Part II—Framework for agroforestry curricula
Chapter 3.

Developing and reviewing agroforestry curricula

A tool for curriculum planning

Part II of this guide aims at providing a tool for the development and review of agroforestry curricula. It outlines a general framework for the agroforestry content of an education programme or a training course.

In Southeast Asia, agroforestry is taught in a very wide range of institutional and ecological settings. Agroforestry may be included as a small course or topic in a certificate or diploma programme in forestry or agriculture; as in-service training course; or as a BSc or an MSc programme with substantial time allocated to agroforestry.

There are two main approaches to agroforestry:

- Agroforestry as an integrated part of natural resource management. This includes fields such as forestry, agriculture, animal husbandry, environmental sciences and landscape architecture, as well as economics and social sciences.
- Agroforestry as a ‘specialized’ field
This guide aims to support agroforestry curriculum development activities in both integrated programmes and specialized ones.

This general framework therefore needs to be adjusted to the local situation in which the training and education take place. This framework is not a curriculum but a flexible tool for the agroforestry curriculum development team.

Part I of this guide introduced the concept of participatory curriculum development, and discussed the different stages of the curriculum development cycle:

- Situation analysis
- Aims and objectives
- Planning the curriculum
- Implementation
- Evaluation

Building on the situation analysis and the aims set for the agroforestry education programme or training course, Part II of the guide deals with the planning of the curriculum. It is one of several tools that the curriculum developer may use. There are many others, such as existing curricula, participants' experiences, extension and research experiences, literature on agroforestry, etc.

The agroforestry curriculum framework, organized in five chapters, discusses the main elements that an agroforestry learner needs to be familiar with. Other subjects in the curriculum may cover some aspects of this framework. In some cases, existing courses in other faculties or departments of the institutions could be tapped. The framework provided is a guide only, which may be interpreted in many different ways.

Overview of the agroforestry curriculum framework

This chapter discusses the general competencies that people working in the field of agroforestry would benefit from. This includes the professional profile, as well as the general areas of knowledge, skills and attitudes. These traits apply both to people working in specialized agroforestry jobs and to the majority of people who would work with agroforestry as part of a broader, integrated perspective on natural resource management.

The actual curriculum framework is then presented in Chapters 4-7, which include the following topics:

**Chapter 4. Concepts and principles of agroforestry**
- Evolution of agroforestry
- Tree-crops-soil interactions
• Agroforestry in rural livelihood: subsistence production and cash income
• Environmental services in agroforestry systems
• Social and economic considerations of agroforestry
• Agroforestry in the landscape

**Chapter 5. Agroforestry systems, practices and technologies**
- Definitions of agroforestry systems practices and technologies
- Classification of agroforestry systems
- Tree domestication
- Local agroforestry systems and practices

**Chapter 6. Institutions and policies related to agroforestry**
- Institutional context
- Policies and programmes related to agroforestry

**Chapter 7. Advancing agroforestry practices**
- Participatory planning
- Technology generation, testing and dissemination
- Monitoring and evaluation

**How each topic is presented**
To facilitate the design of an effective teaching and learning process, each topic is presented in the following way:
- Main learning points
- Content
- Methods
- Materials
- Bibliography

Again, it should be emphasized that this framework is only one of several tools that decide the final outcome of the curriculum development process.

**The professional profile**
Agroforestry is about growing trees on farms to improve the livelihoods of the rural poor and to protect the natural resource base. About 1.2 billion people in developing countries—including a large number in Southeast Asia—depend on agroforestry products and services for their well-being.

Agroforestry, however, is a rather new profession, and while many jobs in the natural resource sector might require agroforestry competencies, specific agroforestry jobs are still relatively few in most countries in Southeast Asia. The natural career pathway that exists for forestry or agriculture is often
lacking in the field of agroforestry. While some graduates will undoubtedly find ‘pure’ agroforestry jobs, many or most will work in adjacent fields where an integrated perspective on natural resource management is useful.

Knowledge and skills

Agroforestry as farmers’ practice and as a science embraces a wide range of disciplines. Agroforestry is part and parcel of a broader context of community-based natural resource management and rural development. It involves biophysical sciences such as agriculture and forestry as well as socioeconomics and local culture. The development of agroforestry also depends on institutions, in particular community-based institutions, and on policies. Agroforestry is a multidisciplinary and integrative field of learning.

Learners of agroforestry therefore need to be familiar with a range of disciplines related to natural resource management, and with the most common concepts and approaches in rural development. While the learner is not expected to become a specialist in the many fields that are related to agroforestry, he or she will become a very special type of generalist. The agroforestry student needs to be able to understand, integrate and communicate concepts and ideas about, and utilize knowledge and skills from, a range of disciplines adjacent to agroforestry (figure 6).
Some of these are often covered in other parts of the curriculum and only to a lesser extent are included in this framework. But curriculum developers should keep the multidisciplinary and integrative aspect of agroforestry learning in mind.

It is a challenge for the mostly sector-oriented education system to deal with the many dimensions of agroforestry learning. New and innovative approaches, institutional arrangements and partnerships are often needed. Team-teaching across faculty and department boundaries is often desirable.

**Biophysical Areas**
- Agronomy: crop science, plant production
- Animal husbandry
- Environmental conservation, biodiversity
- Fisheries
- Forestry: nurseries, seeds, silviculture, processing technologies
- Horticulture
- Hydrology, watershed management
- Soil science, soil and water conservation

**Socioeconomic Areas**
- Anthropology, ethnography, local culture
- Economics, household economics, markets
- Health and nutrition
- Gender
- Policy
- Rural sociology: social differentiation, poverty assessment
- Local institutions

**Research and Development Methods and Approaches**
- Adult learning, communication, extension, psychology
- Community forestry, social forestry, joint forest management
- Landscape analysis, diagnostic and planning tools
- Surveying, mapping and planning
- Participatory tools and methods: Participatory Rural Appraisal, Participatory Technology Development (PTD), Farmer-to-farmer extension, farmer field schools, etc.
- Policy analysis

Figure 6. Agroforestry learning is linked to a range of disciplines.

**Attitudes**

The agroforestry education and training programme will provide the learner with certain perspectives on the professional profile required for agroforestry jobs. This applies both to ‘specialized’ agroforestry jobs, as well as jobs within the natural resource management, which require a broader integrated view on agroforestry.
It is important for curriculum developers and teachers to consider the attitudes that the educational programme intends to develop in the learner. While these attitudes may not be very different from those desired in other fields of natural resource management, they will help shape the professional profile of the student.

To effectively communicate in a diverse and complex agroforestry environment, a range of attitudes would be beneficial, including being:

- Integrative
- Systems-oriented
- Learner-centred
- Open-minded
- Culturally sensitive
- Empathic
- Resourceful
- Thoughtful/reflective
- Sharing/listening
- Ethical

The design of the curriculum, as well as the choice of teaching and learning methods should aim at developing these attitudes in the agroforestry student.
Chapter 4.

Concepts and principles of agroforestry

This chapter discusses the concepts and principles of agroforestry, thus providing an introduction to the learning of agroforestry. The main topics suggested for this introduction are

• Evolution of agroforestry
• Tree-crops-soil interactions
• Agroforestry and rural livelihood: subsistence production and cash income
• Environmental services in agroforestry systems
• Social and economic considerations of agroforestry
• Agroforestry in the landscape

Evolution of agroforestry

Agroforestry is a relatively new term, although it is as old as the farmers’ practice. Agroforestry is rapidly evolving as a science and a practice. It is increasingly seen as an approach to improve the livelihood of the rural poor and to protect the natural resource base by growing trees on farms. Agroforestry science came into prominence only in the late 1970s. Subsequently, there has been progressive development in concept, philosophy, research, education and implementation approaches in agroforestry.

What is agroforestry? There have been many attempts to define agroforestry—both simple and complex definitions abound. There is an educational value in analysing a few of these definitions.

Definitions can be simple such as ‘trees on farms’ or complex, such as in the following examples:

‘Agroforestry is a collective name for all land use systems and practices where woody perennial plants are deliberately grown on the same land management unit as agricultural crops and/or animals, either in a spatial mixture or in temporal sequence. There must be significant ecological and economic interactions between the woody and non-woody components’ (Lundgren 1987).
or:

‘Agroforestry is a dynamic, ecologically based, natural resource management system that, through the integration of trees in farm- and rangeland, diversifies and sustains smallholder production for increased social, economic and environmental benefits’ (Leakey 1996).

Main learning points
- To explain why and how the term agroforestry, as a practice and a science, has evolved
- To explain the concept of agroforestry land use systems and on-farm trees
- To be familiar with definitions of agroforestry and understand the dynamic character of common agroforestry definitions, including biological components, time and space, and social dimensions
- To clarify differences and links between agroforestry, social forestry and other related land use terminology

Contents
- Land use changes and land degradation in the past, as well as present trends of land use change.
- Analysis of conflicts and complementarities between agriculture and forestry land use
- Evolution of agroforestry as an integrated approach to land use
- The main definitions of agroforestry, the biophysical components and their integration within the overall system, and the importance of ecological as well as economic functions
- Agroforestry as one of several types of tree-based rural development programmes, such as social forestry, community forestry, farm forestry, etc.

Methods
- Assignment to review literature related to the evolution of agroforestry
- Definitions can be illustrated by analysis of the term agroforestry, based on definitions and discussion on interrelationship of agroforestry components and a functional combination of those.
- Showing, through AV media, several agroforestry systems, where living and non-living components can be identified and analysed for their interrelationship and interdependency functions
- Study trips to have a more realistic view of agroforestry systems, followed by site discussions
Materials

- Pictures, slides, videotapes and aerial photos showing, for example, land use change at regional, national or even at local level, problems and various types of agroforestry systems
- Case study. Research results can be used to stimulate students in group discussions.

Bibliography


ICRAF____. A series of lecture notes on integrated natural resource management, based on experience in the alternatives to slash-and-burn project (forthcoming). ICRAF website: http://www.icraf.cgiar.org


Tree-crops-soil interactions

For a learner of agroforestry it is central to understand how trees, crops and animals interact. In simultaneous agroforestry systems, trees and crops can share above-ground and below-ground space. Trees and crops interact in many ways, leading to both positive (facilitation) and negative (interference) effects on the growth of both trees and crops. These processes, which are very complex, are related to light, water, nutrients and wind. These processes also affect the soil itself. There are also indirect interactions, for instance related to pests and diseases. This section discusses both the principles of these interactions, and the positive and negative effects that the interactions may have.

Cycling of soil organic matter, nutrients and water are processes that are central to understanding the interactions in agroforestry systems. With a thorough knowledge of these cycles, the tree-crops-soil interactions are then explored.

Main learning points

- To understand the biophysical processes involved in agroforestry systems
- To understand the role of agroforestry systems regarding nutrient and water cycling and in maintaining soil fertility
• To be familiar with the positive and negative tree-crops-soil interactions regarding light, water and nutrients
• To understand that there are trade-offs, and that farmers’ decisions are complex and involve many non-biological factors

Contents

Components of agroforestry
  • The main components in agroforestry systems: trees, crops, animals and soil
  • Principles of the nutrient and water cycles and of light capture

Interactions
  • Principles of component interactions in an agroforestry system, in relation to the nutrient and water cycles and light capture
  • Positive interactions (below and above-ground):
    - Nutrient and water recycling
    - Role of tree root systems as: (1) a ‘safety-net’ for nutrients that have been leached down the soil profile, below the crop roots (and which would otherwise have been lost from the system), (2) a ‘nutrient pump’ for weathered minerals in deep soil layers.
- Role of old tree-root channels in improving water infiltration and reducing soil erosion
- Nitrogen supply by tree roots, due to root decay or by nitrogen fixation
- Mycorrhizal associations to enhance phosphorus availability
- Litter production, functions and quality of litter
- Maintaining soil organic matter content
- Mulching, soil moisture and soil biological activity
- Shading
- Microclimate improvement such as temperature, relative humidity, etc. (for example, coffee needs shading)
- Maintaining carbon stock and above- and below-ground diversity

• Negative interactions (below and above-ground) that may be involved:
  - Above-ground competition for light
  - Below-ground competition for water and nutrients
  - Pests and diseases (for example, intercropped cassava may introduce white root disease to rubber)
  - Allelopathic effect

• Tree-crops-soil interactions and farmers’ priorities

Methods

• Class presentation using AV (transparencies, posters with some photos and slide series, etc.), showing possible tree-crop interaction above-ground (by showing various canopy shapes) and below-ground (by showing various rooting patterns), and also showing how to test interactions in the field.

• Field observations: Tree-crop interaction

• Plot demonstration. Some simple exercises may be useful such as: exposing root distribution of different crops in one soil pit; showing several types of litter in the field and asking the students to describe its quality by hand-crushing, chewing, and chemical analysis in the laboratory (C, N, lignin and polyphenolics).

• Invite students to walk around to observe several tree canopy shapes and measure the light interception underneath

• Invite students to see and feel for themselves soil with a high and low organic material input

• Computer exercise, using a simulation model (WaNuLCAS = Water Nutrients and Light Capture of Agroforestry Systems) to improve students’ knowledge on processes involved in agroforestry.

• Farmer interviews. Farmer experiences of benefits and problems of using agroforestry
Materials

- Lecture notes, literature
- Experimental agroforestry plot
- Villages with different practices

Bibliography


ICRAF____. A series of lecture notes on integrated natural resource management, based on experience in the alternatives to slash-and-burn project (forthcoming). ICRAF website: http://www.icraf.cgiar.org


Agroforestry and rural livelihood: subsistence production and cash income

This section discusses agroforestry from a rural livelihood perspective. Small-scale farmers are the key land managers in many watersheds. Therefore, understanding how rural households and local communities relate to, depend on and influence their environment is a key to a broad and deep understanding of agroforestry. The dynamics of how livelihood strategies change over time is also important.

Agroforestry can provide a range of products and services that contribute to both rural development and environmental conservation. This section deals with the products generated from agroforestry systems (environmental services
are covered in the next section). Products include food, wood and fibres, among others. Agroforestry is also a source of employment and income. Agroforestry systems can thereby contribute to food and nutritional security and increased rural income and employment opportunities.

In Southeast Asia, in particularly in the uplands, several ethnic minorities depend on the forests and forest margins for their livelihood. Understanding the ethnic diversity and its significance for land management and agroforestry development is therefore important.

Main learning points

- To understand the main livelihood strategies for rural households in key agroecosystems in the uplands, lowlands and coastal areas, and how these change over time
- To appreciate the role of agroforestry in providing food and nutritional security
- To appreciate the importance of wood fuel energy production
- To be aware of important wood and non-wood products from agroforestry systems, for subsistence consumption or for the market
- To be aware of opportunities for employment and cash income through agroforestry systems
- To be familiar with the ethnic diversity, particularly in the uplands and forest margins, and the importance of taking ethnic diversity into account in natural resource management

Contents

Livelihood strategies

- Analysis of the main livelihood strategies for rural households in key agroecosystems (note the difference between rich and poor households)
- Food and nutritional security
- Needs of communities to improve their livelihoods: education, health, water and sanitation, etc.
- Possible solutions to problems and constraints in the community

Ethnic minorities

- Importance and role of ethnic minorities in natural resource management

Subsistence production

- Overview of subsistence production from the farm, the forest and forest margins, with a particular emphasis on agroforestry products
- Production of food in agroforestry systems
- Wood and non-wood forest products from agroforestry systems
- Wood fuel energy from agroforestry trees and shrubs
Production for the market
- The main cash crops
- Production for the market from on-farm agroforestry systems, as well as wood and non-wood forest products from agroforestry systems on communal lands, forest margins and forests
- Employment opportunities and farmers' income in agroforestry systems

Trade-offs and farmers' choices
- Farmers' choices of agroforestry practices depend not only on the overall biophysical performance, but also on a range of socioeconomic factors. It is the farmers' perception of the overall system, rather than the total biophysical interactions that counts.
- Income versus risk: food security and farmers' income. Although yield of each component may decrease under mixed planting, agroforestry may reduce risk of harvest failure.
- Distribution of income over the year in an agroforestry system
- Trade-offs between the protection (of forests, soils and biodiversity) and production functions of the system
- Socioeconomic conditions under which agroforestry systems occur; land scarcity and population pressure; labour; off-farm employment opportunities
- Local cultural patterns and local knowledge

Methods
- Class presentation using AV (transparencies, posters with some photos and slide series, etc.)
- Group discussion: By giving some case studies, students can discuss within a group and write a report
- Field trips: Students should be asked to interview farmers, following guide questions prepared earlier in the class. Questions will deal with household needs (foods, fuel, fodder, etc.) and how they are to meet those needs (for example, food yield, amount generated from cash crops, etc.). Students' findings will be discussed in the class including their suggested recommendations.

Bibliography
Environmental services in agroforestry systems

Land use is rapidly changing in the tropics and many countries experience an environmental degradation due to decline in forest cover, loss or degradation of arable land and a subsequent loss of ecosystem functions. At the local level, unsustainable land use practices cause soil erosion and declining soil fertility and changes in the water cycle. At the regional and global level, biodiversity and climate change are affected.
Agroforestry practices can help mitigate or reverse these trends. By incorporating trees in more intensively managed agroecosystems, a number of environmental services are enhanced at farm level as well as globally. Environmental services include improved soil fertility, reduced pressure on remaining forests, biodiversity conservation ex-situ, carbon storage, as well as restored ‘forest functions’.

**Main learning points**
- To understand the causes and effects of land use change at farm level (soil, nutrients, water) and landscape level (carbon stock and emission of greenhouse gases, biodiversity, water quantity and quality).
- To be familiar with environmental conservation and international conventions, in particular the Convention on Climate Change, and the Convention on Biological Diversity, and how they relate to watershed management and agroforestry systems.
- To recognize the need for soil and water conservation, biodiversity conservation and reduced emissions of green house gases, and appreciate the role that agroforestry development—trees on farms—can play in this process.

**Contents**

**Land use change**
- The underlying causes for land use change in relation to farmers’ and other stakeholders’ activities
- Slash-and-burn as a technique: benefits and problems
- Negative and positive trends, as well as opportunities for improvement towards sustainable land use

**Plot/farm level**
- Land use change at plot level and how it relates to soil erosion, soil fertility, nutrient availability and soil physical conditions; water availability and flow; weeds, pests and diseases, etc.

**Global impact**
- Climate change, carbon stock; climate change and greenhouse gas emissions
- Biodiversity conservation
- International conventions on climate change and on biodiversity

**Role of agroforestry**
- The role of agroforestry practices—trees on farms in a watershed—to enhance the environmental services and functions
Method

- Class presentation, using AV (transparencies, posters with some photos and slide series, etc.) showing the impact of land use change on soil fertility conditions, water quality, etc.
- Field trip can be organized to visit several villages in one topographic sequence, to get ideas of different cropping systems and their impact on soil erosion and water quality. Measurements of carbon stock and greenhouse gas emissions can be done directly in the field.
- Case study. Provide a series of environmental assessment data and ask students to discuss it within the group, followed by a presentation.
- Computer exercise. To improve the students' knowledge on the impact of land use change on water distribution at the landscape level, a model simulation such as PC Raster or others could be used.
- In discussing farmers' land use, some questions could be raised: What do farmers do and why do they do so? Does it matter? Could they do it differently? Why don't they do it differently? What are the indicators of the environmental impacts? How can they be measured?

Materials

- Land use maps from different times
- AV teaching materials
- Handouts, posters and literature related to the topic
- Report of survey on biodiversity, ethnic diversity, and buffer zone management

Bibliography

ICRAF. A series of lecture notes on integrated natural resource management, based on experience in the alternatives to slash-and-burn project (forthcoming). ICRAF website: http://www.icraf.cgiar.org
Social and economic considerations of agroforestry

Social and economic aspects of agroforestry are critical factors in characterizing agroforestry systems. Social considerations are important because agroforestry emphasizes the relationship of trees and people. Economic considerations should be taken into account, since they will determine the ultimate value and feasibility of agroforestry for the land user. The social and economic considerations are important for traditional as well as ‘new’ agroforestry systems. These aspects are closely linked to increasing land pressure, changing social perceptions and modern land use options. All this underscores the need for new economic evaluations in many existing systems.

This topic will be discussed in further detail throughout chapter 7. Therefore, this chapter will only briefly discuss the principles and concepts of social and economic considerations of agroforestry.

Main learning points

- To recognize that the rural poor are primary beneficiaries of agroforestry
- To appreciate the importance of social and economic considerations in agroforestry
- To be familiar with the important factors affecting the adoption and impact of agroforestry
- To be familiar with the basic economic concepts as they relate to agroforestry systems and the feasibility of agricultural enterprises
- To be aware of how social and economic changes affect the management of natural resources

Contents

Social considerations of agroforestry

- Agroforestry as it relates to social sciences
- Important sociocultural factors in agroforestry (land tenure, labour, marketability of products, gender issues, and other social factors)
- Farmers’ perception of tree planting; local/indigenous knowledge
• Government policies and agroforestry implementation
• Social acceptability of agroforestry interventions

Economic considerations of agroforestry
• Influence of economic factors on land use choices among rural households and communities
• General principles of economic analysis
• Financial and economic analyses of agroforestry systems and enterprises
• Project analysis (including evaluation: discounting and the discount rate, evaluation criteria, farm budgets, quantification and valuation, and risk evaluation)

Methods
• Role-play
• Group discussion
• Field visits

Materials
• Manual
• Handouts
• Visual materials

Bibliography
ICRAF____. A series of lecture notes on integrated natural resource management, based on experience in the alternatives to slash-and-burn project (forthcoming). ICRAF website: http://www.icraf.cgiar.org
Place C. No date. An introduction to sociological evaluation: Lecture Notes. Introductory training course: Agroforestry research for integrated land use Nairobi: ICRAF.

Agroforestry in the landscape
A watershed or catchment area is the most suitable level for analysis of natural resource management. A succession of ecosystems, or agroecosystems, from the mountains to the sea level interact and affect each other through the
movement of water and soils and through the human activities in the respective agroecosystems.

To understand the role of agroforestry at the landscape level, it is therefore a good starting point to discuss the watershed. In most cases, a typical pattern of land uses (agroecosystems) can be identified within the watershed. These land uses are not static, but change with time depending on factors like land productivity, population, technology development, policy and institutions.

The land use practices in a watershed have both on-site and off-site effects. The individual farming household appreciates the on-site effects—they directly affect the farming enterprise. The off-farm effects (externalities) affect a much larger group of stakeholders. To control or regulate these effects, the society may institute formal and non-formal regulations and organizations through policy and institutions. Understanding the on-farm and off-farm effects of land use, as well as upstream and downstream interactions is, therefore, important.

Main learning points
• To be familiar with the main characteristics of the main upland, lowland and coastal/marine ecosystems
• To be familiar with past and present land use changes in the major ecosystems in a watershed
• To understand the underlying causes behind these changes in relation to population, agricultural and forestry practices, market influences, policy and institutions, etc.
• To understand the on-farm and off-farm effects of current land use practices
• To understand the upstream-downstream interaction among the major ecosystems, with emphasis on land use and the role of trees in the landscape
• To appreciate how agroforestry innovations can affect interactions in a watershed

Contents

Definitions
• Definitions of main terms including ecosystem, uplands, lowlands, coastal/marine and watershed

Characterization of ecosystems and land use
• Description of main natural and man-made ecosystems/agroecosystems in a watershed
• Biophysical characteristics: soils, vegetation, topography, climate
• Land use: farming systems, agroforestry practices; other land uses
• Socioeconomic information: population, including indigenous people; migration; gender and cultural aspects; on-farm and off-farm economic activities; marketing and market access; infrastructure; land and tree tenure.

Relations between household level and watershed level
• Population growth and migration patterns
• Relationships between land use practices by rural household and effects on the watershed. What do farmers do and why do they do so? How does this affect the watershed?
• Intensification of agriculture and how this affects the use of on-farm trees
• Sustainability of land use and natural resource management

Changes, trends and interactions between ecosystems
• Past and present changes and trends in land use in each ecosystem, and interactions between key ecosystems
• Land use change: deforestation, alternatives to slash-and-burn agriculture, potentials of agroforestry systems for maintaining or rehabilitating watershed functions
• Analysis of the underlying causes behind the changes
• On-farm practices and off-farm effects
• Interrelationship—upstream and downstream effects—among the major ecosystems. Both biophysical effects, in particular, regarding soil and water, and socioeconomic interactions should be dealt with.
Agroforestry in the watershed

• The role of agroforestry at the watershed level—the landscape mosaic
• Traditional agroforestry practices, and more recent agroforestry innovations in the watershed
• Watershed classification in relation to land suitability and capability

Materials

• Maps—watershed topographic maps and geographic maps of downstream currents
• Posters—illustrating environmental impact of disturbed/degraded forest versus untouched forest
• Case study reports on the impact of certain watershed management projects
• Documents on the Convention on Climate Change, the Convention on Biological Diversity and the Earth Summit

Bibliography


ICRAF____. A series of lecture notes on integrated natural resource management, based on experience in the alternatives to slash-and-burn project (forthcoming). ICRAF website: http://www.icraf.cgiar.org


Chapter 5.

Agroforestry systems, practices and technologies

This chapter discusses the concept of agroforestry systems and their classification. It further deals with the domestication of trees that are included in these systems. It aims at developing skills to identify and characterize various systems with particular emphasis on local systems and practices.

The chapter covers the following topics:

- Definitions of agroforestry systems, practices and technologies
- Classification of agroforestry systems
- Tree domestication for agroforestry
- Identification and characterization, and assessment of local agroforestry systems/practices

Definitions of agroforestry systems, practices and technologies

The terms systems, practices and technologies are frequently encountered in the agroforestry literature. Even though definitions of these terms have been proposed in the literature, the terms are used very loosely and often as synonyms. However, exploring the meanings and differences of these terms will help reduce the confusion that currently exists.

Main learning point

- To understand and be able to clarify and explain the terms systems, practices and technologies and their differences in the context of agroforestry

Contents

Definitions of agroforestry systems, practices and technologies

A system is an orderly combination of components (or elements, parts or subsystems) that interact with each other and with the environment to perform a functional role. For instance, an ecological system (or ecosystem) consists of organisms (flora and fauna) that interact with each other and with their
immediate environment (soil, climatic factors) and result in cycling of nutrients and flow of energy. People may manipulate the system components in order to maximize the desired outputs from the system.

The terms agroforestry systems, practices and technologies are frequently encountered. In fact, these terms are often used interchangeably. Although there is no definite definition of these terms, some characteristics are suggested:

- **Agroforestry system**: A land use system, which incorporates trees and crops and/or animals and with ecological and economic interactions among these components. Normally, it implies this is a pattern of land use occurring within a geographical area. Examples include alley cropping and home garden systems.

- **Agroforestry practice**: Any activity that farmers carry out within an agroforestry system such as hedgerow planting of Leucaena, or planting of rubber seedlings in a multistrata agroforestry system.

- **Agroforestry technology**: Refers to an improvement in the existing system, through generation and transfer of knowledge and skills or material inputs. This may be either scientist-developed or farmer-developed. Examples include high-yielding variety of maize or a multipurpose tree species, recommendation for fertilizer application rate, and improved rubber-tapping technique.

**Methods**

Slides, posters and video clippings of various agroforestry systems along with examples of some forms under each system. Students may be asked to specify more forms they observe in the teaching materials used. Moreover, students can be asked which of the slides, posters or video clippings or components in them are systems, practices and technologies.

**Bibliography**


Classification of agroforestry systems

A large number of agroforestry systems and practices exist around the world, and many different classifications have been proposed to identify and characterize them. There is no ‘best’ method of classification of agroforestry systems, although some may be more useful than others. The purpose of a general classification is to identify various agroforestry systems and characterize them. Students of agroforestry must acquire the knowledge and skills of identifying these agroforestry systems and practices as well as analysing them to understand their strengths, weaknesses, and opportunities.

Main learning points

- To understand basic criteria for classifying agroforestry systems based on the structure (components involved), predominant use of tree components, temporal and spatial arrangement of trees and crops.
- To be familiar with the common classification of main agroforestry practices

Contents

Classification of agroforestry systems

As an example, the most commonly used agroforestry classification approach, which is based on the structure and composition of the agroforestry systems, is given in Table 2. It should be noted that this is not an exhaustive list and many more combinations and permutations may be possible. Moreover, additional classification systems based on functions, ecological zonation, land altitude, economics, and socioculture are also available. Students may be encouraged to develop their own way of classifying the agroforestry systems that they are aware of.
Table 2. Structural classification and examples of key agroforestry systems.

<table>
<thead>
<tr>
<th>Systems</th>
<th>Key components</th>
<th>Examples/Forms</th>
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</thead>
<tbody>
<tr>
<td>Agrisilviculture</td>
<td>Trees with crops</td>
<td>Shifting cultivation</td>
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<td></td>
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<td>Alley cropping with Leucaena</td>
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<td></td>
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<td>Taungya system in Burma</td>
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<td>Coffee and pepper system in South Sumatra</td>
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<td></td>
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<td>Sloping Agricultural Land Technology (SALT-1 in the Philippines)</td>
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<td></td>
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<td>Jungle rubber agroforestry system in Jambi, Indonesia</td>
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<td></td>
<td></td>
<td>Complex damar agroforestry system in South Sumatra</td>
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<td></td>
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<td>Homegardens in Java and Sri Lanka</td>
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<tr>
<td>Silvipasture</td>
<td>Trees with pastures and livestock</td>
<td>Grazing livestock in tree plantations</td>
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<tr>
<td></td>
<td></td>
<td>Simple agrolivestock technology (SALT-2 in the Philippines)</td>
</tr>
<tr>
<td>Agrisilvipasture</td>
<td>Trees with crops and livestock</td>
<td>Raising chickens in home gardens</td>
</tr>
<tr>
<td>Special component systems</td>
<td>Trees with insects</td>
<td>Entomo-forestry</td>
</tr>
<tr>
<td></td>
<td>Trees with fish</td>
<td>Aqua-forestry</td>
</tr>
</tbody>
</table>

![Image of Agri-Silvicultural System](image1)

![Image of Silvi-Pastoral System](image2)
Methods

Commonly used training materials such as slides, posters and video clippings of various agroforestry systems may be used. Students may be asked to classify a range of agroforestry systems using several criteria. Identification and analysis of the key components along with their comments on the overall functioning and production aspects may be discussed. Field visits in the vicinity will be extremely revealing, especially if students prepare reports on their visits followed by group discussions in the classroom.

Bibliography


Tree domestication

Smallholder farmers harvest ‘non-wood’ forest products or ‘non-timber’ forest products (that is, food, fuel, fodder, medicines, building materials, resins, dyes, flavouring) from a large number of tree species. The range of tree species in agroforestry systems is much larger than the relatively limited number used for
industrial purposes. It is this huge genetic variation that provides the basis for selection and improvement of many indigenous species used in agroforestry systems. These tree species are sometimes called multipurpose trees, ‘Cinderella’ trees or agroforestry trees.

Through tree domestication—human-influenced change of the genetics of a plant—the value of and benefits from these trees can be adapted and increased. The pressure on the remaining forests might be reduced while at the same time ensuring the availability of these non-wood products to smallholder farmers. Tree domestication also means an ex-situ preservation of germplasm.

In applied terms, tree domestication is the naturalization of a species to improve its cultivation and use for mankind. Tree domestication can expand tree management options for smallholder farmers and help them become successful tree cultivators.

Main learning points

• To understand the concept of tree domestication
• To appreciate the importance of tree domestication to the smallholder farmers in particular and to the environment, including the preservation of germplasm
• To be familiar with the different activities involved in the tree domestication process or continuum
• To be aware of the different requirements for and constraints to successful tree growing by smallholder farmers

Content

Tree domestication principles

• Principles for tree domestication and genetic improvement
• Genetic variation, selection and breeding
• The status and importance of agroforestry tree domestication for germplasm preservation, and for farmers’ benefits
• Agroforestry tree species already domesticated, or with a potential for domestication

The tree domestication process

The steps involved in the tree domestication process include:

• Exploration and collection of natural populations
• Evaluation and selection of suitable species and provenances
• Developing propagation techniques
• Multiplication and dissemination of germplasm
• Developing management techniques
• Utilization and tree-product marketing
• Dissemination of relevant technical information

Smallholders and tree domestication

Factors influencing success of farmers’ tree cultivation are, for example:
• Secure land and tree tenure
• Market access
• Germplasm access
• Tree cultivation support programmes (loans, government extension activities)
• Technical know-how, including propagation and management skills

Methods

• Lectures and case studies
• Assignments/group discussions on tree growing culture among small-scale farmers, that is, the reasons for growing or not growing trees on their farm
• Student assignments to list already domesticated and the potential tree species for domestication
• Student field trips to explore the potential of domesticating selected tree species

Bibliography


Local agroforestry systems and practices

Based on the general classification of different agroforestry systems, this section provides students with the necessary ability to identify and understand the common local agroforestry systems and practices. It covers both the biophysical and production components of those local agroforestry systems. This topic also deals with an assessment of these agroforestry systems from the point of view of productivity, sustainability and adoptability (criteria to be taken not singly but collectively).

Main learning points

• To be familiar with commonly practised agroforestry systems in the local setting—district, region or country
• To evaluate strengths, limitations and opportunities of common local agroforestry systems. Aspects for evaluation may include various tree-crop-animal components, seeds, planting materials, labour and financial issues.
• To understand the concepts of productivity, sustainability and adoptability of agroforestry systems
• To be familiar with productivity, sustainability and adoptability criteria and indicators in assessing agroforestry systems

Contents

Identifying and describing local agroforestry practices

• Methods and skills required to identify and describe local agroforestry systems and practices adequately
• The strengths, limitations and opportunities for improvements of local agroforestry systems. Some of the key aspects for consideration in this appraisal are provided in table 3.
Table 3. Suggested content of the section for analysis of local agroforestry practices.

<table>
<thead>
<tr>
<th>Component</th>
<th>Aspects</th>
</tr>
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<tbody>
<tr>
<td>Land and soil</td>
<td>Soil and land type&lt;br&gt;Field preparation&lt;br&gt;Soil fertility management&lt;br&gt;Soil and water conservation</td>
</tr>
<tr>
<td>Trees</td>
<td>Nursery techniques&lt;br&gt;Planting techniques&lt;br&gt;IPM (Integrated Pest Management)&lt;br&gt;Management (thinning, pruning)&lt;br&gt;Harvesting methods</td>
</tr>
<tr>
<td>Crops</td>
<td>Crop types&lt;br&gt;Preparation of planting materials&lt;br&gt;Planting techniques&lt;br&gt;Cropping schedules&lt;br&gt;Crop management&lt;br&gt;Irrigation/water management&lt;br&gt;IPM (weeding, diseases + pest control)&lt;br&gt;Harvesting methods</td>
</tr>
<tr>
<td>Livestock</td>
<td>Livestock type and breeds&lt;br&gt;Hatching and brooding (for poultry)&lt;br&gt;Vaccination&lt;br&gt;Fodder and feed preparation&lt;br&gt;Feeding&lt;br&gt;Management (for each type of livestock)</td>
</tr>
<tr>
<td>Post-harvest technology</td>
<td>Handling, storing, processing and packaging of each agroforestry product</td>
</tr>
</tbody>
</table>

Assessment of agroforestry systems

The ability to properly assess agroforestry systems is an important skill. Ways to evaluate the ‘quality’ of an agroforestry system must be mastered. The general criteria and indicators used in assessment include productivity, sustainability and adoptability of any system or practice. The importance of socioeconomic factors for adoption of agroforestry innovations needs to be emphasized.

- Productivity aspects of agroforestry: tangible and non-tangible outputs and benefits from an agroforestry system
- Methods for quantifying productivity
- The concept of sustainability of agroforestry systems in the context of integrated natural resource management
- Adoptability considerations: social and cultural acceptance; importance of local knowledge, practice and capacity; as well as equity and gender issues
Method

- Lectures, discussions and field trips can be used to introduce the topic
- Students' experiences can be especially interesting to share among the learners. This should lead students to understand and document different agroforestry systems and practices encountered locally. Appropriate field visits must be planned either for the whole class at one time or in smaller groups if the class is big.
- Every student could be asked to produce a list of local agroforestry systems, the outline of which should be first discussed with the teacher. Student reports should be ideally presented to the whole class after which a collated picture of each existing system and its characteristics can be developed.
- Evaluation of student achievements can be based on the quality of reports produced and their individual presentation to the class. This exercise may be in the form of an assessment.
- Lectures and class discussions, posters and slides on principles and theory of productivity, sustainability and adoptability. **Key question:** What are the important indicators of productivity, sustainability and adoptability related to agroforestry systems? How can these be measured and determined?
- Field observation and discussion on agroforestry demonstration areas and villages practising an agroforestry system. **Key question:** What are the issues related to the criteria of a good agroforestry system observed and learned from the field?
- Field exercises to measure/determine productivity, sustainability and adoptability of an agroforestry system. This can be done after familiarizing the students with different methodologies for evaluating productivity, sustainability and adoptability, for example reading assignments on a particular report (evaluation reports or thesis) dealing with the topics.
- Case studies—through slides and/or videos

Bibliography


Chapter 6.

Institutions and policies related to agroforestry

Good and appropriate technologies are only part of the key to successful agroforestry development. Two other areas that need to be analysed are policies and institutions. Policies need to be conducive to empowering small-scale farmers and to the promotion of sound agroforestry activities. Policy constraints need to be properly considered and addressed. Supporting institutions at all levels are needed to give small-scale farmers strength, and to help encourage the adoption of appropriate agroforestry practices at the local level. This chapter includes the following topics:

- Institutional contexts
- Policies and programmes related to agroforestry

Institutional context

The institutional context is essential to natural resource management and agroforestry. A whole range of international, national, provincial and local institutions influence what happens in the field. To know which these institutions are and to understand what they do and how they interact is one key learning point in agroforestry education and training. The main categories of institutions with a bearing on agroforestry are discussed in this chapter.

Main learning points

- To appreciate that technologies are not enough—functioning institutions are also needed for agroforestry development and sustainable natural resource management.
- To be familiar with the important institutions of relevance to agroforestry and understand their roles or potential roles in developing and scaling up agroforestry innovations.

Contents

Government institutions

Many government agencies are involved in natural resource management and have rural development responsibilities. It is a common case that agroforestry falls in a no-man’s land in the government structure, for instance, in-between the departments of forestry and agriculture. Alternatively, agroforestry might
be a domain for several government units and, therefore, prone to conflict of interest. Institutions to discuss in this context include:

- Government agencies with a mandate related to agroforestry and the function of those agencies in relation to agroforestry and natural resource management
- Government agencies involved in extension programmes related to natural resource management
- Government administration at various levels: national, regional and local (including provincial, municipal, district and village levels)

Non-governmental organizations (NGOs)

- Local, national and international NGOs involved in rural development and environmental conservation, etc.
- Overview of NGOs with a role in agroforestry development, and agenda and mandate as well as programme thrusts and priorities of those organizations
- Links, interactions and collaboration between NGOs, the government sector and local institutions and local people

Private sector

Characteristics of the private sector should likewise be dealt with in the agroforestry course (after all, most farmers are doing business with them, directly or indirectly!):

- Overview of the private business sector
- Entry points for involvement in the private sector of smallholders and village organizations
- The private sector links and functions in the rural areas
- Market forces and functions
- Local institutions in relation to the private sector
- Sharing of resources and the benefits from agroforestry development

Community-based formal and non-formal institutions

The importance of community-based and farmer-led organizations is increasingly recognized. These include people's or village organizations, farmers' cooperatives and other farmer-led organizations, labour unions, associations, clubs, federations, etc. They continue to show a great capacity for creating change, since they actually involve the local people, responding to their own needs, goals and desires:
• Identity and profile of existing community-based and farmer-led organizations
• Roles and functions in agroforestry development, including market development for agroforestry products; and in scaling up agroforestry innovations
• Roles in monitoring and evaluation of agroforestry programmes

Research institutions
The institutional context includes local, national and international research institutions, as well as educational institutions with a research mandate. It should be noted that increasing emphasis is being put on the participation of local people in research through on-farm experimentation. The importance of local knowledge in technology development and a two-way flow of knowledge between researchers and the local people are increasingly recognized today.

• Identity of research institutions with agroforestry mandate
• Research programme thrusts and priorities
• The emphasis on field-based research and on-farm participatory experimentation
• Agroforestry research and development links at all levels

Training and education institutions
Training and educational institutions—from primary and secondary schools up to universities and non-formal training institutions—are key institutions at local, regional and national levels:

• Their identity and roles in capability building through formal and non-formal courses
• Roles of training and educational institutions in research and technology development
• Extension programmes in training and education institutions

Bibliography


Policies and programmes related to agroforestry

The policy and legal framework is of great importance for the sustainable management of natural resources. This section deals with the formal and non-formal policies and policy frameworks related to agroforestry, natural resource management and conservation, and with institutions involved in the formulation and implementation of those policies. What improvements in the policy framework are needed to make policies more supportive of agroforestry development?

Main learning points

• To be aware of the main laws and decrees that influence the management of natural resources in the country
• To understand the concept of tree and land tenure, including both the formal legal system and the traditional tenure systems
• To be familiar with policies related to land use, soil and vegetation, and socioeconomics, including trade and market policies
• To be familiar with national, regional and local development plans and programmes relevant to agroforestry and natural resource management

Contents

Laws and decrees

Laws and decrees in areas of importance to agroforestry and natural resource management, including those on:

• Forestry and agriculture including land tenure and land reform policies
• Nature and biodiversity conservation: national parks and other protected areas
• Decentralization, devolution and local governance in natural resource management
• International agreements and conventions with bearing on agroforestry, including the Convention on Climate Change, the Convention on Biological

Plans and programmes
Generally, national laws and policies are translated into long-term plans and programmes for implementation through the concerned government agencies and institutions, with the expected support and cooperation of the local people:

- Relevant plans and programmes that have a bearing, directly or indirectly, on agroforestry. These plans and programmes are generally implemented through the ministries of agriculture, forestry, environment and natural resources, education, local government, agrarian reform, trade and industry, finance, etc.

Land and tree tenure
Land and tree tenure, both formal and informal, affect resource access and property rights in many rural communities. Thus, tenure issues often serve as major facilitating or constraining factors for sustainable natural resource management:

- Existing policies and state regulations related to land and tree tenure
- Formal policies and the indigenous traditional systems and analysis and reconciliation of differences

Economics
Since agroforestry is an activity for providing farmers with cash income, as well as products for subsistence, policies related to economics are vital. A range of economic policies—local, national or international—may facilitate or constrain farmers’ opportunities to produce and sell agroforestry products:

- Market access and marketing mechanisms for agroforestry products
- Trade policies, such as trade tariffs, quotas, permissions and other types of trade control
- Credits and subsidies

Social aspects
Policies in the social area are also closely linked to agroforestry, since agroforestry is about people’s management of the natural resources:

- Gender roles
- Ethnic minorities/cultural groups: traditional knowledge, practice and values; customs and practices that govern management of agricultural land (for example ancestral domains in the Philippines).
- Land conflicts and conflict resolution, including policies, rules and regulations governing encroachments on public forest land; migration and large-scale commercial activities; implications for forest inhabitants/occupants and private landholders.
• Human resources development for the agriculture/forestry sector: formal and non-formal training; job market for the graduates.
• Infrastructure and other social amenities, for example transportation, farm to market roads, post-harvest facilities, communication, health, education, extension, cooperatives, credit institutions, etc.

Methods
• Lectures and discussions supplemented by field visits
• Organize seminar/workshop with government officials and policy makers as resource persons to discuss/review status and needs of policies, plans and programmes
• Use of policy issues/concerns as topics for special studies and thesis research
• Placement of students in strategic projects/offices to expose them to the realities of policy implementation
• Case studies. Example: The teacher presents information regarding problems and constraints related to slow adoption of agroforestry and soil and water conservation technologies in a certain community-based forest management project site. Based on actual mid-term evaluation by external evaluators, the students (trainees) will be divided into smaller groups where each group is required to recommend strategies to address the identified problems or constraints. At the end of the exercise, all groups will reconvene where each group discusses its own recommendations, and the reasons behind each recommendation. Allot an open forum after each group presentation. When all groups have presented their outputs, ask the students which learning experiences they have gained and what more they need to know.
• Assignment: Students will be assigned to read a certain policy study report or programme evolution report and to answer a series of questions asked by the teacher. Their answers should be discussed if the following session.

Bibliography

Relevant policy and administrative issuances (will vary from country to country).


Chapter 7.

Advancing agroforestry practices

Advancing agroforestry practices includes both research and development (R&D) activities. R&D are not separated, but a continuum of collaborative activities with farmers and communities who play a critical role in sustainable natural resource management. Other stakeholders are also involved in this process.

Earlier top-down approaches to agroforestry interventions emphasized the role of experts in the government, NGOs and the academic institutions, but disregarded the significant participation of local people. This led to a lack of local, accurate and applicable information, and a lack of two-way communication between planners and local people. This, in turn, caused misunderstanding, mistrust and low adoption of interventions.

Advancing agroforestry practices, therefore, involves a dialogue with local farmers and other stakeholders in a revolving cycle of planning, generation, testing and implementation of innovations, and evaluation of the impact. Research is integrated in this cycle to generate solutions to problems and fill knowledge gaps.

To facilitate this development in extension and participatory technology development activities is an important task. The framework below illustrates the cycle of advancing agroforestry practices (figure 7).

This chapter deals with

- Participatory planning: A situation analysis to characterize the current status, diagnose the problems and design suitable research and development interventions.
- Technology generation, testing and dissemination: Participatory research and development activities to generate, test and disseminate agroforestry technologies, while taking into consideration the role of institutional options as well as policy options.
- Monitoring and evaluation to reflect on the process used, the impact of the research and development activities and the productivity, sustainability and adoptability of the agroforestry innovations.
Figure 7. Advancing agroforestry practices.

**Participatory planning for agroforestry**

Planning is the process of preparing, in advance of action, and in a reasonably systematic fashion, recommendations for policies and activities so as to reach accepted objectives. In the agroforestry research and development context, planning is done using participatory tools, covering both biophysical and socioeconomic factors.
Main learning points

- To be familiar with the concepts of participatory approaches to community analysis, and the selection and use of appropriate planning tools
- To know how to carry out a characterization of biophysical and socioeconomic aspects in a community
- To diagnose problems and design appropriate agroforestry research and development innovations
- To set the boundaries for issues that the agroforestry team can address (for example not sanitation, health care, etc.)

Contents

Participatory methods and tools

A community analysis is required to examine interactions between the economic, social and biophysical systems. Participatory methods are used to collect and analyse community information. The analysis is normally carried out by interdisciplinary teams of, for example, researchers, extensionists and planners. This ensures that the local knowledge, skills and practices of farmers and local communities are fed into the process.

Participatory techniques also help mobilize and organize local people around issues they consider important. Local people analyse and make decisions based on the information they themselves provide. The learning is rapid, progressive and iterative (not a fixed blueprint). Information gathered could, for instance, provide a picture of the area, demonstrate current management issues and generate ideas on major constraints. In the agroforestry context, this enables local people to feel that they have ‘ownership’ and responsibility in the agroforestry programme. However, it is also important to understand that this may raise expectations that lie beyond what the agroforestry team can address (for example sanitation and health care, etc.).

A whole range of participatory tools for community analysis is available. They provide a ‘basket’ of tools and techniques for visualizing, interviewing and facilitating group work with farmers. The following are some of them:

- Farming Systems Research (FSR), an applied problem-solving approach conducted by multidisciplinary teams, with a degree of farmer-participation
- Agroecosystems Analysis (AEA)
- Rapid Rural Appraisal (RRA) uses a multidisciplinary approach, where specialists from different disciplines gather and analyse information as a team on a variety of technical subjects.
- Diagnosis and Design (D&D) is a methodology for the diagnosis of land management problems intended to assist agroforestry researchers and development field workers to plan and implement effective agroforestry innovations, particularly for agroforestry research.
Participatory Rural Appraisal (PRA) methodology builds upon local people’s capabilities, uses facilitation and participatory techniques, and empowers local people in the process.

Other planning tools that may be used in a participatory way include:
- SWOT analysis (strengths, weaknesses, opportunities, threats)
- Agroforestry Land Capability and Mapping System (ALCAMS)
- Geographical Information Systems (GIS)

Characterization and diagnosis
To arrive at a realistic plan for agroforestry research and development activities, it is necessary to conduct land use and farming household characterization and a problem diagnosis. Characterization is the description and analysis of agroecosystems in order to identify similarities and differences among these systems. Geographical boundaries and the principal components of the systems are identified. Interactions within and among systems are analysed based on ecological, economic, social and cultural criteria. This information is then used in a diagnosis of problems and constraints.

Data that may be gathered include biophysical features:
- Soil, climate, flora and fauna
- Topography and landform—slope and altitude, sun orientation and wind direction and wind force
- Water and hydrology
- Biological organisms—plants, animals, micro-organisms, aquatic life
- Land use practices and farming systems

Data that may be gathered also include socioeconomic and cultural features:
- Demographic profile: population size and structure, household categories, ethnic groupings, migration pattern
- Household composition and labour availability
- On- and off-farm household income; wealth ranking
- Gender
- Religion, beliefs, customs and traditions
- Economic factors: infrastructure, markets, support services (credit, farm supplies, research/extension)
- Preferences of food crops, cash crops and cropping calendar
- Land tenure and status, conflict resolutions
- Social problems (for instance related to health, education, accessibility, peace and order, illegal logging, slash-and-burn, etc.)
- Local organizations and institutions, leadership dynamics
Designing agroforestry interventions
The characterization and diagnosis is followed by the design of possible agroforestry interventions to address the discovered constraints. Simultaneously, research needs may be defined. The suggested options for agroforestry development and research are verified and evaluated in participation with farmers and communities. The output is an action plan of suggested agroforestry development activities, and identified research projects to address knowledge gaps.

As with characterization, several participatory tools and methodologies are currently in use to design improved and appropriate land use practices. All of these methodologies have the same essential features; each however has specific merits for specific situations. The designing tools need to cover three main areas:
- Options for agroforestry technology generation and dissemination
- Institutional innovations, in particular the role of farmer-led organizations
- Policy options and interventions

Methods
- Field exercises to conduct characterization, diagnosis and design. Students can test different approaches and report their findings in the class
- Conduct diagnostic field trips to gather experience from different agroforestry farms and models
- Brainstorming
- Group discussion
- Interviews

Bibliography
Technology generation, testing and dissemination

This section deals with activities that relate to facilitating agroforestry innovations on farmers’ fields. The selection and application of the right approach to agroforestry technology dissemination and generation constitute the key to having an impact on farmers’ fields. To work and learn with farmers in a participatory way is essential. There is no ‘best way’ of achieving this, because each case represents a unique set of problems, constraints and opportunities and requires a unique approach. For agroforestry ‘innovations’ or ‘options’ to have a wide impact, the key conditions are

• Appropriate agroforestry technologies
• Enabling policies
• Facilitating institutions

Each of these areas requires attention in the implementation of agroforestry research and development activities. While policies and institutions are dealt with elsewhere in this guide, this section deals with technology generation, testing of existing and new technologies, and dissemination.

Main learning points

• To be familiar with available agroforestry technologies and innovations and be knowledgeable about the inputs required, key management aspects and post-harvest production and marketing aspects.
• To be aware of the importance of local and indigenous knowledge
• To be familiar with Participatory Technology Development and other tools for technology generation and testing with farmers
• To understand key principles and methods for technology dissemination, using different extension methods and communication skills to advance agroforestry practices
• To maintain or improve the quality of agroforestry products by suitable post-harvest and processing techniques
Contents

Participatory agroforestry technology development

While some fundamental research is carried out in a researcher-controlled environment, most agroforestry research today is done on-farm. The degree of farmer involvement varies, but there is an increasing recognition that the relevance and applicability of the research will improve with a high degree of participation. There is also a continuous flow of knowledge and skills between research and development. To be able to apply participatory methods and work with farmers is therefore important.

The ethnic and cultural variation is great in Southeast Asia. A good starting point in agroforestry development is therefore, often, the farmers’ indigenous knowledge. Starting with something familiar and moving on from there has a greater likelihood of success, rather than starting from scratch. The community analysis should provide the information on existing practices. The indigenous knowledge and technologies are further explored and developed and new technologies brought in and modified as appropriate, through a participatory technology development process:

- Agroforestry technology development as a participatory process, using appropriate research methods and tools, such as Participatory Technology Development (PTD)
- Combining indigenous practices and technologies and new technology innovations
- Identify, document and disseminate indigenous knowledge and technologies related to agroforestry and explore their production potential and constraints
- Plan and conduct participatory research project topics related to agroforestry
• Preparation of research proposals and protocol
• Experimental design and research implementation
• Communication skills and documentation skills
• Gathering and analysis of data
• Report preparation
• Monitoring and evaluation

Technology testing with farmers

Technologies are tested and verified in participation with farmers and other stakeholders, and the biophysical and socioeconomic performance and possible adoptability of technologies are evaluated. The testing, verification and evaluation include

• Farmers’ preferences
• Labour requirements
• Identification of potential ‘bottle-necks’
• Gender analysis
• Financial and economic analysis, and estimation of costs and benefits of agroforestry systems (various evaluation criteria: net present value (NPV), internal rate of return (IRR), benefit/cost ratio (B/C), return on investment, pay-back period).
• Rural credit system analysis

Technology dissemination

When existing or improved agroforestry innovations have been tested with farmers, dissemination, or ‘scaling-up’ follows. Providing an expanded range of options for farmers is a key component in agroforestry dissemination. This may lead to a greater diversity of farm activities. Diversifying the farming activities adds income, spreads risks and can provide better food and nutritional security. What happens after the harvest of agroforestry products, often, has a significant importance for the overall output or income. Post-harvest techniques and processing of agroforestry products are therefore important aspects of technology dissemination. Technology dissemination includes a wide range of technical as well as process-based competencies:

• Select and apply appropriate agroforestry options and livelihood projects, including post-harvest and processing techniques.
• Marketing aspects related to agroforestry products: conducting market surveys and assessing of market demand, and methods to label and promote finished agroforestry products.
• Entrepreneurship
• Practical skills related to training topics in the community, for example, seed production and nursery management, bee keeping, sericulture, mushroom production, poultry raising, food processing, aquaculture, etc.
• Methods and approaches to transferring agroforestry options in an appropriate way: extension and communication methods and skills; farmer-based extension methods.
• Farmers’ organizations, which can support the dissemination process
• Planning and implementation of agroforestry extension
• Continuous monitoring and evaluation of agroforestry extension

Methods
• Brainstorming, group discussion
• Computer analysis
• Practical field exercises (‘practicum’)
• Field trips on manufacturing agroforestry products and agroindustries
• Field visits
• Group discussions
• Interviewing farmers
• Role-play
• Visiting and interviewing farmers, middlemen, and sellers to be able to compare the prices
• Visiting demo-farms

Materials
• Case study examples
• Example proposals
• Examples of research proposals
• Guidelines
• Handouts, sample of feasibility studies
• Manuals
• Visual materials (slide series, video), manuals, guidelines, examples

Bibliography
Monitoring and evaluation

Monitoring and evaluation are an integral part of a programme cycle. Monitoring is a continuous internal process of information collection, recording and reporting in an ongoing programme. Evaluation is a process for assessing the performance and output of a programme or activity. The evaluation tests the conformity vis-à-vis the agreed plan, provides feedback for improving ongoing activities, and assists management in future planning.

In the case of agroforestry, evaluation is particularly linked to impact at farmer level. Testing and evaluation of options are done with farmers as an important step, before dissemination and technology generation take place (figure 7 above).

After implementing the agroforestry innovation, monitoring and evaluation should be taken into account. Since the basic attributes or goals of all agroforestry systems are productivity, sustainability and adoptability, the monitoring and evaluation must consider those attributes.

This section will outline the development of a methodology for evaluating and monitoring agroforestry innovation.

Main learning points

- To appreciate the needs for monitoring and evaluation as part of programme implementation
• To be familiar with the most common methods and tools for monitoring and evaluation
• To be able to integrate monitoring and evaluation within an agroforestry innovation activity

Contents

Background to monitoring and evaluation
• Define monitoring and evaluation, and explain the similarities, differences and relationships between the two processes
• Discuss the advantages of monitoring and evaluation in a programme/project

Evaluation principles
• Productivity evaluation: Express the productivity of the different outputs in measurable, quantitative and meaningful terms, for example, quantity and quality of the produce. Other examples of measurements are for instance: Land Equivalent Ratio (LER) and Harvest Index (HI).
• Sustainability evaluation: Define sustainability in the context of agroforestry interventions. Discuss criteria and indicators for sustainability. Are the agroforestry interventions sustainable from biophysical, ecological/environmental, social and economic points of view?
• Adoptability evaluation: Indicate the adoption of the agroforestry innovations by farmers. Set up the criteria and indicators of agroforestry adoption. List and discuss biophysical and socioeconomic factors affecting the adoption of the innovations.

Evaluation of agroforestry innovations
• Discuss the role of evaluation of an agroforestry innovation, and suggest the procedure for how an evaluation could be conducted
• Criteria and indicators to be included for evaluating an agroforestry innovation: social relevance (suitability), profitability, versatility and creativity, and longevity and reliability.
• Questionnaire to conduct the evaluation

Methods and tools
• Discuss the overall goals of the agroforestry innovation, and discuss suitable methods and tools for monitoring and evaluation, including for example: participatory monitoring and evaluation (PME); impact assessment; environmental impact assessment (EIA); external and internal evaluation.
• Brain storming
• Field visits to farmers
• Group discussions
Materials

- Manual
- Case study example

Bibliography


## Glossary

**Agroecosystem**
A systems view of a farming enterprise in a landscape context, including physical, environmental, economic and social factors.

**Biodiversity**
The variety of life on earth, including all plants, animals, microorganisms, the genes they contain and the complex ecosystems they help form.

**Carbon-stock**
Carbon stored in vegetation or soil (above ground standing biomass, under-storey, litter, roots and soil organic matter).

**Catchment area**
The area of land contributing to the flow of a specific stream or river.

**Ethnological diversity**
The variation in ethnic groups or communities in a given region, with their differences in perception, knowledge, values and resources.

**Evaluation**
A process of assessing and monitoring results for conformity with agreed objectives in order to improve ongoing activities and better plan future ones.

**Leaching (of nutrients)**
The dissolving and washing away of nutrients (e.g. down the soil profile by the action of rain water).

**Microclimate**
The specific climatic conditions as found in small areas, for example, around plants.

**Mineralization**
The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.

**Monitoring**
A continuous process of information collection, recording and reporting.

**Mulch**
A non-mineral layer on top of a soil profile, usually consisting of plant residues, that reduces the direct impact of rain, sun or wind on the soil.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Mycorrhiza</td>
<td>A fungus-plant association in which fungal structures inside or directly around a plant root are connected with hyphae exploring the soil.</td>
</tr>
<tr>
<td>Nutrient pump</td>
<td>A deep tree root system, that takes up nutrients in deep soil layers and brings them to the surface in the tree and its litter fall.</td>
</tr>
<tr>
<td>Resource capture</td>
<td>The processes by which plants obtain light, water and nutrients.</td>
</tr>
<tr>
<td>Root channel</td>
<td>A channel formed by a decayed root.</td>
</tr>
<tr>
<td>Safety-net for leached</td>
<td>Deep tree root systems that take up nutrients that have been leached down the soil profile, out of reach of crop roots.</td>
</tr>
<tr>
<td>Nutrients</td>
<td></td>
</tr>
<tr>
<td>Slash-and-burn system</td>
<td>A technique for land clearing to prepare for planting of annual food crops or trees. The term is also used as a synonym for ‘swidden’ cultivation and ‘shifting cultivation’ where cropping periods alternate with a fallow period during which natural vegetation can reclaim the land.</td>
</tr>
<tr>
<td>Soil organic matter</td>
<td>Material found in soil derived from living matter; it includes labile and stable forms.</td>
</tr>
<tr>
<td>Sustainable land use</td>
<td>Land use that maintains productivity of the land while conserving or enhancing the resources on which future production depends.</td>
</tr>
<tr>
<td>Watershed</td>
<td>Originally the boundary between two catchment areas. Currently often used as synonym of catchment area.</td>
</tr>
</tbody>
</table>
Annex 1. List of organizations

A range of resource materials and information is available from national and regional organizations—often free of charge. Some of these organizations are mentioned below. The Internet is also an excellent source of materials. But since it is constantly being updated, we have not provided specific addresses; we do recommend that you visit the sites of major organizations such as the International Centre for Research in Agroforestry (ICRAF), United Nations Food and Agriculture Organization (FAO), and others.

The following list of organizations in Southeast Asia might be helpful for agroforestry curriculum development purposes:

Regional Organizations

<table>
<thead>
<tr>
<th>Organization</th>
<th>Address</th>
<th>Tel</th>
<th>Fax</th>
<th>Email</th>
</tr>
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<tbody>
<tr>
<td>FAO Regional Office for Asia and the Pacific</td>
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<td>+66 2 281 7844</td>
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