LECTURE-3

LEARINING OBJECTIVE: TO KNOW ABOUT DIFFERENT AGROFORESTRY SYSTEMS, SUBSYSTEM, PRACTICES, AFS CLASSIFICATION, AFS ON NATURE OF COMPONENTS

Different types of agroforestry systems exist in different parts of the world. These systems are highly diverse and complex in character and function. Classification of agroforestry system is necessary in order to provide a framework for evaluating the system and developing action plan for their improvement. Several criteria can be used in classifying them but most common includes **the system structure**, **function**, **socioeconomic scale of management, ecological spread etc.** According to the potential, there are many different systems of agroforestry. In agroforestry the terms like system, sub-system and practices are commonly used. Therefore, these terms require proper definitions in agroforestry languages:

System:

- System refers to a group of physical components, i.e. an assemblage of objects connected or related in such a manner so as to form and/or act as a unit; e.g. ecosystem which consists of living organism and their non-living environment with which they are inseparably interrelated.
- In land use terms, a system refers to a type of land use specific to an area and described according to its biotechnical composition and arrangement, level of technical management of socio-economic features; e.g. rice production system, plantation crop systems.

Sub-system:

- Sub-system indicates a lower order hierarchy of the system.
- It refers to a part of system, with more or less restricted role, content and complexity than the system itself.
- A sub-system produces a defined 'basic needs' as its major output, so that there can be a food sub-system, an energy production sub-system and cash sub-system.

Practices:

- Practices in agroforestry denote specific land management operations of any nature, carried out on a farm or other management unit.
- Such practices are involved in the constitution and maintenance of an agroforestry system; e.g. alley cropping, boundary plantations of trees and shrubs, shelterbelts and windbreaks, etc.

Why classification:

- It include logical way of grouping the major factors on which production of the system will depend
- It indicate how system is managed
- It offer flexibility for regrouping the information
- We usually understood and readily handled

CRITERIA /BASIS FOR AGROFORESTRY SYSTEM CLASIIFICATION

Combe (1982) proposed 24 agroforestry systems based on three type of association of the trees with crops, with pastures and with both crops and pastures); two major functions of the tree components (production and protection); two spatial arrangements (regular and irregular); and two types of temporal association (temporary and permanent).

The most obvious and easy-to-use criteria for classifying agroforestry systems are the spatial and temporal arrangement of components, the importance and role of components, the production aims or outputs from the system, and the social and economic features. They correspond to the systems' structure, function (output), socioeconomic nature, or ecological (environmental) spread. These characteristics also represent the main purpose of a classification scheme. Therefore agroforestry systems can be categorized according to these sets of criteria:

- Structural basis
- Functional basis
- Socioeconomic basis
- Ecological basis

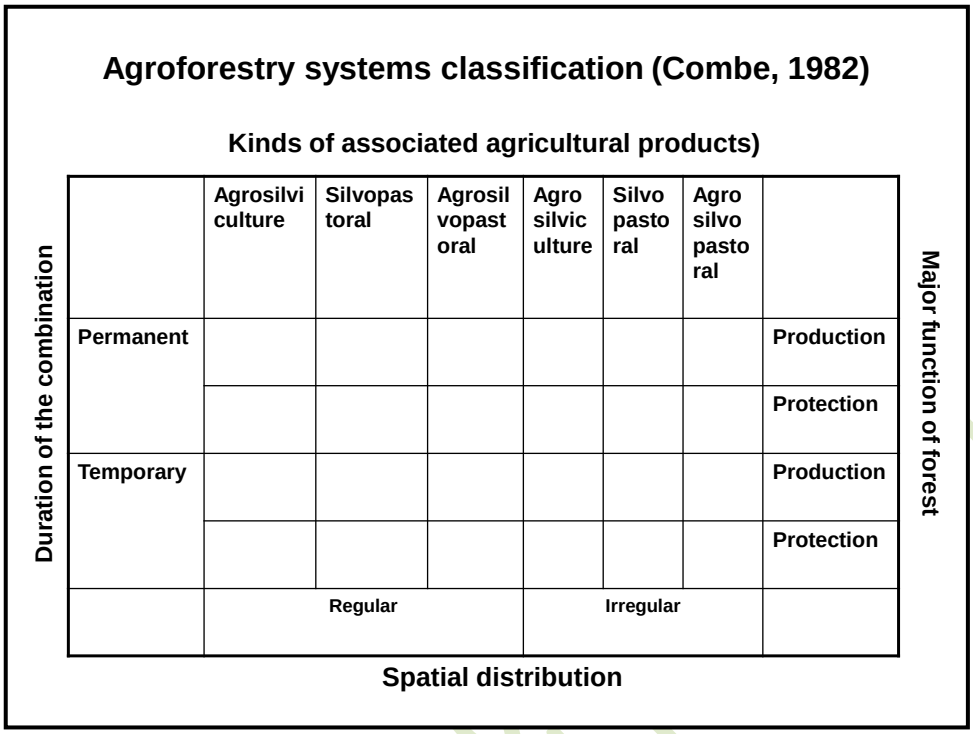

Fig. 3.1(a) Agroforestry systems classification, Combe (1982)

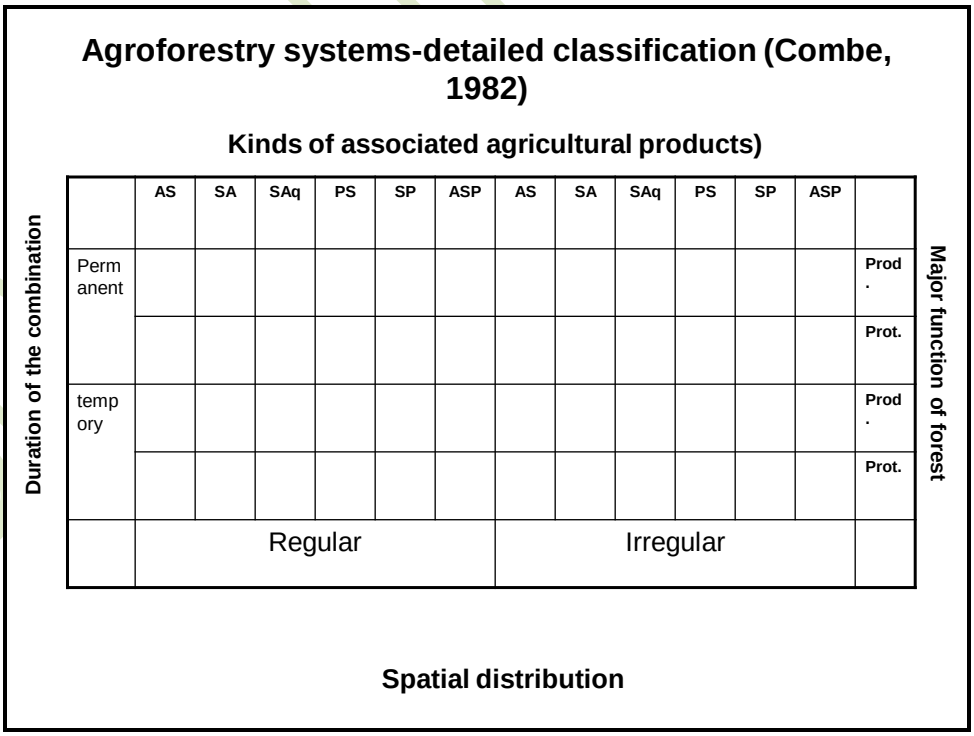

Fig. 3.1(b) Agroforestry systems classification, Combe (1982)

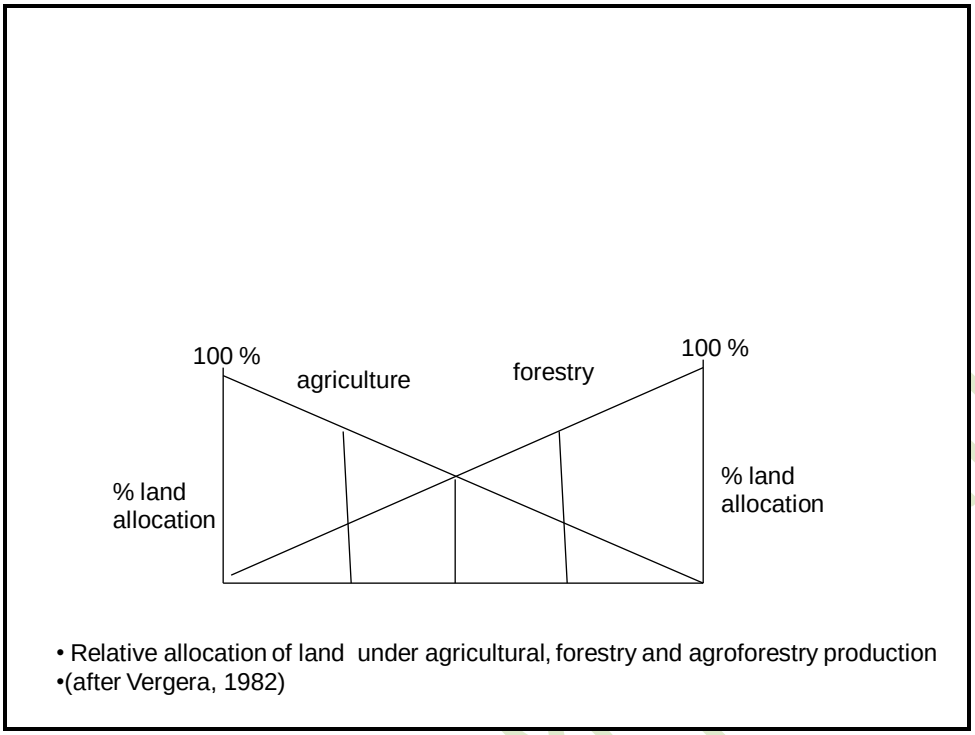

Fig. 3.2 Agroforestry system on relative allocation of land for components

- Vergera (1982) considered the relative allocation of land, trees, crops, pastures in various agroforestry systems.

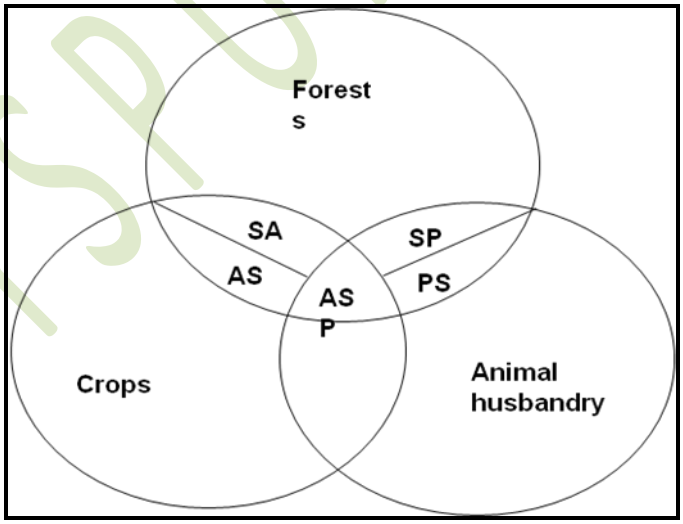

Fig. 3.3 Agroforestry systems on basis of relative dominance of components

- Tejwani (1987) suggested a classification which among the other things also took into account relative dominance of trees or crops/pastures

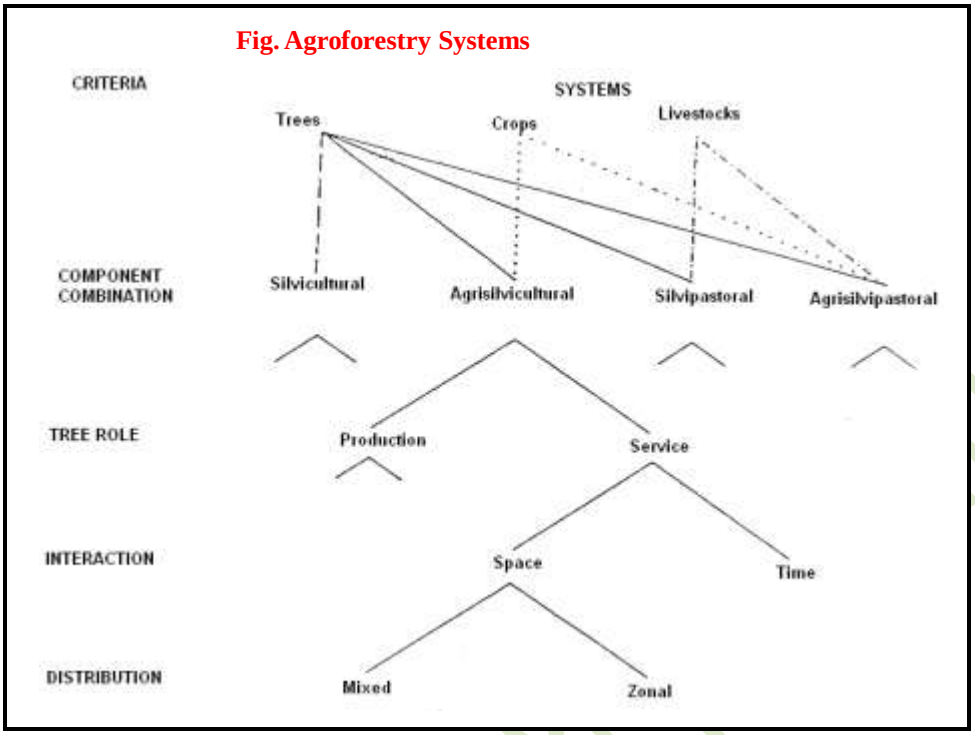

Fig. 3.4 Agroforestry systems based on different criteria

CLASSIFICATION OF AGROFORESTRY SYSTEMS (NAIR, 1985)

- ***Structural basis:*** refers to the composition of the components, including spatial arrangement of the woody component, vertical stratification of all the components, and temporal arrangement of the different components. Hence on the basis of structure agroforestry system can be grouped into two categories.

A) Nature of components

B) Arrangement of components

A) **Nature of components:** Based on nature of component agroforestry systems can be classified into following categories

- Agrisilviculture systems/ silviagriculture/ agrosilviculture
- Silvopastoral systems/ silvipastoral
- Agrosilvopastoral systems/ agrisilvipastoral
- Other systems

- Note: Nomenclature of the system depends upon the prime importance of the component and the component given lot of space placed first in any agroforestry system for eg. Agrisilviculture in which prime component is agriculture crop.
- Agrosilviculture has a wide applicability and it covers in its scope integration of different components of farming system for eg. Vegetables, pulses, oil seed crops, cereals etc.
- Whereas agrisilviculture restricted only to integration of cereals with the tree crop

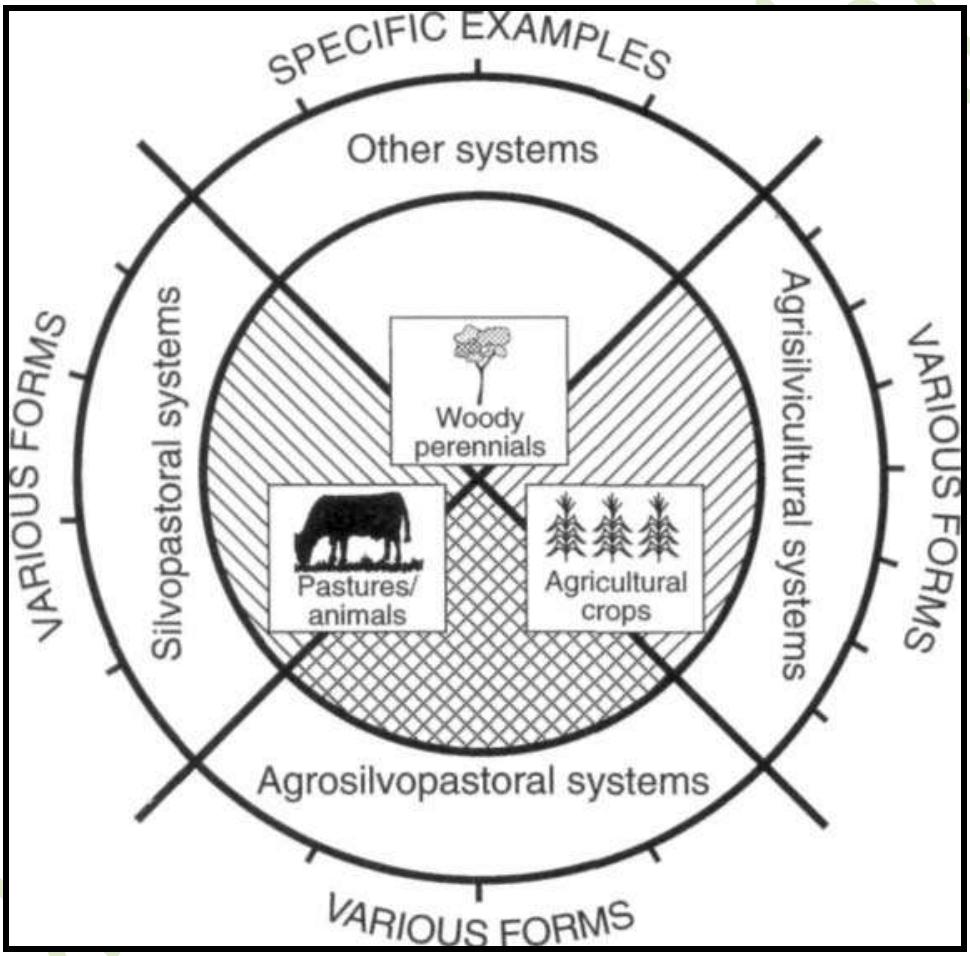

Plate 3.1 Classification of agroforestry systems on the basis of nature of components

I. Agrisilviculture/Silviagriculture/Agrosilviculture

This system involves the conscious and deliberate use of land for the concurrent production of agricultural crops including tree, crops and forest crops. Based on the nature of the components this system can be grouped into various forms:

a) Improved fallow species in shifting cultivation
b) The Taungya system
c) Multispecies tree gardens
d) Alley cropping (Hedgrow intercropping)
e) Multipurpose trees and shrubs on farmlands
f) Crops combinations with plantation crops
g) Agroforestry for fuelwood production
h) Shelter belts
i) Wind breaks
j) Soil conservation hedges etc.

a) Improved fallow species in shifting cultivation:

Shifting cultivation:

- It is prevalent in many parts of Africa, Latin America, South-East Asia and Indian subcontinent.
- In India it is prevalent in Assam, Meghalaya, Jharkhand, Manipur, Orissa, Nagaland, Chattisgarh, M.P., Arunanchal Pradesh, Andhra Pradesh, Mizoram, Tripura, Kerala, West Bengal, Sikkim.
- It is known as 'jhuming' in North-east, 'khallu / kurwa' in Jharkhand and 'dahiya' or 'podo' in Orissa, Andhra Pradesh.
- In this system, forest patch is selected and cleared felled. The herbs, shrubs and twigs and branches (slashed vegetation) are burnt .Cultivation of crops is done for a few years until soil fertility declines. The site is than abandoned (fallow period) and new patch is selected for cultivation of crops. The site is again cultivated after giving rest for few years.
- Earlier the fallow cycle was of 20–30 year. However, due to increasing requirement for cultivation of land due to population pressure, fallow period has reduced from 25–30 years to 2–3 years which has broken down the resilience of ecosystem and the land is increasingly deteriorating. Thus now shifting cultivation has become source of ecological degradation, soil erosion and converting good forests into wastelands.

Plate 3.2 Shifting cultivation

Effect of shifting cultivation

- Deforestation and denudation of hill slopes-in secondary succession, area is occupied by weeds, useless shrubs etc
- Soil erosion which leads to soil and nutrient losses, silting of reservoirs and streams, reduction in water-yield and landslips and landslides
- Shifting cultivation adversely affects cation exchange capacity and physical properties of soil. It leads to lowering of organic matter and lowering the total quantity of sesquioxides, iron, aluminum, calcium, potassium, phosphorus, etc.
- Increases soil pH and reducing microbial activity
- More weed growth and lower crop yield
- No opportunity for infrastructural development

Controlling shifting cultivation

- Motivate public for permanent agriculture by opening demonstration centers for improved agricultural practices, good quality seed, manuring, irrigation, weeding use of improved tools, terracing etc.
- Earning goodwill of local people: By engaging them in forest work and training them to undertake shifting cultivation on scientific lines.

- Arable land can be provided to the tribals for carrying out agriculture and also to settle in the area; a few schemes are being implemented under integrated tribal development programme
- Legal measures: on steep slopes, near to roadside etc
- Using land according to its capability
- Provision of alternative management
- Development of animal husbandry and dairy farming
- Training of artisans and development of handicrafts
- Employment in forest works and other industries
- Providing communication facilities
- Providing economic assistance for houses and agriculture operations

Improved fallow species in shifting cultivation:

- Fallows are crop land left without crops for periods ranging from one season to several years.
- The objective of improved fallow species in shifting cultivation is to recover depleted soil nutrients. Once the soil has recovered, crops are reintroduced for one or more season.
- The best species for the fallow system should induce good nitrogen fixation in the soil.
- The main aim of the fallow is to maintain or restore soil fertility and reduce erosion; some plants can be introduced primarily for their economic value.
- Plants included in improved fallows should be compatible with future crops, free of any negative physical or chemical effects on the soil and not in competition with the crops to be planted later on the same site.

b) Taungya System of cultivation:

- The taungya system was used primarily as an inexpensive means of establishing timber plantations but is finally a recognized AF system.
- The taungya (taung = hill, ya = cultivation) is a Burmese word coined in Burma in 1850. The system was introduced to India by Brandis in 1890 and the first taungya plantations were raised in 1896 in North Bengal.

- It was introduced to S Africa in 1887 and was taken to Chittagong and Sylhat (Now in Bangladesh) in 1870.
- In India it started in 1896 in North Bengal. In 1890, it was introduced to Coorg in Karnataka. Regular plantation however started in North Bengal in 1911 for raising Sal plantations and in 1912, extended for raising Teak. In 1923 it was adopted in UP for raising Sal plantations.
- It is still practiced in the states of Kerala, West Bengal, Orissa, Karnataka and the north-eastern hill region.
- This is a modified form of shifting cultivation in which the labour is permitted to raise agri-crops in an area but only side by side with the forest species planted by it. The practice consists of land preparation, tree planting, growing agricultural crops for 1-3 years, until shade becomes too dense, and then moving on to repeat the cycle in a different area. A large variety of crops and trees, depending on the soil and climatic conditions, are grown in India. In fact this system was introduced to raise forest plantations, but finally became recognized agroforestry system.

Types of Taungya:

i. **Departmental Taungya:** Under this, agricultural crops and plantation are raised by the forest department by employing a number of labourers on daily wages. The main aim of raising crops along with the plantation is to keep down weed growth.

ii. **Leased Taungya:** The plantation land is given on lease to the person who offers the highest money for raising crops for a specified number of years and ensures care of tree plantation.

iii. **Village Taungya:** This is the most successful of the three taungya systems. In this crops are raised by the people who have settled down in a village inside the forest for this purpose. Usually each family has about 0.8 to 1.7 ha of land to raise trees and cultivate crops for 3 to 4 years.

Table 3.1: Trees and crops grown in Taungya

State	Tree crop	Associated agricultural crops
U.P.	*Shorea robusta, Tectona grandis* *Acacia catechu, Dalbergia sisso,* *Eucalyptus spp. Populus spp.*	Maize, paddy, sorghum, pigeon-pea, soyabean, wheat, barley, chick-pea, rape-see and miscellaneous
Andhra Pradesh (AP)	*Anacardium occidentale,* *Tectona grandis, Bombax ceiba, Bamboo, Eucalyptus spp.*	Hill paddy, groundnut, sweet potato
Kerala	*Tectona grandis Bombax ceiba* *Eucalyptus spp.*	Paddy, tapioca, ginger, turmeric, etc.
Assam	*Shorea robusta, S assamica*	Paddy
Tamil Nadu	*Tectona grandis, Santalum album* *Tamarindus indica, Acacia nilotica* *Acacia mearnsii ,Ceiba pentandra* *Cashew, Rubber, Bamboo*	Millet, pulses, groundnut, cotton
Andaman and Nicobar Islands	*Pterocarpus dalbergioides*	Sugar-cane, maize
Maharashtra	*Tectona grandis, Acacia nilotica*	Sunhemp, jute, mesta, sunflower, castor etc.
Tripura	*Shorea spp., Schima spp., Michelia spp.*	Paddy, maize etc
West Bengal	*Tectona grandis, Shorea robusta* *Schima wallichii, Cryptomeria japonica, Quercus spp. Michelia doltsopa*	Paddy, maize, millets, turmeric, ginger, lady's, finger, pineapple, sunhemp
Karnataka	*Tectona grandis, Santalum album, Cassia siamea*	Paddy, tapioca, etc.

ADVANTAGES OF TAUNGYA:

- Artificial regeneration of the forest is obtained cheaply;
- Problems of unemployment are solved;

- Helps towards maximum utilization of the site;
- Low cost method of forest plantation establishment;
- In every case, highly remunerative to the forest departments;
- Provision of food crops from forest land; and
- Weed, climber growth, etc. is eliminated.

DISADVANTAGE OF THE TAUNGYA:

- Loss of soil fertility and exposure of soil;
- Danger of epidemics;
- Legal problems created;
- Susceptibility of land to accelerated erosion increases; and,
- It is a form of exploitation of human labour

c) Multi-species tree Gardens:

- In this system of agroforestry, various kinds of tree species are grown mixed.
- The major function of this system is production of food, fodder and wood products for home consumption and sale.

d) Alley cropping (Hedge row intercropping):

- Alley cropping, also known as hedgerow intercropping,
- In this perennial, preferably leguminous trees or shrubs are grown simultaneously with an arable crop.
- The trees, managed as hedgerows, are grown in wide rows and the crop is planted in the interspace or 'alley' between the tree rows.
- During the cropping phase the trees are pruned and leaves and twigs are used as mulch on the cropped alleys in order to reduce evaporation from the soil surface, suppress weeds and/or add nutrients and organic matter to the top soil.
- The primary purpose of alley cropping is to maintain or increase crop yields by improvement of the soil and microclimate and weed control. Farmers may also obtain

tree products from the hedgerows, including fuelwood, building poles, food, medicine and fodder, etc.

Plate 3.3 Alley cropping

Layout of Alley:

- The position and spacing of hedgerow and crop plants in an alley cropping system depend on plant species, climate, slope, soil conditions and the space required for the movement of people.
- Ideally, hedgerows should be positioned in an east to west direction so that plants on both sides receive full sunlight during the day.
- The spacing used in fields is usually 4 to 8 meters between rows and 25 cm to 2 meters between trees within rows. The closer spacing is generally used in humid areas and the wider spacing in sub-humid or semi-arid regions.

Plate 3.4 (a) Alley cropping

Plate 3.4 (b) Alley cropping

Characteristics of species for hedgerow intercropping: Alley cropping usually includes leguminous trees to improve soil fertility through nitrogen fixation; hence an ideal alley cropping tree or shrub species should have following characteristics:

- It should have a sparse, small crown to permit sunlight penetration into the cropped area

Plate 3.5 Hedgerow intercropping

- It should re-sprout rapidly after pruning, coppicing, pollarding or lopping.
- It should form a deep taproot system so that it takes moisture and nutrient from deeper layers and will not compete with agricultural crops.

- It should have shallow lateral roots that are easily 'pruned' by ploughing along the hedgerow, without serious damage to the plants.
- Fast decomposition rate of leaf litter.
- Ideally, trees and shrubs used for alley cropping should fix nitrogen.
- Trees/shrubs should be non-exacting in nature.

Promising species

- *Gliricidia sepium, Flemingia macrophylla, Leucaena, Calliandra calothyrsus, Erythrina subumbrans, Albizia saman, Pithecellobium dulce, Paraserianthes falcataria, Acacia spp., Paraserianthes falcataria and Cajanus cajan*.

ADVANTAGES

- Improved crop performance due to the addition of nutrients and organic matter into the soil/plant system,
- Reduction of the use of chemical fertilisers,
- Improvement in the physical nature of the soil environment.
- Reductions in erosion losses.
- Provision of additional products such as forage, firewood or stakes when a multipurpose tree legume is used as the hedgerow, and
- Improvement in weed control.

e) Multipurpose trees and shrubs on farmlands:

- In this system various multipurpose tree species are scattered haphazardly or according to some systematic patterns on bunds.
- The major components of this system are multipurpose trees and other fruit trees and common agricultural crops.
- The primary role of this system is production of various trees products and the protective function is fencing and plot demarcation. Examples of multipurpose trees employed in agroforestry are: *Leucaena leucocephala*, *Acacia albida*, *Cassia siamea*, *Casuarina equisetifolia*, *Azadirachta indica*, *Acacia senegal*, *Cocos nucifera*, etc.

f) Crop combinations with plantation crops:

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

i. Integrated multistory mixture of plantation crops;

ii. Mixture of plantation crops in alternate or other crop arrangement;

iii. Shade trees for plantation crops

iv. Intercropping with agricultural crops.

- Tea (*Camilia sinensis*) is grown under shade of *A. chinensis, A. odoratissim, A. lebbek, A. procera, Acacia lenticularis, Derris robusta, Grevillea robusta, Acacia spp., Erythrina lithosperma, Indigofera tesmanii.*
- *Coffee (Coffea arabica)* is grown under the shade of *Erythrina lithosperma* as temporary shade while, permanent shade trees include *Ficus glomerata, F. nervosa, Albizia chinensis, A. lebbek, A moluccana, A. sumatrana, Dalbergia latifolia, Artocarpus integrifolius, Bischofia javanica, Grevillea robusta.*
- Cacao *(Theobroma cacao)* is grown under the shade of coconut and areca nut, *and Dipterocarpus macrocarpa (in forest*).
- Black pepper *(Piper nigrum*) is grown with support from *Erithrina indica, Garuga pinnata, Spondias, Mangifera, Gliricidia maculate* and *Grevillea robusta.*
- Small cardamom (*Elettaria cardamomum*) and large cardamom (*Ammomum subulatum*; *A. aromaticum*) grow in forests under temporary shade tree of *Mesopsis emini..*
- Large cardamom is grown under the shade of natural forest as well under planted shade treesviz., *Alnus nepalensis*, *Schima wallichii*; *Cinchona spp*.; *Lagerstroemia spp*., *Albizia lebbek*; *Castanopsis tribuloides*; *C. hystrix*; *C. indica*; *Terminalia myriocarpa*; *Bischofia javanica*.

g) Agroforestry for fuelwood production:

- In this system, various multipurpose fuelwood/firewood species are inter-planted on or around agricultural lands.
- The protective role is to act as fencing, shelter belts and boundary demarcation.
- Tree species commonly used as fuelwood are: *Acacia nilotica, Albizia lebbek, Cassia siamea, Casuarina equisetifolia, Dalbergia sissoo, Prosopis juliflora, Eucalyptus tereticornis,* etc.

h) Shelterbelt:

- Shelterbelt is a wide belt of trees, shrubs and grasses, planted in rows which goes right across the land at right-angle to the direction of the prevailing winds to deflect air current, to reduce wind velocity and to give general protection to cultivated areas against wind erosion and desiccating effect of the hot winds in lee-ward side.

- A typical shelterbelt has a triangular cross-section which can be achieved by planting tall trees in the centre, flanked on both sides successively by shorter trees, tall shrubs and then low spreading shrubs and grasses.
- A certain amount of penetrability is desirable in shelterbelts as a result of which the zone of influence is very much greater and the velocity curve shows a smooth, slowly declining trend.
- The width of shelterbelt depends upon local climatic conditions, wind velocity, and the soil type.
- Shelterbelt should be oriented as nearly as possible, at right angles to the prevailing wind In case, where winds blow from different directions, shelterbelt should be raised in quadrangles.

Height and spacing—

- Height of shelterbelt is very important
- As it affects the distance to which protection will be afforded on the lee-ward side.
- Higher the trees forming the shelterbelt, the greater is the zone of influence on the leeward side.
- This affects the spacing of the shelterbelts also. If wind erosion has to be completely controlled, the second belt should be located a little before the place where the wind on the lee-ward side often first shelterbelt assumes damaging velocity.
- Taking 20% reduction in wind velocity as the basis of usefulness of a shelterbelt, effective protection zone extends up to 15 to 20 times the height of the belt.
- In Rajasthan, taking the height of shelterbelt to be about 7.5 m, spacing recommended is 10 times the height, i.e., 75 meters.

Length:

- The length of shelterbelt is an important consideration because at the ends of the shelterbelt eddies are produced resulting in increasing the wind velocity at these places.
- It is because of this that road is not ordinarily allowed to cross a shelterbelt.
- In some of the western countries, shelterbelts have been raised right across the country for the protection they afford

- For shorter shelterbelt, the minimum length of shelterbelt to be most effective is 24 times its height.

Soil Preparation:

- Soil preparation should be done at least a year in advance to build up sufficient reserve of soil moisture
- It may be done either mechanically or by manual labour
- Leguminous crops may be raised for the first few years in between the rows of trees and shrubs for improving the fertility of the soil.

Choice of species:

- The choice of species to be raised in shelterbelt is governed by the climate, soil and topography of the area.
- It is better to raise local species because of their easy establishment.
- Exotics may also be used to improve the efficiency of the shelterbelts.

Characteristics of tree spp. used for shelterbelt:

- The species selected should be non-exacting;
- Fast-growing;
- Wind-firm;
- Drought-resistant;
- Unpalatable to animals;
- It should have a dense crown and low branching habit;
- It should not be leafless at a time when protection is required;
- It should be economically a multipurpose species, i.e., fit for firewood, timber and fodder.

The following species are recommended for creation of shelter belt:

Grasses: *Cenchrus barbatus, Saccharum spontaneum, Saccharum munja, Panicum turgidum, Panicum antidotale.*

Shrubs: *Calotropis procera, Crotolaria burhia, Calligonum polygonoides, Clerodendron phlomoides, Cassia auriculata, Dodonaea viscosa, Jatropha curcas, Leptadenia spartivm, Agave* spp. *, Sesbania aculeata.*

Small trees: *Acacia jacquemontii, Acacia leucophloea, Balanites aegyptiaca, Capparis aphylla, Salvadora oleoides.*

Trees: *Acacia arabica, Acacia senegal, Acacia cyanophylla, Albizzia lebbek, Azadirachta indica, Dalbergia sissoo, Lannea coromendelica, Parkinsonia aculeata, Prosopis cineraria, Prosopis juliflora, Pongamia pinnata, Tecoma undulata, Tamarix articulata*$_t$ *Eucalyptus* spp., *Acacia tortilis.*

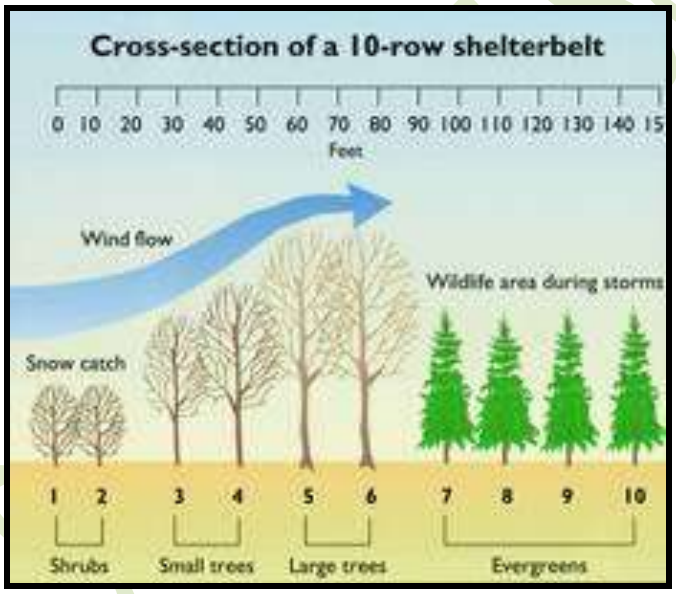

Fig. 3.5 A cross section of 10-row shelterbelts

Method of raising the plants:

- It is better to sow the seeds in polythene bags and plant out the plants so raised.
- For this purpose nurseries should be maintained at site.
- The plant should be regularly watered for one or two years.
- Properly fenced to protect them from browsing cattle.

ADVANTAGES OF SHELTERBELTS:

- Very little research work has been done in our country.

- To find out the benefits of the shelter-belts on yields of agricultural crops, horticultural crops and grasses.
- However, on the basis of research work done in CAZRI, TNAU and abroad, the following advantages of the shelterbelts may be mentioned:

Moderating effect on temperature—

- Shelterbelt has a moderating effect on air and soil temperature by lowering the maximum and raising the minimum.
- Temperature during day time inside the forest is lower evaporation.
- Temperature during night is higher inside the forest than open.

Increase in humidity—

- Shelterbelts increase relative humidity from 1 to 50%.
- There is distinctly perceptible increase in the average relative humidity in the agricultural land protected by shelterbelts

Reduction in evapo-transpiration:

- Shelterbelts reduce evapo-transpiration sufficiently in the zone of their influence.

Increase in soil moisture:

- Shelterbelts increase the moisture content of the soil on the leeward side and delay it's drying up during summer.
- They also increase the underground water supplies by promoting infiltration in the soil.

Reduction in wind velocity and wind erosion:

- Shelterbelts deflect the wind upwards
- Cause considerable reduction in the wind velocity on the leeward side upto a distance of 15 to 20 times the height of the trees forming the shelterbelt.
- As there is considerable reduction in the wind velocity on the leeward side of a shelterbelt, wind erosion is very much reduced.

Increase in agricultural and horticultural crops:

- Shelterbelts increase production of agricultural and horticultural crops.
- Study made in 8 cotton fields in distinctly semi-arid areas of U.S.A. revealed an increase of 17.4% in cotton yield when protection against hot winds was provided by shelterbelts.

- Similar increase in crop yields has been reported from Russia where a shelterbelt of 5 rows increased the oat yield by 25% to 28%.
- Protection of orchards by shelterbelt reduces wind damage and increases fruit yield.
- Studies revealed that even if 0.4 hectare out of 4 hectare orchard is devoted to creation of shelterbelt, the remaining protected 3.6 hectare of orchard yielded about 13.00% more than the unprotected 4 Hectare orchard.
- Similarly, the increase in fodder yield is reported to be as high as 300 - 400%.

Protection of damage to public and private property:

- The shelterbelts hold up the movement of shifting sand
- Save the roads and railway tracks from being covered and otherwise damaged by moving sand dunes.
- They prevent deposition of silt in canals and agricultural fields.

i) Windbreaks:

- Wind break is a protective planting around a garden, a farm or a field to protect it against strong winds.
- It usually consists of 2-3 rows of trees or shrubs, spaced at 0.5 m to 2.5 m apart, depending on the species.

Plate 3.6 Windbreak

j) Soil conservation hedges:

- In this system, the major groups of components are: multipurpose and/or fruit trees and common agricultural species.
- The primary role of multipurpose fruit trees and agricultural species is soil conservation and provision of various tree products.
- The following tree species are used for soil conservation: *Grevillea robusta, Acacia catechu, Pinus roxburghii, Acacia modesta, Prosopis juliflora, Alnus nepalensis, Leucaena leucocephala,* etc.

HORTISILVICULTURE

It is deliberately integration of horticultural trees with timber trees in order to harvest fruits and timber concurrently from single unit of land. Timber trees are planted on bunds of the orchards acts as windbreak thus protect orchard from high winds.

HORTISILVOPASTORAL

In this system various improved leguminous grasses are grown in orchard in order to provide forage to livestock. Trees are planted on the bunds of the orchards. These trees acts as windbreaks and protect horticulture plants from high wind; also provides multiple products.

