

# Agroforestry: The role of trees in Smallholder farming

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# Outline

1. Agroforestry Basics
2. Characteristics of Agroforestry
3. Benefits of Agroforestry
4. Agroforestry Practices



# Agroforestry Basics



# What is Agroforestry?

- “Trees in the agricultural landscape”
- “Trees and crops intentionally cultivated together”
- “Land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land-management unit.
- (Roger Leakey)

# What is Agroforestry?

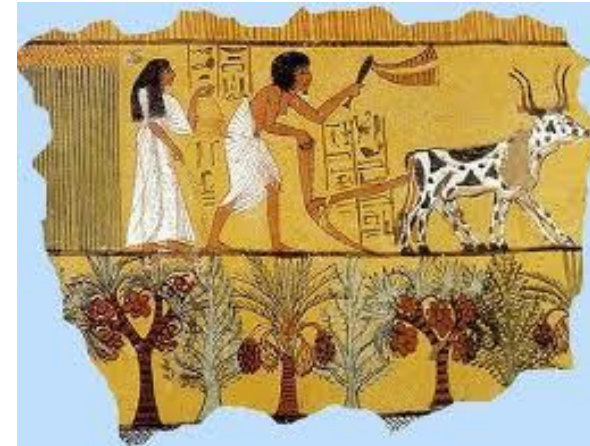
- “Agroforestry is a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains smallholder production for increased social, economic, and environmental benefits”  
(Dennis Garrity, 2005)

Key words: Dynamic, ecologically based, management system

Values: Social, economic, environmental benefits

# What is Agroforestry?

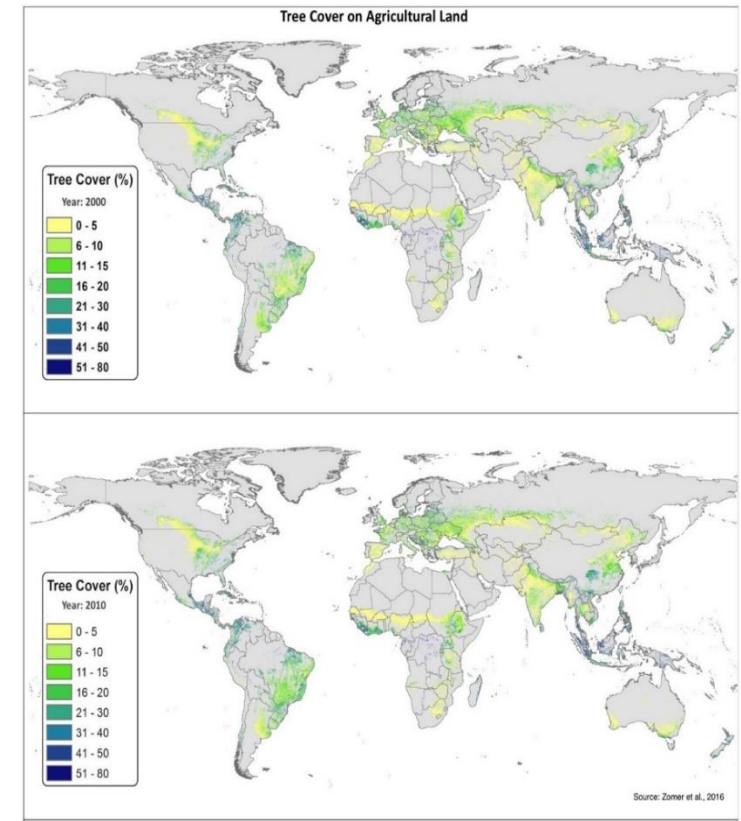
- Agro + Forestry
- *“a new name for a set of old practices”* (Nair)
- An ancient agricultural practice combining the management of annuals crops and/or animals with trees.
- “Discovered” in the late 20th century
- Examples in both the tropics and temperate regions



The homegardens of Kerala, India are thought to be at least 4000 years old!

# Global Extent of Agroforestry

- Where do we find agroforestry systems?
  - Agricultural land with >10% tree cover
  - 43% of all agricultural land (in 2010)
  - Practiced on 1 billion hectares of land supporting 900 million people
  - Potential to expand onto 1.6 billion hectares of degraded land
- Three major tropical ecological zones:
  - Semi-arid and arid tropics
  - Lowland humid and subhumid tropics
  - Tropical highlands



(Zomer et al, 2016)

# Semi-arid and arid tropics

- Savanna and Sudano-Sahelian zone of Africa
- One or two wet seasons and one long dry season
- Common agroforestry systems:
  - Silvopastoral systems
  - Windbreaks and shelterbelts
  - Multipurpose trees on cropland



# Lowland humid and subhumid tropics



- Hot, humid climate
- Evergreen or semi-evergreen vegetation
- Climate conditions favor rapid growth
- Common agroforestry systems:
  - Shifting cultivation
  - Taungya
  - Multilayer tree gardens
  - Homegardens
  - Plantation-crop combination
  - Intercropping systems

# Tropical Highlands

- 20% of the tropics is between 900-1800 meters
- Soil erosion a major concern
- Common agroforestry systems:
  - Plantation crops such as coffee and tea
  - Wood perennials for soil conservation and fertility
  - Silvopastoral systems



# Goal of Agroforestry

- Alleviate poverty (Enrich the asset base of poor households)
  - Food security and income generation
- Enhance soil fertility and livestock productivity
- Balance productivity with the sustainable management of natural resources
- Increase the ecological stability of the land (resilience)
- Maintain and Enhance the supply of environmental services
  - Soil and water resources, carbon sequestration, wildlife habitat

# Characteristics of Agroforestry Systems



P. Van Asten, IITA

# Characteristics of Agroforestry

- Intentional – Design, purposeful (not accidental)
- Intensive – Highly productive systems (in contrast to extensive)
- Integrated - System components are managed as a unit—not independently
- Interactive - Components influence other components - Manage to encourage beneficial interactions

(Gold and Garrett)

# Characteristics of Agroforestry

- *“Over time, the increasing integration of trees into land-use systems through agroforestry can be seen as the passage towards a mature agroforest of increasing ecological integrity.”*

(Leakey)

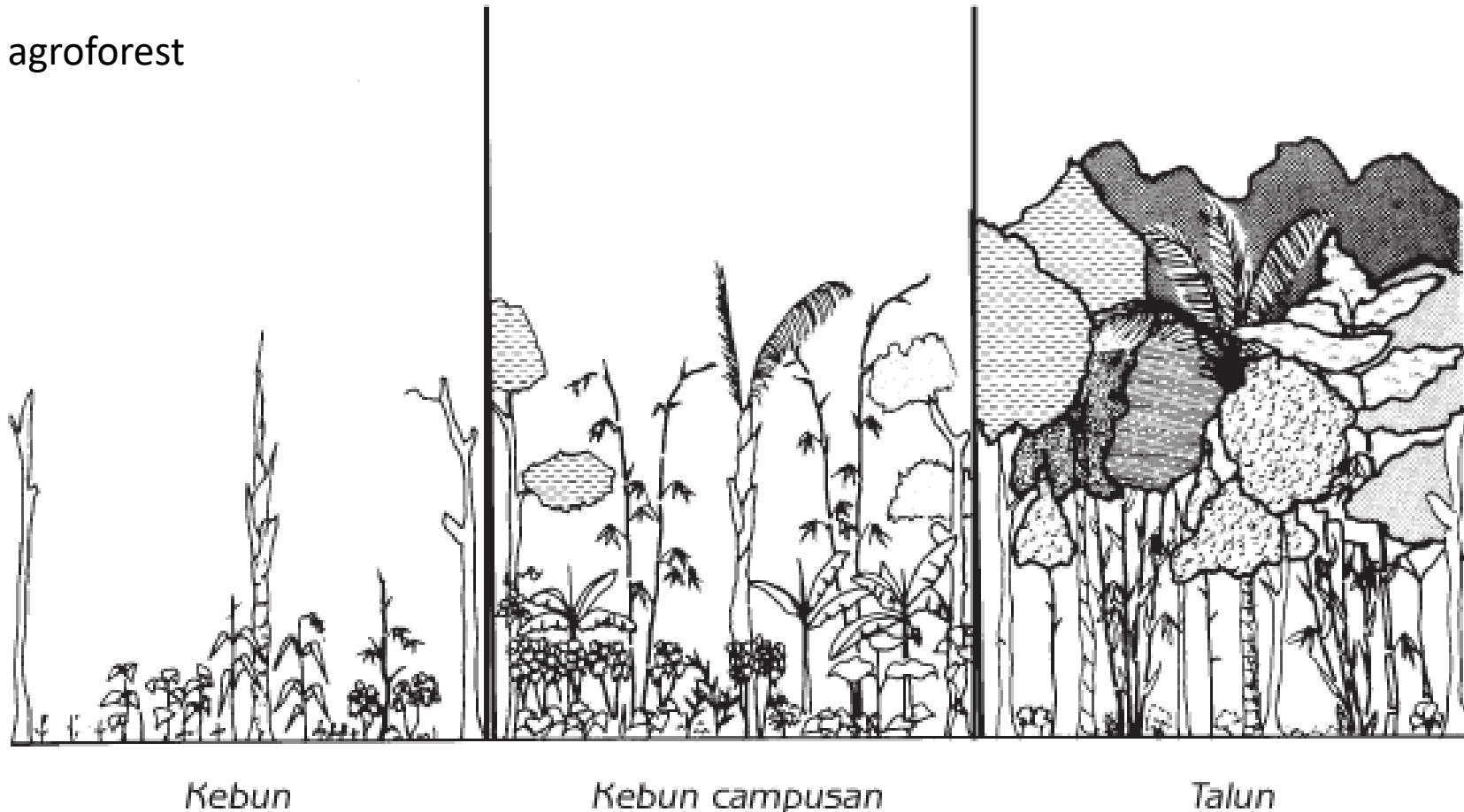
- As agroforests *“become more complex, biodiverse and both ecologically and economically resilient to the normal patterns of climatic variability and pest and disease outbreaks.”*

(Leakey)



# Agroforestry systems resemble highly productive 'early forest succession'

Javanese agroforest



(Kumar and Nair 2004)

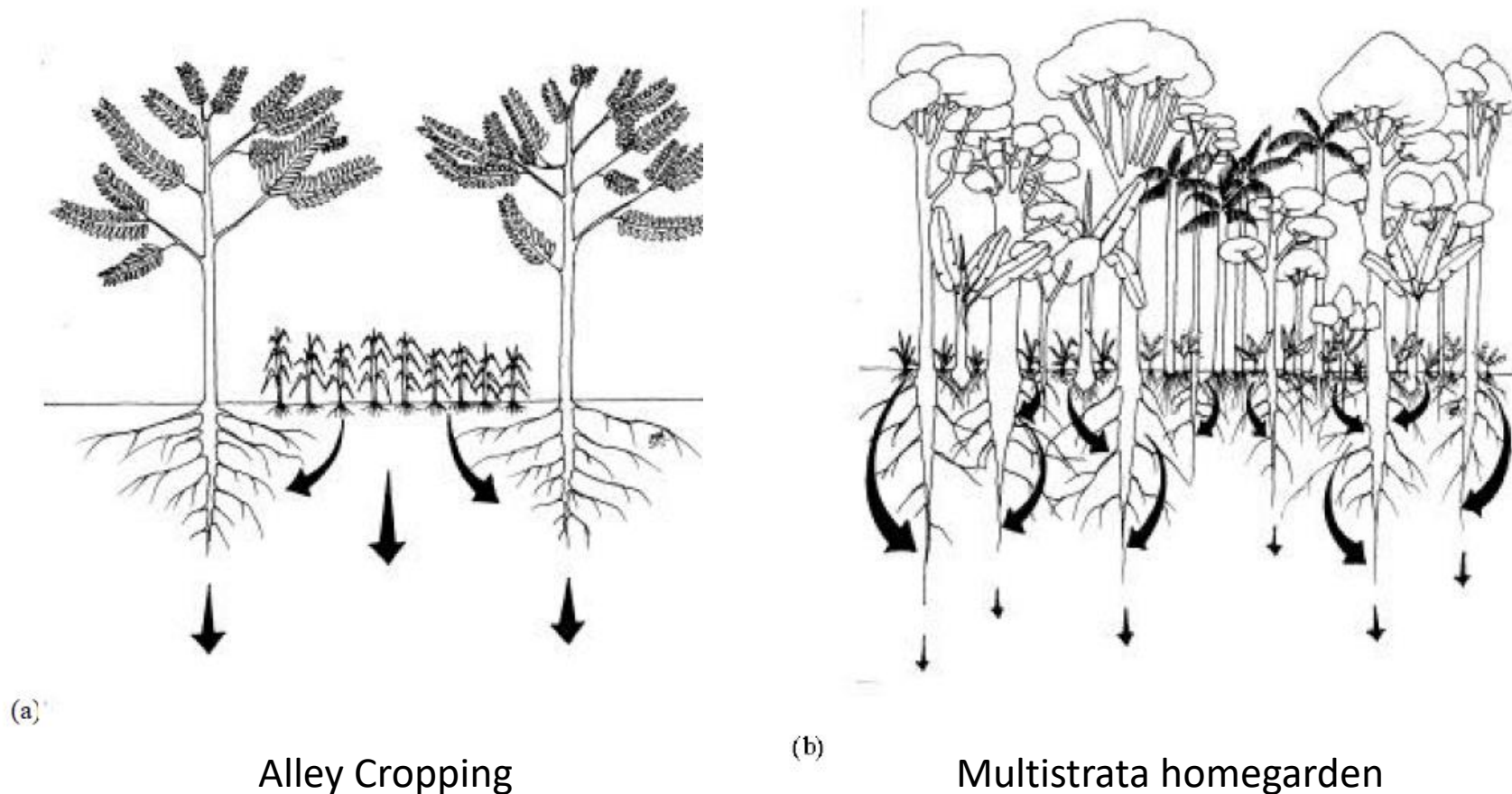
# Vertical and Horizontal Structure

- Agroforestry systems will often display multiple vertical layers
  - Ground layer of annuals and shade tolerant perennials
  - Intermediate layer of smaller fruit and fodder trees
  - Upper layer of larger fruit and timber trees
- They “utilize water, light, and space” resources efficiently because of their complex vertical and horizontal structure

# Benefits of Vertical stratification

- Light Capture: Agroforestry systems can be “more productive” per unit area based on the concept that multiple layers capture greater amounts of light resources and allow for efficient nutrient cycling. (Montagnini 2006)
- High tree density enhances nutrient cycling:
  - High litterfall
  - Low nutrient export
  - High root activity

# Safety-net role of multi-strata Agroforestry systems:



(Seneviratne et al. 2010)

# Benefits of Agroforestry

# Benefits of trees to farmers

- Fertilizer trees for land regeneration, soil health and food security
- Trees provide fruits and nuts for people as well as fodder for animals
- Timber and fuelwood trees for shelter and energy
- Trees can provide fencing or barriers around farms
- Medicinal trees to combat disease
- Marketable products that generate income

# Fertilizer Trees

- Biological Nitrogen Fixation provides a free source of nitrogen
- Many leguminous (and a few non-legumes) trees supply nitrogen to annual crops
- Deposition and decomposition of leaf litter and biomass increases soil mineral nitrogen and improves soil health
- *Examples: Faidherbia albida, Gliricidia sepium, Inga edulis, Parkia biglabosa, Tamarindus indica, Alder (Alnus spp.)...*



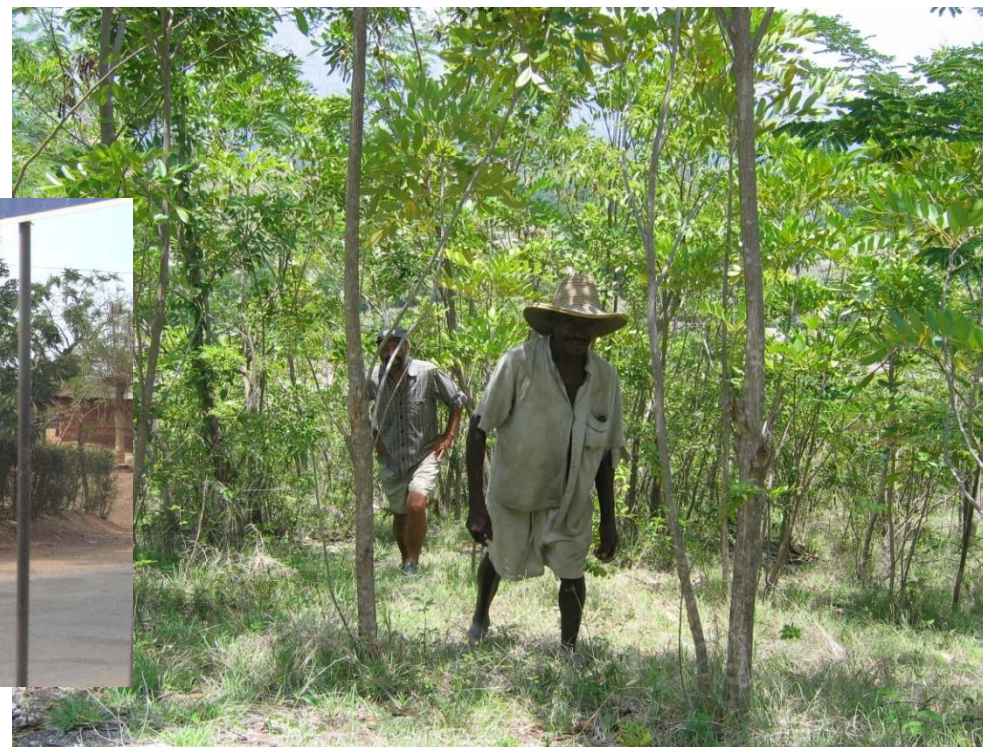
# Trees provide Fruits and nuts

- There is an amazing diversity of fruit and nut trees available
- Important for food security and income generation



# Fuelwood and Timber

- Fuelwood for cooking can be produced on the farm
- Timber for construction is an investment opportunity for small holders



# Fencing and barriers/shelterbelts

- Red Mombin (*Spondias* spp.) posts for a living fence in Nicaragua
- *Gliricidia sepium*, *Bursera simarouba*, *Commiphora africana*



# Trees provide medicine

- Ethnopharmacology is devoted to study of traditional medicines
- Traditional medicines commonly are derived from trees
- A common feature of many homegarden agroforests are medicinal plants
- Chiapas, Mexico: 35% of plants had medicinal uses
- Vietnam: 32% of plants were used for medicine



Photo: Verina Ingram/CIFOR



- Baobab
- Neem
- Prunus africana
- Soursop

# Challenges and obstacles

- Insecure land tenure
- Availability of tree seeds
- Establishment time—usually 1 to several years
- Roaming animals
- Theft/foraging for fuelwood
- Fire
- May attract insects, birds or animals that become pests
- Management complexity
- Cultural obstacles to tree planting



# Agroforestry Practices



# Shifting Cultivation/Swiddon

- Certain trees are retained in forest clearings
- Nitrogen fixing species, fruit trees, and medicinal trees.
- Sustainable given sufficiently long fallows and low population density.



Source: Prashant N S, 2006, Wikimedia

# Taungya

- In Burmese:
  - taung = hill, ya= cultivation
- Originally used to promote establishment of teak plantations in British India (Nair, 1993).
- Farming annual crops between timber trees
- Practiced widely throughout the tropics
  - *Gr. Waldfeldbau, Fr. cultures sylvicole et agricole combine, Sp. parcelero, Sw. shamba system*



# Shaded Coffee, Cacao, Tea

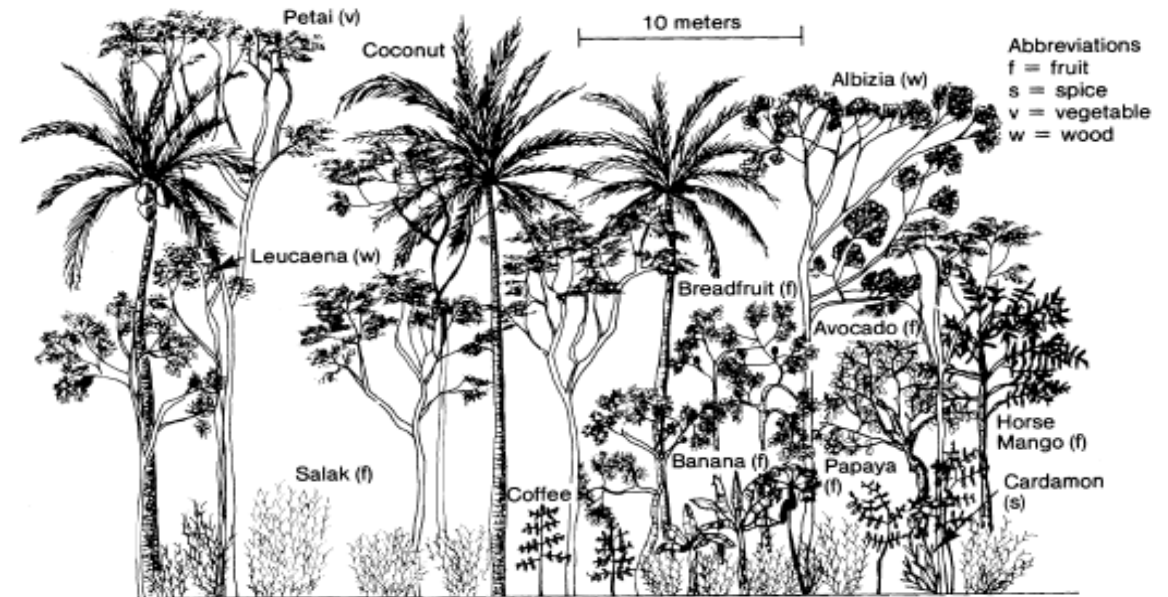
- High value tropical crops are grown in agroforestry systems under managed tree canopies for various benefits.
- Shade tree species: Erythrina sp., Gliricidia sepium, Inga sp., Cordia alliodora



# Multistrata Agroforests

- Multistory or multi-level gardens
- High species diversity
- High structural and functional diversity (closely resemble forests)
- Contain fruit, nut and timber tree species and annuals
- Java, Indonesia - Kerala, India - Chagga Gardens, Tanzania
- Estimated high rates of carbon sequestration

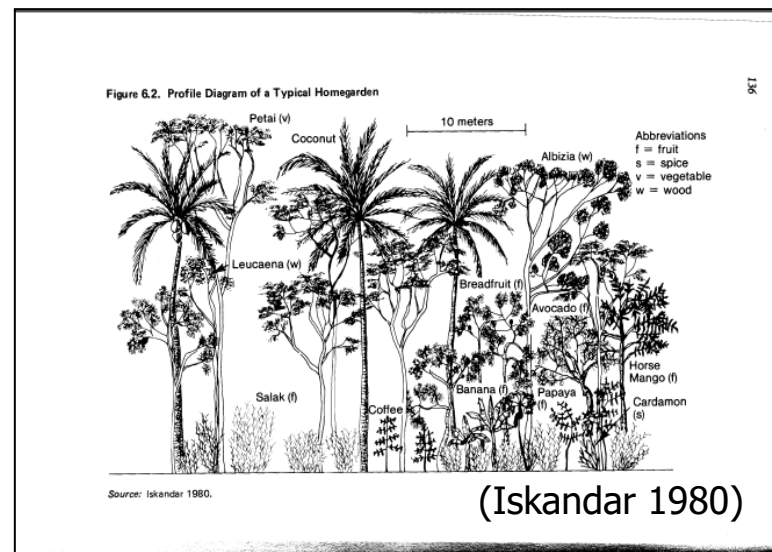
Figure 6.2. Profile Diagram of a Typical Homegarden



Source: Iskender 1980.

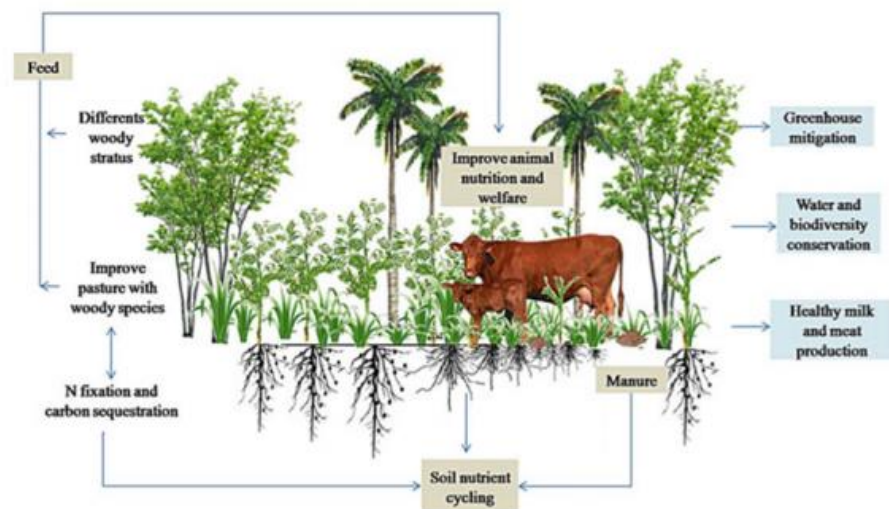
# Homegarden Agroforests

- “the oldest land use activity next only to shifting cultivation” (Kumar and Nair 2004)
  - Home garden agroforests of Java, Indonesia
  - Agroforests of Kerala, India
  - Chagga homegardens, Kilimanjaro, Tanzania
  - Huertos Familiares, Oaxaca, Mexico



# Silvopasture Systems

- Combinations of Trees and Pasture and/or animals
  - Timber trees, pasture and cattle
  - Fruit trees and poultry or sheep
- Livestock benefit from shade and reduced stress
- Timber/tree products diversify income



Source: Solorio, et al. 2017



# Improved Fallow

- Traditional fallows are 10-15 years
- Improved fallow restores fertility in 1-2 years.
  - *Acacia angustissima*
  - *Gliricidia sepium*
  - *Calliandra calothyrsus*
  - *Leucana sp.*
  - Pigeon Pea-*Cajanus cajan*
  - Sun hemp-*Crotalaria sp.*
  - Fish Bean-*Tephrosia vogelii*



Pigeon Pea  
*Cajanus cajan*

# Alley Cropping

- Annual crops are grown between widely spaced hedgerows of planted shrubs and trees
- Hedge is pruned periodically during cropping season
- Plant material is 'mulched' onto crop area
- Best suited for humid and subhumid tropics
- Not generally suitable for areas with less than 1000mm of rain

# Inga pineapple intercrop





Leucaena and cowpea

Photo: IITA



Gliricidia and soybean

Photo: IITA

# Parklands Dispersed Tree Systems

- Parklands are the traditional agroforestry systems of semi-arid West Africa or Sahel region
- Common species include: *Faidherbia albida*, *Parkia biglobosa*, *Vittelaria* (Shea), *Tamarindus indica*...





# Farmer Managed Natural Regeneration

- Toni Rinaudo – World Vision
- Farmers manage the regrowth of select trees in their fields
- Select several shoots from existing stumps
- Wood poles are valuable
- Trees benefit soil and landscape



# Contour Hedgerows/Living terraces

- Soil conservation and crop diversification
- Typically using leguminous trees
- SALT system: Developed in the Philippines
- Management intensive



# Fodder Banks (Protein Banks)



# Shelterbelts-Living Fences



# Woodlots for Fuelwood Production

International  
Agriculture  
Conference

20  
20



# Is this Agroforestry?



# Is this Agroforestry?



Or this?



Or this?



- ECHO's platform for *Agricultural Information Resources, events, and seeds* Technical resource, events, seeds and networking site for agricultural development practitioners.

The screenshot displays the ECHOcommunity.org website. At the top, the ECHO community logo is on the left, and navigation links for 'Contact Us', 'Member Options', and a search bar are on the right. Below the header, a 'Resources' section features a dropdown menu with options: 'By Region', 'Plants & Seeds', 'By Topic', 'By Publication', 'Education and Events', and 'Research'. A language selector shows 'English | Change Language'. The main content area is titled 'ECHOcommunity Updates' and features an article 'The Value of a Seed: Growing a Network of Community Level Seed Banks in Asia' dated 2018-09-20 by Patrick Trail. The article includes a photo of red corn cobs and a brief description of ECHO's mission. To the right, a 'Conversations going on right now' sidebar lists active discussions with user avatars and titles. Below this is a 'SIGN IN' section with input fields for username and password, a 'Keep Me Signed In' checkbox, and a 'Sign in to ECHOcommunity' button. Links for 'Forgot your password' and 'Register' are also present. At the bottom, an 'About ECHOcommunity' section explains the platform's purpose, followed by a world map highlighting ECHO's regional focus in Latin America, Africa, and Asia. A 'CALENDAR' section at the bottom right shows dates for November 13-15, 2018.

## Resources:

By Region ▾ Plants & Seeds ▾ By Topic ▾ By Pub

### Agricultural Techniques

Agroforestry  
Conservation Agriculture (FFC, FGW)  
Dryland Farming  
Green Manure and Cover Crops  
GMCC Selection Tool  
SRI  
Community Gardens  
Urban Gardening  
Soil Life  
Fertilizers  
Plant Nutrition  
Plant Propagation  
Grafting  
Composting  
Vermiculture  
Pest Management  
IPM  
Beekeeping  
Permaculture  
Weed Management

### Appropriate Technologies

Appropriate Technology Key Resources  
Forum  
Seed Production and Storage  
Creating a Seed Bank  
Post Harvest  
Grain Storage  
Food Safety  
Food Processing and Preservation  
Construction  
Biogas  
Water  
Biochar

### Development

Agricultural Development  
Economics of Tropical Agriculture  
Cooperatives  
Value Chains  
Farming Systems

## Agroforestry

In simplest language, agroforestry is the production of trees and of non-tree crops or animals on the same piece of land. The crops can be grown together at the same time, can be grown in rotation, or can even be grown in separate plots when materials from one are used to benefit another. However, this simple definition fails to take into account the integrated concepts associated with agroforestry that make this system of land management possibly the most self-sustaining and ecologically sound of any agricultural system. Thus, a second definition of agroforestry would be the integration of trees, plants, and animals in conservative, long-term, productive systems.

Agroforestry can be considered more as an approach than as a single, finished technology. Although several finished systems have been devised and tested, such technology may require adjustment for particular situations. The flexibility of the agroforestry approach is one of its advantages.

[Connect to the Agroforestry Interest Group here.](#)

Please note that the links listed below may lead to additional resources which have not yet been added to this collection.

### Rate This Resource

🌟🌟🌟🌟🌟

### Permanent Links

<http://edn.link/gf2tr9>

#### 1. 📄 TN #25 Agroforestry Principles

Also available in: Français / Español  
1992-01-20 In simplest language, agroforestry is the production of trees and of non-tree crops or animals on the same piece of land. The crops can be grown together at the same time, can be grown in rotation, or can even be grown in separate plots when materials from one are used to benefit another....  
[Agroforestry](#) [Seed sources](#)

#### 2. 🌐 Agroforestry Interest Group

This group page exists so that individuals involved in Agroforestry around the world can connect. We encourage you to share the challenges you face in your Agroforestry endeavors, discuss lessons and techniques learned through your experiences, and share your story!  
[Agroforestry](#)

#### 3. 📄 Agroforestry

2015-10-06  
[Agroforestry](#) [Asia](#)

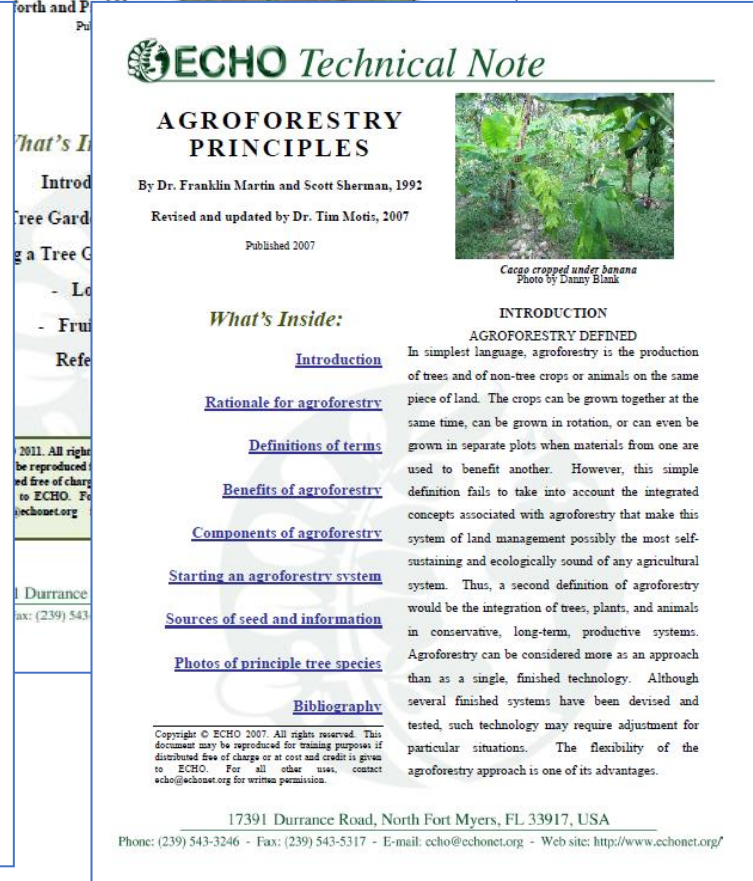
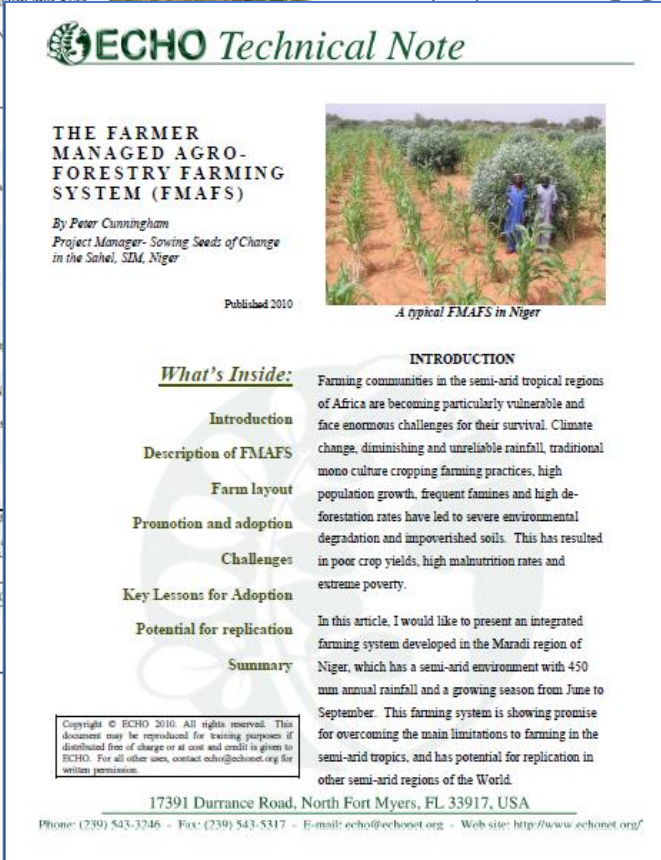
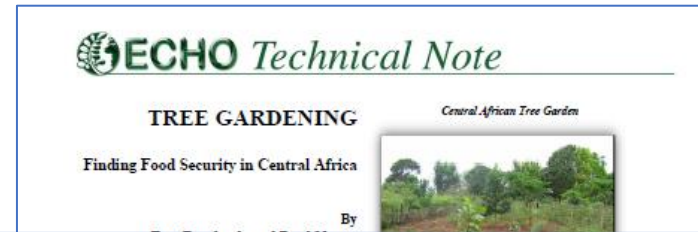
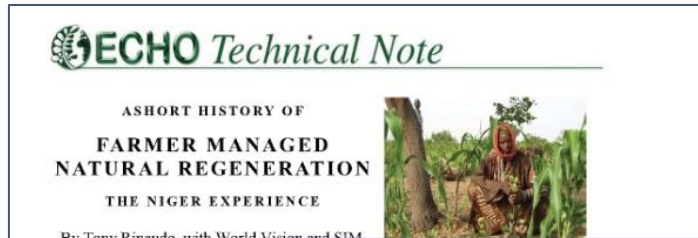
#### 4. 📄 A Lesson in Agroforestry

2004-07-01 Agroforestry: In its simplest definition (as quoted by ECHO's Technical Note "Agroforestry Principles"), "agroforestry is the production of trees and of non-tree crops or animals on the same piece of land." It should be viewed more as a creative process than as a set technique because it is...  
[Agroforestry](#)

# ECHO Agroforestry Resources

International  
Agriculture  
Conference

20  
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# Full Text Agroforestry Resources

International  
Agriculture  
Conference

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