Lec 3. Agroforestry - definition, different terminologies - components- distinction between agroforestry and social forestry- benefits and constraints of agroforestry

Concept of Agroforestry

Agroforestry is a collective name for land-use systems involving trees combined with crops and/or animals on the same unit of land. It combines i) production of multiple outputs with protection of resource base;ii) places emphasis on the use of multiple indigenous trees and shrubs;iii) particularly suitable for low-input conditions and fragile environments ;iv) It involves the interplay of socio-cultural values more than in most other land-use systems; and v)It is structurally and functionally more complex than monoculture.

Definition

Agroforestry is any sustainable land-use system that maintains or increases total yields by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land, either alternately or at the same time, using management practices that suit the social and cultural characteristics of the local people and the economic and ecological conditions of the area.

or

Agroforestry is a collective name for a land-use system and technology whereby woody perennials are deliberately used on the same land management unit as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. In an agroforestry system there are both ecological and economical interactions between the various components.

Difference between Social forestry and Agroforestry

Social forestry is defined as “Forestry outside the conventional forests which primarily aims at providing continuous flow of goods and services for the benefit of people. This definition implies that the production of forest goods for the needs of the local people is Social forestry. Thus, social forestry aims at growing forests of the choice of the local population.

Shah (1985) stated that Conceptually Social forestry deals with poor people to produce goods such as fuel, fodder etc. to meet the needs of the local community particularly underprivileged section.

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Different terminologies for describing tree cultivation in non forest areas

1. **Farm Forestry**

   Farm forestry is the name given to programmes which promote commercial tree growing by farmers on their own land

   Farm forestry was defined by NCA (1976) as the practice of forestry in all its aspects in and the around the farms or village lands integrated with other farm operations.

2. **Extension Forestry**

   Extension forestry is the practice of forestry in areas devoid of tree growth and other vegetation situated in places away from the conventional forest areas with the object of increasing the area under tree growth .

   It includes the following.

   i) Mixed forestry

   Mixed forestry is the practice of forestry for raising fodder grass with scattered fodder trees, fruit trees and fuel wood trees on suitable wastelands, panchayat lands and village commons

   ii) Shelterbelts

   Shelterbelt is defined as a belt of trees and or shrubs maintained for the purpose of shelter from wind, sun, snow drift, etc.

   iii) Linear Strip plantations

   These are the plantations of fast growing species on linear strips of land

3. **Rehabilitation of Degraded forests**

The degraded area under forests needs immediate attention for ecological restoration and for meeting the socio economic needs of the communities living in and around such areas.

4. Recreation Forestry

Recreation forestry is the practice of forestry with the object of raising flowering trees and shrubs mainly to serve as recreation forests for the urban and rural population. This type of forestry is also known as **Aesthetic forestry** which is defined as the practice of forestry with the object of developing or maintaining a forest of high scenic value.

Benefits of agroforestry

i) Environmental benefits

i) Reduction of pressure on forest

(ii) More efficient recycling of nutrients by deep-rooted trees on the site

(iii) Better protection of ecological systems

iv) Reduction of surface run-off, nutrient leaching and soil erosion through impeding effect of tree roots and stems on these processes

v) Improvement of microclimate, such as lowering of soil surface temperature and reduction of reduction of evaporation of soil moisture through a combination of mulching and shading

vi) Increment in soil nutrients through addition and decomposition of litter-fall.

(vii) Improvement of soil structure through the constant addition of organic matter from decomposed litter.

ii) Economic benefits

(i) Increment in an outputs of food, fuel wood , fodder,fertiliser and timber;

ii) Reduction in incidence of total crop failure ,which is common to single-cropping or monoculture systems

iii) Increase in levels of farm income due to improved and sustained productivity

iii) Social benefits

(i) Improvement in rural living standards from sustained employment and higher income

ii) Improvement in nutrition and health due to increased quality and diversity of food outputs

iii) Stabilisation and improvement of communities through elimination of the need to shift sites of farm activities.

Constraints in agroforestry

The following are the major constraints in agroforestry

1. Depression in crop yields due to interference effects caused by the tree
2. Delayed liquidation of planting investments due to long gestation period
3. Increased damage to crops due to birds which the tree attract
4. Increased damage to crops due to pests for which the tree serve as alternate hosts
5. Allelopathy

1. Interference effects

In an agroforestry system, trees being the dominant partners,will compete with the herbaceous substratum for resource pools of light, water and nutrients. When the immediate supply of a single necessary factor falls below the combined demands of the plant, then the competition begins.The competition is also referred as Allelospoly.

a) Competition for Light

Many tree crops are inefficient in interception of radient energy in their early years since full canopy formation in trees may take many years. Under such circumstances, solar radiation falling on bare soil is wasted and promote only weed growth. Intercropping of ground cover crops with the trees in their early years will therefore help in better utilization of the resource. Reduction in crop yield form second year of tree growth under agroforestry systems has been reported.

The shade effects caused by full canopy of a 13 year old untopped *Acacia tortilis* was considerable. Compared to open field, the total and net radiation beneath the tree canopy were only 24% and 16% respectively.

Under limitation of light , there is an inevitable depression in the intersown crop yields. Establishment and growth of *Cenchrus ciliaris* was poor under 13 year old unlopped *Acacia tortilis.* Forage yield of introduced ground cover of grasses under

A. tortilis plantation was alsofound to decline within two years of pollarding due to shading caused by newly sprouted shoots

b) Competition for moisture

One of the primary promises of agroforestry , especially of mixed systems rests on the assumption that trees being deep rooted abstract water from the deeper regions and therefore do not compete in the upper stratum to which the herbaceous component is restricted. The increased yield of arable crops and range grasses under *Prosopis juliflora* was due to the deep taproot of the tree. The predominant occurrence of lateral roots in the top 30cm soil has also been reported in Eucalyptus and it extracted moisture mostly from the upper soil layer. Thus trees do compete with arables in the top 30cm soil profile.

In intercropping experiment, depletion of soil moisture was considerable in bamboo.

The other characteristics which have been associated for competition are high root density, high root-shoot ratio high root length per unit soil volume. etc.

c)Competition for nutrients

A higher concentration of the fine tree roots in the soil layer upto 50cm suggests that trees also obtain most of the nutrient requirements from the soil layer upto 50cm. The lower concentration of the fine roots below 50cm soil depth suggests that the nutrient absorption from deeper soil layers may be small. The main function of the roots reaching greater depths appears to be water uptake, particularly during periods of water stress. The proportional abundance of fine roots of agricultural crops, grassesand trees suggests that there is a keen competition for nutrients between the crops and trees when grown in mixture.

Some trees are said to be great transpire of moisture. Particularly Eucalyptus . But studies carried out regarding water consumption by different species indicate that the value of water consumption per unit of biomass produced is lower in *Eucalyptus tereticornis* and *Albizia lebbeck compared to Acacia auriculiformis, dalbergia sissooand pongamia pinnata* though per plant consumption of water is highest in Eucalyptus spp.

When the trees are grown together with agricultural crops either as intercrop or on bunds, their adverse effects are visible on the agricultural crops in the vicinity of the trees. The adverse effects on the growth and yield of agricultural crops are due to the competition for light, moisture and nutrients. The nature and quantum of these adverse effects depend upon I) the age and size of the trees, ii) nature of the tree species iii) nature of the agricultural crops ,iv) availability of water, nutrients , light, etc. The impact of the adverse effects is greatest in the close vicinity of the trees and diminishes as the distances increases Such effects were observed in different crops with a combination of different tree species. The effects of *Eucalyptus tereticornis, Populus deltoides, Dalbergia sissoo* and *Acacia nilotica* grown on field bunds were studied under

different conditions on wheat, paddy, jowar,potato and it was found that *P.deltoides* caused the least damage to the crops of the rabi season but damage by the other species was higher.

i)Environmental aspects

(i) Possible competition of trees with food crops for space, sunlight, moisture and nutrients which may reduce food crop yields

(ii) Damage to food crops during tree harvest operations

(iii) Potential of trees to serve as hosts to insect pests that are harmful to food crops

(iv) Allelopathic effect of trees on agricultural crops

ii) Socioeconomic aspects

(i) Requirement for more labour inputs, which may cause scarcity at times in other farm activities

(ii) Competition between food and tree crops, which could cause aggregate yields to be lower than those of a single crop

(iii) Longer period required for trees to grow to maturity and acquirean economic value

(iv) Resistance by farmers to displace food crops with trees especially where land is scarce

2. Allelopathy

Muller(1969) emphasized that allelopathy, the direct or indirect effect of one plant upon another through the production of chemical inhibitors that are released in to the environment , should also be recognized as another factor in analyzing mechanisms of plant interactions.

The species interaction due to chemical influences is also designated as **Allelochemistry, Phytochemical ecology or Ecological biochemistry** and **Allelobiology.**

Most of the chemical substances involved in allelopathic reactions are secondary compounds. Though the toxic metabolites are distributed in other plant parts also, leaves are the potent source of allelochemicals. Summer materials are more toxic than those of rainy and winter season. Toxins released from plant litter are the primary causes of allelopathy.

3. Damage due to Birds

It is generally believed that planting of trees in the farm will attract the birds and thereby enhance the risk of damage for agricultural crops.

4. Trees as a alternate hosts to Agricultural crops

Some trees act as alternate hosts for insect pests. For instance, the jowar hoppermigrates to neem tree after harvest of crop and returns to the crop after completing its life cycle on the woody perennial.

Silvicultural options for minimizing the negative interactions

1. **Manipulation of Densities and Arrangement of Trees**

The negative effects of trees can be minimized by increasing the spacing between the trees. The studies carried out in the semi arid regions of India showed that as the distance between the hedgerows of *Luecaena luecocephala* increased , the percent reduction in crop yield decreased. The reduction in the yield of sorghum , cowpea and caster was relatively less in wider spacing (7.2m) compared to narrow spacing(3.6m) .

Tree orientation is also important to reduce the negative effect of trees on crops. Planting in east –West direction may reduce the shading effect of treeson the crops.

2. **Manipulation of Tree crown and roots**

The negative effects of trees can be further reduced by pruning of tree crown and roots. In alley cropping system, pruning of trees and applying the biomass to the soil will reduce the trees competitive ability and increase the growth yield of the associated intercrops by providing green manure and by allowing more light to the intercrops.

In situations of severe root competition for moisture and nutrients, root pruning operation or trenching may eliminate or reduce the negative effect trees on the intercrops.

3. **Choice of Agricultural crops**

There is a great need to identify the suitable agricultural crops which can grow well under trees with limited solar energy available.

Example:

1. Vegetables : Ginger, turmeric, potato, cucurbit
2. Agricultural crops : Oats, maize, soybean, groundnut
3. Grasses : Cenchrus spp, panicum,

Through skillful management practices any or all of these constraints can be controlled. For example, once it is known that trees compete with food crops and may reduce food yields, it is easy to adopt some or all of the following strategies:

(i) Select legume trees that have small or light crowns so that sufficient sunlight will reach the food crops for photosynthesis;

(ii) Select tree species that are deep-rooted so that they will absorb moisture and nutrients from the deeper subsoil while the food crops receive their share from the surface layer of the soil;

(iii) Space the trees farther apart to reduce their competitive effects on the food crops.

Certainly agroforestry has considerable potential, not as the only way to improve agricultural production, but as one important way to enhance and maintain overall productivity of the small upland farm, the agricultural unit that is becoming more prevalent in many parts of the world.