Training Modules on

I. AGROFORESTRY

II. CONSERVATION AGRICULTURE WITH TREES

III. FARMER MANAGED NATURAL REGENERATION

Joyce Njoloma and Athanase Mukuralinda

Training Modules on

I. Agroforestry

II. Conservation Agriculture with Trees

III. Farmer Managed Natural Regeneration

Joyce Njoloma and Athanase Mukuralinda

Joyce Njoloma
Southern Africa Node
World Agroforestry Centre (ICRAF)
Chitedze Research Station
Along Mchinji Road
P.O. Box 30798
Lilongwe 3
MALAWI
J.Njoloma@cgiar.org

Athanase Mukuralinda
ICRAF Rwanda Offices
PO Box 227 Huye District
Rwanda Huye RW
A.Mukuralinda@cgiar.org

Table of Contents

Acknowledgement ... 6
Introduction ... 8
Facilitator's Guide ... 9

MODULE ONE ... 10
PRINCIPLES AND PRACTICES OF AGROFORESTRY ... 10
1 Module aim ... 11
2 Module Objectives ... 11
3 Reference Texts ... 11
SESSION 1 ... 12
AGROFORESTRY CONCEPTS ... 12
1.0 INTRODUCTION ... 12
1.1 DEFINITION, MPTS, POTENTIALS OF AGROFORESTRY ... 12
1.2 SUSTAINABILITY CONCEPT ... 16
1.3 TERMINOLOGY IN AGROFORESTRY ... 16
Practice ... 17
1.4 CLASSIFICATION OF AGROFORESTRY SYSTEMS ... 17
Purpose and criteria of classification ... 17
Structural Basis for Classification of Agroforestry Systems ... 18
1. Mixed/Zonal Arrangement ... 21
2. Dense/Scattered Arrangement ... 22
SESSION 2 ... 23
CLASSIFICATION OF AGROFORESTRY TECHNOLOGIES ... 23
1.5 MAIN AGROFORESTRY TECHNOLOGIES ... 23

MODULE TWO ... 31
CONSERVATION AGRICULTURE WITH TREES ... 31
2.1 Module aim ... 32
2.2 Module Objectives ... 32
2.3 Reference Texts ... 32
SESSION 3 ... 33
CONSERVATION AGRICULTURE ... 33
3.1 Introduction ... 33
3.2 Minimum soil disturbance ... 33
3.3 Maximum Soil Cover ... 34
SESSION 4 ... 38
CONSERVATION AGRICULTURE WITH TREES ... 38
4.1 Introduction ... 38
4.2 Conservation Agriculture with Trees ... 39
4.3 Evergreen agriculture for sustainable agriculture ... 40
4.6 Design and Management of Trees and Shrubs for Agroforestry ... 42

MODULE THREE ... 45
FARMER MANAGED NATURAL REGENERATION ... 45
3.1 Module aim ... 46
3.2 Module Objectives ... 46
3.3 Reference Texts ... 46
SESSION 5 ... 47
FARMER MANAGED NATURAL REGENERATION ... 47
5.1 Introduction ... 47
5.2 What is Farmer Managed Natural Regeneration? ... 47
5.3 The basic concepts of FMNR are as follows: ... 48
5.4 Benefits of FMNR ... 48
5.5 How to promote FMNR on a larger scale ... 49

Acknowledgement

The World Agroforestry Centre (ICRAF) acknowledges with profound gratitude the financial support from the USAID/Food for Peace Development Food Assistance Program (DFAP) called Fararano ("harvest season") in three of the most vulnerable regions of Madagascar through the Catholic Relief Services (CRS) office in Madagascar.

The authors would like to acknowledge the participation of various stakeholders in the process of developing these modules. All sources of information have been dully acknowledged.

Introduction

This training manual containing 3 modules on agroforestry, conservation agriculture with trees (CAWT) and farmer managed natural regeneration (FMNR) has been developed and compiled as part of the 5 year USAID/Food for Peace Development Food Assistance Program (DFAP) called Fararano ("harvest season") in Atsinanana, Vatovavy Fitovinany and Atsimo Andrefana regions of Madagascar. Fararano's goal is to reduce food insecurity and chronic undernutrition and increase resilience in the implementation sites. The programme output to which much of this manual will be of use falls under "*Purpose 3: Community capacity to manage shocks is improved*"

The training manual was initiated after ICRAF's scoping visits to some of the implementation sites for the period between 19th November and 1st December, 2015 with the objective of: "developing tailor made training modules and design agroforestry related intervention for soil fertility enhancement and; soil and water conservation that will ensure improved food and nutrition security". It also draws on ICRAF's past global experience and also related training manuals.

The adapted training modules contained in this training manual provide general understanding of principles and concepts of agroforestry, and its variants including evergreen agriculture, CAWT and FMNR.

Objectives and Target Audiences

This training manual is a compilation of technical tools, principles and concepts, and some examples of field practice in agroforestry, evergreen agriculture and FMNR. The authors aim to provide some basic understanding of technology principles and guide the trainers to facilitate community / farmers training in natural resource management and subsequent project activities planning and implementation in their respective programme areas. While it can be used by all the people engaged in natural resources management, the target audiences are the CRS – Fararano programme stakeholders (partners and communities).

How to use this manual

This manual is built upon the pedagogic philosophy of iterative learning whereby a concept or a tool is introduced at an early stage, and then returned to later on with further elaboration. This repetitive, but expansive, approach is fundamental to this work as it helps to relate the issues. It offers some definitions, and descriptions of the concepts which can then be adapted to the specific contexts of the users.

The three modules which follow are designed as training guides are:

- Module I: Principles and practices of agroforestry
- Module II: Evergreen agriculture and Conservation agriculture with trees
- Module III: Farmer managed natural regeneration

The users of this manual are strongly encouraged to modify and add to the contextual examples. Each training situation has its own special circumstances and special context. This guide will provide useful inspiration and guidance, but not necessarily a rigidly followed text.

Facilitator’s Guide

The facilitator should guide the participants to review the conventional farming system in Madagascar. This can best be done when the participants are divided into groups, small enough to ensure full participation of everyone.

Let the participants discuss the following issues:

- Current/traditional farming systems and its characteristics
- Factors encouraging this traditional farming system

After this exercise, summarize participants’ inputs and add information from the module notes

Thereafter participants should explain what they understand by conservation agriculture (CA), Conservation agriculture with trees (CAWT), their advantages and challenges.

Likewise, do the same for FMNR session.

- Each group should then present their findings in the plenary and key points should then be discussed.
- The facilitator should summarize participants’ inputs and add information from the module notes.

The facilitator should summarize the group discussions on the flip chart or power point presentation. These can be shared with the participants at the end of the training.

Practical or demonstration can be done mostly on tree management aspect such as pruning, thinning on tree stumps and tree selection under FMNR.

MODULE ONE

PRINCIPLES AND PRACTICES OF AGROFORESTRY

1 Module aim

Introduce to participants the scope, principles and applications of agroforestry in land use systems.

2 Module Objectives

By the end of the module, participants should be able to:

a. Define agroforestry and explain some of its basic concepts and terminology;
b. Discuss why and when agroforestry can be considered an appropriate and sustainable land use alternative;
c. List the common agroforestry technologies and practices; and explain how they can be classified based upon their structural classification;
d. Describe the various modes of component interactions in an agroforestry system;

.

3 Reference Texts

1. Nair, P.K.R (1989). Agroforestry systems in the tropics. Kluwer Academic Publishers. Dordrecht, The Netherlands.
2. Young, A. (1997). Agroforestry for soil management. 2nd Edition. CABI International. Oxford.
3. Huxley, P. (1999). Tropical agroforestry. Blackwell Science. Oxford.
4. Nair PKR and Garrity D. (2009). Agroforestry – The Future of Global Land Use. Springer. 541.

SESSION 1

AGROFORESTRY CONCEPTS

1.0 INTRODUCTION

This introductory module on the concepts of agroforestry gives you the background and a broad overview of agroforestry as an exciting or potential form of land use and a rapidly evolving science and provides you with a general framework for the course. More specifically, the module should enable you to:

i. Define agroforestry and explain some of its basic concepts and terminology
ii. Discuss why and when agroforestry can be considered a valid and sustainable land use alternative
iii. List the most common agroforestry technologies and practices and explain how they can be classified based upon their structural and functional analysis.

Module summary

The module defines agroforestry, describes its potential to alleviate major land use problems and indicates what type of interactions can be expected between its various components. The basic concepts of Multipurpose Trees and Shrubs (MPTS), and sustainability are also explained. The module further describes the main agroforestry technologies and practices and provides possible frameworks for their classification, including one using structural criteria to divide technologies into crops under tree cover, animal production under tree cover, Agroforests, agroforestry technologies with a linear arrangement, sequential agroforestry technologies and other technologies.

1.1 DEFINITION, MPTS, POTENTIALS OF AGROFORESTRY

Definition:
Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence *(Lundgren and Raintree, 1982).*

Other more recent definitions for this dynamic system include the following:

Basic definition: *The inclusion of trees in farming systems and their management in rural landscapes to enhance productivity, profitability, diversity and ecosystem sustainability (ICRAF, 2013).*

Broader definition: *A dynamic, ecologically based, natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies and sustains production and builds social institutions. (ICRAF, 2013)*

This definition has several implications.

1. *Agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;*
2. *An agroforestry system always has two or more outputs;*
3. *The cycle of an agroforestry system is always more than one year; and*
4. *Even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a monocropping system.*

Woody plants sometimes called ligneous plants are plants that contain lignin, an organic substance that impregnates and unites the cells and fibres of the plant. Woody plants are, with rare exceptions, perennial.

Trees, woody perennial plants that have a single main stem, constitute the majority of the ligneous plants.

Shrubs are small, usually multi-stemmed woody plants, while a bush is a low, densely branched shrub.

Woody vines (lianas) belong to ligneous plants, and generally require a support.

Bamboos, although they do not contain lignin, are considered to belong to the same class as woody perennials in agroforestry.

Trees, or other woody perennials, seasonal plants and animals are called the **components or elements** of agroforestry.

The last part of the definition of agroforestry by Raintree (1982) shows that to be beneficial the juxtaposition of the different components must have a positive effect on the entire land-use system through **ecological and economic interactions** between these components.

The interactions can be positive or negative. The interaction is **complimentary** if the presence of one component increases the yield of the other; **neutral** if one has no effect on the other, and **competitive** if the presence of one reduces the yield of the other. The aim of agroforestry is to identify positive interactions and maximise them while trying to reduce negative interactions.

The main **ecological interactions** in agroforestry are about climate (light, temperature, humidity, wind), soil (organic matter, nutrients, erosion), biological resources (plants and animals) and the space available for growth. Interactions between annual field crops and animals are not enough to make up an agroforestry land-use system: the presence of woody perennials is necessary for the system to be considered as agroforestry.

In technical terms, agroforestry is a science that distinguishes itself from both agriculture and forestry. Its **objective** is to optimise positive interactions between the woody and non-woody components, so that the production system may be more sustainable and diversified than with a conventional approach under given agro-ecological and socio-economic conditions.

Agroforestry holds much promise for resource smallholder farmers who live mainly from subsistence agriculture. However, there are some agroforestry practices that can be used in intensive land-use systems on large-scale farms, e.g., windbreaks, improved pastures and plantation forests.

Multipurpose Trees and Shrubs (MPTS)

In agroforestry, the tree is considered to be a **multipurpose tree** (often abbreviated as MPTS for "multipurpose trees and shrubs"). "Multipurpose" means that the tree plays several roles in the production system.

One of these roles is that of the **production** factor itself; fuelwood, fodder, food, medicinal products etc. Another group of roles includes the **services** rendered by the trees related to: soil conservation (fertility and erosion), microclimate, shade, land demarcation and socio-cultural aspects.

Multipurpose trees are considered to be the ones that are deliberately grown, kept or managed for more than one use, of either production or service nature or both.

Among the group of MPTS, the sub-group of **nitrogen-fixing trees** is worth noting. These trees are able to fix nitrogen from the atmosphere through symbiotic microorganisms present in root (and sometimes stem) nodules.

They thus increase nitrogen in the soil through green leaf manure and the litter that accumulates on the soil and through the decomposition of the nodules and roots. This supply of nitrogen can have a beneficial effect on the crops planted in association with these trees.

In addition, many of these trees (the majority of which belong to the Leguminoseae family) are also fast growing and produce fodder.

Potentials of Agroforestry

As pointed out earlier, agroforestry combines **production** and **service functions.** Many services of agroforestry can be seen as contributing to resource conservation, an undeniable quality of sustainability.

Some important **service roles** of agroforestry are:

1. **Soil conservation,** either erosion control (presence of a permanent soil cover, barrier effect against run-off), soil fertility maintenance (incorporation of green manure and leaf litter organic matter into the soil, nutrient pumping from the deep layers of the soil through the tree's roots, these nutrients then improving the crops through litter and mulch, nitrogen fixation) or soil physical properties maintenance.

2. The creation of a **microclimate,** which can be beneficial to certain plants and animals, for example modifications of light, temperature, humidity or wind, and can also help fight weed proliferation. Temperature on crop fields with trees may be up to 2°C low compared to fields with trees.

3. The **demarcation** of land and **definition of tenure** through tree planting on boundaries or on farmland.

4. A variety of **sociological roles** through the multitude of traditional functions that trees play in many civilizations, e.g., roles of trees for socialisation of people, religious and magical roles, symbols of social status.

Agroforestry assists in solving well-known problems in **three main agro ecological zones of the tropics:**

a. **Lowland humid tropics,** where agroforestry can play a role in maintaining soil fertility,

b. Areas with **steep slopes** (hills and mountains) where agroforestry can help to control soil erosion,

c. **Semi-arid** and **sub-humid zones,** which are used extensively for grazing, and arable farming where agroforestry can help to combat desertification.

Moreover the combination of several products that are both subsistence and income generating helps farmers to meet their basic needs and minimises the risk of the production system's total failure.

Seen in terms of problem areas, agroforestry can help to **mitigate deforestation** (because it addresses, in general, the issue of tree planting), can **combat land depletion** (because of its potential for soil conservation), and as a result, can contribute to the **alleviation of rural poverty**. Furthermore, agroforestry systems involving fruit trees can also enhance family food and nutrition security and income from the sale of fruits.

1.2 SUSTAINABILITY CONCEPT

Sustainability

The advantages of agroforestry mentioned above are not mutually exclusive, nor are they specific to each zone mentioned; they are only the most obvious being directly related to the presence of trees. They are part of a global concept known as sustainability.

A rural production system's sustainability corresponds to its ability to meet the ever-increasing human needs, without adversely affecting, and if possible improving, the resource base on which the system depends.

A sustainable rural production is only one of the elements in the global concept of sustainable development which includes a series of conditions outside the rural system that are classified as economic, social, ecological, political and institutional.

The main requirements of sustainable agriculture are:

1. Soil conservation, including erosion control and fertility maintenance;

2. The efficient use and conservation of existing resources (soil, water, light, energy, genetic resources, labour);

3. The use of biological interactions between the different elements of the agricultural system (for example, mulching, the association of climbing plants and supports, nitrogen fixation, and the biological control of weeds and diseases); and

4. The use of inputs that are easily available and of inputs and practices that ensures both health and environmental conservation.

1.3 TERMINOLOGY IN AGROFORESTRY

Agroforestry systems

Based on the definition of the word system and the application of the systems approach within the agroforestry framework, an **agroforestry system** can be defined as

"A set of interdependent agroforestry components (trees, with crops and/or animals) representing a current type of land use in a given region".

Practice

Agroforestry practice denotes "a specific land management operation of an agroforestry nature" (Nair, 1989).

Agroforestry practice is "a distinctive arrangement of [agroforestry] components in time and space" (Young, 1989).

The difference between the two definitions is that Nair (1989)'s definition gives a functional meaning while that of Young (1989) gives a structural aspect.

In both cases, "practice" remains a rather broad term. Alley cropping, boundary planting, intercropping, windbreaks, fodder banks, improved tree fallows are agroforestry practices. In the foregoing example, the practice could be called "scattered trees in crop land" or "crops under tree cover".

Technology

An agroforestry technology is a set of specifications for the roles, arrangement and management of MPTS and associated components Von Carlowitz (1989).

These specifications must include the technology related tree characteristics, referred to as the ideotype of the tree.

In common use, an **agroforestry practice** or a **technology** becomes a **system** once they are well developed and commonly used in a given region in such a way that it forms a well-defined land-use system for that region (Nair, 1985).

This is the current use of the expression "agroforestry system". For these reasons, the terms "technology", "system", and sometimes "practice", are often used one for the other in the agroforestry literature.

1.4 CLASSIFICATION OF AGROFORESTRY SYSTEMS

Purpose and criteria of classification

The purpose of classification should be to provide a practical and realistic framework for analysis of systems and development of agroforestry.

Any classification system should:

1. Include a logical way of grouping the major factors on which production of the system will depend;
2. Indicate how the system is managed (pointing out possibilities for management interventions to improve the system's efficiency);
3. Offer flexibility in re-grouping the information; and
4. Be easily understood and readily handled (practical)

The complexities of these requirements suggest that a single classification scheme cannot satisfactorily accommodate all of them. A series of classifications will be needed, and each one has to be based on a definite criterion to serve a different purpose.

For purposes of this module, classification by structure will be adopted.

Structural classification – refers to the composition of the components, including spatial admixture of the woody component, vertical stratification of the component mix and temporal arrangement of the different components;

Structural Basis for Classification of Agroforestry Systems

Presence

The three main agroforestry components, trees, crops and animals (or pastures) define the following structural categories, which are based on the nature and presence of these components:

- **Agrosilvicultural systems:** trees and seasonal crops (including shrubs/vines)
- **Silvopastoral systems:** trees and animals/pastures
- **Agrosilvopastoral systems:** trees, seasonal crops and animals/pastures
- **Other systems:** apiculture in association with trees, fisheries in association with trees (Aquaforestry), or Entomoforestry (trees with insects). They are usually classified separately, although they belong, strictly speaking, to Silvopastoral systems.

Animals must generally be physically present near trees on the same plot for a system to qualify for the suffix "pastoral". For example, an alley-cropping system whose tree fodder is used for animals in a cut and carry management would be Agrosilvicultural. It would only be considered Agrosilvopastoral if the animals grazed on the plot.

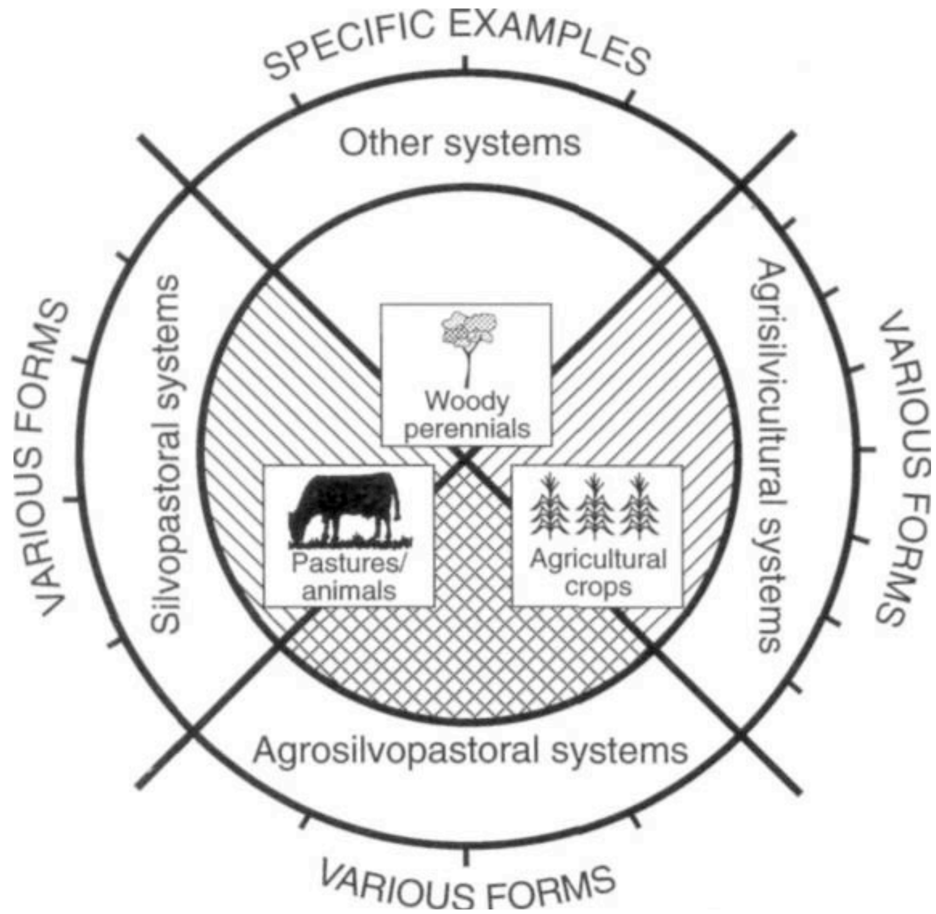

Figure 1: Classification of agroforestry systems based on the type of components.

Source: Nair, P.K.R. 1985. Classification of agroforestry systems. Agroforestry Systems 3: 97-128.

Arrangement

Two aspects should be taken into account with regard to the arrangement of the components: **space and time.**

The spatial arrangement concerns the **physical location** of the components on the plot.

It is also important to describe the **temporal arrangement (or sequence)** because the different components may be on the plot at the same time, follow each other, or partially overlap in time.

The arrangement is generally described according to the woody (trees) and non woody **components** but, in some cases, many components may be woody, like in plantations where trees and perennial crops (e.g. shade trees on coffee) are grown in association, in multipurpose woodlots or in certain home gardens.

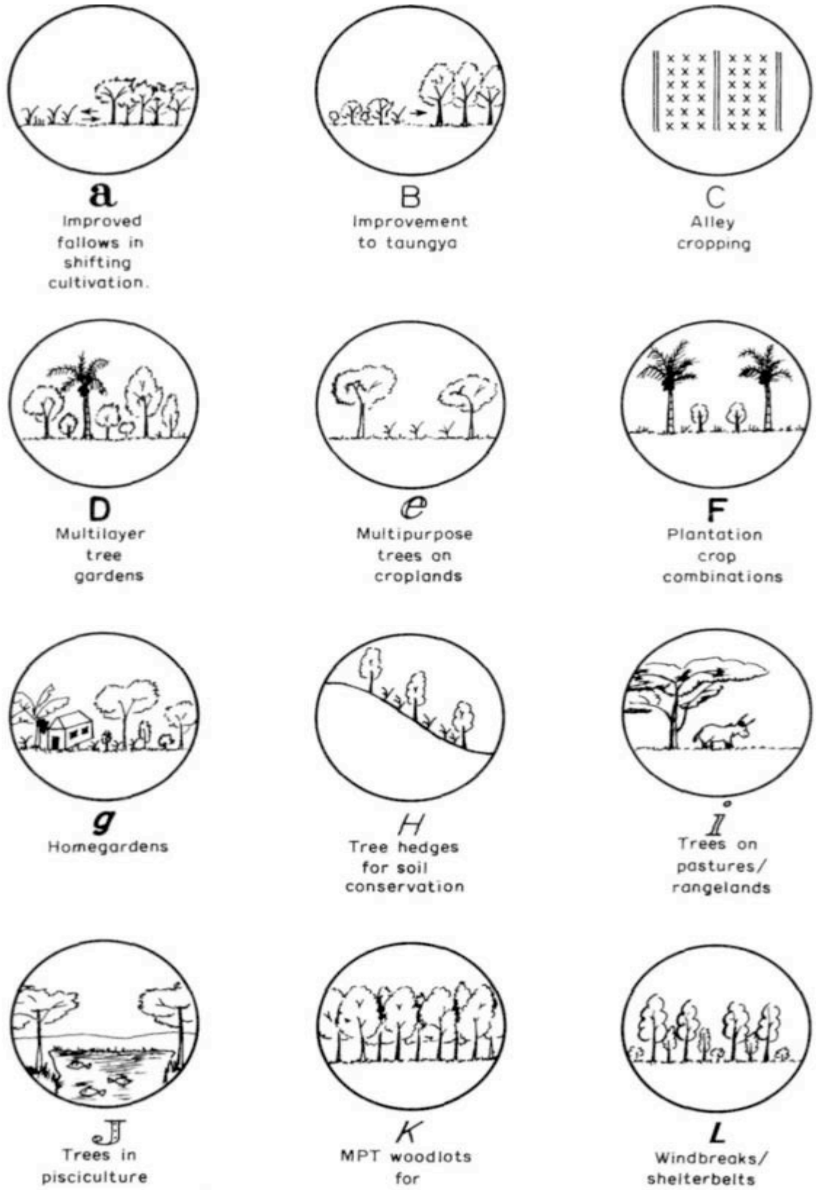

Figure 2: Classification descriptions based on arrangement

Adapted from: Nair, P.K.R. (ed.). 1989. *Agroforestry Systems in the Tropics.* Kluwer, Dordrecht, The Netherlands

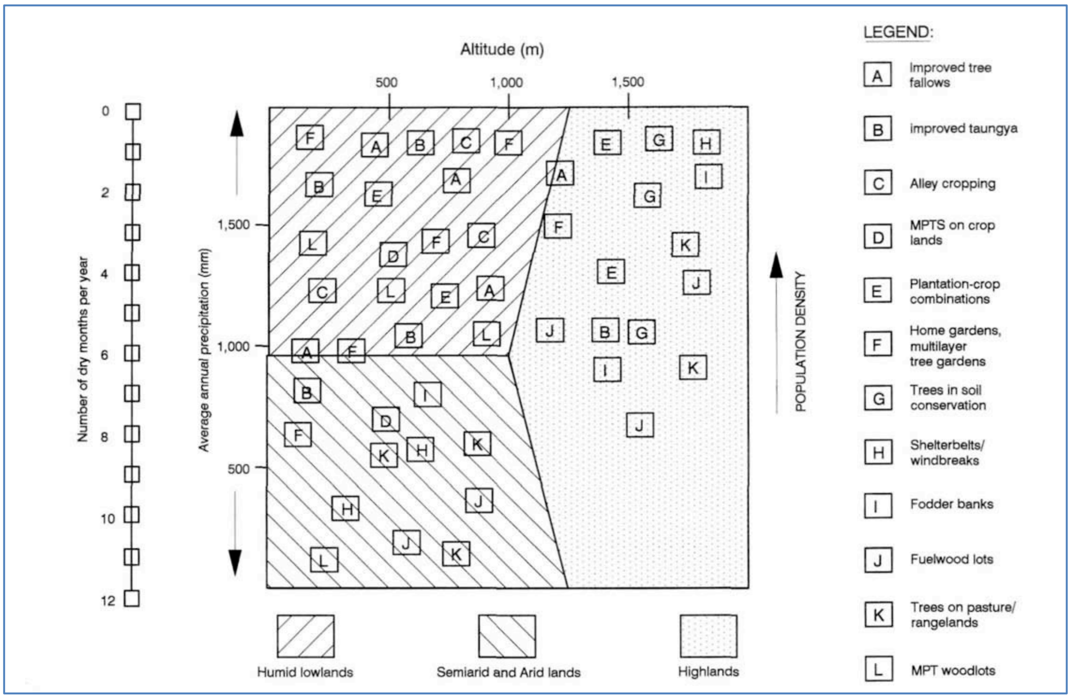

Figure 3: Classification descriptions regrouped based ecology

Source: Nair, P.K.R. (ed.). 1989. Agroforestry Systems in the Tropics. Kluwer, Dordrecht, The Netherlands

The main types of component arrangements possible are described in the four categories that follow. The two characteristics are mutually exclusive in each category.

1. Mixed/Zonal Arrangement

1.1 Mixed: the different components are not geometrically arranged, but appear in an irregular manner. Some examples are: scattered trees dispersed on cropland, home gardens, or aquaculture in mangrove areas.

1.2 Zonal: the different components are geometrically arranged; for example, rows of trees and alleys of seasonal crops, windbreaks, hedgerows, rows of trees/grass on a slope.

Figure 4: Zonal arrangement (planted in lines include maize/beans, Gliricidia (to provide leaf biomass for use as green manure) and vetiver grass (a soil conservation structure) on a steep slope field. (Photo © Land Resources Conservation, Malawi)

2. Dense/Scattered Arrangement

2.1 Dense: the components are close together throughout the plot; for example, in a forest garden, in alley cropping.

2.2 Scattered: the trees are far from each other. They could be planted or naturally regeneration and in some cases various species and in other cases, single species like in most Faidherbia parklands where trees scattered in crop land, or isolated trees in a pasture.

Figure 5: Scattered trees in maize fields mostly mango (left) and Faidherbia trees in leaf in a maize field. (Photo left © ICRAF, Malawi. Photo right © Total LandCare, Malawi).

SESSION 2

CLASSIFICATION OF AGROFORESTRY TECHNOLOGIES

1.5 MAIN AGROFORESTRY TECHNOLOGIES

Criteria of classification of the technologies

The agroforestry technologies we shall look at have been divided into six main categories according to structural criteria of arrangement of the different components.

It is, within structure, criteria of arrangement of the components (and not criteria of presence) that have been taken into account.

1. Crops under tree cover
2. Animal production under tree cover
3. Agroforests
4. Agroforestry technologies in a linear arrangement
5. Sequential agroforestry technologies
6. Other agroforestry technologies

1 Crops Under Tree Cover

All combinations of trees and crops in which the woody components create an upper storey covering the crops are included in this category.

Figure 6: Maize crop under Farmer Managed Natural Regeneration (FMNR). (Photo © Total LandCare, Malawi)

The tree cover can either be very open, like in some wooded savannas, or almost closed, like shaded trees in some coffee or cocoa plantations.

The crops may be seasonal, as is the case with cereals grown under *Faidherbia albida* or perennial like cocoa trees growing under the shade of coconut palms.

Fodder plants and animals under tree cover are not included under this category. They belong to an agroforestry category that pertains specifically to animals.

Systems in which the woody component is multi-strata are not included in this category either.

Structural characteristics of crops under tree cover	
Presence:	- Agrosilvicultural technology
Arrangement:	- mixed or zonal (the trees are either randomly planted or aligned)
-	Dense or scattered (the tree cover is either closed or open)
-	Single strata (multistrata in rare cases)
-	Simultaneous

2 Animal Production Under Tree Cover

This category and the preceding one have the same structural characteristics: a tree storey covering a lower storey made up of other components, but the lower storey (and sometimes also the upper storey) is, here, meant for animal production. So these two first categories belong to the same broad arrangement-based category and are differentiated on the presence of components.

Animals may simply browse in pastures deliberately planted under trees or feed off natural fodder or browse. Fodder production under tree cover can also be meant for cut and carry systems.

Structural characteristics of animal production under tree cover

Presence: Silvopastoral or Agrosilvopastoral technology

Arrangement: - mixed (can be zonal like in the case of animal grazing in industrial forestry plantations)

- Scattered or dense (animals usually browse under a well spaced out tree cover but also, in some cases, under a closed tree canopy.
- Single strata, except in the case of dense multistrata forests.
- Simultaneous or sequential: the animals are either always or occasionally present under the trees. In the same system, the arrangement may be simultaneous with regard to crops or pastures and sequential with regard to animals.
- When the arrangement is sequential, it is generally interpolated.

3 Agroforests

This category consists of agroforestry technologies that give rise to plant communities resembling forests and sometimes-natural forests, hence the name Agroforests.

Often these are only small plots, but their structure is typical of a forest because of the presence of large trees and because they are generally multi-strata and have a dark underwood.

There is often great species diversity and a non-horizontal arrangement of large trees coexisting with smaller ones and underwood plants, which are generally shade tolerant. Animals are also found there frequently.

Another important characteristic of these systems is not found in their structure but has more to do with the way in which they are managed. In Agroforests, there is no mass treatment of the components. Trees and crops are dealt with individually; each one (or each small group) is the object of the different management practices. This fact, more than their Multi-strata nature, is what makes these systems look like natural forests.

Home gardens are especially known in the humid tropics and are the clearest example of this group of technologies. They are small, carefully managed forests of useful plants, which are located close to homesteads. They contain a great many variety of species of many different types, sizes and growth cycles, as well as many domesticated animals, which are self-sufficient on the home garden products.

Figure 7: A home garden showing a mixture of tree and field crops around the homestead (Photo © ICRAF. Malawi)

Village forest gardens (or village forests) are another example of Agroforests. Their structure is similar to that of home gardens, but they generally cover larger areas and are under communal not family management. Village forests because of their size and distance away from homesteads, are generally oriented toward cash crops more than subsistence crops and there is less specific diversity there than in home gardens.

Structural characteristics of Agroforests

Presence:

- agrosilvicultural technology, or agrosilvopastoral technology, if there are animal, as in most home gardens

Arrangement: - mixed

- Dense
- Multi-strata in most cases
- Most often simultaneous but sometimes sequential with regard to certain components that can only be grown occasionally, like in home gardens.
- The arrangement is interpolated for those components that are not present constantly

4 Agroforestry Technologies in a Linear Arrangement

This category groups together different agroforestry technologies whose common denominator is that they appear in a **line arrangement**.

The different groups of technologies in this category are:

Windbreaks, which are used to protect crops or animals from wind. In addition to providing a protective role, windbreaks often produce wood or other products.

In general, the zone of minimum wind velocity occurs about five times the tree height to the leeward side for permeable belts. Some farmers may prefer dense shelterbelts if it is desirable to minimise wind speeds immediately behind the shelter such as is necessary for some horticultural crops, however, for shelter to be adequate over any distance, a series of belts will be necessary.

Boundary planting with trees is used to delineate plots or farms. This is a common practice in many regions as well as a very simple method used to incorporate trees into agricultural landscapes.

Trees can be lopped, pollarded, coppiced or felled, depending upon the species and the type of product desired.

Live fences (or living fences) are made up of trees that act as fence posts.

Woody strips, and tree hedges in general, can be found in different places in the agricultural landscape and may play a variety of roles while providing one or more products or services.

Live hedges serve as barriers and are defined as lines of shrubs or bushes forming a continuous barrier, which are cut regularly so that they form a mass of interwoven leaves and branches. They are typically used for paddocks, soil stabilization and erosion control.

Shelterbelt is a general term that describes any tree hedge that plays a protective role in the landscape. This role is often combined with various classic aspects of tree production. Protecting crops against wind has been mentioned. One might also mention soil moisture conservation and improving irrigation, protecting homes, wild animals, or other ecological or climatic assets, as well as beautifying the landscape.

Hedgerow intercropping (or alley cropping) consists of planting rows (or hedges) of trees on plots where crops are also grown. So the crops are found in alleys, between the rows. Leaf biomass from the trees is applied to the crop as green manure. One example is growing cereals between rows of nitrogen-fixing leguminous shrubs.

Rotational hedgerow intercropping is a particular case in which, after a few seasons of normal alley cropping cultivation, the trees' canopies are left to cover the plot completely, thus making it kind of improved fallow. After a while the trees are pruned back to normal hedge size to make room once again for crops in the alleys. This arrangement combines the spatial and temporal effects of soil amelioration by trees.

Structural characteristics of agroforestry technologies in a linear arrangement

Presence:
- Most often on agrosilvicultural technology but can also be silvopastoral if the product derived from the tree is fodder or if animals graze in the plot like in alley farming

Arrangement
- Zonal
- Scattered (but the distance between the trees on the line may be small, like in alley cropping)
- Normally single strata but some windbreaks with different species may be multistrata
- Simultaneous (but rotational hedgerow intercropping is interpolated during the fallow phase)

5 Sequential Agroforestry Technologies

This category groups together agroforestry technologies in which certain temporal phases consist solely of trees. Other phases are made up of other agroforestry components (crops, animals) or an association between the trees and the other components. It may be a matter of strict rotations in which the components succeed each other or an arrangement where the components overlap at times.

Shifting cultivation, or slash and burn agriculture, as practised in many tropical countries, is an example of agroforestry in rotation.

People who slash and burn natural forests to plant seasonal crops practise this technology in forested areas. The first cropping seasons are generally very good, because plants benefit from residual forest soil, which is rich in nutrients. As the ground is bare after tree clearance, the soil is quickly eroded, and its fertility declines very quickly, so that after a few cropping seasons, the farmers abandon their plots, move on, and clear another, thus the name shifting cultivation.

In the abandoned plot, which lies fallow, the forest regenerates. This regeneration goes through a stage during which it is a “secondary” forest

When the population is low, shifting cultivation is in balance with the natural regeneration of the forest. When the population density is high, the areas to be cleared become rare or else they are far away and a reduction in the rotation time may be observed.

One way to improve shifting cultivation is to practise **improved fallows.** In this case, instead of abandoning or leaving the plot after a few cropping seasons to regenerate or recover naturally, specific woody perennials are planted there to hasten the process of regenerating the land. One can, for example, sow the fallow with nitrogen-fixing trees that will re-establish good quality soil faster than naturally regenerating species. Trees may also be planted for different products, thus making the fallow period into a phase that not only re-establishes the soil's fertility but is also provides other benefits.

Another interesting case for sequential agroforestry is the **Taungya** technology. In this technology, the forest service proposes to farmers to utilize forest plots for growing seasonal crops in association with trees during the first years of a plantation's existence. The farmer commits himself to maintaining the young trees in exchange for land, which he can use for cropping. Once the trees are big enough to cover the crops, the forest service repossesses the plot.

Structural characteristics of sequential agroforestry technologies

Presence: - agrosilvicultural technology, or agrosilvopastoral once there is livestock in the fallow

Arrangement: - most fallows are mixed, but some improved fallows as well as taungya technology may be Zonal

- Dense
- Multistrata, but certain simple fallows, or taungya technology may be single strata
- Sequential: separate or overlapping, concomitant in the case of taungya technology.

6 Other Technologies

This last category consists of different technologies whose structures are different but are grouped together either because they are less important in the world of agroforestry or because of their very specific characteristics.

Aquaforestry: refers to the rearing of aquatic animals in association with trees. Fish, shrimp, or oyster breeding in association with woody perennials is done in mangroves in certain parts of Southeast China Sea region.

Structural characteristics of Aquaforestry

Presence: - technologies used are generally silvopastoral unless a herbaceous component is also grown with trees as fish fodder, in which case the system becomes agrosilvopastoral; the term agrosilvofishery is used

Arrangement: - mixed

- Scattered
- Single strata, except in the case of certain well developed mangroves, which can be multistrata
- Simultaneous

Entomoforestry:

Refers to insect rearing in association with trees. Some well-known cases are apiculture (beekeeping), sericulture (silk worms rearing) and lac culture (insect rearing).

Apiculture is considered to be an agroforestry technology directly, once the hives are set up in the trees, or indirectly, when the bees gather nectar from tree flowers.

Sericulture is a very important farm enterprise in several regions of the world, especially India and China. Silk worms feed only on one tree species, the mulberry tree (*Morus alba*), so that the tree must necessarily be part of the breeding system, hence making it typical agroforestry.

Lac culture is a peculiar agroforestry technology where scale insects (Hemipterous of the genus *Laccifer*) are grown on twigs of trees on which they exude a substance known as lac, used in varnishes and paints (shellac) and other applications (e.g. jewellery) for its insulating and coating properties. Different trees are used for this e.g. *Ziziphus mauritiana,* in countries like India, Bangladesh or China.

Structural characteristics of Entomoforestry

Presence: - as in the case of Aquaforestry, where "pastoral" does not really apply, it is better not to talk of silvopastoral systems in the case of Entomoforestry. The famous Mopane worm and the mopane tree (in Southern Africa) is one such example of this system. "Silvoapiculture" is an appropriate term when we refer to bee keeping and could apply in Madagascar in areas where farmers are involved in honey production. As far as sericulture and lac culture are concerned, the terms are well in use and can stay as such. In Madagascar sericulture is a long traditional activity. Malagasy people used wild silk named *Borocera Madagascariensis* since 1850 when *Bombyx mori* was introduced in Madagascar

Arrangement:

- mixed, but rows of mulberry trees are common on e.g. field boundaries or along roads.
- Scattered
- Single or multistrata depending on the type of canopy from which the bees gather their nectar.
- Simultaneous

Group exercise at the end of the module

- Think of an example(s) of a farming practice in your respective communities that you can classify as an "agroforestry Technology or technologies or practice"
- Describe what characteristics define it as an agroforestry system
- Think of what would make an agroforestry technology and practice be one of the sustainable climate smart agriculture technology

MODULE TWO

CONSERVATION AGRICULTURE WITH TREES

2.1 Module aim

Introduce to participants the scope, principles and applications of CAWT systems a type of Evergreen Agriculture.

2.2 Module Objectives

By the end of the module, participants should be able to:

a. Define the principles and practices of conservation agriculture
b. Describe the benefits and challenges of conservation agriculture
c. Define the principles and practices of conservation agriculture with trees
d. Relate the link between CA and agroforestry, the benefits of integrating trees on-farm, agroforestry practices and technologies and the management of agroforestry tree species.

2.3 Reference Texts

Mutua J, J. Muriuki, P. Gachie, M. Bourne and J. Capis. 2014. Conservation Agriculture With Trees: Principles and Practice. A simplified guide for Extension Staff and Farmers. Technical Manual No. 21. World Agroforestry Centre, (ICRAF) Nairobi, Kenya, 2014. ISBN 978-92-9059-350-8

Garrity, D., Akinnifesi F., Ajayi, O., Sileshi G. W., Mowo, J.G., Kalinganire, A.,Larwanou, M and Bayala, J. 2010. Evergreen Agriculture: a robust approach to sustainable food security in Africa. Food Security. 2(3): 197-214.

SESSION 3

CONSERVATION AGRICULTURE

3.1 Introduction

Conservation agriculture (CA) employs the judicious use of conservation tillage, mulching and integrating of main crop with legume crops and/or trees to conserve natural resources of soil and water for improved and sustainable production. Shifting cultivation has been over a long time the main agricultural practice in Madagascar. It is an extensive system of agriculture evolved and practiced with good results in areas of relatively low population density where the farmer has enough land at his/her disposal and freedom to cultivate anywhere he/she chooses. However, a diversity of shifting cultivation systems has been practiced in different, environmental and socio-economic situations in Madagascar. More important to note is that the practice is common on steep slopes of most highlands. Shifting cultivation refers to farming or agricultural systems in which a short but variable cultivation phase on slash-and-burn cleared land alternates with a long, equally variable fallow period. The clearing of forest, secondary bush, woodland or grassland vegetation is accomplished with simple hand tools and it involves slashing down of herbaceous plants, stragglers and saplings. Useful trees and shrubs are selectively left standing, sometimes with light pruning. Other trees and shrubs are pruned down to stumps of varying height for fast regeneration or support of viney crops requiring staking. The dry plant debris is then burned before seeds and other planting materials are sown in holes on the flat, lightly tilled, or untilled mounds or ridges. During the short (two or three year) cultivation phase, crops are grown in mixtures of several varieties and species for subsistence and/or sales. It is so crucial in the social dynamics of tillage practices because burning of crop residues is strongly engraved in the current practice of smallholder agriculture in Madagascar. It requires a systematic transformation of the mindset of smallholder farmers from shifting cultivation to conservation agriculture as economically viable, ecologically sustainable and smallholder farmer friendly. Conservation agriculture enhances natural ecological processes to conserve moisture, enhance soil fertility and improve soil structure. CA also reduces soil erosion and emergence of pests and diseases.

Conservation agriculture is a combined application of three key principles which are:

a. Minimum soil disturbance
b. Maximum soil cover and
c. Crop associations and rotations

3.2 Minimum soil disturbance

This key principle stipulates that a farmer should till the soil as little as possible. The numerous on-farm research works indicate that maize and other crops can still grow well in less tilled or un-ridged fields. This principle encourages farmers to only disturb the soil where strategic inputs such as the seed, fertilizer and manure are to be placed. Conservation Agriculture promotes the minimum soil disturbance to no more than 12%-15%. Under conventional agriculture, soil tillage is 100%.

Minimum tillage overcomes many of the disadvantages of ridging and ploughing. Ploughing and hoe ridging disturb soil layers and thereby destroying the structure of soil. When the soil structure is destroyed, water infiltration is reduced and soil organic matter is rapid lost. Low levels of organic matter render soil less capable of retaining nutrients and water. The conventional way of farming such as shifting cultivation across the slopes accelerates soil erosion and land degradation.

3.3 Maximum Soil Cover

3.3.1 Retaining Residues

Conventional tillage system encourages the clearing of crop and weed residues during land preparation. The cleared residues are burnt to control weeds, pests and diseases and ensures a fine tilth. However, the removal or burning of crop residues means that nutrients in the residues are lost rendering nutrient cycling impossible and difficult. This burning of residues also predisposes the bare soil to be washed off by early heavy rains leading to soil erosion and land degradation. Due to continuous clearing of residues and rain splash for a number of years coupled with continuous hoeing, a pan (often called hand hoe pan) is created rendering root penetration and water infiltration difficult. It is against this background that conservation tillage encourages the incorporation or spreading of crop residues. The residues are supposed to come from the same crop field unless otherwise. For instance, cotton and tobacco residues are supposed to be burnt to avoid sustaining pest and disease build up. However, the fields which can be spread with tobacco and cotton residues can be rotated with other crops.

Figure 8: Maximum soil cover with dry grass or crop residues, the farmer is hand weeding and behind the farmer is Gliricidia and Tephrosia trees managed for both green manure and soil & water conservation. (Photo © Land Resources Conservation, Malawi).

3.3.1.1 Residue management and challenges

In mixed crop-livestock based systems, the multiple uses of maize stover render them scarce and unavailable for farmers to cover their field. The residues are often fed to livestock, especially during the dry season when pastures are poor. It is a bigger where it's used as livestock feed without reciprocal use of the manure. Some of the challenges include wild fires that burn the maize stovers.

3.3.1.2 Benefits of maximum soil cover

Well placed residues reduce the impact of rain splash and runoff. This checks soil erosion and land degradation. The residues promote biological activity by the soil fauna. These activities facilitate the breakdown of residues into humus or soil organic carbon. The increased fauna activity improves nutrient cycling, soil aggregate stability and porosity Residues retain soil moisture by reducing evaporation and evapotranspiration. Soil temperature is regulated by the crop residues which act as heat insulators.

3.3.2 Cover Crops

Alternatively, cover crops are intercropped with main crop to serve the physical attributes of soil cover, biological nitrogen fixation and mineralization from the N rich biomass. Although this could be classified as following the third principle of crop association or crop intercrop, it however needs to be emphasized that farmers who have problems of scarcity of maize stover and crop residues due to their multiple uses can use cover crops to attain maximum soil cover. The cover crops include cowpeas, velvet beans, soya beans, common beans. After harvest of the main crop, the cover crops should be well managed against livestock and fire. Care should be observed when intercropping with cover crop. Recommended spacing for cover crop under intercrop should be followed to avoid light, space and nutrients competition with crops.

3.3.3 Dealing with livestock problems

Livestock problem has been cited as one of the challenges of adoption of CA by farmers in most areas with agro-pastoral systems. It has to be emphasized that livestock and CA are still compatible but proper management and regulatory systems have to be put in place. The practice of free-ranging cattle without herders after crop harvest is the biggest challenge to protecting crop fields. Adoption of bylaws controlling livestock during the dry season has in some places been found to be effective.

3.4 Crop Associations and Rotations

Main crops are planted in different associations and rotations with legume crops or grain crops in space and over time. Crop association is when the main crop and sub crop are planted in the space and time whereas crop rotation is when the crops are planted on the same piece of land one after the other (at different times). Both crop associations and rotations help control pests and diseases by breaking their cycles. The legume intercrops help fix nitrogen in the soil through the nodules and biomass incorporation from the leaves. Soil structure is improved through the penetration of different root system across the soil layers and the addition of organic matter.


Figure 9: Cowpea serves as soil cover crop during maize vegetative period and when maize is harvested, the cowpea is left grow until harvest. (Photo © Total LandCare, Malawi)

SESSION 4

CONSERVATION AGRICULTURE WITH TREES

4.1 Introduction

The practice of conservation agriculture (CA) has been steadily increasing globally after decades of research such that millions of hectares are now managed under some form of Conservation Agriculture practices. There are three established principles in CA: Minimum soil disturbance, crop residue retention, and crop rotation. The short-term advantages observed where CA is currently practiced include increased rainwater infiltration and conservation in the soil to better support crops during drought periods (Rockstrom et al 2009).

However, the uptake of CA in the rainfed upland areas has been modest so far. There are a number of unique constraints to smallholder adoption of CA that are retarding its more rapid uptake. Most important among these are: competing uses for crop residues where livestock production is common, inadequate biomass accumulation of cover crops in the off-season, increased labor demands for weeding when herbicides are not used, variable yield results across soil types, and the need for greater application of organic and inorganic nutrients.

How can biomass production be increased to enhance surface cover and to generate greater quantities of organic nutrients to complement whatever amounts of inorganic fertilizers a smallholder farmer can afford to apply? Recently, the CA and agroforestry research and development communities have mutually recognized the value of integrating fertilizer trees and shrubs into CA systems which is now referred to as conservation agriculture with trees (CAWT). Practical systems for intercropping fertilizer trees in cereal dominating farming have been developed and are being extended to hundreds of thousands of farmers in Africa and globally. Depending upon which woody species are used, and how they are managed, their incorporation into CA helps to maintain vegetative soil cover, increase nutrient supply through nitrogen fixation and nutrient cycling, suppress insect pests and weeds, enhance soil structure and water infiltration, increase carbon storage and soil organic matter (Garrity et al 2010).

4.2 Conservation Agriculture with Trees

Conservation Agriculture with Trees (CAWT) also known as evergreen agriculture is the inclusion of trees to reinforce the CA system in order to combine the best of CA and the best of agroforestry leading to a working model under different social, economic, biophysical, institutional and policy conditions. This practice is aimed at improving the uptake of CA through provision of fodder, fuel, construction materials, agricultural implements, biomass, nutrients, fencing, fruits, among other products and services.

The CAWT model therefore introduces two more aspects to the three basic principles of CA explained in Session 1 (minimum tillage, maximum soil cover and crop rotations/associations). CAWT systems are a type of Evergreen Agriculture with emphasis on reduced tillage, but it expands on the principle of residue retention to include the integration of trees and shrubs throughout the crop fields to supply increased high-quality residues from tree leaf litter and other organic sources of nutrients. This broadens the concept of crop rotations to incorporate the role of fertilizer/fodder trees to more effectively enhance soil fertility and provide needed biological and income diversity in the system.

Figure 10: Integration of Tephrosia in a maize field for soil fertility improvement. (Photo © ICRAF, Malawi).

4.3 Evergreen agriculture for sustainable agriculture

Evergreen agriculture is an alternative to modern, intensive agriculture that exploits the environment. It is a proven way to achieve the increased yields needed to feed a growing population in a way that is sustainable, affordable and does not further threaten biodiversity. Evergreen agriculture is the integration of trees into annual food crops. Intercropping trees with food crops and livestock helps sustain a green cover (instead of just crop residue alone) on the land throughout the year. This bolsters nutrient supply, increases direct and income from tree products. It also enhances carbon storage and resilience to climate change.

Evergreen agriculture increases farm productivity while conserving the natural resource base and the environment. It is based on conservation agriculture principles such as tilling the soil as little as possible, rotating crops, including trees to provide the additional value of holding the soil in place. The canopy, roots and leaf litter all play a role in controlling soil erosion, capturing water runoff and protecting watersheds.

Evergreen agricultural systems are already restoring exhausted soils and increasing yields, helping to feed the rural poor while protecting the natural resources on which we all depend. The most promising evergreen agriculture systems are those that integrate 'fertilizer trees' into cropping systems. These trees improve soil fertility by drawing nitrogen from the air and transferring it to the soil through nitrogen fixation in their roots and subsequent incorporation of leaf litter into the soil. A combination of dry grass or crop residues at tree establishment stage is of importance as it also enhance the tree growth.

Top left : One year old Gliricidia plants established using potted seedlings.

Top right: Gliricidia being established using cuttings in combination with maize stover as soil cover

Bottom Left: Well established Gliricidia ready for biomass harvest to be used as green manure during the cropping season

Figure 11: Establishing an evergreen field with Gliricidia for CAWT. (Photos © ICRAF, Malawi).

Table 1: Common agroforestry (AF) practices and technologies that can be integrated with CA to form CAWT.

Agroforestry practices	**Some recommended tree/shrub species**	**Potential attributes to be maximized in CA**
Dispersed systematic planting of trees	*Faidherbia albida, Acacia polyacantha, Acacia galpinii, Gliricidia sepium*	Increased organic matter (**Soil cover**)
Annual undersowing	*Tephrosia vogelii, Sesbania sesban*	Increased organic matter (**Soil cover/ reduced till**)
Improved fallow	*Tephrosia vogelii, Cajanus cajan, Sesbania sesban*	Shortens soil enhancement period Reduce weeds/ pests/ diseases (**Crop rotation**)
Homestead/boundary /woodlots	*Acacia spp., Albizia lebbeck, fruit trees*	Fuel wood (**Soil cover**)
Fodder banks	*Leucaena diversifolia, Sesbania sesban, Gliricidia sepium, Moringa oleifera*	Feed for livestock (**Soil cover**)
Live fences	*Acacia spp, Prosopis juliflora, Ziziphus spp., Moringa oleifera, Jatropha carcus*	Live fence reduces animal damage to valuable crops. Tree s like Moringa will also provide animal feed. Can also provide shade. (**Soil cover**)

Figure 12: CAWT using Faidherbia and maize stovers. (Photo © Total LandCare, Malawi)

4.6 Design and Management of Trees and Shrubs for Agroforestry

Planting design and management of an agroforestry practice depends on existing site conditions and the objectives of the smallholder farmer. Trees can be planted in single or multiple rows, on contours or in groups. Consider the products you wish to produce, any conservation benefits desired, on-farm equipment and the needs of companion crops when planning the planting design.

As trees require some maintenance, management requirements may influence the planting design. Some important management considerations include:

1. Weed control - most important in a young trees life
2. Fertilization - depends on species selected and production objectives
3. Pruning - a must for timber production and recommended for nut production
4. Thinning - timely thinning are critical to maintaining optimum productivity of trees and companion crop
5. Grafting - recommended for some fruit production.
6. Coppicing – for some timber, fertilizer and fodder trees

7. Pollarding – for fodder and boundary trees
8. Lopping or crown thinning– cutting some crown branches to reduce shading of crops

- Weed control can reduce competition for moisture, nutrients and, in some cases, for light. Options for weed control include the use of mulches (including living mulches such as many food crops and cultivation. To gain the best growth from newly established trees, weed control is for initial early years depending on tree species.

- Timely fertilization may be necessary for high-yielding fruit and nut production. In fruit and nut production, having certain nutrients available to the tree at the appropriate time of year is often essential for improved flowering and fruit or nut set.

- Pruning allows room for both people and equipment to pass below the branches and can be used to promote the production of desired products such as timber. Pruning is also a useful tool in management of fruit and fodder trees. Through proper pruning, the shape of the crown and its density can be managed to facilitate and improve trees productivity as well as that of the companion crop.

- Timely thinning promotes good tree growth by reducing competition for water, light and nutrients. As trees mature they grow to occupy more of the space where they are being managed. As crowns of adjacent trees begin to touch or overlap, this is also a general indicator that their root systems are overlapping. When trees touch or overlap, competition for light, moisture and nutrients between adjacent trees may become a factor limiting tree growth. At this point, thinning can be beneficial.

- Grafting primarily applies to some fruit and nut production. By grafting scion wood to a tree you are assured that the fruit or nut produced has the potential to exhibit the exact same characteristics as the adult tree from which the scion came. However, this does not always occur, since moisture, nutrients and management also play a significant role in fruit and nut development. Yet, it is the best way to ensure success. Spread planting over several years to limit the number of trees that will require grafting in a single year.

- Coppicing and pollarding are two types of pruning for trees and shrubs

- Coppicing is a pruning technique that cuts trees and shrubs to less than 30cm above ground level, causing new shoots to grow rapidly from the base during growing season. This method is commonly used for harvesting the thin shoots, keeping the plants small and to produce larger and/or brighter stems or foliage in coppicing fertilizer tree fallows and fodder production. Coppicing also creates a multi-stemmed plant instead of one with a single, large trunk. In timber production however, only one or two coppices are allowed to grow into bigger trees

- Pollarding is when young trees and shrubs are cut to the main stem or trunk, ultimately controlling the height of the plants. This is different from coppicing because the trees and shrubs are not cut at ground level, but much higher, usually around 1.5m. Pollarding maintains a desired height for the plants, reduces shade and defines the plants' shape. This method is also employed to prevent tall trees from obstructing electrical wires and phone lines when planted near these facilities.

- Lopping branches is deliberate technique of removing some branches to improve light penetration (reduce shading). It is often called crown thinning.

Figure 13: Tree management showing some pruned &pollarded trees and leaf litter spread out. (Photo © Total LandCare, Malawi)

MODULE THREE

FARMER MANAGED NATURAL REGENERATION

3.1 Module aim

Introduce to participants the scope, principles and applications of farmer managed natural regeneration (FMNR).

3.2 Module Objectives

By the end of the module, participants should be able to:

1. Define the principles and practices of conservation agriculture
2. Describe the benefits and challenges of conservation agriculture
3. Relate the link between CAWT and FMNR

3.3 Reference Texts

World Vision International 2012. World Vision Guidance for Development Programmes. Published by Integrated Ministry on behalf of World Vision International.

Sosola, BG, AO. Mulwafu, B. Nyoka J. Njoloma and S. Mn'gomba. 2016. Farmer Managed Natural Regeneration: Trainers' Guide for Extension Workers and Farmers and in Malawi, World Agroforestry Centre, Lilongwe, Malawi (*in press*).

SESSION 5

FARMER MANAGED NATURAL REGENERATION

5.1 Introduction

5.2 What is Farmer Managed Natural Regeneration?

Farmer Managed Natural Regeneration (FMNR) is a rapid, low cost and easily replicated approach to restoring and improving agricultural, forested and pasture lands. FMNR is based on encouraging the systematic regrowth of existing trees or self-sown seeds. It can be used wherever there are living tree stumps or roots with the ability to coppice (re-sprout) or seeds in the soil that can germinate. Vast areas of land around the world, particularly in the tropics and semi arid tropics, still have coppicing tree trunks, roots, and seeds in the ground from which there is the potential to reestablish trees through FMNR.

FMNR is an empowering form of social forestry. It gives individuals and communities responsibility for the care and nurture of naturally occurring woody vegetation and rewards from the sustainable harvesting of wood and non-timber forest products. Conventional approaches to reversing deforestation, such as planting tree seedlings raised in nurseries, rarely spread beyond the project boundary once external funding is withdrawn. Particularly in arid and semi arid areas, the scarcity of water makes tree planting projects particularly prone to failure. By comparison, FMNR is cheap, rapid, locally-led and implemented, uses local skills and resources, and is highly successful.

FMNR uses nothing new. It is simple and cheap so that the poorest farmer can learn by observation and teach her/his neighbour. FMNR can be done on a large scale without on-going government or non-governmental organization interventions. Given an enabling environment, or at least the absence of a 'disabling' environment, FMNR can, and does, spread well beyond the original target area without project or government help. 'Farmer' Managed Natural Regeneration started with farmers, but it can be implemented by whole communities and by people of any profession.

5.3 The basic concepts of FMNR are as follows:

1. Trees from coppicing stumps, roots or germinated seeds are selected based on the goals, resources and needs.
2. Those trees selected for retention are then pruned, leaving only a small number, sometimes even only one strong sprout. This can then grow more quickly because it is not competing for resources.
3. Land owner or community members periodically return to the site to prune away new sucker branches so they do not drain resources from the selected stem(s).
4. Depending on the management style and goals, the tree may be harvested once it has grown large enough, or maintained with unwanted trimmings used for green manure, fodder, food or fuel wood, or portions of wood may be periodically harvested once large enough.
5. If there are few or no stumps, trees that sprout from seed within the ground may be protected from animal damage and human use so they grow large enough to begin pruning and managing.
6. Management of tree stems is mostly pruning but could also include most of the techniques under CAWT.

5.4 Benefits of FMNR

1. FMNR depends on the existence of living tree stumps, roots and seed already in the soil bank that are already anchored in the fields to be re-vegetated. New stems can only be selected and pruned for improved growth on the stump. This saves the farmer a lot more time as there is no management of the trees in the nursery.

2. Standard practice by most farming communities has been to slash/cut these valuable regrowth each year in preparation for planting of field crops.

3. With a little attention, the spouts can be turned into a valuable resource, without jeopardizing, but in fact, enhancing crop yields.

4. Much more can be gained by selecting and pruning the best five or so stems and removing the remaining unwanted ones. In this way, when a farmer wants wood can only cut the stem(s) needed for use and leave the rest to continue growing. These remaining stems will increase in size and value each year, and will continue to protect the environment and provide other useful materials and services such as fodder, humus, habitat for useful pest predators, and protection from the wind and shade. Each time one stem is harvested, a younger stem must be selected for replacement to ensure sustainability.

5. However, the important determinants of which species to use will be: whatever species are locally available with the ability to re-sprout after cutting, and the value local people place on those species.

5.5 How to promote FMNR on a larger scale

1. Awareness creation by working group members and the coordinating partners who participate and facilitate without taking over the community's ownership. Thus, a wide-scale awareness creation, consultation and all-stakeholder planning is encouraged at the outset of the programme.

2. Potential partners, including traditional organizational structures (such as cooperatives or farmers clubs) should be established or strengthened. If governing structures are not already present they must be established.

3. An inventory of indigenous species and their uses should be made and the number and density of species occurring in specific sites recorded.

4. By-laws on tree use and management should be created by local authorities and a buy-in by all stakeholders.

5. Government recognition and the formalization of rights and responsibilities of those practicing FMNR should be promoted.

At farm level farmers are given guidelines, but are free to choose the number of stumps per hectare and minimum stems per stump to leave, and the time span between subsequent pruning and harvest of stems and the method of pruning.


Figure 14: Young trees being nurtured in the early phase of FMNR (photo © ICRAF, Malawi)


Figure 15: Ground nut under FMNR. (Photo © Total LandCare, Malawi).


Figure 16: Agricultural landscape under FMNR. (Photo © Total LandCare, Malawi).