of Social Forestry Plantations:

In case of forests raised for social forestry the management differs from that of reserved forests. It is decided based on the objects of raising wood lots. **It can be for small timber, fuel wood, usufructs, oil seeds, leaf manure or protective purpose.**

1. **Small Timber :** Trees and shrubs with 30-40 years age which produce 1 to 1.5 meters girth are enough for this purpose. At that time lighter poles are selected and felled or coppice. A system is followed or the entire block is felled and replanted.
2. **Fuelwood :** A shorter rotation of 8-10 years is followed and if the plants are watered even earlier they can be felled. Generally Eucalyptus, Sissoo grown for fuel wood are clear felled, the stumps or stools are dressed up to give coppice shoots and there is no need for replanting the area.
3. **Usufructs :** Only physical rotation is followed. Here the trees are not felled only right to collect the fruits are leased out, and trees leased out every year.
4. **Oilseeds :** Here also physical rotation is followed. In case of oil yielding trees like neem, soapnut, Brassia etc., the right to collection is leased out.
5. **Leaf manure :** Collection of fallen leaves and flowers or lopping the branches for green leaf manuring or composting should be done. The lopping should not damage the tree. Removing of leaf or lopping should be done once or twice a year well before collection of usufructs. Normally $1/3^{rd}$ of crown is left intact while lopping.
6. **Protection :** All the trees that are grown for protecting the river course tanks to prevent erosion etc, are never cut or disturbed except to collect it's fruits.
7. **Marketing :** By auction to public agencies or by departmental agencies the collected produce is sold.

Protection of Plantations : Under social forestry the plantations are to be protected from

1) Grazing or browsing by cattle and sheep and goats

2) Illegal or illicit cuttings

3) Fire damage either purposefully or accidentally

4) By to prevent grazing or browsing by cattle barbed wire fencing can be provided

5) For protecting from fire five lines of 4-6 m width are created around each block by clearing the grass and to prevent illicit cuttings proper watch ward is to be arranged.

Lecture No. 5

SOCIAL FORESTRY NURSERIES – PRINCIPLES AND PRACTICES

Nursery is the pre-requisite for raising artificial plantations. In the recent years importance of nursery grown seedlings has grown immensely because of heavy requirements of seedlings both for supply to the public for planting under social forestry programmes and for massive afforestation programmes taken up by the Government. For a social forestry project it is the choice of species and the location of the nursery that matters much. The cost of raising plantations rises high if the production of seedlings is delayed, seedlings are undersized malnourished or short of numbers. A planned nursery with time framed operations growing genetically improved plants with abundant supply for field planting is therefore essential.

Definition of Nursery : Nursery is defined as an area where plants are raised for eventually planting out. A well defined nursery comprise of nursery beds, paths for inspection sites for loading and unloading of material and seedlings, irrigation network. An essential part of the nursery is the "nursery bed" which is a prepared area for sowing seeds, transplanting or rooting of cuttings on the basis of kind of plants growing in them. Nursery beds are classified into seedling beds and transplanted beds. Beds in which seedlings are raised either for transplanting in other beds or for planting out are called "seedlings beds". On the other hand "transplant beds" are those in which seedlings raised in seedling beds are transplanted before planting out on the site. Accordingly nursery is termed as seedling nursery if only seedlings are raised and nursery having only transplant beds is called transplanted nursery. In India seedling and transplant beds are prepared in one nursery. Generally whatever is grown in the nursery for planting out is called **"nursery stock".**

Objects of raising nursery :

1) To prepare healthy and vigorous stock

2) To prepare seedlings for distribution among the public

3) To raise tall and sturdy seedling to a) Overcome the weeding competition at the planting site b) To suit difficult site conditions such as roadside plantations c) To supplement slow growth by intensive care in the nursery for reducing overall cost of plantations.

4) For introducing exotics species like tropical pines Eucalyptus, poplar so that their initial growth could be watched in nursery

5) Species which cannot be raised successfully by direct sowing, for them nursery raised seedlings perform better

6) To raise nursery seedlings for poor and barren sites which is the surest method for artificial regeneration

7) To supplement natural regeneration and direct sowing methods only healthy seedlings can assure uniform stocking. Replacement of causalities is always done by planting nursery raised seedlings

8) Species which do not seed each year or seeds which are difficult to store or of which viability erodes quickly nursery grown seedlings can ensure availability of stock in poor seed years.

Principal of Nursery Management :

1) Well grown seedlings that are reared and conditioned in the nursery will be in a better position to resists the extremes of field conditions

2) The nursery should be as far as possible near to the planting site and seedlings raised for about one or two years in a nursery are planted out

3) The site of the nursery should have good water supply and shade for some of the species

4) Hardening of the seedlings raised should be done before a planting by withholding irrigation and watering for a couple of days before planting

5) After transporting the seedlings to the site they should be allowed to recover from the shock of transport and a day is enough for this purpose.

Types of forest Nurseries : Nurseries are either temporary or permanent depending upon duration of their use.

1) **Temporary nursery :** It is also called a “field nursery” as it is always adjacent to the planting area. It is a established temporarily to meet the requirement of stock for a difficult and limited areas as soon as the demand is met it is abandoned or shifted to another place. Temporary nurseries are also opened in the hilly areas for forward supply to the difficult sites. Although it is very convenient to supply the plants from

a temporary nursery, the cost of production some times rises exponentially. Also as the site has to be prepared freshly weeding is required to be carried out time and again which is the major disadvantage for maintenance of temporary nursery. However the hilly areas it is more convenient and economical to raise temporary nursery as it enables easy and quick transport of seedlings without serious damage.

2) **Permanent Nursery :** Permanent nursery is established to supply nursery stock on a long term basis, it is established at a strategic point from where transportation of seedlings to all possible planting sites is easy. By locating it at Headquarters of Range Officer or other official it receives constant and closer supervision. A permanent nursery should contain most of the species in use. Cost of production of seedlings in a permanent nursery is considerable less than a temporary nursery. A permanent nursery should have a live fenced area, roads, and inspection paths well laid out irrigation system and shading facilities.

   It is always advisable to choose the best available soil and raise the healthiest possible stock. Good healthy seedlings have more vigor to withstand and unfavourable conditions long enough to establish, than a poor unhealthy week and steady plants. In arid areas the location of nurseries is more governed by the availability of good quality water as the nursery stock must be watered through out the year on the basis of irrigation facility nurseries are classified into.

   1. **Dry Nurseries :** These nurseries are usually unirrigated or not having a permanent source of water. It is not every successful and used only for species which do not need a large quantity of water.
   2. **Wet nurseries :** These are irrigated nurseries having a permanent source of water. It is possible to raise large planting stocks in such nurseries.

Factors determining successful production of nursery stock :

1. Efficient administration supervision and management 2) Systematic and timely execution of nursery stocks. 3) Selection of the correct site 4) Economic and successful site

development 5) Utilisation of best cultural methods available 6) Adoption of the optimal nursery practice 7) Elimination of losses 8) Pre-sowing treatment of seed is very important for successful production of nursery stock.

Details of Nursery operations for preparation of nursery stock :

I. **Selection of Site :** It is one of the most difficult tasks in nursery management however it is difficult to get all favourable conditions in a particular area. The most important factors influencing the selection of nursery site are

1) Soil : A good soil is very essential for the success and economy of plant production and physical properties important than chemical properties of soil. Light sandy loam or loamy sand soils are the ones which meet the requirements of diversity of species. Soils should be deep and fresh and a heavy clay should be avoided as it lacks in porosity, permeability etc. Stony soils are very difficult to work and not suited for tender roots.

2) Water Supply : Sustained supply of water throughout the year must be available at the site. Alkaline and polluted water should not be used for watering the plants.

3) Natural zonation : The nursery should be located in the natural physiographical and altitudinal conditions of the species which are to be raised in it.

4. Transport : The nursery should be readily accessible all the year round to facilitate transportation of materials required in the nursery.

II. Size of the Nursery : The size or area of the nursery depends upon

a) species to be raised

b) age of the seedlings

c) nature of the nursery whether temporary or permanent

d) spacing used in the plantation. The area is calculated on the basis of the above and a 50% increase made in the area so as to allow for inspection paths irrigation channels road etc. It should be 0.4 ha for every 1.00 lakh seedlings.

III. Protection of the Nursery Area : Forest nurseries to be protected against outside influences such as grazing damage by domestic and wild animals. For this purpose.

a) Erection of 1.5m height barbed wire fencing for temporary nursery.
b) Erection of stone wall or cattle proof fence around permanent nursery.
c) In arid areas planting of wind breaks, shelter belts to provide shelter.
d) Protection against birds by placing thorny bushes on the bed.

Lecture No. 6

AFFORESTATION

Afforestation : Raising of forest crop on lands which were not originally forested and it may be undertaken for productive protective and bio-aesthetic purpose.

Objectives of afforestation : The main objectives of afforestation is to bring out over all development and prosperity in the area.

1. To meet the needs of fuel wood, fodder, small timber and other minor forest produce.
2. To release the cow-dung as a manure for increasing agriculture production.
3. To provide gainful employment opportunities to the rural masses.
4. To develop cottage industries in rural areas.
5. To utilize all available land according its productive capacity to the best advantage.
6. To provide efficient soil and water conservation.
7. To improve the aesthetic value of the area and to meet recreational needs of the people.
8. As integrated development programme it aims to bring out overall development of the rural areas.

AFFORESTATION ON DIFERENT SITES

1. Shifting Sandunes : Shifting sand dunes occupy an appreciable area in western Rajashthan Haryana. The sand dunes are highly deficient in humus and soil moisture and water table 150 meters deep climate of the area is highly on favorable for any afforestation activity. The annual rainfall is about 150-250 mm temperature goes as high as 49^{o}C during May – June and wind velocities are generally high.

Any afforestation on these sites calls for rapid stabilization of the drifting sand dunes and maximization of soil conservation and selection of suitable species etc. shelter belts play an important role in sand dune fixation reduce the wind velocity and to check the shifting sand dunes in the leeward side. The species like *Acacia nilotica* spp and Zizypus spp., are found suitable.

2). Saline and Alkaline Soils : These sites are mostly located in arid and semi arid tropics of the country. High concentration of salts, lack of moisture availability, poor permeability, presence of hardpan, high pH, toxic effects of sodium are some of the inhibiting factors for plant growth. Species having tolerance to high salt concentration soil binding characters and fast growth should be selected for afforestation of saline and alkaline soils.

Species suitable are *Acacia nilotica, prosopis juliflora, Azadirachta indica, Albizzia procera, Butea monosperma, Pongamia pinnata, Ailanthus excelsa.*

3. Ravine lands : Ravines are net work of deep gullies. The whole land mass is cut by a no.of deep gullies. These lands mainly occur on the banks of rivers of Jammuna Chembal in the states of Uttar Pradesh, Rajasthan, Gujarat and Madhya Pradesh. The soil is generally calcareous and compact with wide various in texture. The ravines are characterized by absence of vegetation of any type the run office maximum, slopes are steep and gullies are varying in depth from few meters to 100 meters or more in order to achieve better results the afforestation of ravines may be accompanied by proper management of agricultural lands.

It has been observed that prevention of erosion by easing of the slopes of gullies and by diverting the surface flow is an essential pre-requisite for any successful afforestation programme. The gullies have to be plugged with suitable mechanical measures to conserve soil and moisture. The sloppy areas of ravines have to be clothed with grasses and Agave etc.

The species which have been grown successfully in India are *Eucalyptus spp., D.Sissoo, Dendrocalamus Strictus, A. nilotica, Prospois juliflora* etc.

4) Lateritic Soils : These soils are mainly located in the states of eastern central and southern regions of India. The low fertility status hard vesicular structure and deficient moisture supply render many of these soils unsuitable for growth of tree species. *Tectona grandis* grown in lateritic soils of West Bengal gave encouraging results. Another two species of *Agave sisalana Agave cantula* grown on lateritic spills have been found successful. Other species like *Acacia auriculiformis, Eucalyptus spp, Grevillea robusta, Anacardium accidentale* have given good results in many parts of the country.

5). Coastal Sea Sands: Coastal sea sands occupy in the form of narrow strip along the eastern and western coasts of the country. The soil are generally alkaline in reaction, salt content is high, poor in nutrients, low in water holding capacity, water table is high at some places the conditions become water logged sea water causes high concentration of sodium salts.

The urgency of afforestation of coastal areas have been fast due to continuous occurrence of cyclone. Plantations of *Casuarina equisetifolia* can be raised successfully on large scale in the coastal sandy soils. Other species which have been encouraging are *Avicennia officianlis, Acacia auriculiformis, Eucalyptus spp* etc.

6). Dry rocky and Murrumy areas : These soils are problematic and generally called skeletal soils. These soils are very shallow course, poor eroded and degraded. These soils occur both in high and low rainfall regions. Due to shallow nature of the soils the vegetation is xerophytic in nature such as *Euphoribia spp*.,

The selection of the species is carried out depending upon the rainfall and other climatic factors of the area. In low to medium rainfall area *Eucalyptus teritiocornis, D.strictus A.excelsa, Hardwickia binnata, Cassia siamea* have been successful. In high rainfall areas species such as *Eucalyptus. Globules, Acacia decurrens* were found suitable.

7). Wet lands : Wet lands may be defined as lands where soils is badly or imperfectly drained. These soils are generally found in high rainfall areas along canals etc. The problems are water logging, physiological drought, defective aeration, excessive salt concentration, poor nutrient availability. The total area of all kinds of wet lands in the country is about 20 m.ha.

In water logged areas of India some of species which have yielded good results are *Erobusta, Sygizium cumini, Salix spp, Poplus nigra.*

8). Grass Lands : Grass lands may occur almost every where but are mostly concentrated on the indogangetic alluvium. The grass lands are problematic for afforestation because of dense growth of grasses. Grasses usually modify the structure of the soil and also affect the translocation of soluble salts and thus latter the morphology of the soil. Soil aeration drainage, biological conditons is largely poor. Many species of grasses like *Imperate, ischaemum, Cymbopogan, Saccharus spp.,* form dense rhizomes., the root system of these grasses are difficult to remove even by ploughing.

The growth of grasses exerts inimical effects on the seedlings growth. Therefore it is essential that species selected should put forth fast growth so that it is not suppressed by the growth of grasses and shrubs. *D.Sissoo Acacia. catachu, Bombax Ceiba A. excelsa* have been found successful.

9). Denuded and Eroded Hill slope : Denuded and eroded hill slopes are generally found in sub tropical and temperate regions of the country. The southern aspect of Himalayas is generally denuded. These denuded hill slopes are heavily grazed, frequently brunt and thus are liable for serious erosion. Denuded hill slopes are more common in western Himalayas than in Eastern Himalayas. These type of areas are largely found in states of J & K, H.P., and U.P.,

The hills have been denuded by unrestricted fellings associated with excessive grazing and frequent fires. In most of the areas the surface soils has been eroded. The soil is poor in moisture and nutrients.

Before starting afforestation the area should be closed for grazing by fencing only hardly species are likely to succeed on exposed and eroded areas. pinus ***roxburghii*** and other *Pinus spp* are quite hardly have been successfully used for afforestation of these areas insub-tropical and temperature regions. In dry areas of N.W., India the species such as *Acacia modesta, P.juliflora, A.catechu* have been successful. In peninsular region *E.tereticornis, A.accidentale, Prosopis spp., Cassia siamea, A. lebbeck* have been successful.

10). Canal Banks : Strips of lands on the both the sides of the canal are generally left for the management of canal. These strips are used for roads, paths and for repairs of canals. The largest area under canal banks is in U.P.,

The soil is characters by high amount of moisture in the surface due to seepage from the canal. The conditions become bad with the presence of higher amount of clay. Local alkaline, saline patches are also common *D.sissoo A.niotica, Syzygium Cuminii* may be planted.

11). Road side areas : Road side plantations have special problems of protection from local population and cattle. The road side soils are comparatively depressed because soil excavated from these areas is used to raised the level of road surface. Generally road side areas are well drained but many times water logged patches are also faced.

The species with proportions such as hardiness, fast growing, compact crown, less spreading branching behavior, evergreen or winter deciduous, wind firm with edible fruits may be preferred. The important species are *Mangifera indica, Tamarindus indica, D.sissoo, Ficus spp., A.indica.*

12) Bio-aesthetic plantations : Planting of trees is also undertaken because they are good to look at. They grown in beautiful shapes and curves. They are the cheapest large scale parasol shielding us from sun rain wind and other various factors. The trees are good screens and effectively shut out the view of an unsightly picture and structures such as buildings walls etc. Planting of trees for these purposes is undertaken by house owner, designers, managers of parks, town and country planners.

Trees like *M.indica* A.*indica T.indica, Ficus spp., Grevillea robusta* may be selected for shade species such as *P.longifolia Michalia chapaca, Populus spp, Saraca indica and Eucalyptus spp* are generally grown for their shape of bole and crown. Flowering trees like *Delonix regia, Peltophorum spp, Jacaranda mimosifolia, Cassia fistula, Erythrina indica, Spathodia companulata, Tecom spp., Thespesia populanae* etc are grown for ornamental purpose.

Lecture No:7

VILLAGE WOOD LOTS

Need for village wood lots : The main purpose of establishing village wood lots is to make village self-sufficient and self-reliable in the matter of their bonafied needs of fuel wood, poles, bamboos, grass, fodder and other forest products. By doing so the women would be spared the drudgery they have to undergo in several rural areas of the country to go out in search of fuel wood and spend considerable time which would be normally utilised for the care of the children and the home. In a view areas the rural women have to trek a distance of about 15 km to gather the fuel wood needs of a family for a week.

Fuel wood is commodity which has registered the highest inflation rate thus hitting the poorest, the hardest. It the present situation continues a time is not far off when the poor may be forced to change their food habits or may have to resort to consuming semi-cooked and some times raw food as it is happening already in some part of Africa

Strategy : A village should be taken as a unit. The selection of a village should be governed by the acceptability of the programme by the community. To create this situation the publicity and Extension wing of social forestry organisation will have to start extension activity in the area at least two years in advance. The extension education and motivation should include a visit by the local villagers to a few neighbouring villages where the people have accepted the idea and implemented it to their advantage. It is desirable that the people whole have benefited from the activity narrate their experiences to the rest. This would be the best way of extension culmination in motivating the villagers to accept the programme.

The area of the village wood lot would be governed largely by the availability and willingness of the people/ villagers. The area so selected with the consent of the villagers should be free from all encumbrances. The quantum of the area of the village wood lot is also depend on the need of the villagers. The area made available by the villagers is not less than that required to meet their needs in full. However where the area made available is more there should be no hesitation in creating wood lots provided it is not at the cost of other villagers. Normally an area between 2 and 4 ha. is selected in a village for raising a village wood lot. In sparsely habituated villages where the demand for fuel wood is in significant the areas available are large. In such cases selection of species should be such as

to promote economic activities in the area. Fruit trees and trees which yield raw materials for cottage industries commend themselves.

If the bud exists in degraded forests in a village the planning for it should also be integrated with that of village wood lots to answer that the resources created in both these categories of land meet the local needs in full.

If there is a right of way it should be conceded and provided. If it is necessary to provide a passage for the village cattle it should be provided right from the beginning. A neglect of these two considerations have lead to a large no. of unavoidable problems and alienated the villagers.

Species selection and Design : The species selection should ultimately rest with he villagers. It is desirable to sacrifice to some extent silivicultural suitability in favour of accommodating the desire of the people. The choice of species should be based on

i. Capacity to put on fast growth so that it can be harvested in short period of 5-6 year.
ii. Coppicing power
iii. Multi-purpose and
iv. Soil improving ability.

Some important species are :
Albizzia spp, *Azadirachta indica, Bauhinia* spp, *Dalbergia sissoo, Dendrocalamus strictus, Emblica officinalis, Eucalyptus* spp, *Ficus* spp, *Sapindus* spp, *Morigna* spp, *Gravellia robusta* etc.,

Design Selection :

As far as design is concerned the best approach would be to prepared a soil map followed by a treatment map. As far as possible species should be planted in blocks so that management becomes easier and that suppression is avoided. However almost freedom should be allowed to the field functionaries in this regard.

Since the village wood lots are largely for fuel wood a close spacing is indicated. Normally 2 x 2m which is a standard espacement in conventional forestry should suffice. A closer spacing of 1 x 1m. in two staggered rows now near the fence is indicated. For bamboos and other fruit trees it should be 5 x 5m. However one seedling of fuel wood species should be planted in between two adjoining plants so that there is a better utilisation of land.

A special mention is considered necessary for fodder trees. In most of the villages fodder scarcity is acute. Fodder suitable fodder trees should therefore be planted. Some of the fodder trees are *Salix, Albizzia, Bauhinia, Dalbergia, Ficus, Leucaena* etc. The main criterion for selection should be quality, quantity, palatability and early availability of fodder. Care should be taken to locate the fodder plot in one corner of the wood lot which his closest to the road/ cart track / foot path. A oil seed bearing trees through very important in village economy are largely neglected some of the oil yielding trees are *Shorea, Madhuca, Azadirachta, Pongamia , Jatropha, Butea* etc.

Another area which has failed to attract attention is uncultivated fruit trees. Villagers are conscious of fruit trees and their importance in rural health and nutrition hence by and large want fruit trees to be grown in village wood lots. It is therefore essential that the forest functionaries are exposed to a suitable training in the art of horticulture for inclusion wood lots. Healthy and quality seedlings should be obtained from the Government horticultural nurseries.

Management : The management responsibility should rest with the Village Panchayat Forest Committee (VPFC) under the guidance of the forestry extension organisation.

Use of Woodlots :

1. The production of wood materials for farm use.
2. Production of revenue
3. Protecting the growing crop, the farm stead and livestock in the forma of windbreaks / shelter belts.
4. Protection of water supply and to prevent soil erosion
5. A well stocked wood lot serves as a nature of reserve fund.
6. For reclamation of degraded and eroded lands.
7. Wood lots serves as a breeding place of many birds which help to keep down the harmful insects.
8. Woodlots helps to improve the climate by reducing pollution of air and sound.
9. Woodlots increases the aesthetic value of the area.

Measures for shortage of Fuel wood:

To meet the acute shortage of fuel wood many measure have been suggested 1. Utilisation of logging waste and introduction of improved logging practices which may increase production (by 10 %) 2. Introduction of gobar gas plant in the rural areas by utilizing the cow-dung 3. Installation of improved chullas having heat utilisation efficiency of 30 to 40% (Traditional chullah has 13.5%) 4. Produce gas plants using agril. wastes. 4. High density plantations using intensive production measures 5. Energy plantations 6. Tree growing on private lands through Social forestry, Farm Forestry, Agroforestry.

Properties of Fuel wood : The value of wood as a fuel depends mainly on it's combustibility (Readiness with which it catches fire and continues to burn) and its heating power or calorfici value (Calorfic value is the quantity heat emitted by a given weight of wood during the process of combustion).

Thus overall efficiency of wood utilisation depends upon the moisture content of the fuel wood. Freshly cut wood contains about 23-25% moisture. About 8-9% moisture is just enough for domestic wood burning stoves (Vimal 1984). The commonest method for fuel wood drying are the solar drying and air drying.

Wood of dense structure generally takes longer time to burn and therefore gives steady heat than porous wood which burns quickly. Similarly unsound wood gives less heat than a sound without any fissures. With some exceptions the heart wood possess high heat value than sap wood as it contains greater concentration of organic substance such as tannins salts etc. then enhance the heat value.

Generally speaking hard woods are better fuel woods than softwoods as the former give out more lasting and uniform heat and are therefore preferred. Freedom from smoke, crackling, sparking ease and completeness of combustion, rapidity of burning etc., could also be considered for selection of species for fuel wood plantation.

A energy plantation is one that grown purely for plant material for their fuel value than for fibre content. In energy plantations it is necessary to select fast growing plants, spacing should be close (one meter) and short rotations of 3-4 years. This concept is based on the principle that yield of dry matter of certain fast growing species is independent of spacing. In such a method canopy closure occurs rapidly at very early stage resulting in more dry matter per unit area when compared to traditional silvicultural methods using large spacing. In this approach the idea is to use trees that grown very fast during first few years and coppice them at intervals of less than five years.

Advantage of Energy Plantations :

1. A dependable supply of energy
2. Will create and control vagaries of weather
3. Produces fodder for cattle and minor forest products
4. Fuel form energy plantation is essentially sulphur free
5. Ash can be used as manure
6. Use of fuel does not interfere with the CO_2 balance of earth
7. Handling and disposal of by products is safe
8. Thermal pollution is 25% less
9. Wood burning boilers help in generating 80 mega watts of electricity
10. Suns energy can easily be stored

11. Photosynthetic energy process are less costly than photo-voltaic and photo thermal process.

Choice of Species : Choice of species play a vital role in success of energy plantations. The important properties of trees for energy biomass are 1. A large portion of available insulation must be absorbed by green tissue which can be achieved by

a) using plants with high photosynthetic efficiency e.g. C_4 plants which convert 2-3% of available solar energy into plant material compared to 1% for most of forest tree species

b) Replacing each harvest with new crop as quickly as possible.

c) Breeding plants with leaves whose shape and orientation make maximum use of sunlight

2) Selection of fuel crops should be based on energy budget

3) Ease of establishment and regenerate on after harvesting

4) Free from pests and diseases

5) Ability to reduce transpiration in arid areas

6) Minimum drain on nutrients and ability to improve site quality

7) Should be fast growing leguminous and drought resistant

8) Should adapt quickly to site environment and should produce multipurpose products.

Lecture No :8

DIFFERENT TREES SPECEIS SUITABLE FOR FUEL WOOD, FODDER AND TIMBER

STUDY OF SUBABUL & EUCALYPTUS

1. Subabul *(Leaucaena, leucocephala)*

Family : Leguminosae (Horse Tamarind, Khari).

Origin : Native of Central America and has been introduced widely in many tropical countries.

Phenology : It is a tall tree grown upto 20 meters or a shrub, less than 5 meters in height unarmed and evergreen. It ahs feathery leaves, small white flowers and large bunches of long flat pods each containing 15-30 seeds. Immature pods are light green ad translucent, mature pods are brown shining with waxy cost and open spontaneously when dry.

Three types have been mainly recognised 1. Hawaiian types are short bushy trees grow upto 5 meters and mainly grown for fuel wood. 2. the Peru types are medium tall trees, grown upto 15 meters with extensive branching mainly grown for fodder purpose (forage varieties) 3. The Salvador types are tall trees, grow upto 20 meters having large leaves and pods mainly grown for timber etc. Varieties K-8, K-268, Hawaiian giants.

Silvicultural Characteristics : *Leaucaena*, is a light demander, fast growing, can tolerate partial shade, but grows best in full sun. It is frost tender but can withstand drought but prolonged drought may kill the seedlings. It is a good coppicer and pollarder and allows repeated harvests of firewood timber and forage produces plentiful seed in first or second

year. It is a species of warm tropics, grow on wide range of soil types but mainly grows on neutral soils.

Establishment :

1. **Natural regeneration :** *Leaucaena,* reproduces itself fairly through seed coppice. It seeds profusely and the seed gets scattered under the mother tree which establishes well only under full sun and moisture conditions.
2. **Artificial regeneration :** *Leaucaena,* can be raised by direct sowing of seed or by planting container raised seedlings.
3. **Seed collection and storage :** It seeds twice a year July to November and February to May. Pods are collected before they dehisce. The seeds collected after drying the pods are liable to be attacked by stored pests for which the seeds are to be treated before storage. It can be stored for along period of 10 years (Viable seed). The seed requires pre-sowing treatment for quick germination which is being carried by either 1.Mechanical scarification of seed coat 2. Soaking in ordinary top water for 48 hours 3. soaking in hot water at 80^{o} C for 2 minutes and cooling in cooling in cool tap water for 12 hours. Seed requires inoculation with Rhizobium at 250 g/20 kg seed. Germination capacity is 80%. A seed rate of 10-20 kg of seed per ha. is required. A spacing of 3 x 3 meters is recommended. In the nursery the seeds are sown in polythene bags during March – April which germinate in 4 – 6 days and the seedlings attain plantable size by July – August.

Management growth and yield : For fire wood the plantations may be harvested in 2 -3 years rotation for timber rotation of 5 – 6 year may be followed for forage the cutting the branches at the frequencies of 1-3 months depending upon the growth rate. Growth in terms of height can exceed 4 m/year initially achieving 20 meters in 5-6 years. Wood yield of 10-20 m^3/ha/yr. on average under dryland situation is possible.

Utilization :

1. **Fire wood :** *Leaucaena,* wood makes excellent firewood and charcoal and the calorific value of wood is 4200 – 4600 K.Cal/Kg of wood.
2. **Timber :** The wood is hard strong heavy (about 880 Kg/M3) mostly suitable for carpentry purposes and makes cheap constructional timber and as a poles for fencing.
3. **Fodder :** Leaves pods and seeds are nutritious digestible and relished by cattle sheep and goats. However a toxic alkaloid mimosine is present in the leaves of some of the varieties at level (2-5%) that can be injurious to health of cattle. It is therefore important to select low mimosine strains (Hawaiian giants) and supplement it with other forages. The mimosine content can be reduced to 50% when leaves are dried at high temperature or by immersing in ferrous sulphate solution.
4. **Other uses :** Its pulp is mixed with bamboo pulp for manufacture of paper, for afforestation of denuded watersheds as wind breaks for farm and agroforestry pods yield a dye used to colour wool cotton, fishing nets, powdered seed make good manure. The plant is said to be a fish poision and worm repellent.

2. **Eucalyptus (*Eucalyptus, tereticornis*)**

Family	:	Myrtaceae
Common Names	:	Mysore gum, Mysore Hybrid
Origin	:	Native of Australia

Phenology : Mysore gum is a tall clean bole, straight tree with white smooth bark and thin evergreen foliage under favourable conditions it attains a height of more than 40 meters and DBH over 65 cm. Bark is shed annually in long stripes or plates. The leaves contain some essential oil which has some medicinal properties. Flowers do not have sepals or petals and appear to consists of only a large no. of stamens. The capsules (fruits) are divided in to 4 or 5 cells which open by valves.

Silvicultural characters : It is a versatile tree adopted to a variety of edaphic and climatic conditions. It failed under high rainfall conditions of 2000 mm of Kerala and Assam, does well in well drained soils and can come up in areas with rainfall as little as 500 mm well drained loamy soils are best suited. It is not suitable for steep hill sloes for dry eroded and ravined or water logged areas.

It is a strong light demander, without full over head light it becomes lean lanky and crooked. It can tolerate mild frost but not severe drought, can withstand light fires, but young plantation are susceptible to severe fire damage. It has the cardinal advantage that it is not browsed by cattle and also a strong coppicer.

Establishment : Natural regeneration – rare, propagated artificially, artificial regeneration : – Planting of nursery raised seedling in polythene bag is adopted for large scale plantations planting naked root seedlings or stump planting have met with varying success. Direct sowings are very rare.

Seed collection storage sowing and Nursery : Mysore gum starts seeding after 2-3 years. Trees of 5 years old and above seeds profusely. Seeds are very small being 75,000 – 1,00, 000 per Kg. The tree seeds twice a year in autumn (Oct) and summer (May). Seed is collected from dominant felled trees or standing trees of superior phenotype. Air dried seed is stored in air tight containers and retains fair germination capacity for 1 or 2 years. Minute size of the seed calls attention for handling in the nursery. For raising container plants seed is first sown in nursery beds and then pricked out into polythene bags after germination. About 200 gms. of seed per bed of 10 m^2 is sufficient. Germination takes place within 5-15 days and each bed yield about 12,000 to 15,000 seedlings.

The seedlings are to be pricked out into polythene bag normally 4 to 6 weeks after germination. Seedling grow 1.0 to 1.5 meters tall and fit for planting out in 6-8 months. Plantings are established at spacing of 1.0 x 1.5 to 4.0 x 4.0, meters in pits of 30 cm^3 or 60 cm^3.

Management growth and yield : The crop is clear felled at the end of each rotation and is regenerated by coppice. Under favourable conditions 3 years coppice crops can be taken after which the area is need to be replanted. On an average 90% stumps will coppices. Rotations of 8-14 years may be adopted depending on site quality for pulpwood. Rotation of more than 12 years is not advisable because the tree develops dark coloured wood.

The tree is quite fast growing but growth varies widely with site and management. An average plantation will yield about 5 m3 (3 t/ha/year). The yield form the first coppice is same as the first crop but the 2^{nd} and 3^{rd} coppice crops yield less by 10 – 20%.

Utilisation :

1. **Fuel wood :** Mysore gum gives a good quality firewood and burns slowly. The calorific value of the dry fuel is 4880 K Cal/Kg of wood. It gives good quality charcoal weighing 420 Kg/m3 and calorific value is about 7550 K Cal/Kg.
2. **Timber :** Mysore gum wood is moderally heavy (640 Kg/m3) and hard it is suitable for timber, transmission poles, packing cases, boxes, beams, columns, poles and posts.
3. **Pulp wood :** Mysore gum wood gives a suitable raw material for paper pulp, news print and rayon grade pulp of good quality.
4. **Leaf Oil :** Leaves are an important source of essential oil which “contains cineole” oil has medicinal value.
5. **Other uses :** It is a suitable species for honey production

   Bark is a suitable raw material which yield oxalic acid (40-45%) by oxidation process.

Lecture No.9

STUDY OF CASUARINA AND NEEM

1. Casuarina *(Casuarina equisetifolia)* :

Family	:	Casuarinaceae.
Common Names	:	Saru, Saruvii, Beaf wood
Origin	:	Casuarina is exotic to main land of India. However it occurs naturally in the Andamans, Bangladesh and Burma coasts.

Phenology : Casuarina is a large, fast growing with graceful appearance resembling feathery conifer. Bole is long cylindrical, foliage feathery consisting of long slender dropping leafless branchless which are green and perform the function of leaves, the leaves being reduced to minute scales forming a whorl round the branches. The tree attains a height of 40 meters and a diameter upto 60 cm, often buttressed at the base. It is short lived it's natural span of life seldom exceeds 50 years. The tree flowers generally twice a year, in. February to April and then again in September to October. Fruits appear in June and December.

Silvicultural characters : Casuarina is a fast growing and light demanding species. It is very sensitive to excessive soil moisture, fire frost and to the drought upto the sapling stage but can withstand drought when its roots are long enough to tap the ground water. It can tolerate low temperatures and light shade. It coppices badly but regenerates to some extent by self seeding and root suckers. It is considered as effective soil improver by virtue of its vigorous root nodulation with nitrifying bacterial. C. equisetifolia fixes N (with help of frantrial bacteria) from 100 to 320 kg /ha year. Casuarina grows best on loose fine coastal stands but cannot grow on coarse sands or clayey soils.

Establishment :

1. **Natural regeneration :** Natural reproduction of casuarina from seed is scanty in coastal and Inland plantations of India. It some time produces root suckers and also reproduce by natural layers from the lower branches.
2. **Artificial Propagation :** Direct sowing and coppice have not prove successful. Coppicing is some times successful if trees are cut high leaving at least one vigorous branch and felling is carried out in the middle of the rainy season. The only reliable method of propagation casuarina is the planting out of 6-10 months old nursery raised seedlings. It can also be propagated by vegetatively from lateral or side shoots by air layering and root suckers.
3. **Seed collection, storage, planting techniques :** Ripe cones are collected from well grown mature trees (10 – 15 yrs) before they dehisce (June – December) by lopping the branches or beating the trees. Green cones are immature and mature cones are brown in colour. The sun dried cones on threshing give rise the winged seeds which are dried and stored only for few months . It should be preferably sown soon after collection. About ½ Kg. of seed is sufficient for nursery sowing for one hectare of plantations. Germination average is about 50%. Since seeds are tiny direct sowings are not successful. In the nursery the seeds are tiny direct sowings are not successful. In the nursery the seeds are broadcasted @ of 10 g/m^2 usually in November and watered. The germination will be complete in about 10-20 days. The seedlings are fit for planting in 5-6 months (35-45 cm tall). Polythene bag containers are used some times. Naked root seedlings of 35-60 cm. tall should be planted out in 30 cm^3 planting spacing varies from 1 x 1 to 4 x 4 meters depending on site and purpose.

Management growth and yield : Casuarina plantations are managed by clear felling followed by concentrated regeneration or replanting. Rotation depends upon site and purpose but a short rotation of 5-7 years gives high quality fuel wood still shorter rotation yields poles. After planting it achieves 1.2 – 1.5 meters growth per annual for about 7-8 years. Volume growth is maximum at 20 year being 7-10m^3 ha/years.

Utilisation:

1. **Fuel wood :** Casuarina makes excellent fuel and best fire wood in the world with its calorific values of 4950K. cal/kg. Its roots are used for making charcoal.
2. **Timber :** Timber is strong heavy (850 kg/m^3). It is liable for crack and split and is not easy for saw or season. It is used for poles, scaffolding, transmission poles and rapters.
3. **Other uses :** a) Bark of casuarinas is a tonic and astringent useful in dysentery and diarrhea. b) Powdered seeds are applied as plaster in head aches. c) Bark contains 6 – 18% tannin which is used for dyeing wool and silk fabrics and for toughening fisher man's nets d) Pulp is used for wrapping paper. d) Needles are used for preparing activated carbons f) It is the most suitable species for afforestation of sandy beaches and shifting sand dunes along the sea coast.

2 Neem *(Azadirachta Indica)*

Family	**:**	**Meliaceae.**
Common names	**:**	**Neem, Vepa, Margosa tree (English)**
Origin	**:**	**Native of India.**

Phonology : Neem is a medium to fairly large sized tree with dense rounded crown, deep rooted, usually evergreen, leaf less for a short period in February – March. The tree attains a height of 15 – 20 m. and a of 80 – 150 cm. New leaves appear in March – April, Greenish

white sweet scented flowers appear in March – May, fruit ripens during the rains i.e., July – August.

Silvicultural Characters : It is a light demander but seedlings can tolerate shade, sensitive to frost, drought hardy, wind firm, not tolerant to water logging, susceptible to fire a damage. It coppices and pollards well and produce root suckers. It is readily browsed by goats.

Climatic and Soil Requirements : Neem can with stand keep as high as 49^{o} C and as low as 0^{o} C. It is most successful in tropical and sub-tropical zones having a mean average rainfall of 450-1150 mm. However it can tolerate or little rainfall as 130 mm / annum.

It grows on dry stony clay and shallow soils. Optimum soil pH – 6.2, 5- 9.8 (Saline & alkaline soils) with soluble salt content upto 0.45% in the sub soils

Establishment :

1. **Natural :** Seedlings regeneration is plentiful. It is also regenerates will by coppice and root suckers.
2. **Artificial regeneration :** Direct sowing of freshly collection seed proved successful. Transplanting, stump planting is also common practice of propagation.
3. **Seed collection storage and planting techniques :** Neem bears the seed at the age of 5 years profusely. Ripe seeds are collected in July – August and sown with in about a fortnight of collection because the seeds rapidly loose viability thereafter seeds can be stored will only upto a maximum period of 2 months. Germination ranges from 70 to 90%. Direct sowing by dibbling the seed is common practice. Nursery sown seeds start germination in a week and attain plantable size in 2 to 3 months. One or two year old nursery seedlings with ball of earth are used for planting out in 30 cm3 pits at a spacing of 3 x 3 m. (Monoculture system). Agro forestry system – 8 x 10 x m time of sowing June to August, Seed rate 3-4 kg/ha – direct sowing.

4. **Management growth and yield :** In general neem is being managed by clear felling and planting. It is a fast growing and attain a height growth of 20 – 25 meters and dbh of 100-150 cm. The Mean Annual increment is about 5 – 18 m3 / ha / year. A rotation of 8 years is followed for fuel, wood purpose fully grown neem tree seed yield 30 kg / fruits / tree 2000 – 3000 seeds / kg.

Utilisation :

1. Timber : Neem wood is hard heavy (800 Kg m3) not attacked by termites hence used in construction, furniture, poles and resistant to decay.
2. Fuel wood : Gives excellent fuel wood with calorific value of 20900 kj/kg
3. Fodder : Nee leave make very good fodder for goats and camels and less palatable for other cattle.
4. Oils : Neem seed contains 40% oil (Margosa oil) of commerce used in face creams, soaps, tooth pastes, disinfectant insecticide, pesticide and also for skin diseases.
5. Seed cake : It is generally valued as manure because of its high nitrogen content and has insecticidal properties and not used as cattle feeb because of bitter and foul small N – 5.2 – 5.3% P: 1.0 – 1.1%, K – 1.4 – 1.5%.
6. Other uses : a) Bark yields tannin, seed oil b) powered leaves are used as antioxadant to poisons, itches and worms, bitter extract used as fever tonic, antiseptic and for skin diseases. C) Leaves and seeds also contain, ***Azadirachtine*** acts as insects repellent for stored grains. The tree is useful for shade, shelter, wind break for soil improvement etc.

Lecture No. 10

STUDY OF BABUL AND TEAK.

1 Babul (Acacia nilotica)

Family	**:**	**Leguminosae *(Mimosaceae)***
Common Names	**:**	**Babul, Kikar, Nalla Tumma (Telugu)**
Origin	**:**	**Indigenous to India**

Phenology : It is a medium sized tree attaining a height of 18 m and diameter of 90 cm. It is almost evergreen in habit it has a flattish umbrella shaped crown, feathery foliage paired whitish long thin thorns at the base of each leaf, bright yellow sweet scented flower heads and grey or black long flat pods with constrictions between the seeds which look like strings of beads and characteristic feature of babul. The tree beings to flower from the age of t here years and seeds every year thereafter. It flowers in June to September and pods ripen in May – June. Three main varieties namely Telia, Rediana and Vamakanta babul have been recognized in India out of which Telia is most popular since it provided less shade to crops.

Silvicultural Characters : Babul seedlings and mature trees are susceptible to shade, fire and frost and the tree insusceptible when moisture is limiting. It is poor coppicer but it pollards will. Root suckers and seldom produced. It is browsed by goats, camels when it is small but mature trees can be repeatedly lopped for regular fodder and small fuel wood. It is moderately resistant to drought but it is a drought resistant and a tree of warm dry regions. It prefers recent alluvial sandy loam but can grow on heavy black and clayey soils. It is a tree of colonizer and Nitrogen fixer temperature 0o C – 50^{o} C, Rainfall 100 – 1000 cm.

Establishment :

1. Natural regeneration : It regenerates naturally through the seed under favourable conditions.
2. Artificial Regeneration : The babul tree can be propagated either through direct sowing or nursery raised seedlings in poly pots.
3. Seed collection storage and planting : The ripen pods are collected form mature trees in May – June and seed are extracted and stored after drying properly dried seed can be stored upto 3 yeas. For getting good germination pre-sowing seed treatment of dipping in hot water and soaking for 24 hours is necessary of soaking, in concentrated sulphuric acid for 10 – 15 minutes and wash minutes is required.

   Planting of nursery raised seedlings is pits of 30 cm3 at a spacing of 3 x 3 meters proved successful seed rate is 2 – 3 Kg/ha. Germination on average is 50%. Time of sowing June – July

4. Management growth and yield : Fast growth under favourable conditions. It attains a height of 8 – 14 metes and diameter growth of 2 – 3 cm / year is possible. Rotation of 15 – 20 years is followed and the plantations are managed by clear felling and replanting the area. The manual increment is about 3x 3 /ha.

Utilisation :

1. Fuel wood : Babul is an extremely valuable fuel wood with calorific value of 4400 K.Cal/Kg. It gives charcoal of excellent quality and very popular source of fuel wood in the Indian sub-Continent.
2. Timber : Babul wood is heavy (air dry wt. 760 Kg/M3) very hard strong tough resistant to termites and impervious to water. It is most popular timber for carts, tool handle boats and building purposes.
3. Fodder : Leaves and pods are widely used as fodder and constitutes the chief diet for goats and sheep’s in arid and semi arid regions.

4. Tannins : Bark and pods are widely used in the tanning industry. Tanin content values from 12 – 20%.
5. Gum : Babul gum is probably the earliest commercial source of gum Arabic used in the manufacture of inks, matches, paints and confectionary.
6. Other uses : Babul is mostly suitable for planting in Tank fore shore areas and not suitable for agro-forestry because of its shallow root system of the tree.
7. Thorny branches can be used for the protection of newly planted plant species

2 TEAK *(Tectona grandis)*

Family	:	Verbenacea.
Common Names	:	Teak , Sagwan Teku etc.
Origin	:	Teak is a native to Burma, Indian Peninsula.

Phenology : Teak is a large deciduous tree with a rounded crown under favourable conditions grows to a tall clean cylindrical bole. Leaf fall occurs during months of November to January in dry areas and March in moist localities. In very moist pockets teak becomes almost evergreen. Leaf renewal takes place in the period between April to June. In remains leaf less in summer season in hot dry localities. Flowering occurs soon after the new leaves have come up *i.e.,* from June to September. Teak has a large inflorescence originates terminally having small white flowers. Fruiting takes place in the period from November to January seed fall occurs soon after the fruits have ripened and collection of seed is done from January to February germination of seeds takes place immediately after fall of seed on to the ground.

Silvicultural Characters :

Teak is a strong light demander. Seedlings and grown up trees are sensitive to severe drought and frost sensitive too. Moderately wind firm. Teak has greater resistance to fires. It is not readily browsed by cattle and other animal but deers and antelopes caused damage to the bark when it is succulent. Teak coppices and pollards well and retains the power of coppicing to a considerable size. The vitality of the teak stumps is remarkable.

Teak is unable to tolerate conditions of both water logging and salinity. Soil must be well drained for the teak to prosper. Teak thrives best in fairly most warm tropical climate.

Establishment :

1. **Natural regeneration :** The following factors aid in the natural regeneration of teak i) It is hardly once it has come up. ii) It spreads naturally however factors like climate soil cover and fire may influence the natural regeneration.
2. **Artificial regeneration :** large scale plantations of teak have been raised in different parts of country by artificial means mostly form nursery raised seedlings.
3. **Seed collection, storage and planting techniques :** Good seed occurs almost every year, fruits are collected, from the forest floor after it has been swept clean. Seeds from coppice trees as well as seedling trees are both equally fertile. Pre-sowing treatment in necessary to get good germination a) Scorching the seed in light fire b) Immersion in hot water for a period of 2 to 4 hrs c) Alternating soaking and drying d) Burying the seed near an ant hill e) placing the seed in a paste of cow dung and water. f) Weathering the seed by exposing it to sun and rain on leaving it in the open for 2 or 3 weeks. G) Acid treatment. Each kg of seed thus collected contains 1200-3000 seeds. Stored seed upto one year germinates well than the fresh seed indicating some sort of dormancy and long viability of seed. Nurseries are to be established near the planting site. Seed are sown by broadcast @ about 5-7 kg per bed. Sowings are generally carried out from February – March. Germination takes place within 7-10 days of sowing. Germination percentage is 90 to 99% and seed from survives from 80 to 90. The process of pricking in teak nurseries is not recommended as it develops bushy root system. The seedlings

are planted in crow bar holes at the beginning of monsoon at a spacing of 2 x 2 meters. One year old seedlings provide stumps for planting. The optimum diameter varies from 1 to 2 cm at the collar. Quarter and half stumps also give good results.

Management growth and yield : Teak is managed under three different methods 1) Clear felling is practiced in such areas where regeneration is possible by artificially or naturally 2) Coppice system is followed in areas where the rainfall is below 100 cms. Where rotation age varies from 30 to 60 years. 3) Selection cum improvement system was employed with a view to improve the general conditions of the crop and in areas which are remote inaccessible and undulating etc. Initially the diameter growth upto 10 years age will be increased at the 3 cm / yr later upto 60 years the diameter growth will increase @ 5 cm/yr. In a 40 – 60 years rotation the crop may yield about 80 -100 M^3 / ha.

Utilisation : Teak is most important timber tree of India. It enjoys place of pride amongst the timbers all over the world. This is due to a rare combination of its physical and mechanical properties. It has a shock resistance and shape resistance power. It is extensively used for furniture, cabinet work, joinery, house building, railway carriage and wagons, carving, ordinance work and general carpentry.

LECTURE NO. 11

STUDY OF BAMBOO, TAMARIND AND SOAPNUT

1. Bamboo *(Dendrocolamus strictus)*

Family	**:**	**Graminae**
Common name	**:**	**Male Bamboo, Sandan, Veduru**
Origin	**:**	**Two varieties of Dendrocalamus occur in India. Indigenous to India.**

Phenology: Bamboo is densely tufted, unarmed, deciduous gregarious in habit, culms variable according to site, strong thick walled or solid 6-15m in height 2.5-10 cm in diameter. Sporadic flowering occurs, clumps in small groups year after year. However gregarious flowering takes place over long gap of time. It is believed that this interval is 12

years vary with local conditions. Flowers occur in dense globular heads in the period from November to February. Seed fall takes place from April to June. As a rule leaves are shed from December to March and new foliage begins to appear in April – May. It tends to be evergreen in moist localities.

Silvicultural Characters : Best known widely distributed and hardiest of all the India bamboos in drought prone regions and is frost hardy. It is a light demander and makes only poor growth as an under storey however seedlings in general benefit from a certain amount of protection from the direct sun. Dense shade and heavy weed competition are highly inimical to its growth.

Establishment :

1. **Natural regeneration :** D. *strictus* reproduces itself naturally by seed and from rhizomes giving out annual shoots aerial clums. It can also be multiplied naturally by producing new clums. It can also be multiplied naturally by producing new culms from rhizomes annually during the rains.
2. **Artificial propagation :** Seeding of bamboo annual or periodic is rare and procurement of sufficient fresh and viable seed is a problem. But it can be propagated by seed as well as nursery raised seedlings too.
3. **Seed collection storage and planting techniques :** Seed is collected in April – May by cutting flowering branches and seed is extracted which can be stored for one or two years is kept in sealed tins. Fresh seed germination averages 75%.

By far the surest method of raising bamboo is by direct sowing. Fresh seed is sown just before the rains, in lines at a spacing of 4.5 X 4.5 meters. One kg. of seed can be sown in 400 running meters. In the nursery the seeds are broadcoasted in the nursery beds of 10 x 1m. in September – October at the rate of 1.5 Kg. per bed. After three months the seedlings are pricked out into polythene bags of 20 x 10 cm. size. The seedlings are ready for planting in the field during next year (July) which are planted out in 30 cm^3 pits spaced at 5

x 5 or 6 x 6 meters. D. *strictus* can also be propagated vegetative by planting stem (culm) or rhizomes cuttings layers of offsets.

Management growth and yield : Management of bamboos forest essentially involves the removal of mature culms on a regular cycle in addition to cleaning thinning and removing of dead broken twisted and crooked culms to avoid congestion. The usual cutting cycle is 3 or 4 years but may be 2 to 5 years depending upon site quality cut only during winter at a height of 15 to 30 cm retaining one node and culms on the outer periphery should not be cut. On an average 5 culms are produced per year and is (productivity) about 275-300 culms/ha. The biggest culm seldom exceeds 5 cm in diameter and the high would be 7. Industrial plantations of bamboo on an average site yield about 3 tons / ha /year.

Utilization :

It is used for house construction making baskets, mats, furniture, parquet, flooring, laminated, bamboo boards, tool handles, chicks, ladders, scaffolding and shafts etc. It is an important source of long fibred pulp and paper, and for rayon. Bamboo leaves are used as fodder for cattle and Elephants. It is an ideal species for soil conservation.

2 TAMARIND

. Tamarind *(Tamarindus indica)*

Family	:	Leguminosae *(Caesalpineace)*
Common Name	:	Tamarind, Imli, Chinta
Origin	:	Indigenous to dry regions of tropical Africa and introduced into India long age probably by Arabs

Phenology : Tamarind is a large handsome long lived evergreen tree cultivated for its shade ornamental and fruit. It attains a height of 30 m girth 3 -5m, has a wide spreading crown of 9-12m diameter. In excessively hot and dry regions it may be come leafless for a short period in February – March. New leaves appear in March – April, flowers in April – June. Fruit pods are formed during winter and ripened during February – April.

Silvicultural Characteristics : It is a slow growing light demanding species very sensitive to frost, resistant to drought, wind firms. It coppices fairly well and produces root suckers freely.

Climate : Tropical climate with hot summer and mild winter 0 – 40^{o} C, rainfall 500 – 1000 mm.

Soil : Can be grown on poor soils.

Establishment : Scattered natural regeneration is observed under protection of bushes. It can be raised artificially either by direct sowing or planting container raised seedlings or stump planting. Tamarind starts flowering and during at the age of 10 – 15 years continue to produce fruits upto 200 years. Ripe pods are collected in March – April and the seed is separated from edible pulp and stored in bags. The seed retains viability for about 1 – 2 years. Germination capacity is about 70%. In direct sowing 20 Kg seed / ha is sufficient and sown in lines of 4-5m apart. Nursery sown seeds germinate in one week complete by one month and seedlings attain plantable size by 8 -14 months and planted with onset of monsoon. The spacing may vary form 5 x 5 to 10 x 10 meters depending on purpose. Seed soaking in hot water for 24 hrs. Seed soaking in cold water for 48 hrs, will improve germination percentage.

Growth and yield : The tree is slow growing and attains 0.5 m growth annually. It begins to bear the fruit in 10 – 12 years (3-5 years in grafted seedlings) at the age of 20 years the yields about 150 – 200 kg fruits / tree, 1800 – 2000 seeds / Kg.

Uses : It gives good firewood with calorifc value of 4969 K Cal/Kg. Wood is hard very heavy (1300 Kg /m^{3}) used for naves, parts of wheel, mallets, rice pounders, oil process and sugar crushed and good for nursery, leaves make good fodder. Tender leaves are used as vegetable, leaves are also used to heal wounds and to reduced inflammation and bark yields a red dye. Fruit is acidic, 55% pulp 11% shell and fibre. 33% pulp is favorite preparations. Seeds are extensively used in Jam, Jelly and confectionary industries. Bark is

a tonic, astringent and contains tannin, kernel powder is extensively used as sizing material in the textile and jute industries.

3.Soapnut *(Sapindus trifolia, S. emarginata Sapindus mukorossi)*

Common Names	:	Rita, Kunkudu
Origin	:	Native of China much cultivated in Northern India. Specially in moisture tracts.

Phenology : A fairly large deciduous tree bark grey smooth leaves (12 – 18" long 4-6" breadth) composed of 5-10 pairs of leaf lets, flowers small greenish white in large loose pyramidal branches at the end of branches. Fruits ¾ in diameter globular usually solitary but some times two together smooth with yellow flesh containing a solitary smooth black globular very hard seed.

A handsome tree attaining a height of 10 mts (60 ft). The tree has much appearance of the toon tree but has nearly smooth bark. The leaves turn in pleasing yellowish colour before being shed in December. The young leaves are light green appear in March – April. The fruits ripen in October – November but do not fall readily and are often conspicuous when the tree is leafless.

Silvicultural Characters : Light demanding species, drought resistant moderate coppicer requires moisture in dry grown in wide range of edaphic and climatic conditions not browsed.

Propagation : By direct sowing of the seed which his being hard (with hard seed coat) does not germinate for 3 or 4 months and some times not till the following year. Propagation is also done by nursery raised seedlings. The seedlings do not stand transplanting well and should be moved carefully. The growth is not fast. Seed required seed treatment for getting good germination. The soapnut does best in localities with a good rainfall needs a moist climate in places where the rainfall is scanty. It thrives well in almost on any kind of soil.

Uses : The fleshy portion of the fruit contains ‘Saponin’ (alkaline nature) and lathers with water. It is much used as a substitute for soap. For washing woollen articles it is preferred to soap and as also for washing the hair. A semi-solid oil extracted from the Kernels of fruits used medicinally. The root is used as an expectorant. Pestaries made from the kernel of the seed are used to stimulate the uterus in Child birth and amenorrhoea. The wood is hard and is used for building carts and a variety of articles.

Lecture No 12

FORESTRY PRODUCTS – MAJOR FOREST PRODUCTS

Forest produce can be broadly classified into wood *i.e.,* Timber and fuel or what has often been called the major forest produced and non-wood products called minor forest produce. The demand for forest products is increasing rapidly in India as any where also in the world and the gap between there demand and supply is widening.

Wood is used by man from the cradle to the grave. Weight of timber is as strong as Iron and five to six times stronger than cement concrete. It is superior to the other two mentioned materials in thermal insulation, sound absorption, electrical resistance etc. It also has a high salvage value as compared to the other two materials. Besides these properties wood is a national asset of very great value because it comes from a renewable crop and is therefore inexhaustible in supplies while iron and steel have a limited availability. To select wood for a particular purpose requires accurate knowledge of the qualities required and reliable information as to the woods possessing those qualities. The important features usually concerned in the selection are 1) Hardness 2) Strength 3) Specific gravity 4) Toughness 5) Anatomical structure 6) Flexibility 7) Shape of size of tree 8) Elasticity 9) Colour grain figure etc. 10) Adaptability or otherwise to seasoning 1)

Adaptability to working with tools / machines 12) natural durability and adaptability to treatment of preservatives 13) Freedom from defects.

1.Paper and Pulp : Conservation of raw material into paper involves a number of steps. The first step is the separations of cellulose fibers which in turn are converted into paper mat. In chemical separation of fibers over 50% material goes into solution mostly leonine. The pulp is processed to run on a paper machine for conversion into paper. The physical strength of paper and runnability depends upon the fiber characteristics.

Among the species poplars and Eucalyptus are the most promising raw material for pulp and paper manufacture because of their astonishing growth. Eucalyptus is considered to have some advantages over the traditional long fibred pulps such as 1) They yield more paper per weight of wood 2) Cheaper pulping processes can be used 3) The shorter fibers have lower flow resistance 4) They are more suitable for strongly hydrating pulps with transparency and high fiber to fiber bond strength. Even Bamboo and Casuarinas plantations can be considered for pulp wood.

2.Ply Wood : Plywood is a term applied to glued wood construction built of veneers in such a manner that the grain of each veneer is at right angles to that of adjacent veneer in the assembly. The most significantly advantages of plywood is that it possess dimensional stability which is lacking ins sold wood. Plywood has little tendency to split and can be moulded to various shapes.

Nearly any kind of wood may be used for veneers but woods with close firm grain are best. The more important woods used for veneering in plywood manufacture are *Mangifera indica, Dalbergia.*

3.Match wood : The principal raw material required for the manufacture of safety matches are wood, red phosphorus, sulphur potassium chlorate and match paper wood is the key factor controlling the production of matches. The main characteristics of a match log are that it should be round, soft and straight grained light in weight free form knots and cracks. For feeling thin match veneers the density of wood should be uniform without much

difference between sap wood and core wood. Good fissility is another property required in veneer logs very hard strong and every wood is unsuitable. The match logs should reach the factor in fresh conditions. Fast growing species, straight cylindrical bole, without too great a taper buttress of flutes are gown for match wood plantation. *Bombax ceiba* is most suitable. Other species are *Ailanthus* etc.

4.Sports Goods : In general for all sports good logs free from knots and having absolute straightness and uniformity of grain and whitish colour are insisted upon. The gross suitable species are *Salix alba, Morus alba*. However if roots are unavoidable shall not in interfere with the production of at least 75% clear blanks out of the largest number blanks or defects that can be obtained from the tree.

5. Shoe-Lasts : Logs with pitch concentric are prepared from the point of view of economic conservation lack of straightness is permissible if it does not interfere with the preparation of straight grained pieces of length of 40 cm. *Dalbergia sissoo* is the most widely used timber for superior lasts. Other species are *Adina cordifolia* etc.

6. Pencils : The timber used for pencil making should be even and fine texture free from knots light in weight but reasonably strong. It should have good marching properties and should not wrap or chip off during machining. The trees for this used should be preferably 35cm. Or over in girth. *Cedrus deodara* is the main stay of the industry at present which is used after suitable pressure – cum – vacuum dyeing treatment and softening by wax. Chestnut and cypress are also suitable.

7. Artificial limbs : Willow is the ideal timber for this purpose because of its toughness combined with light weight and amenability to neat scooping by hand tools logs over 75 cm free of knots are acceptable. The pitch must be concentric and deviations more than 5 Cm. are considered objectionable.

8.Furniture Making Industry: A better quality of wood and above 90 cm. girth is required for this purpose which is attainable at long rotations. The essential qualities required are good colour handsome grain or figure non-liability to crack or split wrap or

move excessively ease or working finishing and polishing. India possesses many cabinet wood such as Teak, Rose wood, Satinwood which are well known for their qualities through world.

9.Packing cases : Wooden packaging is preferred for fresh fruits machinery plate glass and precision instruments. The primary requirements of wood for packing cases are lightness (400 Kg/cum) combined with requisite strength for the purpose in view and good nailing and screw holding power for specialized purpose superior quality heavier woods are also used. Timber for cheap type of packing cases should be seasoned to a moisture content not exceeding 18% Fire and spruce are the most popular timbers for packing cases.

10.Pit props for Mining : There is a steady demand for suitable timbers for mineral extraction industries. Durability is the essential factor in this wood use. At the same time resistance to compression parallel to the grain and strength and stiffness in bending are necessary in case of pit props as they have to bear the enormous pressure of the weight of earth. Pit props are generally used in the round form in lengths of 1.8 to 3.6 meters. Amongst the best timbers for this purpose are Babul, Chirmanu etc.

11. Truck Body Building : The chief requirements are strength resistance to fungus attack freedom from excessive movement combined with lightness hardness to with stand friction and wear and tear in bold holes and mortise joints. *Lagerstroemia* (Benteak) is extensively used in Tamil Nadu.

12.Railway Coaches : Wood used for railway coach building should generally be strong but not very heavy and mostly round wood is preferable. Besides Teak, Pterocarpus, Rose wood are the main timber suitable.

Derivatives trees of minor forest products:

1. Tendu Leaves : Tendu (*Diospyros melanoxylon)* leaves are of great commercial importance in India and are used as wrappers of tobacco to produce bidi. Coppice shoots and root suckers of the tree produce good quality leaves and for the purpose pollarding and pruning are practiced in certain parts of the country. Pollarding should be done in March

while plucking starts about the middle of the April and continues upto the end of May, with onset of monsoon, collection of leaves stops because of difficult in drying.

2 Katha and Cutch : Katha and cutch are produced from the heart wood of khair (*Acacia catechu*) trees. Katha is a pale brown product rich in 'catechin'. It is used in pan (betal leaf), cutch is a dark brown product obtained from bark of tree rich in 'catechu' tannic essence has preservative properties and is used fry dyeing canvass, fishing nets mail bags and sail clothes and also used as a boiler compound and in drilling operations. Maximums yields of Katha are obtained from the trees felled in autumn and winter. The yields from freshly felled trees is higher.

3 Resins : Resins may be grouped into 1) Pine-resins 2) Resins from broad leaved tree species. A very important pine resin is obtained from tapping chirpine *(Pinus roxburghii* and blue pine *(pinus wallichiana*) trees occurring in Himalayan forests. It is an important forestry industry. Pine trees are regularly tapped making blazes which are freshened every week and over a period of 8 or 9 months the resin being collected in earthen or tine pots fixed at the bottom of the channels on the tree. The important products of resin obtained by distillation are 'rosin' about 80% and 'turpentine' about 17%. Rosin is used in the manufacture of paper and other derivatives. Turpentine is used in a large no. of chemical industries like ester, gum, rubber, emulsifiers, camphor, varnish, phenyl etc.

The Resin from broad leaved species are some time are called '*daminers'* through true dammar comes from a coniferous tree not found in India. They are obtained from *Hopea odorat Shorea robusta* and Indian coral tree and used for varnish, caulking boats and ships for burning as incense and in medicine.

4 Edible fruits : Forests supply large no. of edible fruits which occur naturally and are being increasingly cultivated in forest areas now. Among the important of these is Tamarind, Ber, Cashew, Aonla, Wood apple, Seethaphal, Jamun, Chiranji and Jack fruit etc. Mahua is also important for its flowers.

5.Incense Products : Obtained from a tall evergreen tree of eastern Himalaya Assam, Eastern Bengal etc. It furnishes the eagle wood or agarwood of commerce occurring in the

form of dark coloured resinous fragrant masses in the centre of bole these are used for burning as incense while the light coloured wood in which the masses are embedded is distilled into on oil called agar attar. Which is used as a perfume. The eagle wood is obtained from 'Aquilaria agallocha' (Eagle wood or Agar). Similarly Benzoin a balsamic resin is obtained from incisions of bark of tree *Styrax benzoin* (Dryander) is a tree of Malay penisula which is used medicinally and in the preparation of incense wood powder.

Lecture: 15

FOREST PRODUCTS – II MINOR FOREST PRODUCTS

1. Bamboos : Bamboo is called the poor man's timber. India has rich bamboo resources. The most valuable and universally used species i.e., *Dendrocalamus strictus* a comparatively small, solid or hallow bamboo found all over India. Other common species are *Bamboosa arundinecea, B. nutens, B. tilda, Ochlandra ebracteatea O. seriptoria* etc. The strength of bamboo culms, their straightness, lightness combined with hardness range in size abundance, easy propagation and short period in which they attain maturity make them suitable for a variety of purposes including house mats, scaffoldings ladders, bridges, fences, sticks, tools handles, toys, sports goods, furniture and musical instruments etc. and in paper manufacture too.

2. Oil seeds : The forest oil seeds can make a sizeable contribution in meeting the vegetable oil demands of the country. The important oilseeds of forest origin are Mahua (*Madhuca latifolia),* sal *(Shorea robusta),* Karanj *(Pongamia pinnata),* neem *(Azadirechta indica)* Kusum *(Schleichera olesa),* Dhupa *(Vateria indica)* palu *(Salvodara oleoides) Kokam (Garcinia indica).* These trees occur both in the forests and on village lands road sides. Sal is a very important forest tree occurring gregariously. The sal seed (Kernal) has an oil content of about 12.5%. The oil extracted from the sal seed is now acceptable in the soap industry and it's de-oiled meal is used as a cattle or poultry feed. Sal oil is a substitute for cocoa butter in making chocolate which is used for export for this purpose and thus

assumed great importance. Oils produced from most of the seeds referred to above are sued in various industries particularly in soap industry.

3. Essential Oils : Among the important essential oils is the Indian sandal wood. This oil is obtained by distillation of heartwood of sandal and evergreen parasitic tree. Besides sandal wood oil the other essential oils of forest origin are lemon grass palmarosa grass and Eucalyptus oils. The oils from these grasses and *E.globulus* are extracted by distillation and in Eucalyptus the leaves are suctioned. Oil is also produced from the leaves of *E citriodora* where the species is pollarded annually and maintained as bush. There is a good future of Linaloo *(Bursera penicillata*) tree, extracted from heart wood by distillation (Karnataka state).

4. Tans and Dyes : The important tanning materials are the myrabolans nut obtained form Harra (*Terminalia chebula)* and bahara (T.bellirica). Among these the first one is most important (Harra) which is large deciduous tree mostly found in the states of M.P. The best time of collection of harra fruits from the point of tannin content in January fruits collected later or earlier being considered inferior. The average tanning content of a good commercial samples is 32%.

Dyes : The well know Kamala powder obtained from the fruit glands of *Mallotus spp.* a small tree found all over India is extensively collected and yields a red dye. The pulp of seeds of *Bixa orellana* yields *ornatto* dye of commerce with which silks are dyed yellow and red. Native series and clothes are often dyed with the flower of *palas* or *Dhak* tree. The yellow dye obtained from the flowers of *Cedrela toona* is also used for this purpose.

6 Gums : Certain valuable gums are extracted in India's forests which ooze out from the trees either naturally or on making artificial incision known as exudates gums. Technically the term refers to plant 'polysaccharides' or their derivatives which are dispersible either in cold or hot water to produce viscous mixtures or solutions. All gums are not soluble in water. Some of them merely swell up in water and form a sort of gel while other are completely soluble. The important Indian gums are commerce are Malabar Kino. *(Pterocarpus spp)* Bengal Kino *(Butea monosperma)* Ghatti *(Anogeisus* spp) and

gum Arabic from babul tree *(Acacia nilotica).* True gum Arabic is obtained from Acacia *sonegal* in which *sudan* has world monopoly. The most important of all the Indian gums is however gum *Karaya* obtained from *sterculia urens* and *S.villosa* both trees of dry deciduous forests. Gum *karaya* is important for pharmaceutical industries both industries consumption and for export. Generally trees of about 90 cm. girth or more in girth are tapped. Rectangular blazes 10 x 15 cm are prescribed which are freshened upwards at fortnightly intervals extending by 4 cm. with each freshening.

7. Lac : Lac is the resinous protective secretion of the tiny lac insect *Laccifer lacca.* The ministered coloured larvae of the insect settle on young shoots of the host plants in myriads. The secretions from the individual insects. Coalesce and form a hard continuous encrustation over the twigs. After the completion of life cycle and just about the time the adults of the next generation begin to emerge the resinous encrustation is scrapped from the twigs and branches of host trees giving what is called sticklac. Shollac is obtained by either melting or extracting the resins by solvents from seedling. Lac finds a wide variety of application in plastics electrical adhesives leather and wood finishing printing ink and other industries. It is also the principal ingredient of sealing wax. There are well over 100 species of plant on which the insect has been recorded but the major hosts are palas or Dhak and Ber *(Zizyphus spp)* in the case of rangeen strain and Kusum in the case of Kusum strain.

8. Fibers : From the leaves of sago palm or Bustard sago ***Caryota urens*** is obtained the Kittal fibre of commerce. This palm is found growing scattered in the moist forests of Assam, Orissa, East Bengal etc. The fiber is of considerable value being strong and lengthy. It is used by fishermen in preparing nets fishing lines for bristles of cloth and sari and in rope making. There are several species of well known *Agave* (Sisal) plant yielding sisal fiber is also important.

Lecture No. 14

FARM FORESTRY

Need for farm forestry: The total forest cover in India is about 11 – 14% as against 33.3% ($1/3^{rd}$) required to maintain the ecological balance. Besides the country is facing serious energy crisis and acute shortage of domestic fuel consumption because of dwindling reserve fossils of petroleum products. Inspite of several efforts to popularize the gobar gas plants the country is not in a position to meet the demand of fuel wood. Cowdung worth of crores of rupees is being used as a fuel which can be diverted to agriculture for increased productivity. Pressing demand for food grains and other agricultural products / commodities made clear that it is not possible to divert more area to forest plantations. Therefore the only alternative is to focus attention on Farm forestry and Social Forestry.

Definition : Farm Forestry is defined as the practice of forestry in all its aspects on farm and village common lands more or less integrated with the farm operations. Or an integration farming with forestry practices on the farm to benefit the agriculture. (Dr.M.S. Randhawa 1988) or Farm Forestry is the name commonly given to programmes which promotes commercial tree growing farmers on their own land.

Scope : The farm forestry has a scope around well, tube wells, water channels, field boundaries, farm roads and marginal and sub-marginal lands uneconomical for crop culture. Farm forestry is one of the easiest components of social forestry to implement. It is very much similar to agriculture except that the period of gestation is fairly long. In some of the states such as Jammu and Kashmir, Tamil Nadu, Karnataka people have been

practicising farm forestry for decades. In U.P. and Gujarat wind breaks and shelter belts are widely made use of for protection against sugarcane fields.

Management considerations for success of Farm Forestry :

1. The effect of farm trees on *kharif* crops is less marked than on growth of *rabi* crops. Therefore deciduous narrow crowned trees like *mulberry, bombax,* sissoo and *Acacia albida* should be preferred
2. Use of root cutters is recommended for eliminating root competition between and joining trees and crops.
3. Dense crowned shady fruit-cum-timber trees like Mango, Jamun, Jack fruit, Tamarind and Ber may be grown near the wells, tanks, tube wells, farmsteads and habitations.
4. The trees should be kept under regular surveillance and prophylactic sprayings or dustings should be adopted to avoid the risk of harbouring insect pests and diseases.
5. The trees with short sparse crown are not suitable for birds nesting. Such trees which are resistant to saline and alkaline conditions and fast growing should be preferred.

Characteristics of Tree species suitable for Farm Forestry :

The species 1) Rapid growth and short rotations 2) Good keeping quality of wood 3) Combustibility with high calorific value 4) Ease of propagation and reproduction as by coppice root suckers and layering etc. 5) Low cost of production and maintenance. 6) Availability of seed 7) Proven techniques for establishing and maintenance.

Species : *Acacia spp. Albizzia lebbek, Azadirachta indica, Cassia siamea, Casuarina equisetifolia, Dalbergia Sissoo, Eucalyptus globulus, Syzygium cumini, Morus alba, Prosopis spp, Sesbania spp. Glyricidia spp, Leucaena lucocephala, Zizyhus spp. Emlica officinalis* etc.

TYPES OF FARM FORESTRY

Farm forestry may be grouped into 1) Commercial Farm Forestry 2) Non – Commercial Farm forestry

1) Commercial Farm Forestry (CFF) : It is the terms applied to a process under which farmers grow trees on commercial basis. This programme is usually undertaken in areas where there is a ready market for wood and other forest based products. F.A.O. (1980) describes this as turning peasants into entrepreneurs and producers.

Once the price available for poles, fuel wood and the forest products provides better rate of return to the farmer than traditional agricultural crops he is liable, to alter his land use pattern.

The success of CFF depends upon :-

1) Finance viability : The finance viability of farm forestry projects of an individual farmer depends upon cost of labour, materials, cost of raising plantations. Returns depends upon the growth rate, yield prevailing prices and financial capacity of the farmer for whole rotation of the crop.

2) Input levels :

A) High input level : The more prosperous a farmer is the more the resources available to him and larger are the alternatives available.

1. Fertile agricultural lands may be diverted to farm forestry.
2. Irrigation and fertilizers may be used to boost the growth of forest crop.
3. Labour may be hired to supplement the work of family.
4. Financial stability enables rich farmers to take great risks as compared to poor farmers
5. Rich farmers can wait for long period and can bargain for a good price for his produce to obtain at least marginal gain.

B) Low input level : It is absolutely impracticable for a small and marginal farmers to have various alternatives who is suffering to produce barely enough food for his household.

1. Unless alternative source of income is available it is not possible to divert good available land to tree plantations.
2. The tree planting is restricted to agriculturally infertile areas and waste lands.
3. Dearth of adequate finance and credit inhibits the taking of tree farming on large scale.
4. Long gestation period (Maturity period) is the most important factor influencing farm forestry by small farmers as they have to wait for 5-10 years to get returns.
5. Risk involved is also high, hence a small farmer cannot take up commercial farm forestry .

To be successful through low input approach a poor farmers required 1) Addition financial resources 2) Extra land which is already limiting 3) Diversion of labour from traditional agriculture to tree plantation 4) More time to be spent by the farmer for raising the trees which may not possible because labour intensive method of cost of production is adopted by marginal farmers in developing countries 5) Certain degree of technical know how which is not available among poor farmers.

However it cannot be ruled out that all small farmers are not participating in farm forestry in a big way. Direct cash incentives were given and at the same time certain support services should also be provided for implantation of CFF. The various facilities required to be provided to a small farmer are credit marketing and tax incentives etc.

Criticism of Commercial Farm Forestry :

Over last two decades CFF has been introduced in a big way in a number of developing countries. Its success has been fairly wide spread. But it's implementation faced criticism in India because:-

1. Failure to deliver environmental and social benefits :

Because these programmes were aimed at getting maximum returns from the tree planting. More over for getting higher returns the farmers tend to plant quick growing high timber value species on fertile lands whereas forgetting social benefit. Planting of any species on degraded sites is sufficient.

2. Harm to the poorest of the Poor :

CFF programme cause more harm to the poorest than the good it can deliver one of the harm is 1) By reduction in employment opportunities because tree crops require less labour than agriculture crops. 2) Another is it may also cause a reduction of availability of fuel wood and fodder if the trees are grown for commercial purpose. Further if CFF spreads widely there are chance of rise in prices of food grains.

3. Benefits the rich :

Big farmers are getting more benefits as they can easily obtain credit, technical know how and inputs etc which are essential for any commercial farm forestry project.

2. Non-Commercial Farm Forestry (NCFF) :

The NCFF programmes aim at increasing the number of trees raised by individual farmers for their own needs such programmes are mainly based on Non-commercial incentives and undertaken in areas of several fuel wood/agril, timber shortage and also where there is no commercial demand for wood. In most agril. areas tradition of raising trees to meet their own needs already exist only a little motivation is needed to persuade the rural people for taking up this on large scale. In almost all countries which have social forestry programme NCFF is being promoted in one form or the other.

In India the programme of vanamahotsava is being celebrated every year to promote farm forestry. It was emphasized by Sagreya (1967) that Vanamahotsava was not a poetic fancy nor a spectacular festival. It was a process of land transformation to create forests. He reminded the nation that if it had survive the philosophy of life must be rewritten not only in words, ideas or achievements but in terms which would replant us firmly on the earth and under the shade of trees.

Today NCFF is the main thrust of most of the social forestry projects in India. Forest department nurseries distribute the seedlings on free of cost. In certain parts of South India and holdings are already stocked with trees but there is always a willingness to plant few more.

Scope and Limitations :

The main issue which determines the scope of raising trees for domestic uses in may areas in whether the farmers see the benefits as out weighing the cost. The response of a person or a group of persons towards the farm forestry programme depends upon 1) The area of land under tenancy 2) Financial status and ability to raise credit 3) The area of land owned 4) Personal performance programme and prejudices 5) General attitude towards and public programme 6) Availability of fuel wood and other wood products locally 7) Average size of family or house hold 8) Extra time available for undertaking tree planting 9) Generally mental outlook of the family particularly with respect to response towards new ideas.

Response for failure of NCFF projects :

1) The forest department of many developing countries have been lacking in their methods of extension 2) In many areas where fuel is not a problem the farmers do no seem to feel the pinch 3) Farmers lack time and energy to take up the additional task of raising and tending trees 4) Lack of sufficient credit facilities 5) The farmers have fear that tree will reduce water availability for agril. Crops, harbour birds and create shade by planting trees around field boundaries 6) Lack of suitable planting material and technical know how

serves as an obstruction 7) Farmers feel that non-commercial tree raising does not generate direct income 8) In any areas tree planting season coincide with the crop sowing and hence there is a dearth of labour for free planting.

Shelter Belts and Wind Breaks :

Need for shelter belts and wind breaks : The arid regions of the world are characterized by temperature extreme, low and erratic rainfall, strong hot and cold winds, high evaporation rates and reduced soil productivity. In many areas there is a general shortage of adequate fuel wood fodder and shelter which can contribute to poor socio-economic conditions. The problems in arid areas often seem so vast diverse and challenging that no amount of modern knowledge can make meaningful changes in the landscape. However changes are being made in making the deserts more productive and as desirable places to live. These changes are often made possible by planting of wind breaks shelter belts and block from vagaries of nature. In addition in developing countries these plantings are the critical source of fuel for domestic consumption. There is a little doubt that wind break play a very important role in combating desertification controlling wind erosion, crop damage and improving the yield and quality of crops through the amelioration of the microclimate.

Functional roles of shelter belts : 1) Protecting soils, crops and livestock 2) Conserving soil moisture and irrigation efficiency 3) increasing farm management options flexibility and diversification of enterprise 4) Improving working conditions and general efficiency of wind 5) Conserving fuel in green house, farm, domestic buildings and transport system 6) Providing fuel from wood. 7) Providing timber for farm use or sale. 8) Conserving wild life and other ecological values 9) Enhancing landscape values 10) Improving capital values.

Design Criteria : The term wind break refers to one or two rows of protective planting of trees whereas a shelter belt is a more extensive and a long barrier. Wind breaks are planted perpendicular to the direction of wind in a given locality. Generally in our country the wind breaks are planted in North South direction to meet the wind forces from south west and north east.

Properly designed shelter belts show the effect over a distance of 40 times the height of the wind break. There are two distinct zones on the leeward side of the wind breaks a triangular quiet zone starting from top of the wind breaks and extending near to the ground level to a distance of 8h where the turbulence velocity fluctuations of wind are reduced and below the values of approach flow. 2) Above and down wind of the quiet zone is a wake where the turbulent fluctuations are greater than those in approach flow. The degree of protection offered by a wind break depends upon the orientation, height, density, species composition and spacing of the wind break.

1. **Orientation** : Wind breaks should be oriented at right angles to the prevailing or problems winds because the protected zone has maximum extension in the down wind direction.
2. **Height :** The protected zone associated with wind break is directly proportional to the height of wind break. Hence the height should be from the top of the crop canopy and should be atleast two to three times the height of the crop.
3. **Density :** Moderately dense wind breaks significantly reduce the wind velocities (50 – 60%) wind breaks with lower densities are generally in effective for most crop protection purpose. The moderately dense wind breaks do not cause as much down wind turbulence as dense wind breaks hence they are more effective.
4. **Species Composition** : The most desirable plants for a variety of field wind breaks are those that have a density of about 50 – 80% in single row plantings. There spread not exceeding 3 meters and should have a potential height of 5 – 30 meters. Tall narrow crowned species usually provided the greatest benefit for the mount of land taken out of production.
5. **Spacing :** In general within the row spacing are 1 to 2.5 metes for shrubs 1.5 – 2.5m ST form small trees, 2 – 6 meters MT for medium to tall trees. Normally the spacing between the rows varies from 2 – 6 meters.

Characters of tree species for wind breaks :

A wide range of plant species have been utilized for wind breaks in the arid areas through out the world. The most important criteria for selection of tree species are 1) Resistant to drought 2) Resistant to frost snow breakage and wind throw 3) Tolerance to

temperature extremes 4) Easy to establish long lived 5) Fast growing with tall uniform shape 6) Resistant to pests and disease 7) Should not serve as alternate hosts for fungi and other pests.

Lecture No.15

AGROFORESTRY

Need for Agroforestry :

1. India's population is expected to touch 1000 millions by 2000 A.D. The cattle population of the country could be about 448 millions by the same period. This vast human and animal population needs food, fuel, fodder, small timber and as well as raw material for agro-based and forest based industries.

2. With functional allocation of 46.4% land area under agriculture and 22.7% under forestry the country is not in a position to meet the requirements of its growing populations of both human and livestock.

3. Poverty (48%) of total population lives below poverty line and

4. The unemployment (about 166 millions are unemployed by 1994 in the country Kapor 1979) are rampant.

5. Extensive areas are suffering denudation as a result of heavy biotic pressure due to which 144 m.ha area is seriously affected by wind and water erosion.

6. Pollution of air and water is causing serious concern in the country.

Thus the only answer appears to be to integrate the land use for agriculture and forestry in such a way so as to maximize the production of goods and services required by the society at large.

Concept of Agroforestry :

The concept of agorforestry implies the integration of farming with forestry practices on farm to the benefit of agriculture. This concept perhaps originates from the realization that trees play a vital role in safeguarding the long range interests of agriculture and in making agricultural economy viable. Agroforestry has been considered as viable land use system in the tropical regions. Agroforestry is the new term for the old practice of growing woody perennials with agril. crops or livestock together on the same piece of land. It is a new discipline that integrate both forestry and agriculture to maximize the production of goods and services required by the society at large. A system of land management which eschews (avoids) the false dichotomy (division) of agriculture and forestry which conserves the ecosystem and at the same time provides the food and wood is called Agroforestry (King 1978).

Definition :

Agroforestry has been defined as sustainable land management system which increases yield of land combines production of crops forest plants and/or livestock together simultaneously or sequentially on the same piece of land and applies management practices that are compatible with the cultural practices of local population (King and Chander 1978).

Benefits :

I. Multiple needs : -

It yields extended range of products viz., food, fodder, fuel, fibre fertilizers fruits fence etc.

Presence of trees gives extended range of management options and trees can be harvested as per farmers choice and market demands.

II. Soil and water conservation :

- Trees stabilize the soil conservation structures and make productive use of land

- Act as vegetative barrier and check run off.
- Reduce rain drop impact and control soil loss.
- Trees utilize off season precipitation.
- Serves as a shelter belt and reduce wind velocity.

III. Nutrient recycling :

- Trees recycle the nutrients both from atmosphere and lower soil layers.
- *In situ* green leaf manuring through leaf drop.
- Green leaf mulching by applying lopped foliage.
- Trees check the increase in soil temperature specially in summer months there by protect the soil microflora and fauna.

IV. Employment Generation

- Off season family labour utilization
- Assured income for the labourers round the year
- Prevention of labour migration

V Drought Proofing

- It imparts stability besides resulting in risk reduction even one component fails the other would give a harvest.
- Results in improved and stable income.

VI Bio-aesthetic

- It can be devised for landscaping and beautification of country side which provide recreation and increase aesthetic value.
- Conserving the ecosystem.

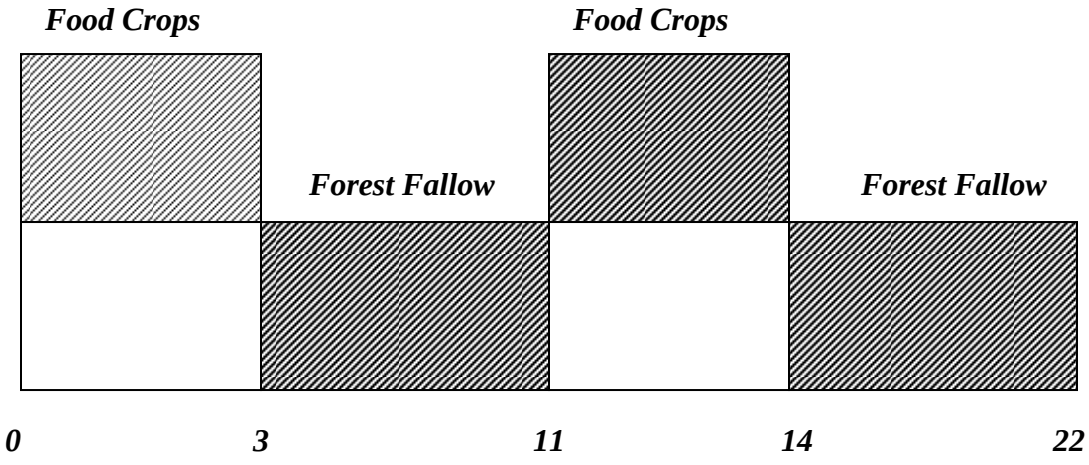
PRACTICES IN AGROFORESTRY SYSTEMS

Various agroforestry practices that can be applied are 1) Boundary planting 2) Live fences and hedge 3) Shelter belts and wind breaks 4) Trees and shrubs for stabilizing soil and water conservation 5) Trees for aerial fodder and shade for animals 6) Trees as vegetative barriers 7) Sand dune stabilization 8) Apiculture / Lac culture / sericulture 9) Trees for land reclamation 10) Taungya afforestation.

Classification of Agroforestry Systems :

The definition of agroforestry shows that the component crops are arranged either temporarily or sequentially so that two crop arrangements can serve as principal categories as follows :

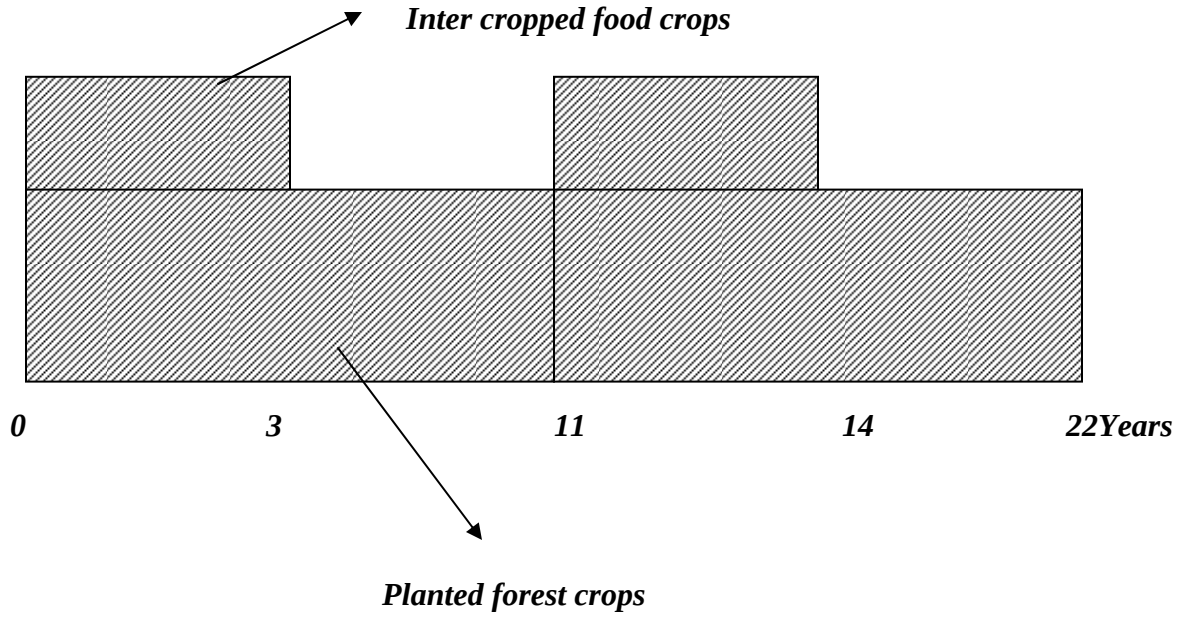
I. Crop rotation systems : (Based on temporal arrangement of crops). As the name implies that this system includes all agroforestry systems / types where annual food or cash crops are alternated with tree crops over time. The two types under this are : **a) Swidden or shifting cultivation :** This is the oldest known agroforestry practice (Mayer 1980). The forest is cut dried and burned to clear the land for planting and to return the nutrients trapped in the forest biomass to the soil to be used by the food crops. Cropping lasts for about 2-3 years after which the land is left over a long period (8-10 years) to forest fall in order to rejuvenate the soil and get it ready for the next cycle of burning and cropping.



This practice was on it's sustainability in the recent past due to low pressure of population. But as the pressure mounted displaced low land farmers shortened or eliminated the forest fallows.

b) **Taungya systems :** Started in Burma in the mid 1980's . This system is the first "modern" agroforestry practice. It was designed as a low cost governmental approach for afforestation of open lands. Farmers are temporarily allotted government lands and contracted to plant desired tree species while the trees are young and before the canopy closure (1-3 years) the farmers are allowed to plant food crops the yield of which becomes their entirely and is regarded as their compensation for planting trees. When food cropping is no longer possible due to shading etc. The farmers are transferred to another open area where they repeat the process. Mean while the abandoned area is by then a well established forest and will not be cultivated for annual food crop again until the planted area reach the maturity and are harvested.

The taungya system is slightly different from swidden regarding (1) There is a temporary overlap between the corps 2) The trees in crops during the follow consists of systematically spaced and selected tree species under taungya system.



The farmers have grown away about taungya because it grants no guarantee of long tenure over land and participants have to be shift from one location to another usually every three years and in some cases to prolong their stay they have damaged young developing trees also. Another reason for decline of taungya is the raising realization among the farmers that their compensation in terms of sole yield of their food crops is less than those of reforestation workers under normal wage arrangements.

II. Inter-cropping (Based on physical structure)

(Based on the spatial arrangements of crops)

Under this system the annual perennial crop components are simultaneously present on site but are spaced in such a manner that they become mutually supportive rather than competing where they jointly yield higher outputs per hectare per year. Four sub-systems under this.

1. Border tree planting

It is often found where farmers use lines of trees specially as boundary maker live fences, wind breaks or fire breaks. In addition to protection and stabilization of site they also produce green manure as organic fertilizer, fodder for farm animals and produce fuel wood.

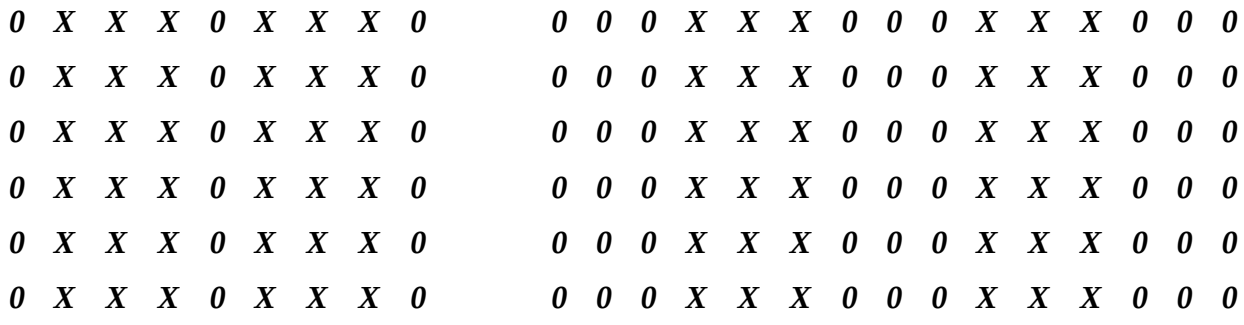
0 0 0 0 0 0 0
0 X X X X X 0
0 X X X X X 0
0 X X X X X 0
0 X X X X X 0
0 0 0 0 0 0 0

0 = Trees ; X = Crops

Border tree planting is gaining importance due to (a) rising prices of energy including biomass energy (b) need for permanent fence posts around farm or house gardens.

2. Alternate strips or Alternate row planting :

(Strip consists of 2 or more rows). It is also referred as “Alley” or Avenue corridor zonal or Hedge row cropping. When positioned across the slopes and along the contours they are found most effective for erosion control and slope stabilization. Most modern agroforestry system being advance through government programmes are of these two sub-systems and the multiple objectives are food fodder production and site stabilization.



Alternate row planting **Alternate Strip Planting**

They are more favoured agroforestry system because the rows act as contour hedge rows which help in stabilization and conserve soil on slopes and act as terracing. They are easy and less laborious to undertake. If the trees planted are nitrogen fixing and are able to generate by coppicing they would serve as a steady source of organic fertilizer to rehabilitate degraded sites.

3. Random mix : It displays no specific or orderly placement of the component crops while the arrangement appears in utter confusion, the plants actually occupy their own special ecological nich (influence) and are able to coexist very well.

0	***X***	***X***	***X***	***0***	***X***	***X***	***X***	***0***
X	***X***	***0***	***0***	***X***	***X***	***0***	***X***	***X***
0	***X***	***X***	***X***	***X***	***X***	***0***	***X***	***X***
0	***X***	***X***	***0***	***X***	***X***	***X***	***0***	***0***

For badly eroded and depleted soils random mix may not be as effective as alley cropping (alternate strips).

4. Multi-storied cropping : The multi – storied / tiered crowns of the integrated plants ranging from root crops through grain crops small fruit trees (cocoa etc) to dominant coconuts are close replicas of multi-storied tropical rain forest and represent highly efficient for utilization of soil surface vertical space, nutrient and moisture and solar energy. This system is mostly practiced in Kerala. For this reason it is sustained over many decades in much of Asia.

III. Based on components : Based on components combinations Agroforestry systems are classified as below :

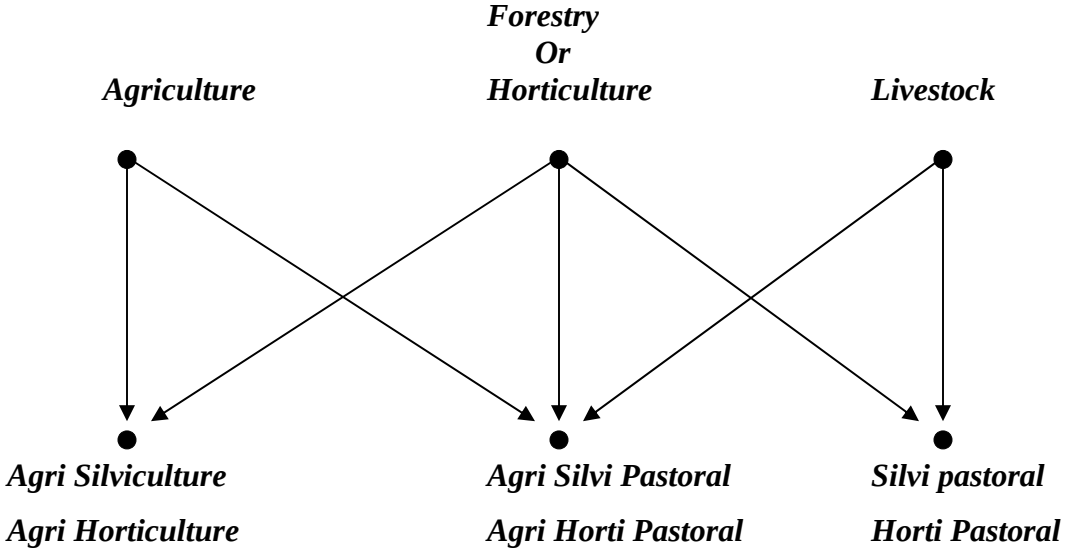


Fig : Schematic Representation of Agro-forestry System

Choice of species : In Agroforestry one of the most important considerations is to identify species which are compatible with each other also compliment with each other. Fortunately in our country we have 15,000 different vascular plants and therefore it is just a matter of experimentation to identify suitable species fulfilling the above requirements. In the selection of suitable species due importance is to be given to those which improve the productivity of site. It is also equally necessary to establish a compatibility and implement ability between the trees as well as agricultural crops to be raised in conjunction. In brief the species that are chosen to be grown in conjunction with the agricultural crops should have interalia the following characteristics (King 1979).

(1) They should have small and attenuated crown which allows light to filter through. 2) Their phenology particularly in respect of leaf flushing and leaf falling should be advantageous to the growth of annual crops 3) They should be light branching in habit 4) Their above ground changes overtime in structure and morphology should be such that they retain or improve those characteristics which reduce competition for solar energy nutrients and water. 5) they should be tolerate of shade if indeed not of full over head such shade in early stages of growth. 6) They should be amenable to early wide spacing 7) they should possess self – pruning properties. In the absence of self pruning they should be able to withstand the shock of heavy pruning. 8) Their rate of litter fall and litter decomposition should have positive effect on the soil 9) Their root system and root growth characteristics should ideally result in the exploration of soil layers that are different from those being tapped by agril. species. 10) They should be efficient nutrient pumps and the selected trees are such that they harbour birds and insets which are beneficial to crops being raised.

Trees species suitable for Agroforestry :

1) Acacia albida 2) Bombax ceiba 3) Grevellia robusta 4) Dalbergia sissoo 5) Hardwickia binata 6) Leucaena leucocephala 7) Prosopis cineraria 8) Sesbania Spp. 9) Zizyphus spp. 10) Albizzia lebback 11) Emblica officinalis.

Management implications : After the package of technology is developed the main problems of management are 1) Planting 2) Execution 3) Coordination 4) Monitoring 5)

Evaluation for effective implementation. The management will have to be trusted to a single agency. In India over 95% of the forest area is under the control of state forest department to whom the management of all public lands forest areas and waste lands could usually be transferred.

Socio – economic considerations and legal aspects have to be kept in view while executing Agroforestry projects particularly in public lands because the country is facing great land hunger and implementation of programmes like taungya afforestation may lead to illegal encroachments and there is a possibility of land alienation.

The problems are more complicated if Agroforestry projects are implemented on agricultural lands because of involvement of larger no. of farmers and other agencies. To executive the such projects on agricultural lands extension approach should be adopted wherein the project can be entrusted to a village panchayats under the technical control of forest department. Alternatively the state Forest Development Corporations can undertake the extension work of monitoring and evaluation of Agroforestry projects or the farmers have to be assured that the absolute ownership of the trees grown their fields vests with them. Some exemptions from income tax / wealth tax may be given as an incentive for growing trees on private lands.

While planning individual agorforestry projects and fodder needs of the rural community should get priority at free of cost rather than at economics of the project. However without willing cooperation of the people it is difficult to implement such programmes.

Tree Canopy Managements in Agroforestry :

Agorforestry system can be considered as a form of intercropping in the same way as in arable crops in which there is a need to seek out various complementarities between woody perennials and the arable crops. But the agorforestry system experimentation is more complex than arable crops intercropping because of three main factors (1) Wide range of products have to be taken into account while assessing the yield advantages (2) The products become available at different times (3). Wide range of management options. The range of management options are of particular interest in agorforestry systems because the

leaf canopy of wood perennials may be evergreen or deciduous if ever green manipulation of canopy by lopping may be done at different times elected either on the basis of the complementarily to the light demand of the under storey crop or on the basis of timely need for the product (fuel fodder, green manure etc.) when other resources are unavailable.

To regulate the shad easy the tree species selected should have the character of producing erect branches growing close to the main trunk so that area covered under canopy will remain small. Tree having smaller leaf let should be preferred so that sunlight can reach the canopy of under storey of trees of deciduous in nature should be preferred. However it is often difficult to find trees which allow crop growth under the canopy without thinning the branches from time to time. Therefore species should be such that they are able to tolerate pruning and continues to the income.

Trees canopy could be managed through various pruning practices as indicated below :

1. **Lopping :** This type of pruning practice is also called ‘branch pruning’ which involves removal of certain branches allowing some light to reach the herbaceous crops underneath. It should be selective and tree productivity depends upon the lopping intensity frequency and vigour. Intensive lopping encourage the growth of under crops.
2. **Brashing :** It is also called ‘low pruning’ involves removal of side and lower branches during initial 1-5 years to enable the tree to grow straight which facilitates intercultural operations and allows some light penetration to under planted arable crops.
3. **Pollarding :** Grown up trees are cut at an height of not more than 2 meters where top of the stem is cut off in order to obtain flush of shoots from below cut. It is practiced to facilitate manual working to avoid frequent browsing by cattle and to avoid competition for the resources between component crops. Pollarding can only be done during onset of monsoon after the trees is attaining required girth (usually 4-5 years after planting).
4. **Coppicing :** It refers to cutting back of the grown up trees to the ground level. Coppicing increases the ground cover reduces the weed growth and

greater use can be made of those already growing and advantage if planting stock is in short supply. Coppicing should be done during monsoon and the cut should be in slanting position to prevent rain water to retain on the cut.

Lecture No.16

AGROFORESTRY SYSTEMS (Based on Components)

Based on components combinations the Agroforestry systems are classified as below :

Schematic Representation is shown in Page No.85

1. Agri-silviculture : It is system of integration of forestry trees with arable crops mostly on the arable lands to get both food and wood. Mostly nitrogen fixing trees (NFTS) are intercropped with arable crops which not only provides rich organic matter and atmospheric nitrogen but also improves the soil structure. NFT's offer immense possibility of supplementing the nitrogen requirements of corps through leaf fall loppings or green leaf manuring. In semi arid tropics it is not possible to have a residual build up of organic matter and therefore it important that organic mater supplies are to be renewed every year. Moreover in dry lands the farmers with their frugal resources can not afford to apply costly nitrogen fertilizer because of the risk involved that they may go as waste leaving them in debts owing to unreliable and undependable rains. The advantage of nitrogen fertilizer to the crops can be taken by growing NFT's in association with the field crops.

2. Alley cropping : It is a type of Agrisilviculture system where in food crops are grown in alley formed by hedge rows of trees or shrubs. (The space between tow hedge rows of trees is called "Alley". The essential feature of this system is that the hedge rows are cut back and kept pruned during cropping to prevent shading to reduce the competition with food crops.

Advantages :

1. It provides higher total biomass per unit area than arable crops alone. 2). It utilizes the off season precipitation which otherwise would go waste. 3) It provides green fodder during lean period 4) It provides additional employment during off season 5) When planted along the contours on also land it serves as a vegetative barrier reduces the run off and conserves moisture. 6) Provides green manure to component food crops 7) Pruning material when applied as surface much suppress weeds and prevent hardening of soil 8) Reduces soil temperature and provides favourable conditions for soil macro and micro-organisms 9) Provides biologically fixed nitrogen to associated food crops.

This system is mostly suitable for arable lands especially for marginal and sub-marginal lands of arid regions.

3) Agri-Horticulture System : It is a system of integration of fruits trees with food crops. It is also termed as food fruit system in which short duration arable crops are grown in inter spaces of fruit tree. Most of the fruit plants develop full canopy after several years and some of them required regular pruning thus permitting an intercrop. Inter cropping provides weed free area and yield obtained will be a bonus to the farmers. The concept is to encourage small farmers to take up tree planting and ensure good returns. This system works bets in medium to deep soils with good water holding capacity. Individual farm ponds and pot watering will certainly prove the scope of fruit farming is hardy species like Ber, Guava, Pomegranate, Custard apple and Phalsa etc. are choosen.

Inter cropping of fruit trees with short duration legumes and vegetable proved beneficial. It is not desirable to grown cereals in orchards.

4) Silvipastoral System : It is two-tier model of fodder based agroforestry system and is suitable for class IV and above lands. This system essentially integrates top-feed tree species with ground storey forage crops to support livestock and to prevent land degradation. This system is essentially suitable in areas where fodder scarcity loams large. In additional this system is pored advantageous in semi arid tropic (SAT) where 60% of

SAT cropped area is occupied by shallow soils and these soils support only *Kharif* crops and crop failures are quite common. The water holding capacity and nitrogen content of these soils is very low too. Besides the SAT regions are facing acute shortage of fodder because of which most of the dry land framers can not afford to won a pair of bullocks. At present hardly $1/3^{rd}$ of the fodder requirements are being met only 2% of farmers are able to produce fodder for their cattle and more than 90% of cattle are remained unproductive. More over 144 m.ha of land in the country is being subjected to server erosion. Therefore combining of top feed trees with forage grasses as under storey crops not only supplied fuel fodder but also helps in conserving the soil and moisture in SAT regions selections of suitable tree component and grass component having the following characters will play a prominent role in success of the system.

Tree component : 1) Fast growing having multipurpose usages i.e., fuel, fodder, small timber etc. 2) High palatability and digestibility of foliage 3) Good coppicing ability 4) Ability to with stand browsing trampling and intense lopping 5) Resistance tolerance to drought and extreme temperatures.

Pasture component : 1) It should be able to grow well as under storey and be compatible with other forage crops. 2) Must be prolific seeder and in case of non-seedling type it should be able to propagate vegetative 3) Possess high palatability and good nutritive value 4) It should be able to with stand over grazing and trampling.

5) Horti Pastoral System :

It is a two tier model for fruit-cum-fodder based Agroforestry system. This system works best in medium soils. Slow growing and later bearing fruit tree species like Tamarind, Jamun, Aonla, Bael, Cashew, Wood apple and highly suitable. In a low input management system with continuous grazing custard apple will be most appropriate. Horti-pastoral system is defined as one of the agro-forestry system which integrates fruit trees with grasses / pasture species.

6) TIMFIB : (Timber-cum-fiber system) : This is one of the Agroforestry system mostly suitable for non-arable lands i.e. degraded sites. It involves integration of some timber yielding tree species with fiber yielding plants like sisal (*Agave spp*). It was proved more remunerative than arable cropping. In Bijapur dry farming Research Station Karnataka intercropping of subabul with sisal is found to be beneficial than arable farming.

7) Agro-Silvipastoral System : It is a system integration of trees with grasses having cattle component in it where the cattle are allowed to graze. Sometimes arable crops are grown as under storey crops with the trees and grasses like *Panicum* and Elephant grass are being grown along the rows of trees which serves as vegetative barrier to control the erosion. In European countries under the coniferous trees like Larches and even under *Alnus spp* panicum grass is being allowed to grow where the cattle will graze.

Thus various Agroforestry systems are developed both for arable and non arable lands as follows based on components.

Agroforestry Systems

Marginal lands (Class IV and above lands) Arable lands (Non-arable)

(Class I II and III)

- Silvipastoal	-	Alley cropping
- Horti – pastoral	-	Agri - Horti system
- TIMFIB	-	Agri – Silviculture (with NFT’s)

Disadvantages of Agroforestry Systems : -

Through there are several advantages of agro-forestry systems there are few disadvantages which include :

- Profile seedling habit of subabul resulting in weedy growth depresses the yield of arable crops.
- Root and shade effect of trees on cultivated crops even up to 2o m in case of Babul *(Acacia nilotica) Leucaena* psyllids (Heteropsylla Cuban in near future may become pests of cultivated crops.
- Agroforestry systems are labour intensive and reduces the scope of farm mechanization.
- Allelopathic effect of trees in crops eg. Eucalyptus spp.