Lec.11 ROLE OF TREES IN SOIL FERTILITY
ECONOMICS OF AGROFORESTRY

ROLE OF TREES IN SOIL FERTILITY

Soil is one of the most important natural resources to suffer as a result of tree cutting. If it is not protected, its productivity declines and it may become difficult to sustain the human and animal population even at its present level. Therefore, protection of this resource is important and an understanding of how this resource is influenced in an agroforestry system is necessary.

Tree Root Patterns

It is generally assumed that trees have deep and spreading roots and hence are capable of exploiting more soil volume and taking up nutrients and water from deeper layer not usually contacted by herbaceous crops. This process of taking up nutrients from deeper soil profiles and eventually depositing at least some portion of them on the surface layers through litter-fall and other mechanisms is referred to as **'nutrient pumping'** by trees. It is well known that the development of plants depends on site characters and environmental factors. Many woody species have the largest number of roots and the majority of the fine roots are located in the uppermost fertile portion of the soil profile. Some tree species are shallow rooted. *Prosopis chilensis* has a shallow and spreading root system whereas *P. juliflora,* is known to have a very deep root system.

Role of trees in soil fertility

a) **Organic matter and nutrient addition to the soil**

Tree species contain large quantities of 'living' biomass .About 20 to 25 per cent of the total living biomass of the trees is in roots and there is a constant addition of organic matter to the soil through dead and decaying roots. The major addition of organic matter and other nutrients to the soil from the trees standing on it is through **litter fall** ie., dead and falling leaves, twigs, branches, fruits etc.

b) Dinitrogen fixation by trees

There is a possibility for improvement of the fertility status of agricultural lands' through additional amounts of nitrogen added to the soil by the tree legume component. **Mimosoideae** and **Fabaceae** are well known to fix nitrogen.Therefore, among the various avenues of addition of nitrogen to a soil through natural and biological means, the most significant one brought

about by the presence of trees on agricultural lands could be nitrogen fixation by leguminous trees. For example, *Leucaena leucocepha/a* grown for forage for 9 months yields about 12,600 kg forage, 3,600 kg protein and 575 kg nitrogen per ha.

c) Nutrient cycling

The nutrient cycling model consists of the soil-plant system that is partitioned into several compartments. The crown surface forms the boundary of the system where input of bioelements occurs through precipitation. The soil surface is the entry point for inputs into the soil compartment, occurring through fertilizers, rainfall and stem flow. The surface layer may be considered the zone of intensive root activity, with the subsoil constituting the extensive root activity zone. The lower end of the extensive root layer is the boundary 'of the ecosystem to the hydrosphere and lithosphere. Bioelements transported beyond this layer are lost from the ecosystem and appear as output from the system.

ECONOMIC ANALYSIS OF AGROFORESTRY SYSTEM

A) Analysis at different times

1. Ex ante economic analysis
2. Ex post economic analysis

Ex ante economic analysis

The main aim of Ex ante economic analysis of a potential agroforestry system is to give the various interested parties some idea of whether a system that is technically feasible is economically viable and if so, whether it has a chance of meeting specified objectives. It may also help to prioritize the various technology options available and/ or guide scientists to formulate or propose other technologies.

Ex post economic analysis

The main aim of the ex post economic analysis of an agroforestry system that is already on the ground is to determine whether a such system should be readjusted so as to better meet the objectives . Such an analysis would also indicate the areas for adjustments.

B) Analysis from different view points

1. Private economic analysis

2. Public economic analysis

Private economic analysis

Private economic analysis is referred to as **Financial analysis**. In private economic analysis , the objectives of the individual or group are taken in to account. This is reflected in the inputs and outputs to be considered as well as the values given to them. Common objectives for individuals are to obtain higher levels of income and leisure time as well as the avoidance of risk that results from widely fluctuating income and consumption.

Public economic analysis

Public economic analysis referred as **Economic analysis** and that it takes into consideration costs and benefits outside the farm or area where the system is present.

C) Evaluation criteria (Tools used to economic analysis)

a) Benefit Cost Ratio

b)Net Present Value

c)Internal Rate of Return

a) Benefit Cost Ratio:

B:C ratio = Total discounted Benefits/Total discounted Costs

$$\text{B:C ratio} = [\sum^{n} (B_t) / (1+r)^t] / [\sum^{n} (C_t) / (1+r)^t]$$

Where 'B' are the benefits accruing in year 't'

'C' are the costs accruing in year 't'

'r' is the selected discount rate

The BCR should be greater than one for agroforestry , then only it can be considered worthy

b)Net Present Value :

The net present value of AF system is obtained by present worth of costs from the present worth of benefits. The NPV should be positive .

$$NPV = \sum (B_t - C_t) (1+r)^t$$

Where ‘B’ is the benefit in a year ‘t’

‘C’ is the costs in a year ‘t’

‘r’ is the selected discount rate

c)Internal Rate of Return:

IRR calculates the maximum rate of interest that a project can repay on loans while still recovering all investment and operating costs. The IRR determines the earning power of the money invested in a particular venture.

$$IRR = \text{Lower discount Rate} + \text{Diff .between the discount rates} \times \frac{\text{Present worth of incremental net benefit stream at the lower discount ate}}{\text{Sum of the Present worth of incremental Net benefit stream of both discount rates}}$$

Types of Economic Analysis

1. **Labour input analysis:** showing the flow of labour inputs required for the introduction and maintenance of an agroforestry technology .
2. **Material input analysis:** showing the flow of material inputs required for the introduction and maintenance of an agroforestry system
3. **Cash flow analysis :** showing the flow of cash expenditures and receipts results from the introduction and maintenance of an agroforestry technology. Such an analysis should include loans and repayments when applicable.

4. **Discounted cost / benefit analysis :** determining the profitability of the agroforestry system.

Data requirements for Analysis of Agroforestry systems

1. **Inputs : Quantitative Aspects**

   Inputs are called as **resources or production factors** or goods and services used to produce an output. The main inputs are land, labour and capital which includes buildings, equipment , livestock, seeds and fertilizers.

   a) **Land** should be specified in hectares, tenure status, productive capacity and how it is used over time.

   b) **Labour input** is expressed in work days or hours by type, activity , and timing during and over the years.

   c) **Capital inputs** are specified in weight, volume, or numbers by type

   (planting material, fertilizres, agricultural chemicals , water, tools , fodder, equipments, , etc., and source (farm produced , purchased or hired) .

2. **Outputs : Quantitative Aspects**

   Outputs are goods or services produced by the an activity . Major goods are crops and livestock products, wood fuel, timber. Service outputs are live fence , soil conservation works, nitrogen fixation , etc. The outputs need to be specified in terms of units such as volume, weight, numbers, quality and timing.

D) Valuation of Inputs

In a financial analysis, inputs are valued at their market price or at their opportunity cost to the individual concerned. In principle, market prices are applied when inputs are commonly purchased or hired by the individual. Opportunity costs are used where most of the inputs are provided by the farm family.

In a public analysis, the shadow price of the input , representing the true economic worth to society as a whole, has to be used.

a) Land:

When a farmer wants to change the existing land use to an agroforestry land use , there is no need to value such land. If a farmer has to purchase or rent a land to introduce an agroforestry system, such purchase or rental price has to be entered into the financial analysis.

b) Labour :

In financial analysis, all labour hired is valued at its market price while all family labour is valued at its opportunity cost.

c)Capital:

In a financial analysis all purchased materials , equipments are valued at their market price.

E) Valuation of outputs

Similar to the inputs valuation, outputs are valued at the market price or opportunity cost in a private economic analysis and at shadow price in a public economic analysis.

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

Fuel Wood : In a private economic analysis, fuel wood is valued at the local market price if commonly sold *and*/or purchased by the farmers concerned. To value the standing volume of fuel wood, the price to be used should be the net of the cost of labour for collecting it and transport cost. If neither is the case, fuelwood is valued either in terms of alternative fuels used by the farmers or in terms of labour savings made. A frequently used alternative fuel source is kerosene and sometimes dried cattle dung.

Tree Fodder: Tree leaves and pods have increasingly been recognized as potential sources of animal fodder, especially in arid and semi-arid conditions. However, we have no data on the production of tree fodder and its valuation. 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.

Deriving the shadow price of tree fodder for 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. So far, there are no recorded Instances of leaf litter being sold commercially. The

market price may be derived, however, on the basis of nutrient content and prices of commercially available fertilizers.

Environmental Outputs

i) Preservation of productive capacity of a resource

ii) Improvement of the productive capacity of a resource

iii) Preservation /Improvement of the productive capacity of a resource

Examples of AF technologies with environmental output are tree based soil and water conservation measures , soil improvement through nitrogen fixing trees, wind protection through shelterbelts and preservation of forest areas or woodlands

In a private economic analysis of environmental benefit, only those points are considered which directly benefit the farmers but in a public economics analysis, all benefits are considered albeit they do not benefit the creator.

The valuation of environmental outputs may be handled in different ways

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 environmental activity
3. Purchase price of the land affected by the environmental activity.