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Introduction

Till 1949-50, the land area in India was classified into five categories known as the five-fold land utilization classification.

These categories were:

- 1 forests
- 2 area not available for cultivation
- 3 other uncultivated land, excluding the current fallows
- 4 fallow land and
- 5 the net area sown.

Concept :

Agro forestry is an old concept. Trees crops and animals have traditionally been raised together on small farms throughout the world. This concept first died in the temperate zone due to the demise of the small 'family farm' norm as trees, crops and animal became separately managed on a large scale in modern agriculture and forestry. In India also we received this legacy from the Britishers who exploited our natural resources and adopted this sectoral policy. At present our major land-use classification comprises cultivated land, forest land, pasture land and wasteland. Of a reported area of 306 million hectares in India (Of a total area of 329 million hectares), 67.4 million hectares are forest land, 16.9 million hectares cultivatable waste land and 12.1 million hectares permanent pasture and other grazing lands. Most of the forest land is owned and managed by state forest department (SFDs). People have rights to these forest lands for grazing their animals and collecting fodder, fuel and timber as per prescribed rules and regulation. However, in all the land-use systems, the tree generally belongs to whomsoever owns the land.

Beginning in the 1960's India made massive investment in agriculture and achieved spectacular success in food production, as did most of the developing countries which undertook sectoral monoculture. Many traditionally food deficit countries have become self-sufficient and even food-surplus countries. Despite such a satisfactory global situation, scientists and planners are worried. For them, increasing the pace of food production to keep pace with the unabated population growth in the tropics and subtropics is still an unfinished task. Although most countries in the world are in the process of demographic transition, progress towards the final stage of this transition is lagging behind demographically in Africa, the Indian subcontinent, Latin America, the Middle East and South-East Asia. It is predicted between 1995 and 2050 the world population will increase by one billion. Ninety percent of this growth will occur in the developing countries. This tremendous increase will require at least 60 percent greater agriculture output than in 1995.



Concepts and scope in the present situation

[For Graphical Presentation...](#)

**Ag.
Technologies
(Agro
Forestry)**

Concept and Scope in present situation

Agro forestry is an old concept. Trees, Crops, and Animals have traditionally been raised together on small farms throughout the world. Agroforestry is a collective name for land use systems. Involving trees combined with crops and / or animals on the same unit of land. Further it

- | combines production of multiple output with protection of resource based,
- | places, emphasis on the use of multiple indigenous trees and shrubs,
- | is particularly suitable for low input conditions and fragile environments.
- | Involves the interplay of socio-cultural values more than in most other land use systems and
- | Is structurally and functionally more complex than monoculture.

Agro-Forestry is a relatively new name for the set of old practices. It has now become an accepted land use system. In an Agro-Forestry system there are both ecological and economical interactions between the various components.

The most acceptable definition of Agro-Forestry is

Agro-Forestry is any sustainable land use system that maintains an increases total yields by combining food crops (annuals) with tree crops (perennials) and/or live stock 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 the ecological conditions of the areas.

SCOPE:

The shrinking of land per capita, huge demand supply gap of various kind of woods, food products as well as fodders are making Agroforestry viable and alternative landuse option.

Agroforestry is a potential approach to minimize unsustainable with drawals from forest an instead promote production of fuel wood, fodder and timber in conjunction with Agricultural crops on non-forest land which provides vast scope.

Heavy fertilization coupled with high irrigation frequencies led to soil loss, nutrient loss and degradation of land whereas in forest cover, land upgradation is a continuous process, it restores soil and moisture

conservation and there is a gain from all angles. Taking good points, from forest and agriculture, agroforestry concept itself becomes a profitable professions.

Now clearly, 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.



Social Economical and environmental considerations

**Ag.
Technologies
(Agro
Forestry)**

Taking into account the social benefits like increase in crop and tree product and in the sustainability of these products, following social aspects are to be considered as it implies:

- i. Improvement in rural living standards from sustained employment and higher incomes
- ii. Improvement in nutrition and health due to increased quality and diversity of food outputs.
- iii. Stabilization and improvement of upland communities through elimination of the need to shift sites of farm activities.

Economical considerations:

Agroforestry systems on croplands, farmlands, bring significant economic benefits to the farmers, the community, the region or the nation. Such benefits may include

- a. Increment in maintenance in the outputs of food, fuel wood, fodder, fertilizer and timber.
- b. Reduction in incidence of total crop failure common to single cropping or monoculture systems.
- c. Increase in levels of farm incomes due to improved and sustain productivity.

Environmental considerations:

Combining trees with food crops on cropland farms provide certain important environmental benefits.

- i. Deduction 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 runoff, nutrient leaching and soil erosion through impeding effect of tree roots and stains on this processes.
- v. Improvement of micro -climate such as lowering of soil surface, temperature and reduction of evaporation of soil moisture through a combination of mulching and shading.
- vi. Increment in soil nutrients through addition and decomposition of litter foil.
- vii. Improvement of soil structure through the constant addition of organic matter from the decomposed litter.

It is clear from the above point that environment has major considerations in Agroforestry.



Selection of suitable trees for Wetland Agroforestry

Wetlands, including swamps and waterlogged soils, amount to several hectares in India. Long underutilized, they could be made productive by adopting various AF practices, such as aquaforestry etc.

[more info...](#)

Selection of trees for arid agro-forestry

The arid regions of India cover an area of 317,090 km² and lies a 24⁰-29⁰ latitude and 70⁰-76⁰ longitude. The region is spread over seven states, viz., Rajasthan, Gujarat, Punjab, Harayana, Maharashtra, Karanataka and Andhra Pradesh, the north-western part of the country constituting almost 90% of the total arid zone area.

[more info...](#)

Selection of Suitable Trees

Trees play the important and most dominant roles in Agroforestry systems. Basically, the trees ideal to be incorporated in various agroforestry systems are called the multipurpose tree spaces. (MPTs). The terms multipurpose (MPT) refers to all woody perennials that are purposefully grown so as to provide more than one significant to the production and/or service functions (shelter shade, land sustainability) of the landuse system they implement. Better emphasis is given which are indigenous in nature and have the capability to fix atmospheric nitrogen. Selection and management of MPT's lies the success of any agroforestry system. The nitrogen fixing tree species (NFT's) besides their `N' fixing ability provide protein rich foliage which can be used for fodder and green manuring. More than 640 tree species are known to fix nitrogen. Most trees used in agroforestry grow relatively quickly, whilst many also fix nitrogen i.e. many MPT's are fast growing nitrogen fixing tree species (FGNFT's). In addition , Nitrogen fixing trees have the following uses:

- i. The important genera are acacia, dalbargia, provide high quality timber,
- ii. Protein rich leaves and pods make many NFT's excellent forage for animal.

E.g. A. Senegal , L. leucocephala

- iii. Many NFT's provide excellent green manures, and add phosphorous and potash to the soil e.g. Sesbania grandiflora.
- iv. Many NFT's are planted for erosion control, for water shed protection, wind breaks, living fences, ornamentals and for production of timber products such as tannins, gums, and medicines.

While selecting Nitrogen fixing trees, following points must be considered:

1. Rapid growth rate
2. Nitrogen fixing ability]
3. Coppicing ability

4. Multiple utility
5. Ability to survive in any type of soil.
6. Easy to propagate.

In case of arid zones, the tree species are selected while considering following points:

- a. Deep root system to draw water from deeper soil profile.
- b. Leaf shading in summer to conserve moisture
- c. Water binding mechanism
- d. Other xerophytic characteristics like wax coating hairiness, sunken and covered stomata on leaves to minimize the loss of water through transpiration.
- e. The crop should have tolerance to salinity and saline water and alkalinity.

Following Tree and Grass Species are recommended for various desert regions:

Type of Region	Tree species
Shallow soils	Acacia tortilis, Azadirachta indica, Albizia lebbek, Zizyphus, mauritiana, Eucalyptus terminalis
Sandy plains	Acacia tortilis, Prosopis juliflora, Cassia siamea, Leucaena leucocephala
Sand stones rocky sides	Cassia auriculata, Acacia senegal, Boswellia serrata
Saline areas	Salvadora oleoides, Salvadora persica, Tamarix auriculata.
Shifting sand dunes	Acacia tortilis, Prosopis juliflora, Dichrostachys glomerata, Albizia lebbek



Better Use Of Wasteland

Ag. Technologies (Agro Forestry)

Introduction

Agroforestry is a collective name for land use systems involving trees combined with crops and/or animals on the same unit of land. It actually involves cycling of nutrients and flow of energy through various trophic levels interacting positively act higher ecological efficiency. From the early *taungya* systems to scattered trees on farm lands, agrisilviculture, silvipasture, agrihorticulture, hortipasture, energy farms, farm boundary planting, aquaforestry, home garden, slash and burn agriculture etc. are various forms of Agroforestry practised throughout India. Land for agriculture is a shrinking source because some land is being taken out of production all the time and diverted to uses such as roads, housing and industry, care for the soil is a priority tasks. Unscientific land use practices on such marginal soil lead to many problems notably soil erosion. A major part of soil erosion is deforestation over cutting for fuelwood, grazing arid and semi-arid regions, unknown suitable resource use system commercial greed and careless technologies are some of the important reasons for desertification which directly affects agriculture. These leads to having problems soils viz. Acidic soils, Saline and Alkaline soils, deforestation and unsuitable for crop cultivation.

Land use systems

Land use systems focussed on the cropping system and Agroforestry. Suitable location, specific crop production technologies having been developed for tillage, seeding, weed control, water and fertilizer application and crop management for enhanced productivity. Land use systems having been developed for desert areas involving suitable trees, grasses and legumes. Land degradation is the biggest challenge affecting healthy environment and reducing the basic live support systems. Agroforestry is being viewed as a restoration agent, rehabilitation process, bio remediation, and mechanism to high input agriculture on fragile lands.

Management systems

This systems involves the conscious and deliberate use of land for the concurrent production of agricultural crops including tree crops and forest crops

- **Improved Fallow Species in Shifting Cultivation**

The objective is to recover depleted soil nutrients. The best species for the fallow system should include good nitrogen fixation in soil. Plants included 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. This include direct seeding of clean tilled, harvested plots, selective cutting of bush, followed by enrichment planting with tall seedlings. Introducing tall seedlings and cuttings into poor quality fallow on degraded land e.g. *shorea robusta*, *Acacia catechu*, *Dalbergia sissoo*, *Anacardium occidentale* (Cashew), *Bombax ceiba*, *Santalum album*, *Acacia nilotica*, *Schima wallichii*, *Michelia doltsopa*, *Pterocarpus dalbergioides*, *Albizia lebbek*, etc.

Soil conservation hedges

To stabilize the structure and to make productive use of the land, in steeply slopping lands the risers or terraces are densely planted with trees, with multiple use for fruit, fodder and fuelwood. The following trees species are *Grevillea robusta*, *Acacia catechu*, *Pinus roxburghii*, *Acacia modesta*, *Prosopis juliflora*, *Alnus nepalensis*, *Leucaena leucocephala* etc. Fruit trees planted are ber, papaya dwarf mango, guava, citrus etc.

Management of arid and semi-arid lands

The region is spread over the Rajasthan, Gujarat, Punjab, Haryana, Maharashtra, Karnataka and Andhra Pradesh. These lands are characterized by hostile environmental conditions viz. Productivity potential of the land is low, soils are immature, structureless, coarse in texture and poor nutrient status with low water holding capacity. Correct selection of trees is of prime significance in this region for the development of Agroforestry. The trees should have following characters

1. Drought tolerance mechanism like deep root system, leaf shading in summer to conserve moisture, water binding mechanism and other like deep root system, leaf shading in summer to conserve moisture, water binding mechanism and other xerophytic characteristics.
2. Tree crops should have tolerance to salinity and saline water and alkalinity which are

common features are these areas. The following tree and grass species recommended for

various types of lands.

• Sandy soils

Acacia tortilis, *Prosopis cineraria*, *Albizia lebbek*, *Azadirachta indica*, *Leucaena leucocephala*, Grass species: *Cenchrus ciliaris*, *Cenchrus setigerus*.

• Shallow soils

Acacia tortilis, *Prosopis juliflora*, *Dichrostachys glomerata*, *Ailanthus excelsa*, *Zizyphus mauritiana*, grass species: *Cenchrus ciliaris*, *Dichanthium annulatum*, *Panicum antidotale* etc.

• Sandstone rocky sites

Albizia lebbek, *Boswellia serrata*, grasses: *Cenchrus ciliaris* and *Cenchrus setigerus*, *Acacia senegal*, *Cassia auriculata*

• Saline areas

Tamarix auriculata, *Prosopis juliflora*, *Prosopis tamarugo*, *Salvadora oleoides*, *Chenopodium*, Grass species: *Sporobolus*, species and *chloris* species.

• Shifting sand-dunes

Prosopis juliflora, *Prosopis cineraria*, *Acacia senegal*, *Albizia lebbek*, *Tamarix articulata*, *Cenchrus ciliaris*, *Sacharum munja*.



- **Horticultural fruit trees for arid areas**

Zizphus mauritiana, *Punica granatum*, *Psidium guajava*, *Phoenix dactylifera*, *Aegle marmelos*, *Annona squamosa*.

- **Agricultural crops for arid areas**

Pearl-millet, cowpea, sorghum, cluster bean, black gram, green gram.

- **Planting in arid areas**

At the beginning of the rainy season.

- **Trees for wetlands**

Salix babylonica (water willow), *Alnus cremastogyne* (long peduncled alder), *Alnus trabeculosa* (trabeculate alder), *Morus alba* (mulberry), *Taxpdoium distichum* (swamp cypress), *Taxodium scandens* (pond cypress)

Tree Cutting Production

Ag. Technologies (Agro Forestry)

Introduction

Agroforestry is a land management system that optimizes land productivity by harnessing positive interactions between tree-crop-live-stock system. Conservation of natural resources and optimization of productivity could be considered as vital to its functioning. Creating rural opportunities for value-addition of products and establishing mechanisms for efficient marketing is vital to agroforestry adoption, upgrade the planting materials, innovate planting management and utilization technologies and emphasis on multipurpose indigenous trees. The basic goal would be providing protection to the watershed, arresting further land degradation and enriching natural resources including the biodiversity. Besides these, it should aim at meeting the deficits of fodder, firewood and small timber requirement of the area. Most important multipurpose trees for meeting these demands have been identified, viz. Eucalyptus hybrid, Populus deltoides, Acacia spp., Dalbergia spp., Morus alba, Anthocephalus cadamba, Casuarina equisetifolia, Prosopis spp., bamboos, Grevillea robusta, Leucaena leucocephala etc. Agroforestry is to be promoted on 'wood catchment' basis to support a large number of wood/ pulp-based industries.

Benefits

• Food

1. Human food from trees (fruits, nuts, leaves, cereal substitutes etc.)
2. Livestock feed from trees (one step down the trophic chain)
3. Fertiliser trees for improving the nutritional status of food and feed crops through:
 - a. Nitrogen fixation,
 - b. access to greater volume of soil nutrients through deep rooting trees, and
 - c. improved availability of nutrients associated with higher cation exchange capacity and Organic matter levels.
4. Soil and water conservation.
5. Microclimate amelioration associated with properly designed arrangements of trees (e.g. shelter-belts, dispersed shade trees) in crop and grazing lands (indirect production benefits).

• Energy

1. Firewood for direct combustion.
2. Pyrolytic conversion products (charcoal, oil, gas).
3. Produces gas from wood or charcoal feedstocks.

4. Oils, latex, other combustible spas and resins.
5. Augmentation of wind power using appropriate arrangements of trees to create venturi effects wind power is proportional to the cube of wind velocity).

- **Shelter**

1. Building materials for shelter construction.
2. Shade trees for humans, livestock and shade-loving crops.
3. Wind-breaks and shelter-belts for protection of settlements, cropland and pastures.
4. Use as living fences.

- **Raw materials for processing**

1. Wood for a variety of craft purposes.
2. Fibre for weaving industries.
3. Fruits, nuts etc. for drying or other food-processing industries.
4. Tannins, essential oil, medicinal ingredients etc.

- **Cash**

1. Direct cash benefits from sale of above-listed products.
2. Indirect cash benefits from productivity increases (or input savings) via associated crops or livestock.

- **Social production**

1. Production of goods for socially motivated exchange (e.g. cattle for bride price, ceremonial foods etc.)
2. Increased cash for social purposes (ritual expenses, development levels, political contributions etc.)

Fodder purpose

For fodder purpose following trees are used: *Acacia aneura*, *A.auriculiformis*, *Albizia amara*, *chinensis*, *falcataria*, *lebbek*, *lucida*, *procera*, *Bambusa arundinacea*, *nutans*, *vulgaris*, *Bauhinia racemosa*, *variegata*, *Bombax malabariucm*, *Cajanus cajan*, *Calliandra calothyrsus*, *Cassia auriculata*, *fistula*, *Ceiba petendra*, *Cordia dichotoma*, *Cordia dichotoma*, *Erythrina fusca*, *indica*, *variegata*, *Eucalyptus camandulensis*, *Gliricidia sepium*, *Morus alba*, *serrata*, *Phoenix dactylifera*, *P.juliflora*, *Pterocarpus dalbergioides*, *Pyrus communis*, *Ricinus communis*, *Sesbania aculeata*, *Theobroma cocoa*, *Z.nummularia*



- **Fuel**

For fuel purpose following trees are used: *Achras zapota*, *Ailanthus excelsa*, *grandis*, *integrifolia*, *Balanites aegyptiaca*, *Borassus flabelifer*, *Capparis decidua*, *Casuarina equisetifolia*, *Flemingia macrophylla*, *Grevillea robusta*, *Pithecellobium dulce*, *Quercus spp.*, *Pterocarpus dalbergioides*

- **Food**

For food purpose following trees are used: *Annona squamosa*, *muricata*, *Areca catechu*, *triandra*, *Cinnamomum zeylanicum*, *Embllica officinalis*, *Litchi chinensis*, *Mangifera indica*, *Salvadora oleoides*, *persica*, *Tamarindus indica*, *Zizyphus mauritiana*

- **Industrial uses**

For industrial use following trees are used: *Anacardium occidentale*, *Avicennia marina*, *officinalis*, *Borassus flabelifer*, *Ceiba pentandra*, *Coffee arabica*, *cenephora*, *Diospyros melaxylon*, *Ercalyptus camandulensis*, *Melia azedarach*, *Syzygium aromaticum*

- **Timber**

For timber purpose following trees are used: *Thespesia populnea*, *Tectona grandis*, *Santalum album*, *Robinia pseudoacacia*, *Prunus armeniaca*, *cerasoides*, *domestica*, *persica*, *Manilkara littorails*, *Madhuca indica*, *Hardwicikia bipinnata*, *Grewia elastica*, *Dalbergia sissoo*, *Cocos nucifera*, *Calliandra calothyrsus*, *Barringtonia acutangula*, *racemosa*, *artocarpus altilis*, *heterophyllus*, *lakoocha*, *Anogeissus latifolia*, *Planifrons*, *senegal*, *tortilis*

Returns and B.C. Ratio

Ag. Technologies (Agro Forestry)

Introduction

Economic evaluations are important in diagnosis and design of AF technologies, working out cost: benefit ratios and for rationalisation of choice of technologies to be researched or disseminated for development. To understand the role of economic consideration in selecting an AF system and its modification, some of the existing AF systems, such as home gardens and wood lots can be examined, which are deeply rooted in the past.

Cost/Benefits analysis

Whenever input/output data are available, computations may be made to evaluate proposed/existing systems. Optimization requires a large amount of data, presently lacking in AF technologies, and hence the non-optimal method, better known as cost: benefit analysis is used.

Inputs, sometimes called resources, are goods or services used to produce an output. The main categories are land, labour and capital, which include buildings, equipment, livestock, seeds, fertilisers, chemicals etc.

Outputs can be defined as goods or services produced by an activity. The main categories are land, labour and capital, which include buildings, equipment, livestock, seeds, fertilisers, chemicals etc. Major goods are crop, livestock products, firewood and timber. Usually the smallest scale of analysis is the farm or a farm activity and the largest the nation as a whole. In a public economic analysis, inputs are valued at their opportunity cost/value to society as a whole, usually referred to as shadow price. In a private economic analysis, inputs are valued depending in whether they are purchased or withdrawn from alternative uses on-or off-farm. A special case are inputs provided by the government of community.

Land

In a private economic analysis, a distinction should be made as to whether new land has been obtained for the introduction of AF component or a change been affected in a present land resource. In the first case, land is costed at its purchase price, or, if the rented, the annual rent may be incorporated as an operating cost. In the second case, the cost will depend on its productivity in its existing use. The most common way of dealing with land cost if there is a change in existing land use is to include it in the combined opportunity value to family resources in the non-agroforestry use. In a public economic analysis, the shadow price of land is usually the same as the opportunity cost of land in a private analysis.

Labour

In a private economic analysis, all hired labour is valued at its market price, while all family labour is valued at its opportunity cost, which differs depending on length of time required, the type of labour. The hired labour wage rate as an approximation of opportunity cost, increasing the price by 25% under the peak season and decreasing it by 25% under off-season conditions. In a public economic analysis, the shadow price of labour in most analyses is based on the opportunity cost, increasing the price by 25%

under the peak season and decreasing it by 25% under off-season conditions. In a public economic analysis, the shadow price of labour in most analyses is based on the opportunity cost principle.

Valuation of outputs

Outputs are valued at the market price or opportunity cost in a private economic analysis and at shadow prices in a public economic analysis.

- **Fuel wood**

In a private economic analysis, fuelwood is valued at the local market price if commonly sold and/or purchased by the farmers concerned. The price to be used should be the net of the cost of labour for collecting it and transport cost. In a public economic analysis, all market and opportunity prices should again be adjusted to reflect the true economic value to society as a whole. Also, in considering substituting existing fuels, the choice for society as a whole may be wider than in private economic analysis.

- **Tree fodder**

In a private economic analysis, tree leaves may be valued at market price if they can be sold locally. However, if leaves are not sold, they can be evaluated on the basic energy or protein value. A public economic analysis requires adjustment of market and opportunity prices, subsidies and taxes.

- **Leaf litter**

Leaf litter from trees and shrubs may be used to add nutrients and organic matter to the soil. The market price may be derived, however, on the basis of nutrient content and prices of commercially available fertilisers (organic/inorganic). It can also be valued through the agricultural production system.

- **Environmental outputs**

AF technologies with environmental output are tree-based soil and water conservation measures, soil improvement through nitrogen fixing trees, wind protection through shelter belts and preservation of forest areas or woodlands. The valuation of environmental outputs may be handled

1. Difference in output stream of the production system affected by the environmental activity.
2. Cost of preventing/reducing the damage done to the environment due to the lack of an environment due to the lack of an environmental activity;
3. Purchase price of the land affected by the environmental activity.

- **Distribution of costs and benefits**

This raises an important issue with regard to the distribution of costs when viewing such an environmental activity from a community of costs when viewing such an environmental activity from a community or public viewpoint.



The general principle underlying contributing to the inputs required for the environmental activity which, in a community could be through taxation and subsidies. The amount of tax funds utilised should not exceed the off-site benefits obtained from the environmental activity. Subsidizing the environmental activity on individual farms may be done through reduction of the cost of seedlings or direct subsidies based on work completed.

In agroforestry, such project outputs include timber, fuelwood, fodder, and fertiliser and food crops. The by-products or residuals from an AF project may be positive or negative. Positive by products includes reduced erosion, improved water-retention capacity of the soil and reduced leaching. Negative by products could include aggressive seedling and plant spread of fast-growing trees or shading of food crops. AF should be designed to have positive effects. Recognize the potential for personal economic benefits from a new or changed system such as AF before they will accept it. For this reason, factors that influence their decision-making, such as credit, size of holding land tenure and discount or interest rates, must be considered explicitly. Any plan, to be accepted by farmers, will have to be both persuasive and beneficial to each of them, as well as capable of achieving a desired long-run cumulative result.

Profitability Comparison

Ag. Technologies (Agro Forestry)

Introduction

It is precisely these system/technologies which have to be put to the test to prove their usefulness from an economic consideration. Economic evaluations are important in diagnosis and design of Agroforestry technologies, working out cost: benefit ratios and for rationalization of choice of technologies to be researched or disseminated for development. To understand the role of economic consideration in selecting an Agroforestry system and its modification, some of the existing Agroforestry systems, such as home gardens and wood lots can be examined, which are deeply rooted in the past.

Benefits

- i. Maintains or increases site productivity through nutrient recycling and soil protection, at low capital and labour costs.
- ii. Increases the value of output on a given area of land through spatial or intertemporal intercropping of tree and other species.
- iii. Spreads the need for labour inputs more evenly seasonally, thereby reducing the effects of sharp peaks and troughs in activity characteristics of tropical agriculture.
- iv. Provides productive applications for under utilised land, labour or capital.
- v. Creates capital stock available to meet intermittent costs or unforeseen contingencies.

Costs and Constraints

- i. Reduces output of staple food crops wherever trees compete for use of arable land and/or depress crop yields through shade, root competition of allelopathic interactions.
- ii. Incompatibility of trees with agricultural practices such as free grazing, burning, common fields, etc. which make it difficult to protect trees.
- iii. Trees can impede cultivation of monocrops and introduction of mechanization and so (a) increase labour costs in situations wherein the latter is appropriate and/or (b) inhibit advances in farming systems.
- iv. Wherever the planting season is very restricted e.g. in arid and semi-arid conditions, demand on available labour for crop production may prevent tree planting.
- v. Relatively long production period of trees delays returns beyond what may be tenable for poor farmers and increases the risks to them associated with.

Adoption of Agroforestry practices

- i. To maintain productivity of land in situations of scarce capital, the presence of trees would assist as a substitute for purchased inputs of fertilizer and herbicide and for investments in soil and crop protection.
- ii. To augment productive use of land in situations of scarce capital and labour, trees, as low-input, low-management crops, would constitute

the most effective use of these resources.

- iii. To increase usable biomass per unit of land area in situations where land and capital are limited and tree/crop/livestock combinations permit fuller use of available labour, then alternative uses of land.
- iv. To increase income-earning opportunities from use of farm resources as size of landholding and/or site productivity fall below the level at which the household; basic needs can be met from on-farm production.
- v. To strengthen risk management through diversification of outputs, wider seasonal spreads of inputs and outputs, and build-up of tree stocks which could be sold to meet periodic or unforeseen needs for capital.



Beneficial Effect on Soil, Environment, Water Conservation

Ag. Technologies (Agro Forestry)

Beneficial Effect on Soil

Soil is one of the most important natural resources to suffer as a result of trees cutting. Obviously all agroforestry systems have effects and influences upon the soil. Agroforestry technologies that have potential applicability to improve soil fertility, soil conservation, soil physical properties, and use of shelter belts and wind breaks.

1. Plantation of compatible and desirable species of woody perennials on farmland results in an improvement in soil fertility.
 - a. Increase in the organic matter content of the soil through the addition of leaf litter and other plant parts;
 - b. More efficient nutrient cycling within the system and consequently more efficient utilization of nutrients that are either inherently present in the soil or externally applied;
 - c. Increase in the plant cycling fraction of nutrients, with a resultant reduction in the loss of nutrients beyond the nutrient-absorbing zone of the soil;
 - d. Enhanced nutrient economy because of different nutrient absorbing zones of the root systems of the component species.
2. Inclusion of trees and woody perennials on farmlands can, in the long run, result in marked improvements in the physical conditions of the soil in permeability water-holding capacity, aggregate stability and soil temperature regimes. Although these improvements may be slow, their net effect is a better soil medium for plant growth.
3. The role of trees in soil conservation and erosion control is one of the most widely acclaimed and compelling reasons for including trees of farmlands prone to erosion hazards. The beneficial effects of trees in this regard extend beyond protecting the immediate farmland under consideration, to impart stability to the ecosystem and reducing the rate of siltation of downstream aquatic ecosystem, dams and reservoirs.

Beneficial Effect on Environment

Combining trees with food crops on cropland farms yield certain important environmental benefits include:

- 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 soils surface temperature and reduction of evaporation of soil moisture through a

combination of mulching and shading. Increment in soil nutrients through addition and decomposition of litter-fall.

- vi. Improvement of soil structure through the constant addition of organic matter from decomposed litter.

Beneficial Effect on Water Conservation

1. Improvement of soil moisture-retention in rain-fed cropping systems and pastures through improved soil structure and microclimatic effects of trees.
2. Regulation of stream flow for reduction of flood hazard and more even supply of water, through reduction of run-off and improvement of interception and storage in infiltration galleries, through various watershed protection practices involving trees.
3. Improvement of drainage from water logged or saline soils by phreatophytic trees.
4. Increased biomass storage of water for animal consumption in forage and fodder trees (higher water content of tree fodder in dry season).



Beneficial Effect on Soil, Environment, Water Conservation

Ag. Technologies (Agro Forestry)

Beneficial Effect on Soil

Soil is one of the most important natural resources to suffer as a result of trees cutting. Obviously all agroforestry systems have effects and influences upon the soil. Agroforestry technologies that have potential applicability to improve soil fertility, soil conservation, soil physical properties, and use of shelter belts and wind breaks.

1. Plantation of compatible and desirable species of woody perennials on farmland results in an improvement in soil fertility.
 - a. Increase in the organic matter content of the soil through the addition of leaf litter and other plant parts;
 - b. More efficient nutrient cycling within the system and consequently more efficient utilization of nutrients that are either inherently present in the soil or externally applied;
 - c. Increase in the plant cycling fraction of nutrients, with a resultant reduction in the loss of nutrients beyond the nutrient-absorbing zone of the soil;
 - d. Enhanced nutrient economy because of different nutrient absorbing zones of the root systems of the component species.
2. Inclusion of trees and woody perennials on farmlands can, in the long run, result in marked improvements in the physical conditions of the soil in permeability water-holding capacity, aggregate stability and soil temperature regimes. Although these improvements may be slow, their net effect is a better soil medium for plant growth.
3. The role of trees in soil conservation and erosion control is one of the most widely acclaimed and compelling reasons for including trees of farmlands prone to erosion hazards. The beneficial effects of trees in this regard extend beyond protecting the immediate farmland under consideration, to impart stability to the ecosystem and reducing the rate of siltation of downstream aquatic ecosystem, dams and reservoirs.

Beneficial Effect on Environment

Combining trees with food crops on cropland farms yield certain important environmental benefits include:

- 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 soils surface temperature and reduction of evaporation of soil moisture through a

combination of mulching and shading. Increment in soil nutrients through addition and decomposition of litter-fall.

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Beneficial Effect on Water Conservation

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Product Utility

Ag. Technologies (Agro Forestry)

Introduction

Agroforestry is a land management that optimizes land productivity by harnessing positive interactions between tree-crop-live-stock system. Conservation of natural resources and optimization of productivity could be considered as vital to its function. Agroforestry system that is trees product has following benefits-

- **Shelter**

1. Building materials for shelter construction.
2. Shade trees for humans, livestock and shade-loving crops.
3. Wind-breaks and shelter-belts for protection of settlements, cropland and pastures.
4. Living fences.

- **Raw Materials For Processing**

1. Wood for a variety of craft purposes.
2. Fibre for weaving industries.
3. Fruits, nuts etc.for drying or other food-processing industries.
4. Tannins, essential oil, medicinal ingredients etc.

- **Fodder trees**

Integration of some of the important fodder trees with agriculture crops could play an important role in meeting the fodder requirements of animals; thereby production would go up and the working efficiency of the farm animals would improve. There are several forest trees which could be integrated with agricultural crops to fulfil the fodder needs the common existing fodder trees e.g. *Acacia auriculiformis*, *Acacia senegal*, *Achras sapota*, *Albizia lebbek*, *Cordia myxa*, *Bombax ceiba*, *Prosopis cineraria*, *Leucaena leucocephala*, *Morus indica*, *Prosopis cineraria*.

- **Fuel woods**

Fuelwood is the most significant reason for tree cutting. To save forests from denudation, fuelwood tree-growing should become part of agriculture through agroforestry e.g. from *Acacia auriculiformis*, *Acacia leucophloea*, *Albizia lebbek*, *Anthocephalus cadamba*, *Cassia siamea*, *Diospyros malaxylon*, *Lannea coromandelica*, *Populus euphratica*, *Schleichera oleosa*, *Tectona grandis*.

- **Cash**

1. Direct cash benefits from sale of above-listed products.

2. Indirect cash benefits from productivity increases (or input savings) via associated crops or livestock.



Forest Based Industries

Ag. Technologies (Agro Forestry)

Introduction

Agroforestry is a potential approach to minimize unsustainable withdrawals from forests and instead promote production of fuelwood, fodder and timber in conjunction with agricultural crops on non-forests land. Highly adopted trees species have been identified for each agro ecozone to encourage high productivity and diversify the products for use. Agroforestry is to be promoted on wood catchment basis to support a large number of wood/pulp based industries. Following are the major agroforestry systems, which are economically beneficial.

Some Important Agroforestry System

The poplar based agroforestry system as proved more profitable over the most intensive cropping systems of rice-wheat in the northern region. Poplars are an excellent source of fibres for various grades of paper, fine paper, and packing papers and newsprint paper. Poplar wood is used for making match splints, plywood, sports goods, toy, pencil-making, packing cases and crate-making.

Teak is one of the most popular and highly valued timber trees. Attracted by the economic advantages of teak culture, many private companies in India had ventured into establishing commercial plantations of teak. Teak tree is graded in India as first, second, third, fourth and fifth quality as per the girth and height attained at maturity (50-60 years). The market price of timber reduces progressively from the bottom to the top end of the tree. The crown and branch wood of trees is sold at about Rs. 1,000 per m³ as fuel wood. The average price of the timber obtained for the entire tree can, therefore, be only about 20% of the highest price obtained, for the best quality of timber.

Bamboo extensively traded throughout the country a good quality bamboo of about 6-meter length and 18 cm girth sales for about Rs.30. In the northeastern states bamboo's are abundant commercial uses of bamboo are Bamboo parquet (Block Flooring), laminated bamboo, bamboo reinforced concrete, artificially shape bamboo viz. handicrafts, decoration items and cottage industries, and medicine. Also bamboo charcoal in electric batteries. It is used in deodorizing fish oil in Asian Countries.

Sandalwood yields maximum heartwood with a good amount of sandal wood oil. The sandal wood oil is in great demand all over the world for its use in perfumery products. Sandalwood is also in demand for use in perfumery products. Sandalwood is also in demand for use in wood carvings. Sandalwood fetches a very high price, 1 kg of sandalwood fetches an astronomical price of Rs. 1000 in the market. Apart from these agroforestry system the most important multipurpose trees are viz. *Populus deltoides*, *Acacia spp.*, *Dalbergia spp.*, *Morus alba*, *Anthocephalus cadamba*, *Casuarina equisetifolia*, *Prosopis spp.*, *Bamboos*, *Grevillea robusta*, *Leucaena leucocephala* etc.

Trees in agroforestry systems are used for making agricultural implements, furniture, bark yields gum/tannin, softwood, mats, and thatches, turpentine and for oil purpose. The tree species in agroforestry can be used for sericulture and apiculture also. Thus tree species in agroforestry systems are

useful for many forest-based industries.



Employment Generation

Ag. Technologies (Agro Forestry)

Introduction

Agroforestry is a land management system that optimizes land productivity by harnessing positive interactions between tree-crop-livestock system. All agroforestry systems have evolved as livelihood systems. Their variations could be seen in form of small farmer's home gardens to large farmers commercial agrisilvicultural or agrihorticultural systems.

Landless and Marginal Farmers

Landless labourer also earns his daily wages and livelihood. Meeting the basic need of biomass for forage and firewood is most important activity in such a system. Availability of more diversified on-farm employment, wood and NWFP based small industry, rural handicrafts. Creating rural opportunities for value addition of products and establishing mechanisms for efficient marketing product diversification, viz. bamboo matboards, panels, medicinal plant products etc. need to be created at village level to attract higher prices for the products. The increased availability of timber and pulpwood will help in reducing the annual import demands, which is currently estimated at Rs 60,000 million.