CHAPTER I

INTRODUCTION

Agroforestry 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 animals 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, pastureland and wasteland. Of a reported area of 306 million ha in India (of a total area of 329 million ha), 67.4 million ha are forest land, 16.9 million ha cultivable wasteland and 12.1 million ha permanent pasture and other grazing lands. Most of the forest land is owned and managed by state forest departments (SFDs). People have rights to these forest lands for grazing their animals and collecting fodder, fuel and timber as per prescribed rules and regulations. However, in all the land-use systems, the tree generally belongs to whomsoever owns the land.

Beginning in the 1960s, India made massive investments 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 that between 1990 and 2000 the world population will increase by one billion. Ninety per cent of this growth will occur in the developing countries. This tremendous increase will require at least 60 per cent greater agricultural output than in 1990. What then should be the appropriate strategy for increasing food production?

It is sufficiently clear today that any increase in food production has to come primarily from raising the productivity of existing agricultural land rather

than by bringing more area under agriculture. In fact, a large portion of currently tilled marginal area will have to be phased out of agriculture for economical and ecological reasons. Land for agriculture is a shrinking resource. 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 task.

The carrying capacity of land in many developing countries is over-stretched. According to a recent FAO study, 54 of 117 developing countries did not have sufficient land resources to meet the food requirement of their 1975 populations at a low level of input use. At the same level of input, the number of such countries will become 64 in 2000 A.D. and the population in excess of land potential carrying capacity may be over 500 million. Even if the level of inputs is raised to an intermediate level, 36 countries will still be in a critical situation with 141 million people above the carrying capacity of the land. The rising population of humans and animals, with their ever-expanding food, fodder and fuel needs, exerts great pressure on the stabilising elements of agroecosystems. As productive land becomes scarce, marginal farmers are pushed into fragile croplands and forest lands unsuitable for modern agriculture. If the present trend of population growth persists, pasture and forest lands will be further reduced.

Unscientific land-use practices on such marginal soils lead to many problems, notably soil erosion. According to one estimate, if soil erosion is continued at its 1983 rate, loss in rain-fed cropland in the developing world will range from 9.7 per cent to 35.6 per cent, leading to an overall 28.9 per cent reduction in crop production by the year 2000 A.D. (Table 1.1).

Table 1.1: Projected effects of unchecked soil erosion on productivity (1983–2000)

	Africa	*South-west Asia*	*South-east Asia*	*South America*	*Central America*	*Global (av.) %*
Decrease in area of rain-fed cropland (%)	16.5	20.0	35.6	9.7	29.7	17.7
Decrease in rain-fed crop productivity (%)	29.4	35.1	38.6	22.6	44.5	28.9

A major cause of soil erosion is deforestation. A gap exists between rate of deforestation and tree plantation in the tropics (Table 1.2). The World Resource Institute has estimated that 160 million ha of upland watershed in the Himalayas and Andean range and in the Central American, Ethiopian and Chinese highlands have been seriously degraded due to human activities (WRI, 1985). Cherapunji, once the wettest area in the world covered with dense tropical vegetation, is now almost devoid of vegetation. Overcutting for

fuelwood, overgrazing in arid and semi-arid regions, a non-sustainable resource-use system, commercial greed and careless technology are some of the important reasons for desertification, which directly affects agriculture. Extensive deforestation results in raised river-beds, reducing their carrying capacity and consequently their irrigation capacity and concomitantly leads to widespread floods. The National Commission on Floods in India has projected that an irrigation potential of almost 60,000 ha may be lost every year due to this situation.

Table 1.2: Annual deforestation and plantation projections for the tropics

Region	*Annual rate of deforestation (ha × 10^3)*	*Annual rate of plantation (ha × 10^3)*	*Plantation degradation ratio*
Tropical America (23 countries)	5611	535	1:10.5
Tropical Africa (37 countries)	3676	126	1:26
Tropical Asia (16 countries)	2016	438	1:4.5

Source: FAO, 1982

Shifting cultivation and cutting of trees for fuelwood are the major causes of deforestation. If the gap between tree plantation and deforestation continues to be same, then the fuelwood crisis will become more severe. It has been projected that to meet the fuelwood requirement in 2000 A.D. we shall have to plant 3 million ha annually.

The global forests are vast storehouses or sinks for carbon. Worldwide loss of forest cover, by releasing this vast stockpile of carbon into the atmosphere as CO_2 creates the greenhouse effect. As a consequence of destruction of 10 million ha of forest cover, about 2000 to 10,000 million tons of CO_2 is released in the atmosphere annually resulting in an elevated terrestrial temperature. This produces a greenhouse effect with incredulous consequences, such as rise in sea level, resulting in inundation of the coastal area and accelerating erosion of the seashore, creation of salinity, shifting of population, and increased susceptibility to coastal storms; creation of new coastal lines; shift in productivity, reduced water level in great lakes, reduced rainfall in arid regions, change in power equation etc. It is therefore necessary to put a stop to this destructive phenomenon.

It is at this stage that tree growing assumes great significance and it should become a people's programme. This seems feasible only when tree-growing is combined with the single most important land-use system, namely, agriculture. It is against this background that 'agroforestry' should become an important land-use system so that we not only meet the food and wood

requirement of the people, but protect this good earth from environmental hazards.

Concept of Agroforestry

Agroforestry is not something new. What is new is the science of agroforestry; the art is old, indeed very old. Farmers, especially those in the tropics, have a long tradition of raising food crops, trees and animals together, as well as exploiting a multiple range of production from natural wood lots. But foresters and agriculturists, who have traditionally operated within rather rigid disciplinary boundaries concentrating on monocultural production of their preferred commodities of crops, animals and trees used to ignore such combined integrated production systems.

— 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 outputs with protection of resource base;
— 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 sociocultural values more than in most other land-use systems; and
— is structurally and functionally more complex than monoculture.

Definitions

Agroforestry is a relatively new name for a set of old practices. The people have used different definitions and even some imaginative and fanciful illustrations to describe agroforestry. However, it has now become an accepted land-use system and the most acceptable definition is:

> 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.
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> Or
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> 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.

This definition implies that:

1. Agroforestry normally involves two or more species of plants (plants or animals), at least one of which is a woody perennial;
2. An agroforestry system always has two or more outputs;
3. The cycle of an agroforestry system is always more than one year; and
4. Even the most simple agroforestry system is more complex ecologically (structurally and functionally) and economically than a monocropping system.

Benefits from Agroforestry

Environmental Benefits

Combining trees with food crops on cropland farms yield certain important environmental benefits, both general ecological benefits and specific on-site benefits. The general ecological 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 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-fall.
(vii) Improvement of soil structure through the constant addition of organic matter from decomposed litter.

Economic Benefits

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

(i) Increment in an maintenance of outputs of food, fuelwood, fodder, fertiliser and timber;
(ii) Reduction in incidence of total crop failure, common to single-cropping or monoculture systems; and
(iii) Increase in levels of farm incomes due to improved and sustained productivity.

Social Benefits

Besides the economic benefits, social benefits occur from increases in crop and tree product yields and in the sustainability of these products. These benefits include:

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

Limitations of Agroforestry

An integrated food-tree farming system, while advantageous, does have certain negative aspects.

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 crop during tree harvest operations;
(iii) Potential of trees to serve as hosts to insect pests that are harmful to food crops; and
(iv) Rapid regeneration by prolific trees, which may displace food crops and take over entire fields.

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 acquire an economic value;
(iv) Resistance by farmers to displace food crops with trees, especially where land is scarce; and
(v) The fact that agroforestry is more complex, less well understood and more difficult to apply, compared to single-crop farms.

Through skillful management practices any or all of these aspects 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; and

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

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.