CHAPTER 1

The history of agroforestry

Cultivating trees and agricultural crops in intimate combination with one another is an ancient practice that farmers have used throughout the world. Tracing the history of agroforestry, King (1987) states that in Europe, until the Middle Ages, it was the general custom to clear-fell degraded forest, burn the slash, cultivate food crops for varying periods on the cleared area, and plant or sow trees before, along with, or after sowing agricultural crops. This "farming system" is no longer popular in Europe, but was widely practiced in Finland up to the end of the last century, and was being practiced in a few areas in Germany as late as the 1920s.

In tropical America many societies have simulated forest conditions to obtain the beneficial effects of the forest ecosystem. For example, in Central America, it has been a traditional practice for a long time for farmers to plant an average of two dozen species of plants on plots no larger than one-tenth of a hectare. A farmer would plant coconut or papaya with a lower layer of bananas or citrus, a shrub layer of coffee or cacao, annuals of different stature such as maize, and finally a spreading ground cover such as squash. Such an intimate mixture of various plants, each with a different structure, imitated the layered configuration of mixed tropical forests (Wilken, 1977).

In Asia, the Hanunóo of the Philippines practiced a complex and somewhat sophisticated type of "shifting" cultivation. In clearing the forest for agricultural use, they deliberately spared certain trees which, by the end of the rice-growing season, provided a partial canopy of new foliage to prevent excessive exposure of the soil to the sun. Trees were an indispensable part of the Hanunóo farming system and were either planted or preserved from the original forest to provide food, medicines, construction wood, and cosmetics (Conklin, 1957). Similar farming systems have also been common in many other parts of the humid lowland tropics of Asia.

The situation was little different in Africa. In southern Nigeria, yams, maize, pumpkins, and beans were typically grown together under a cover of scattered trees (Forde, 1937). The Yoruba of western Nigeria, who have long practiced an intensive system of mixing herbaceous, shrub, and tree crops, claim that the system is a means of conserving human energy by making full use

of the limited space won from the dense forest. The Yoruba also claim that this system is an inexpensive means of maintaining the soil's fertility, as well as combating erosion and nutrient leaching (Ojo, 1966).

There are innumerable examples of traditional land-use practices involving combined production of trees and agricultural species on the same piece of land in many parts of the world. These are some examples of what is now known as agroforestry. Trees were an integral part of these farming systems; they were deliberately retained on farmlands to support agriculture. The ultimate objective of these practices was not tree production but food production.

By the end of the nineteenth century, however, establishing forest or agricultural plantations had become an important objective for practicing agroforestry. In the beginning, the change of emphasis was not deliberate. At an outpost of the British Empire in 1806, U.Pan Hle, a Karen in the Tonze forests of Thararrawaddy Division in Myanmar (Burma), established a plantation of teak (*Tectona grandis*) by using a method he called "taungya," and presented it to Sir Dietrich Brandis, the Governor. Brandis is reported to have said, "this, if the people can ever be brought to do it, is likely to become the most efficient way of planting teak" (Blanford, 1958). From this beginning, the practice became increasingly widespread. It was introduced into South Africa as early as 1887 (Hailey, 1957) and was taken, from what was then Burma, to the Chittagong and Bengal areas in colonial India in 1890 (Raghavan, 1960). The ruling philosophy of the taungya system was to establish forest plantations whenever possible using available unemployed or landless laborers. In return for performing forestry tasks, the laborers would be allowed to cultivate the land between the rows of tree seedlings to grow agricultural produce. This is a simplification of a system whose details varied depending on the country and locality (see Chapter 6 for details of the taungya system).

As a result of foresters' preoccupations with the forests and the forest estate, the main objective of the research undertaken by them on such mixed systems was to ensure that:

- little or no damage occurred to the forest-tree species;
- the rates of growth of the forest-tree species were not unduly inhibited by competition from the agricultural crop;
- the optimum time and sequence of planting of either the tree or agricultural crop be ascertained in order to ensure the survival and rapid growth of the tree crop;
- the forest species that were capable of withstanding competition from agricultural species be identified; and
- the optimum planting-out spacings for the subsequent growth of the tree crop be ascertained.

In short, the research conducted was undertaken for forestry by foresters. It appears the foresters conducting the research never envisioned the system as being capable of making a significant contribution to agricultural development, or its potential as a land-management system (King, 1987).

Many factors and developments in the 1970s contributed to the general acceptance of agroforestry as a system of land management that is applicable to both farm and forest. These factors included:

- the re-assessment of development policies by the World Bank;
- a reexamination of forestry policies by the Food and Agricultural Organization (FAO) of the United Nations;
- a reawakening of scientific interest in both intercropping and farming systems;
- the deteriorating food situation in many areas of the developing world;
- the increasing spread of tropical deforestation and ecological degradation;
- the energy crisis of the 1970s and consequent price escalation and shortage of fertilizers; and
- the establishment by the International Development Research Centre (IDRC) of Canada of a project for the identification of tropical forestry research priorities.

At the beginning of the 1970s, serious doubts were expressed about the relevance of current development policies and approaches. In particular, there was concern that the basic needs of the poorest, especially the rural poor, were neither being considered nor adequately addressed. Robert McNamara, the President of the World Bank at that time, confronted these concerns quite clearly (McNamara, 1973):

> Of the two billion persons living in our developing member countries, nearly two-thirds, or some 1.3 billion, are members of farm families, and of these are some 900 million whose annual incomes average less than $100...for hundreds of millions of these subsistence farmers life is neither satisfying nor decent. Hunger and malnutrition menace their families. Illiteracy forecloses their future. Disease and death visit their villages too often, stay too long, and return too soon.
>
> The miracle of the Green Revolution may have arrived, but, for the most part, the poor farmer has not been able to participate in it. He cannot afford to pay for the irrigation, the pesticide, the fertilizer, or perhaps for the land itself, on which his title may be vulnerable and his tenancy uncertain.

Against this backdrop of concern for the rural poor, the World Bank actively considered the possibility of supporting nationally oriented forestry programs. As a result, it formulated a Forestry Sector Policy paper in 1978, which has been used as the basis for much of its lending in the forestry sub-sector in the 1980s[1]. Indeed, its social forestry program, which has been expanded considerably since the 1980s, not only contains many elements of agroforestry but is reportedly designed to assist the peasant and the ordinary farmer by increasing food production and conserving the environment as much as it helps the traditional forest services to produce and process wood (Spears, 1987).

[1] The World Bank's Forestry Policy, which was further revised in 1991 gives even more emphasis to agroforestry and "trees outside the forest" (World Bank, 1991).

It was around the same time that, with the appointment in 1974 of a new Assistant Director-General responsible for forestry, the FAO made a serious assessment of the forestry projects which it was helping to implement in developing countries, as well as the policies which it had advised the Third World to follow. After assessing the program it became clear that although there was notable success, there were also areas of failure. As Westoby (1989) would later express it:

> Because nearly all the forest and forest industry development which has taken place in the developing world over the last decades has been externally oriented...the basic forest-products needs of the peoples of the developing world are further from being satisfied than ever...
>
> Just because the principal preoccupation for the forest services in the developing world has been to help promote this miscalled forest and forest industry development, the much more important role which forestry could play in supporting agriculture and raising rural welfare has been either badly neglected or completely ignored.

FAO redirected its focus and assistance in the direction of the rural poor. Its new policies, while not abandoning the traditional areas of forestry development, emphasized the importance of forestry for rural development (FAO, 1976). It also focused on the benefits that could accrue to both the farmer and the nation if greater attention were paid to the beneficial effects of trees and forests on food and agricultural production, and advised land managers in the tropics to incorporate both agriculture and forestry into their farming system, and "eschew the false dichotomy between agriculture and forestry" (King, 1979).

To these two strands of forest policy reforms, which evolved independently, one in an international funding agency and the other in a specialized agency of the United Nations, were added the simultaneous efforts of a large number of tropical land-use experts and institutions. Faced with the problems of deforestation and environmental degradation, these individuals and institutions intensified their search for appropriate land-use approaches that would be socially acceptable, ensure the sustainability of the production base, and meet the need for production of multiple outputs. Efforts to design major programs which would allow local communities to benefit directly from forests paved the way for new forestry concepts, such as social forestry, which were implemented in many countries.

Several developments in the area of agricultural research and development during the 1960s and 1970s were also instrumental in initiating organized efforts in agroforestry. Under the auspices of the Consultative Group on International Agricultural Research (CGIAR), several International Agricultural Research Centers (IARCs) were established in different parts of the world to undertake research with the objective of enhancing the productivity of major agricultural crops (or animals) of the tropics. The development of high-yielding varieties of cereals and related technologies through the joint efforts of some of these

centers and the relevant national programs paved the way for what became known as the Green Revolution (Borlaug and Dowswell, 1988). However, it was soon realized that many of the green revolution technologies that placed a heavy demand on increased use of fertilizers and other costly inputs were beyond the reach of a large number of resource-poor farmers in the developing countries. Most of the IARCs and the national programs were focusing on individual crops such as rice, wheat, maize, and potato, and production technologies for monocultural or sole-crop production systems of these crops. However, the farmers, especially the poorer farmers, often cultivated their crops in mixed stands of more than one crop, and sometimes crops and trees; in such circumstances the production technologies developed for individual crops would seldom be applicable. These shortcomings were recognized widely by a large number of policy makers.

As a consequence, there was renewed and heightened interest in the concepts of intercropping and integrated farming systems. It was being demonstrated, for example, that intercropping may have several advantages over sole cropping.[2] Preliminary results from research in different parts of the world had indicated that in intercropping systems more effective use was made of the natural resources of sunlight, land, and water. The research also indicated that intercropping systems might have beneficial effects on pest and disease problems; that there were advantages in growing legumes and nonlegumes in mixture; and that, as a result of all this, higher yields could be obtained per unit area even when multi-cropping systems were compared to sole cropping systems (Papendick *et al.*, 1976).

It became obvious that although a great deal of experimentation was being carried out in the general field of intercropping, there were many gaps in our knowledge. In particular, it was felt that there was a need for a more scientific approach to intercropping research, and it was suggested that greater efforts were needed with respect to crop physiology, agronomy, yield stability, biological nitrogen fixation, and plant protection (Nair, 1979). Concurrently, the International Institute of Tropical Agriculture (IITA), an IARC in Ibadan, Nigeria, extended its work to include integration of trees and shrubs with crop production (Kang *et al.*, 1981). Other research organizations had also initiated serious work on, for example, the integration of animals with plantation tree crops such as rubber, and the intercropping of coconuts (Nair, 1983).

Building upon the success of these scientific studies, agricultural scientists began investigating the feasibility of intercropping in plantation and other tree crop stands as well as studying the role of trees and shrubs in maintaining soil productivity and controlling soil erosion. Livestock management experts also began to recognize the importance of indigenous tree and shrub browse in mixed farming and pastoral production systems.

Environmental concerns became very conspicuous at the same time as these changes and developments were happening in the land-use scenarios of tropical

[2] Some of these common land-use terms are explained in the glossary at the end of the book.

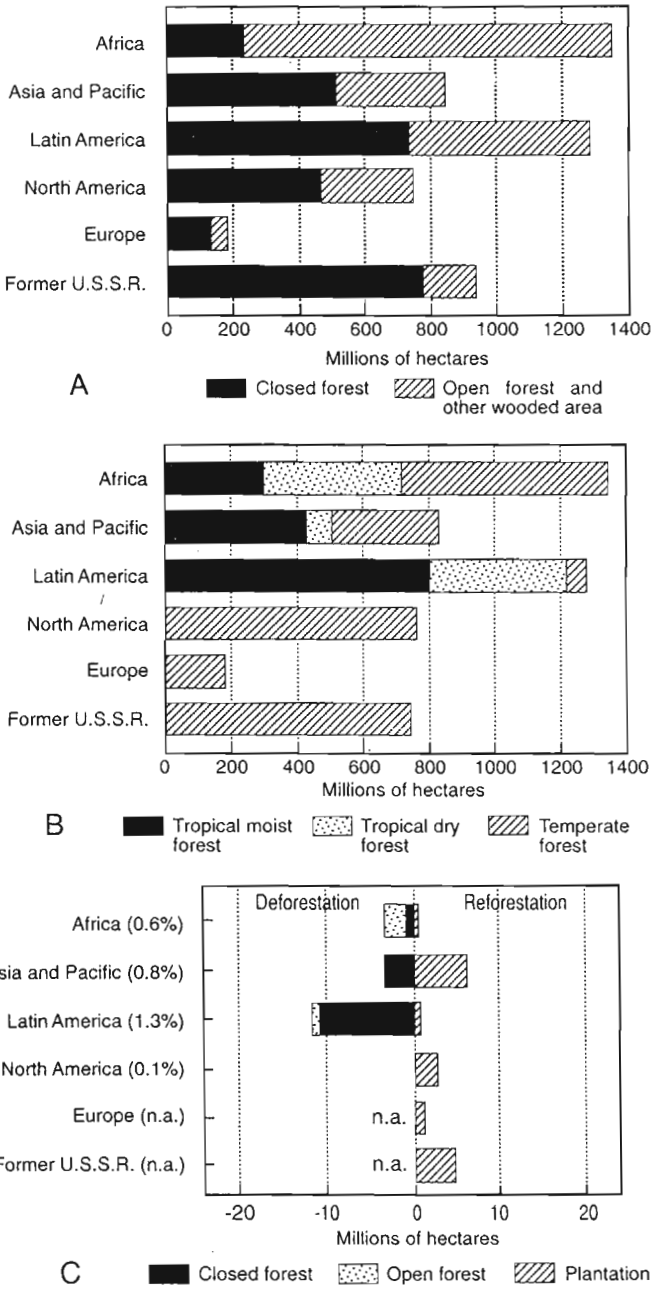

Figure 1. World forestry typology and deforestation rates.
A and B: Typology of forests in the world
C: Average rates of deforestation and reforestation in the 1980s.
Note: n.a. = not applicable; numbers in parentheses as a percentage of total forest area.
Source: World Bank (1991).

forestry and agriculture. Deforestation of the world's tropical region, which attained the status of a "hot topic" on the agenda of almost all environment-related discussions at all levels during the 1980s, was a major environmental issue even during the 1970s. Definitions and estimates of the rates of deforestation vary. For example, the World Bank, which defines deforestation *as the disturbance, conversion, or wasteful destruction of forest lands,* has assembled statistics on the extent and progression of deforestation in the tropics during the past two decades, and estimated the current rates at about 12 million hectares per year (World Bank, 1991; Sharma, 1992). The World Bank's data on average rates of deforestation and reforestation in the world during the 1980s is given in Figure 1. FAO, on the other hand, based on its preliminary estimates from the 1990 assessment, reports that the actual rate of deforestation during the 1980s was about 50% higher, 17.1 million hectares annually (Matthews and Tunstall, 1991). As pointed out in a study by the World Resources Institute, one of the main reasons for these differences is that many of the assumptions on which estimates of the extent of tropical deforestation are made have proven false, and very little effort is being made to update the information systematically (World Resources Institute, 1990). In spite of these differences in its estimates, there is no divergence of opinion on the consequences of deforestation: it is widely agreed that deforestation causes a decline in the productive capacity of soils, accelerated erosion, siltation of dams and reservoirs, destruction of wildlife habitats, and loss of plant genetic diversity (World Bank, 1991). It is also generally agreed that the main causes of this deforestation are population resettlement schemes, forest clearance for large-scale agriculture, forestry enterprises and animal production, and, in particular, shifting cultivation. A 1982 FAO estimate showed that shifting cultivation was responsible for almost 70% of the deforestation in tropical Africa, and that forest fallows resulting from shifting cultivation occupied an area equivalent to 26.5% of the remaining closed forest in Africa, 16% in Latin America, and 22.7% in tropical Asia (FAO, 1982). Faced with these challenges and maladies of deforestation, several studies and efforts were made to reduce the extent of deforestation and suggest alternative land-management strategies. Though the problem has, unfortunately, not been contained, several sound strategies have evolved, thanks to the efforts of large numbers of researchers from different disciplines. For example, ecologists produced convincing evidence of positive influence of forests and trees on the stability of ecosystems, leading to the call for measures to protect the remaining forests, introduce more woody perennials into managed land-use systems, and change farming attitudes. Studies carried out by anthropologists and social scientists on farmer attitudes to improved land-use systems showed the importance of mixed systems in traditional cultures and highlighted the need to build upon these practices when developing new approaches.

Many of these studies and efforts, although not coordinated, provided important knowledge about the advantages of combined production systems involving crops, trees, and animals. But, perhaps the most significant single

initiative that contributed to the development of agroforestry came from the International Development Research Centre (IDRC) of Canada. In July 1975, the IDRC commissioned John Bene, an indefatigable Canadian, to undertake a study to:

- identify significant gaps in world forestry research and training;
- assess the interdependence of forestry and agriculture in low-income tropical countries and propose research leading to the optimization of land use;
- formulate forestry research programs which promise to yield results of considerable economic and social impact on developing countries;
- recommend institutional arrangements to carry out such research effectively and expeditiously; and
- prepare a plan of action to obtain international donor support.

Although the initial assignment stressed the identification of research priorities in tropical forestry, Bene's team came to the conclusion that first priority should be given to combined production systems which would integrate forestry, agriculture, and/or animal husbandry in order to optimize tropical land use (Bene *et al.*, 1977). In short, there was a shift in emphasis from forestry to broader land-use concepts which were perceived as having immediacy and long-term relevance.

How was the agroforestry research that was proposed by Bene and his team to be undertaken? Their report stated:

> It is clear that the tremendous possibilities of production systems involving some combination of trees with agricultural crops are widely recognized, and that research aimed at developing the potential of such systems is planned or exists in a number of scattered areas. Equally evident is the inadequacy of the present effort to improve the lot of the tropical forest dweller by such means.
>
> A new front can and should be opened in the war against hunger, inadequate shelter, and environmental degradation. This war can be fought with weapons that have been in the arsenal of rural people since time immemorial, and no radical change in their life style is required. This can best be accomplished by the creation of an internationally financed council for research in agroforestry, to administer a comprehensive program leading to better land-use in the tropics (Bene *et al.*, 1977).

It was apparent that despite the growing awareness of the need for information, on which agroforestry systems might be effectively based, very little research was being undertaken. Furthermore, the research that was being conducted was haphazard and unplanned. The IDRC Project Report, therefore, recommended the establishment of an international organization, which would support, plan, and coordinate, on a world-wide basis, research combining the land-management systems of agriculture and forestry. This proposal was generally well received by international and bilateral agencies; subsequently, the International Council for Research in Agroforestry (ICRAF) was established in 1977. The ancient practice of agroforestry was institutionalized for the first time.

This congruence of people, concepts, and institutional change has provided the material and the basis for the development of agroforestry since then. Although many individuals and institutions have made valuable contributions to the understanding and development of the concept of agroforestry since the 1970s, ICRAF – renamed in 1991 as The International Centre for Research in Agroforestry – has played the leading role in collecting information, conducting research, disseminating research results, pioneering new approaches and systems, and in general, through the presentation of hard facts, attempting to reduce the doubts still held by a few skeptics.

Today, agroforestry is taught as a part of forestry- and agriculture-degree courses in many universities in both the developing and industrialized world. Today, agroforestry, instead of being merely the handmaiden of forestry, is being used more as an agricultural system, particularly for small-scale farmers. Today, the potential of agroforestry for soil improvement and conservation is generally accepted. Indeed, agroforestry is fast becoming recognized as a land-use system which is capable of yielding both wood and food while at the same time conserving and rehabilitating ecosystems.

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CHAPTER 2

Definition and concepts of agroforestry

Community forestry, farm forestry, and social forestry

It is clear from the previous chapter that agroforestry is a new name for a set of old practices. The word and concept attained a fair level of acceptability in international land-use parlance in a rather short time, but not without some difficulty. In the beginning, undoubtedly, a lot of ambiguity and confusion existed regarding the question "what is agroforestry?" Even the people who were supposedly experienced and knowledgeable about agroforestry in the late 1970s and early 1980s were unable to clearly define agroforestry. Perhaps as a manifestation of this lack of precision, most of the writings on agroforestry during this period contained at least one definition, and often some imaginative and fascinating interpretations, of agroforestry. The situation was reviewed in an editorial, appropriately titled, "What is Agroforestry," in the inaugural issue of *Agroforestry Systems* (Vol. 1, No. 1, pp. 7–12; 1982), which contains a selection of "definitions" of agroforestry, proposed by various authors.

In summarizing these definitions, Björn Lundgren of ICRAF stated that:

> There is a frequent mixing up of definitions, aims and potentials of agroforestry. It is, for example, rather presumptuous to define agroforestry as a successful form of land use which achieves increased production and ecological stability. We may indeed aim for these, and in many ecological and socioeconomic settings agroforestry approaches have a higher potential to achieve these than most other approaches to land use. But, with the wrong choice of species combinations, management practices, and lack of peoples' motivation and understanding, agroforestry may indeed fail just like any other form of land use may fail, and it will still be agroforestry in the objective sense of the word.
>
> A strictly scientific definition of agroforestry should stress two characteristics common to all forms of agroforestry and separate them from the other forms of land use, namely:
>
> - the deliberate growing of woody perennials on the same unit of land as agricultural crops and/or animals, either in some form of spatial mixture or sequence;

- there must be a significant interaction (positive and/or negative) between the woody and nonwoody components of the system, either ecological and/or economical.

When promoting agroforestry one should then stress the potential of it to achieve certain aims, not only by making theoretical and qualitative remarks about the benefits of trees, but also, and more importantly, by providing quantitative information (Lundgren, 1982).

These ideas were later refined through "in-house" discussions at ICRAF, and the following definition of agroforestry was suggested:

> Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components (Lundgren and Raintree, 1982).

This definition implies that:

- agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;
- an agroforestry system always has two or more outputs;
- the cycle of an agroforestry system is always more than one year; and
- even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a monocropping system.

This definition, though not "perfect" in all respects, was increasingly used in ICRAF publications and thus achieved wide acceptability.

In the meantime, the surge of enthusiasm for defining agroforestry has subsided. The concepts, principles, and limitations of agroforestry have been articulated in several publications from ICRAF and other organizations. Thus, agroforestry is no longer a "new" term. It is widely accepted as an approach to land use involving a deliberate mixture of trees with crops and/or animals. However, the question of "what is agroforestry" comes up occasionally even today (early 1990s) in many discussions and some publications (e.g., Somarriba, 1992). But the discussants eventually realize that the discussion, after all, has not been worth their while; they reconcile themselves to the fact that even the long-established land-use disciplines such as agriculture and forestry do not have completely satisfactory definitions, and more importantly, that a universally acceptable definition has not been a prerequisite for the development of those disciplines.

Today there is a consensus of opinion that agroforestry is practiced for a variety of objectives. It represents, as depicted in Figure 2.1, an interface between agriculture and forestry and encompasses mixed land-use practices. These practices have been developed primarily in response to the special needs and conditions of tropical developing countries that have not been satisfactorily

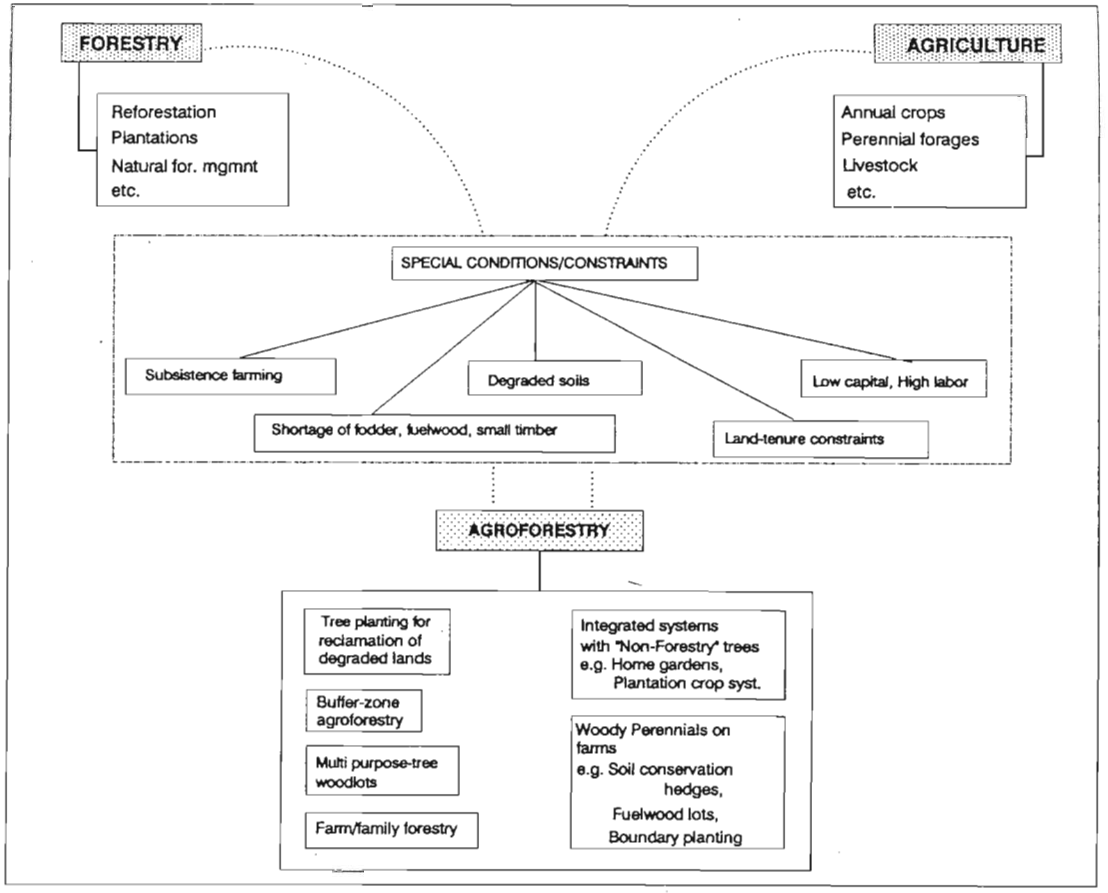

Figure 2.1. Agroforestry has developed as an interface between agriculture and forestry in response to the special needs and conditions of tropical developing countries.

addressed by advances in conventional agriculture or forestry. The term is used to denote practices ranging from simple forms of shifting cultivation to complex hedgerow intercropping systems; systems including varying densities of tree stands ranging from widely-scattered *Faidherbia (Acacia) albida* trees in Sahelian millet fields, to the high-density multistoried homegardens of the humid tropics; and systems in which trees play a predominantly service role (e.g., windbreaks) to those in which they provide the main commercial product (e.g., intercropping with plantation crops). Detailed descriptions of a variety of such systems in the tropics are now available (e.g., Nair, 1989). It needs to be reemphasized that one concept is common to all these diverse agroforestry systems: the purposeful growing or deliberate retention of trees with crops and/or animals in interacting combinations for multiple products or benefits from the same management unit. This is the essence of agroforestry.

Additionally, there are three attributes which, theoretically, all agroforestry systems possess. These are:

1. *Productivity:* Most, if not all, agroforestry systems aim to maintain or increase production (of preferred commodities) as well as productivity (of the land). Agroforestry can improve productivity in many different ways. These include: increased output of tree products, improved yields of associated crops, reduction of cropping system inputs, and increased labor efficiency.
2. *Sustainability:* By conserving the production potential of the resource base, mainly through the beneficial effects of woody perennials on soils (see Section IV of this book), agroforestry can achieve and indefinitely maintain conservation and fertility goals.
3. *Adoptability:* The word "adopt" here means "accept," and it may be distinguished from another commonly-used word adapt, which implies "modify" or "change." The fact that agroforestry is a relatively new word for an old set of practices means that, in some cases, agroforestry has already been accepted by the farming community. However, the implication here is that improved or new agroforestry technologies that are introduced into new areas should also conform to local farming practices.

These attributes are so characteristic of all agroforestry systems that they form the basis for evaluation of various agroforestry systems as discussed in Chapter 24.

Community forestry, farm forestry, and social forestry

The escalating worldwide interest in tree planting activities during the past two decades (1970–1989) resulted in the emergence and popularization of several other terms with "forestry" endings. Notable among these are *Community Forestry, Farm Forestry, and Social Forestry*. Although these terms have not been defined precisely, it is generally accepted that they emphasize the self-help aspect – people's participation – in tree planting activities, not necessarily in

association with agricultural crops and/or animals as in agroforestry, but with social objectives ranking equally in importance with production objectives. Thus, social forestry is considered to be the practice of using trees and/or tree planting specifically to pursue social objectives, usually betterment of the poor, through delivery of the benefits (of trees and/or tree planting) to the local people; it is sometimes described as "tree growing by the people, for the people." Community forestry, a form of social forestry, refers to tree planting activities undertaken by a community on communal lands, or the so-called common lands; it is based on the local people's direct participation in the process, either by growing trees themselves, or by processing the tree products locally. Though claimed to be suited for areas with abundant common lands, the success of community forestry has been hampered by the "tragedy of the commons."[1] Farm forestry, a term commonly used mainly in Asia, indicates tree planting on farms.

The major distinction between agroforestry and these other terms seems to be that agroforestry emphasizes the interactive association between woody perennials (trees and shrubs) and agricultural crops and/or animals for multiple products and services; the other terms refer to tree planting, often as woodlots. As several authors have pointed out (e.g., Dove, 1992; Laarman and Sedjo, 1992), all these labels directly or indirectly refer to growing and using trees to provide food, fuel, medicines, fodder, building materials, and cash income. Only blurred lines, if any, separate them and they all encompass agroforestry concepts and technologies. No matter what the experts may say, these terms are often used synonymously, and sometimes even out of context, in land-use parlance.

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[1] The "tragedy of the commons" assumes that land held in common will be exploited by all, and maintained by no one! (Hardin, G. 1968. The tragedy of the commons. *Science* 162: 1243–1248.)