AGROFORESTRY

D. J. Mead
Silviculture Adviser, Golden Bay, New Zealand

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Summary

Agroforestry is a dynamic, ecologically based management system for growing woody perennials, either trees or shrubs, with crops and/or pastures and/or animals. There is a wide range of systems and practices, with their selection and use dependent on ecological, biophysical and social factors. The main focus of agroforestry is to meet the needs of rural people in developing countries in a sustainable manner. Its growth and implementation has been closely linked with social and community forestry programs in developing countries. However, it is also accepted as a viable land-use practice in industrialized countries. While agroforestry, as a subject, is relatively new, its roots and many of its practices are very old. Research and development initially focused on the classification, description and use of existing practices. Later the research focus shifted to understanding the complex ecological factors between trees, crops and animals. A recent emphasis is on viewing agroforestry from an ecological perspective, where complexity, biodiversity and succession are important attributes to make the systems

sustainable and resilient. There are increasing efforts at domestication of agroforestry trees and in developing markets for their products, because profitability is a seen as key to sustainability and poverty alleviation. Understanding biophysical interactions between trees, crops, animals and the soil, along with the wider ecological view of their dynamic nature, is the basis for better implementation and the development of new agroforestry practices. The presence of trees and ecological complexity is important for ensuring biological sustainability. Agroforestry has often been promoted as being a sustainable solution to poverty alleviation and soil degradation problems and for use in soil reclamation projects. As practitioners, science and social science gain better insight into and experience with agroforestry, it will be applied more widely, carefully and with improved integration at a farm, catchment or landscape level.

1. Introduction

Agroforestry—the combination of agricultural practices with forestry practices—has become important for sustainable land-use in many parts of the world, although most clearly so in tropical, developing countries. In these developing countries it is seen by many as a means of poverty alleviation, particularly for rural peoples. The scientific application is relatively new, although many of the practices are ancient. The variety and implementation of agroforestry practices are myriad, yet are really based on a few clear biological and social principles. While the science and social science that underpin agroforestry are still being explored, there have been great gains in understanding in the last decade or so. Agroforestry now has a sound basis as an applied ecology, although, because of the very wide range of combinations of trees, understory plants, and perhaps animals, the actual implementation of practices is still dependent on careful observation and interpretation of the local situation and the needs of the farmer.

1.1 What is Agroforestry?

The term agroforestry is an "umbrella" term for those land-use practices and technologies where trees or other woody perennials are deliberately grown with crops, pastures or animals on farms. The International Center for Research in Agroforestry (ICRAF) defines agroforestry as a dynamic, ecologically based, natural resources management system, that through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for all land users at all levels. Thus, agroforestry focuses on the integration of farming and trees on a property, whether that property is a small home garden, a large estate or communally owned land. Agroforestry practices are also increasingly seen as a way of diversifying agroecosystems by creating new niches for flora and fauna. Under this view, agroforestry practices are not seen so much as a set of distinct prescriptions, but rather as dynamic phases in the development of a productive ecosystem. Thus, over time, the increasing integration of trees into land-use systems can be seen as movement towards a "mature" agroforest of ecological integrity.

The term "farm forestry" is used in some countries, where it often has slightly different connotations, such as more emphasis on production forestry, but the difference is somewhat academic. In practice both refer to growing trees in conjunction with agriculture, to provide a range of services and products. The integration of the two,

concern for total ecosystem management, and the exploitation of positive interactions, are the critical features. Consequently, another feature of agroforestry applications is that it requires inputs from a wide range of disciplines.

Agroforestry is viewed as deliberate management practice to distinguish it from many naturally or casual mixes of trees, crops or animals. However, it encompasses both traditional and modern variations, and those situations where forests dominate yet are deliberately managed to provide agricultural benefits as well.

1.2 The Focus of Agroforestry

While agroforestry is about integrating trees and agriculture, it is also very focused on the needs of people, and on sustainability. In developing countries poverty alleviation is usually the major goal in programs promoting agroforestry. This is why agroforestry has close links with social or community forestry in developing countries. Social forestry aims to assist individuals or communities to meet their basic needs. People usually have multiple needs, such as food, wood for fuel and building, income, good living conditions, and perhaps being good stewards of their land. Often agroforestry practices are the practical means by which these needs are met. Furthermore, the social and economic well-being of farmers governs, in part, which particular agroforestry practice is adopted. Sustainable land use not only comes from improving biophysical aspects of the site, but also from enhancing the livelihood of local people, partly through products and services from trees.

The situation is similar for farmers in temperate industrialized countries, although this is less often stressed. Farmers often want multiple benefits from their land. A good farm adviser, extension agent, or consultant, is able to assist the farmer in achieving these needs, as trees on farms are one element for obtaining the best production from the land. Farming profitability revolves around generation of income in the most cost-effective manner. Profitability should be considered in a reasonably long time frame and be sustainable. It is in this longer-term perspective that trees often play a critical role, for they can be planted with an eye to ameliorating the climate, preventing erosion, site rehabilitation, protecting waterways, and providing addition revenues or enjoyment. Carefully planned use of trees can also increase the diversification potential of the farm, and be used to reduce the impact of commodity price fluctuations.

Trees also have other major impacts, some of which are not so readily translated into financial terms, but which can be very important to the individual, or to society as a whole. Thus, while the broad landscape is governed by the underlying topography, the size, color, texture, variety, and placement of trees means that they can markedly alter perception. Many rural people place great importance on preserving or enhancing native or introduced flora and wildlife. Agroforestry practices in developing countries are also seen as ways of reducing deforestation and maintenance of biodiversity. Often, planting or retaining trees or forests are important ways of achieving these and other environmental goals, such as carbon sequestration. Most people also place great value on having comfortable, pleasant living and working conditions—here again trees usually play a major role.

However, trees sometimes have negative impacts. For example they can compete with crops for moisture, or may interfere with farming operations, and some species have the potential to become weeds. Such negative impacts can be avoided by careful agroforestry planning.

1.3 History of Agroforestry

Agroforestry has its roots in many traditional farming practices, although it has only been recognized as a separate "technology" in the last two decades. For example, traditional shifting agriculture, still common in many parts of the world, makes use of the forest to rehabilitate the soil between periods of crop production. In Indonesia, there are large areas of agroforests developed by subsistence farmers where the fallow period is lengthened by enriching it with commercially important trees species. Improved fallow techniques have built upon this same concept. Similarly, homestead orchards in temperate areas, which are often grazed underneath, have been a long tradition. The home garden, seen in many tropical areas, is an ecologically more complex extension of this practice with its multilayered combination of a variety of trees and crops, sometimes with animals. The taungya system was begun in Myanmar in 1806 as an aid to establishing teak (*Tectona grandis)* plantations. Since then the concept of planting crops in the early stages of plantations has spread worldwide, and it has become recognized as a land-management system.

In agriculture, scientific attention was focused on multiple cropping in the late 1960s and early 1970s. This, coupled with an awareness of some of the difficulties associated with modern, intensive, high-input agricultural developments, particularly in the tropics, led to a search for other alternatives by the Food and Agriculture Organization (FAO), The World Bank, and others. Farmers and society in many countries have experienced problems such as massive soil erosion, loss of stream quality, and salinization, all of which rely on trees and or shrubs in order that they be overcome. In Europe, a reason for agroforestry development has been agricultural surplices and the desire to set aside land from agriculture.

However, perhaps the most important impetus to the development of agroforestry was the report commissioned by the International Development Research Centre (IDRC) of Ottawa, Canada. The team, led by John Bene, concluded in their1977 report, that research priority should be given to the tropical forestry-agriculture interface as way to assist the poor in developing countries. The report also recommended the establishment of an international organization to support this work. In 1978 the International Council for Research in Agroforestry (ICRAF) was established within the Consultative Research Group for International Agriculture Research (CGIAR). ICRAF, which in 1991 changed its name to the International Centre for Research in Agroforestry, is based in Nairobi, Kenya, and has been a huge spur to the development and acceptance of agroforestry. It has moved from an initial emphasis on coming to terms with the myriad of traditional agroforestry practices, to providing many of the underlying science and social science concepts. In both the developing and industrialized world, agroforestry is now accepted as an important land-use system, driven by the need to create sustainable, robust agroforestry ecosystems.

2. Agroforestry Systems and Practices

The great variety of agroforestry practices around the world has been classified into a number of systems, subsystems, or practices. A system is defined, in this context, as a distinctive agroforestry land-use type. Subsystems and practices are lower–order terms in the hierarchy. They should be seen as aids to communication, understanding and synthesis, but should not set restrictions on what is possible or ideal, or how a particular farmer approaches agroforestry. Nor should the classification be seen as clear-cut, for some of the practices overlap and new ones may develop. Furthermore, these classifications do not recognize the dynamic and evolving nature of these ecosystems. For example, there is potential for an agroforestry ecosystem to move from a relatively simple one to one of greater complexity, which is akin to natural succession in forests. Nor do such classifications recognize the spatial complexity that can occur at different levels from individual fields to landscapes.

2.1 Classification

The three basic components of an agroforestry land-use system are the tree or woody perennial, the herbaceous component, and animals. Agroforestry systems must have trees and at least one of the other components. This is the basis of the classification into trees plus crops (agrisilvicultural), trees plus pastures and/or animals (silvopastoral), and trees plus crops and animals (agrosilvopastoral). It is possible to subdivide these systems according to how they are mixed by arrangement of the components (Table 1). There are two basic categories—simultaneous systems where the agricultural component occurs along with trees—and sequential systems where trees and crops take turns in occupying the same space. Many options are possible in tropical developing countries, depending on ecological, social and economic factors. In industrialized countries fewer options are common.

Agrosilvicultural systems—trees with crops

Rotated in time (sequential practices)

- **Improved fallow** (shifting cultivation)—trees, preferably N-fixers, left or planted to grow during the fallow phase[a]
- **Taungya—**agricultural crops grown early in the life of plantations[a]
- **Relay intercropping—**trees and crops planted together each year; crops mature quickly; trees develop slower[a]

Spatially mixed (simultaneous practices)

- **Trees on cropland** (parkland systems)—scattered trees over crops – often multipurpose trees[a]
- **Plantation crop combinations—**multiple-use plantation crops, shade trees or intercropping with plantation crops[a]
- **Home gardens** (multistrata systems)—intimate multistory trees with crops, often round homesteads[a]

Spatially zoned (simultaneous practices)

- **Alley cropping—**hedgerow intercropping with woody species in hedges and crops between; contour hedging[a]
- **Boundary planting—**trees on erosion control structures, terraces, streams, field boundaries; live fences

- **Strip planting—**plantations with corridor farming
- **Shelterbelts—**trees planted to shelter crops from wind
- **Woodlots—**woodlots for cut-and-carry mulching (Biomass transfer), woodfuel, soil conservation etc.[a]

Silvopastoral systems—trees with pasture and/or animals

Spatially mixed (simultaneous practices)

- **Trees on rangeland or pastures** (parkland systems) – scattered or systematically planted trees or shrubs
- **Perennial crops with pasture** – agricultural plantations like rubber or coconut[a] and orchards

Spatially zoned (simultaneous practices)

- **Boundary planting—**trees on boundaries for fodder or other uses[a]; live fences[a]; streamside protection
- **Shelterbelts—**trees planted to shelter pastures and/or animals from wind and snow
- **Woodlots—**woodlots used stock havens, fodder banks, or soil protection etc in pastoral farming

Agrosilvopastoral systems—trees with crops and pasture/animals

Spacially mixed (simultaneous practices)

- **Home gardens with animals**[a]

Spatially zoned (simultaneous practices)

- **Multipurpose woody hedgerows—**Woody hedges for fodder, mulch, woodfuel, soil conservation etc.[a]
- **Multipurpose woodlots**[a]

Other systems

- **Entomoforestry** (trees with insects)—trees and beekeeping
- **Aquaforestry**—trees planted around fishponds with fish utilizing fallen leaves etc., sometimes spatially mixed[a]

[a]Found mainly in tropical areas

Table 1. Major agroforestry systems and practices

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Biographical Sketch

Donald J. Mead, B.Sc. (NZ), B.Sc. (For, Edin), Ph.D. (Fla) is currently self-employed as an independent silviculture and agroforestry adviser, based in Golden Bay, New Zealand. Don Mead is a New Zealander and worked for many years as a scientist in soils and tree nutrition with the Forest Research Institute in New Zealand. Later he taught silviculture and agroforestry at the School of Forestry, University of Canterbury in Christchurch, and later still he was Reader in Forestry at Lincoln University, Canterbury, New Zealand. His consulting and research has been in boreal, temperate and tropical countries. His special interests are in forest plantations and agroforestry; he is a specialist in tree nutrition, tree-crop interactions, sustainability, and radiata pine. He has published extensively in these areas. He has also been Editor of *New Zealand Forestry* and Associate Editor of *Agroforestry Systems*.