



Module 2 – Agroforestry for grazed Woodlands
Course 1 – Introduction to agroforestry for grazed woodlands

Chapter 1 – Introduction to Agroforestry Concept

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The Definition of Agroforestry

Investors say agroforestry isn't just climate-friendly; it's also profitable, and a responsible business practice.

According to FAO (2015), **agroforestry can be defined** as a dynamic, ecologically based, natural resource management system that diversifies and sustains production by integrating trees and shrubs on farms (with crops or livestock) and in the agricultural landscape. This results in increased social, economic and environmental benefits for land users, especially small-holder farmers and other rural people

In Africa, for example, despite some increased risk of infectious disease, agroforestry is likely to improve a diverse range of pressing health concerns





Traditional Agroforestry - History

- Since ancient times, **agroforestry systems** have received increasing attention for their **multifunctional role** and as models of **sustainable development**
- The practices adopted varied according to **agro-geographical zones**, but the main goal was to allow **better land management**
- The earliest practitioners of agroforestry perceived food production as a system for persistence, in which trees were an integral part, so they were kept on established farmland to support agriculture. The ultimate objective was not tree production, but food production
- By the end of the nineteenth century, however, the establishment of forest plantations had become the dominant objective wherever agroforestry was being utilized as a system of land management





Traditional Agroforestry - History

- In 1806, U Pan Hle established a plantation of teak through the use of what he called the "taungya" method and presented it to Sir Dietrich Brandis (Blanford, 1958). This method was introduced into South Africa as early as 1887 (Hailey, 1957) and later transferred to the Chittagong area in India in 1890 and to Bengal in 1896 (Raghavan, 1960)
- In the second decade of the twentieth century, the system became more and more popular with foresters as a relatively inexpensive method of establishing forests, and as Shebbeare (1932) puts it, "became a full and rising flood." This period also saw its wider dispersal in Africa, and today it is practiced in varying degrees in all the tropical regions of the world





Traditional Agroforestry - History

Some have asserted that in many parts of the world, local farmers were exploited in pursuit of the goal of establishing cheap forest plantations (King, 1968). Be that as it may, it was often stated that the socio-economic conditions that were necessary for the successful initiation of the system were land hunger and unemployment. It was sometimes said that another essential prerequisite was a standard of living which was low enough to border on poverty

Ref: http://apps.worldagroforestry.org/Units/Library/Books/Book%2007/agroforestry%20a%20decade%20of%20development/html/1_the%20history.htm?n=7/

Although the story varies greatly from one place to another, the practice of maintaining or integrating trees in the agricultural landscape has existed around the world since ancient times, constituting the default practice for land use management

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Traditional Agroforestry - History

It was only during the last few centuries that farming and trees became dissociated as monocropping became more common, in an effort to intensify food production

- In **Europe**, the Spanish Dehesa system, in which pasture for cattle, swine, or sheep is covered by scattered oaks, is said to date back 4,500 years. In Germany, until the Middle Ages, farmers would start growing crops on small pieces of land they had just cleared of trees. They would then have trees grow anew on the land, parallel to the crops
- In **the Americas** during the pre-Columbian period, numerous peoples practiced what is today called multistorey agriculture, whereby vertical space is maximized with three or more layers of intercropped plants of different heights. In this way, farmers made an effort to mimic complex forest ecosystems in order to enjoy their multiple benefits

Ref: <http://www.fao.org/forestry/agroforestry/89997/en//>





Traditional Agroforestry - History

- In **Asia**, in the Indian peninsula, traditional home gardens have existed for millennia, and leaders have formally encouraged certain agroforestry systems at specific times
- As for **Africa**, tree canopies have shaded ground crops while tree roots grew below the crops. Swidden cultivation, also known as shifting cultivation or a “slash and burn” technique, was one of the first agricultural techniques ever developed, and it is still used today

There are **plenty of other examples** of ways people have combined the ecological functions of species of trees and plants in order to provide themselves with various goods and services. This is what has come to be called agroforestry

Ref: <http://www.fao.org/forestry/agroforestry/89997/en//>





Agroforestry Gearing Up!

Identify land type and its characteristics and climate



Understand the reason for establishing an agroforestry system; select the species for it with that in mind



Design the space and allocate appropriate resources to each component, considering the expected output





Agroforestry's Disadvantages

- Agroforestry systems give a lower crop yield than monocropping due to competition with trees for resources, such as sunlight and moisture (especially for trees with shallow root systems). Agroforestry systems require also more maintenance. Sometimes low bushes are more effective than trees with large canopies
- This is a long-term system. Thus, there may be an income deficit for farmers during the initial phase

- Some trees may have an allelopathic effect; that is, they exude substances that can be harmful to the main crop
- Trees can also serve as alternate hosts for the crop pathogens, causing diseases in the main crop
- Agroforestry may not have a beneficial impact under certain climatic conditions, slopes, and soil conditions. For example, falling tree parts can severely damage the main crop during storms



Agroforestry's Advantages

Agroforestry is identified as a food production system of the future. And here are some good reasons why:

- Soil fertility and closed nutrient cycles
- Soil salinity control
- Prevention of runoff and better water management
- Stabilization of soils and microclimates

- Low input of agrochemicals
- Improvement of wildlife and pollinator habitats
- Remediation of polluted soils
- Provision of diverse products, enabling poverty reduction
- Prevention of damage to forests
- Climate change mitigation

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Agroforestry - A Challenging System

- It integrates multiple natural components
- At the crossroads of **tradition and modernity**



Brings together people from **diverse fields of knowledge**: agronomists, animal care specialists, landscape planners, foresters, economists, soil analysts...

It's a strength

It's complex

It's a challenge

Communication

Coordination





Agroforestry Can Help Enhance Food Security & Meet Sustainable Development Goals (SDGs)

- One goal: double food production over the next few decades, since the growing population poses a major challenge to global food security
- Conventional practices achieve yield increases through chemical inputs, genetic improvement, and mechanization, but these have also been a principle cause of social and environmental problems such as climate change, loss of biodiversity and ecosystem integrity, land degradation, water insecurity, and disruption of social systems
- Consequently, there is now a broad consensus that we need to move away from the current narrow focus on yield, and toward a more multifunctional agriculture and multigoal approach that combines food security (SDG2) with environmental, climate, and social goals
- It is necessary to increase yield sufficiently to meet the SDG of food security before advancing other SDGs





Agroforestry Can Help Enhance Food Security & Meet Sustainable Development Goals (SDGs)

- One of the most multifunctional forms of agriculture is agroforestry. Through the combined production of trees and agricultural species on the same piece of land, it has been proven to increase the overall yield by 96%, depending on crop type, local conditions, and level of expertise
- These yield increases have been shown to reflect the multiple ecosystem services provided by the trees, including enhanced soil nutrient status, reduced crop stress, reduced soil erosion, and regulation of the water supply, all of which increases sustainability
- So far, conventional yield-enhancement strategies have dominated the debate on food production, hindering implementation of more multifunctional alternatives like agroforestry
- Governments and institutions now have the opportunity to rebalance agricultural policy and investment toward multigoal approaches. In doing so, they could achieve important improvements on multiple international commitments related to the interlinked themes of food security, climate change, biodiversity conservation, and social well-being





Agroforestry Systems & Types

- **Agrisilvicultural systems** combine **crops and trees**, as in alley cropping and home gardens
- **Silvopastoral systems** combine **forestry and grazing of domesticated animals** in pastures, rangelands or farms
- The three elements, namely **trees, animals and crops**, can be integrated in several spatial and temporal arrangements and for different functions to create **Agrosilvopastoral systems**. Examples are home gardens involving animals, or scattered trees on croplands used for grazing after harvests





Agrisilvicultural Systems (Trees Combined with Crops)

This system involves the conscious and deliberate use of land for the concurrent production of agricultural crops alongside trees. Depending on the nature of its components, this system can be grouped into various categories:

- a) Fuelwood production
- b) Shelter belts
- c) Wind breaks
- d) Improved fallow species in shifting cultivation
- e) Taungya system
- f) Alley cropping (Hedgerow inter-cropping)
- g) Multispecies tree gardens
- h) Multipurpose trees and shrubs on farmlands
- i) Trees used in soil conservation and reclamation





Agrisilvicultural Systems - Fuelwood Production

- In this system, various multipurpose fuelwood/firewood species are planted on or around agricultural lands. The primary productive role of this system is to produce firewood; the protective role is to act as fencing, shelter-belts and boundary demarcation
- Tree species commonly used as fuelwood are Egyptian acacia (*Acacia nilotica*), lebbek tree (*Albizia lebbek*), Thailand Shower (*Cassia siamea*), Australian pine tree (*Casuarina equisetifolia*), and forest red gum (*Eucalyptus tereticornis*)
- This systems helps reduce the acute scarcity of this form of energy in tropical regions, and helps decrease the CO2 emissions resulting from global warming
- The Kyoto Protocol to the United Nations Framework Convention on Climate Change has introduced new opportunities to finance wood energy and agroforestry projects through the instrument of joint implementation in the coming years





Agrisilvicultural Systems - Shelterbelts, Windbreaks, Live Hedges

Wind breaks slow down the wind speed and keep cold air above the plants, even up to 30 times the height of the sheltering trees

Live hedges allow crop protection from stray animals and other biotic influences

Shelterbelts are useful to indigenous and migratory birds, wild animals and beneficial insects





Agrisilvicultural Systems - Fallow

Fallows are crop land left without crops for periods ranging from one season to several years

- The objective of improved fallow species in shifting cultivation is to recover depleted soil nutrients, restore soil fertility and reduce erosion. Once the soil has recovered, crops are reintroduced for one or more seasons
- The best species for a fallow system induce good nitrogen fixation in the soil, are compatible but not competitive with future crops, and have no negative physical or chemical effects on the soil

Improved fallows can be established in a variety of ways, depending on the previous land use, value of the fallow vegetation, condition of the land, and expected duration of the fallow. Fallows may be established by:

- 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 fallows on degraded land
- Planting tree seedlings in closely spaced, deep planting holes or furrows within blocks of cleared cropland





Agrisilvicultural Systems - The Taungya System

Taungya (taung = hill, ya = cultivation) is a Burmese word coined in Burma in the 1850s; the system is practiced in areas with an assured annual rainfall of over 1200-1500 mm. In this system, forest land is cleared of trees, and food crops are planted. Then timber seedlings are planted on the same plot. Crops can be raised there until the young trees produce too much shade

Advantages of the taungya system:

- Cheap artificial regeneration of the forest
- Additional jobs and income
- Maximum utilization of the site
- Provision of food crops from forest land
- Weed and climber growth is eliminated
- Free grazing for animals
- Free timber for house and school construction
- Increased water supply

Disadvantages of the taungya system:

- Loss of soil fertility and exposure of soil
- Danger of epidemics
- Legal problems
- Susceptibility of land to accelerated erosion
- Exploitation of human labour
- Intensive production may produce more products than farmers can easily sell
- High logistics costs





Agrisilvicultural Systems – Alley Cropping

Alley cropping involves managing rows of closely planted (within rows) woody plants with annual crops planted in alleys between hedges. The position and spacing of hedgerow and crop plants in an alley-cropping system depend on plant species, climate, slope, soil conditions and the space required for the movement of people and tillage equipment.

The primary purpose of alley cropping is to

- Maintain or increase crop yields by improving the soil, microclimate and weed control
- Provide farmers with benefits from tree products from the hedgerows, including fuelwood, building poles, food, medicine and fodder
- Control erosion on sloping land, in the hedgerows

Alley cropping works best where people feel a need to intensify crop production but face soil fertility problems.

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Agrisilvicultural Systems

The system should include leguminous trees to improve soil fertility, and it must

- Allow sunlight penetration
- Not compete with crop roots
- Have shallow lateral roots that are easily eliminated with no serious damage to the plants
- Ensure easy decomposition of leaf litter, thus ensuring an adequate nutrient supply for the cropping cycle
- Ensure nitrogen fixation and produce wood, food, fodder, medicine or other products
- Grow well under the specific conditions of the site (saline or acid soils, drought, flooding, heavy winds, insect pests or other hazards)

For example, *Cassia siamea*, *Leucaena leucocephala*, *Gliricidia sepium*, *Callianda calothyrsus* and *Sesbania sesban* are commonly used tree species for alley cropping





Agrisilvicultural Systems

Multispecies Tree Gardens

- In this system of agroforestry, various kinds of tree species are grown together
- The major function of this system is production of food, fodder and wood products for home consumption and for sale

Multipurpose Trees and Shrubs on Farmlands

- In this system, various multipurpose tree species are scattered haphazardly or according to some systematic patterns on bunds, terraces or plot/field boundaries
- The major components of this system are multipurpose trees and other fruit trees and common agricultural crops
- The primary role of this system is production of various tree products; it also can be used for fencing, for example for plot demarcation, which gives it a social value





Agrisilvicultural Systems - Trees in soil conservation and reclamation

These include trees on bunds, terraces, raisers, etc. with or without grass strips, as well as trees for soil reclamation

Where soil erosion is severe, a land area may be denuded of topsoil and interlaced with a dendritic, or branched, system of steep-sided watercourses called gullies. These areas are generally devoid of vegetation, and sediment eroded from them may menace lower-lying lands or water retention structures

Bench terraces generally consist of a series of horizontal, or almost horizontal, bands of variable width, generally arranged in steps along the slope and supported by steep banks. These embankments are built either in vegetation-protected earth or in stone walls

The objective of terracing and protective waterways is to sustainably cultivate these steep slopes, thereby increasing agricultural production, minimizing soil erosion and improving the farms' ecology





Silvopastoral Systems - Trees and Pastures or Animals

- **Trees on rangeland or pastures:** The major rangeland types of the world are grasslands, desert shrublands, savanna woodlands, forests, and tundra. Each of these rangeland types has several unique plant associations that host a variety of different biota depending on the climate, soils, and human influences. The type of rangeland must be considered when planning management activities, because they differ in terms of precipitation, soil, and terrain. Therefore, management practices that work well in one region may be unsuitable for another region.
- **Protein banks:** production of protein-rich tree fodder on farms or rangelands for cut-and-carry fodder production
- **Plantation crops with pastures and animals:** for example, cattle under coconut trees in southeast Asia and the south Pacific





Silvopastoral Systems - Trees and Pastures or Animals

- **Apiculture with trees:** for honey production
- **Home gardens involving animals:** intimate, multistorey combinations of various trees and crops, as well as animals, around homesteads
- **Multipurpose woody hedgerows:** woody hedges for browse, mulch, green manure, soil conservation, etc.
- **Aquaforestry:** trees next to fish ponds, tree leaves used as 'forage' for fish



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Thank you for your attention!!!

This publication has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of the Lebanese Agricultural Research Institute (PP3-LARI) and can under no circumstances be regarded as reflecting the position of the European Union or Programme management structures.

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