



# **Natural Resources Conservation and Development**

## **Level II**

# **Learning Guide-45**

**Unit of Competence: Facilitate Agro-forestry Practices**

**Module Title: Facilitating Agro-forestry Practices**

**LG Code: AGR NRC2 LO4-LG-45**

**TTLM Code: AGR NRC2 M10 TTLM 0919v1**

**LO 4: Apply Agro Forestry technology for soil  
productivity and protection**



<b>Instruction Sheet</b>	<b>Learning Guide #45</b>
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This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identifying and promoting agro-forestry practices
- Identifying Agro forestry technologies
- Role of Agro forestry technologies for soil productivity and protection

This guide will also assist you to attain the learning outcome stated in the cover page.

Specifically, **upon completion of this Learning Guide, you will be able to:**

- Identify and promote different Agro-forestry practices.
- Identify Agro forestry technologies based on their ecological and socio economic importance
- Practice Agro forestry technologies are for soil productivity and protection.

Following up and evaluating Rehabilitation activity progress

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet , Sheet 2 and Sheet 3
4. Accomplish the “Self-check 1, Self-check 2 and Self-check 3,” **in page -5, 10, and 12 ,** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1,” **in page -13.**
6. Do the “LAP test” **in page – 14** (if you are ready).



<b>Information Sheet-1</b>	Identifying and promoting agro-forestry practices
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#### 4.1. Identifying and promoting agro-forestry practices

It has been stressed that major adverse effects of soil erosion is lowering of fertility and that is the main reason why measures should be taken for its control. The hazard of water erosion is at its most serious on slopping land as well wind erosion in the semi- arid zone, Level or nearly level land in the sub- humid and humid zones, there is no substantial erosion hazard, but frequently subjected to soil degradation or lowering of soil fertility through “ over- cultivation.

##### Agro forestry for control of erosion and fertility maintenance

Soil erosion is the cause of substantial lowering of crop yields and loss of production. The effect on yield is in general greater on tropical than on temperate soil .The major causes of such yield reductions are loss of organic matter and nutrient. Hence agro forestry practices, which combine maintenance of fertility with control of erosion/soil loss, are particular importance. Also it must be stressed, that soil conservation is only likely to be most effective or successful where it is conducted through the active and willing co-operation of farmers .It must therefore be in their perceived interests, as an integral part of improvement leading to higher production.

##### Effects of trees on soils

###### Beneficial effects

Trees improve soils through increasing inputs, improving soil physical properties and through its beneficial effects on soil biological processes. Here summary of the known or possible effects of trees on soils are presented. Theses refer to a tree or shrub cover in general, not specifically with in agro forestry system.

###### Addition to the soil

- Maintenance or increase of soil organic matter: This is proven and widely demonstrated, including through build-up of organic matter. One of the main avenues of organic matter addition to the soil by trees is believed to be through continuous degeneration of roots of live trees.
- Nitrogen Fixation: Some leguminous trees have shown the addition of nitrogen to the soil and have been proven through soil nitrogen balance studies and by observation of nodulation.
- Nutrient up take: This is probable, but has not been specifically demonstrated. The hypothesis is that, in general, trees are more efficient than herbaceous plants in taking up nutrients released by weathering of the deeper soil horizon, potassium,

Phosphorus and micronutrients are released by rock weathering particularly in the B/C and C soil horizons into which tree roots penetrate. Thus nutrients in deeper horizons, which are unavailable to shallow rooted crops are taken up by deep root trees are recycled through litter decomposition and can be used by crops.

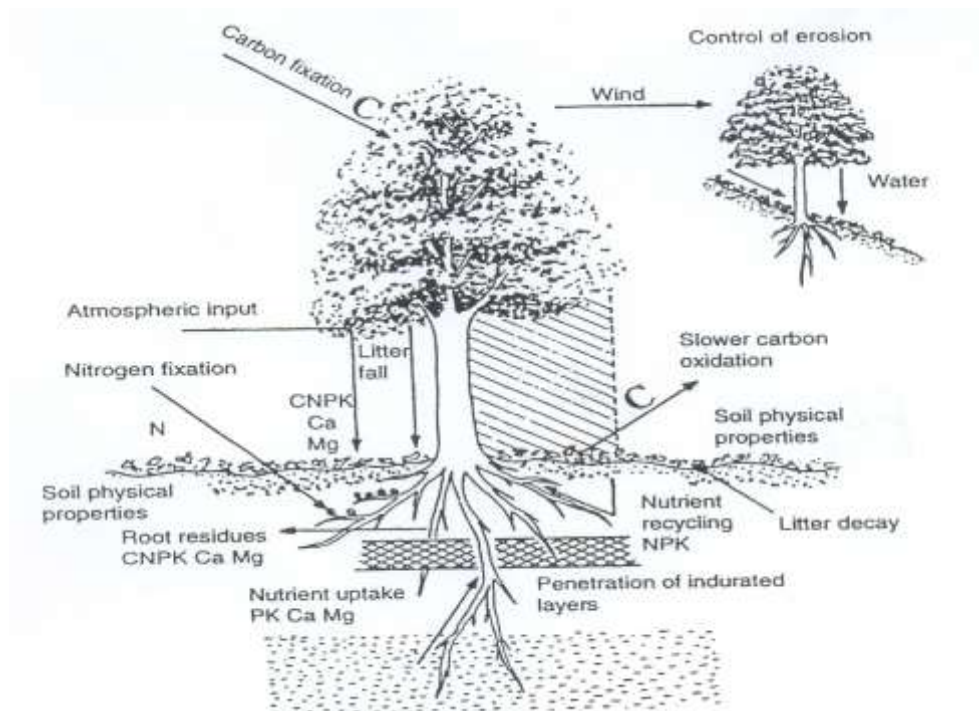


Figure1. Schematic presentation of the processes by which trees can maintain or improve soils

- **Atmospheric inputs:** It consists of nutrient dissolved in rainfall (wet-deposition) and those contained in dust (dry-deposition). However, it is difficult to determine what proportion originates from leaf leaching and from washing.

#### Reduction of loss from the soil

- **Protection from erosion:** Forest cover reduces erosion to low levels, primarily through ground-surface litter cover and under story vegetation. Trees and shrubs can also be employed, through proper planting arrangement and management, as effective barrier to control soil erosion (e.g. hedgerows for soil erosion control). Agro forestry practices are playing a great role in minimizing the six basic factors of soil erosion ( $A=R*K*L*S*C*P$ ).
- **Enhanced nutrient-use efficiency:** This is related to nutrient uptake. It is commonly supposed that tree-root system intercept, absorb and recycle nutrients on the soil otherwise be lost through leaching (e.g. the efficiency of mycorrhizal associate with trees on facilitating the up-take of nutrients).



- The terraces would be planted with grass species (e.g. bana grass) and fruit trees to assist in their stabilization. Stall feeding for cattle and fodder crops would be encouraged. Biological methods of **soil conservation** would also be **promoted**.

<b>Self-Check -1</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. How do you promote agro-forestry practices to your community? (10pts)

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**Note: Satisfactory rating - 5 points**

**Unsatisfactory – below 5 points**

You can ask your teacher for the copy of the correct answers.

### Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Short Answer Questions

1. \_\_\_\_\_  
\_\_\_\_\_



<b>Information Sheet-2</b>	Identifying Agro forestry technologies
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## 4.2. Identifying Agro forestry technologies

Some Agro forestry practices and technologies suitable for soil and water conservation are Contour hedgerows, trees on erosion control structures, reclamation agroforestry, wind break and shelter belt and alley cropping based on ecological and socio economic importance.

### **Contour hedgerows**

This is a form of alley cropping adapted for planting on sloping land. The hedges are planted along the contour. The functions for soil conservation are:

1. Cover effect of vegetation and by laying prunings on the cropped alleys.
2. To reduce surface runoff, increase infiltration and reduce soil loss through their barrier effect.
3. To develop terraces progressively, through the accumulation of soil upslope of hedgerows and stabilisation of the risers by stems and roots.

### **Trees on erosion control structures**

#### **i) Trees on grass strips**

Where grass strips form an effective contour barrier to soil transportation, trees can be planted at intervals along the grass strip to increase productivity in fruit, wood, fodder or other products. The tree roots will further anchor the soil to deeper levels. Obviously you have to select carefully tree species, which will be compatible with the grass species, and the trees must not be planted too closely together or they may cause shading.

#### **ii) Trees on ditch-and-bank structures**

Many soil and water conservation structures employ a combination of ditches and banks. Such structures are suitable for tree planting for the same reasons as above.

#### **iii) Trees on terraces**

Trees can be planted on terrace risers. They are then either pruned or coppiced and serve the following multi-purpose functions;

1. Stabilization of terrace risers, reducing the need for maintenance.
2. Production of fuelwood, fodder or fruit
3. Cover protection by canopy and by encouraging under storey growth.

This has a lot of potential in Ethiopia where wide scale terracing is going on. Additionally it must be emphasized that in dry climates the moisture capture by the terraces may be the difference between survival and mortality in any seedlings planted. So afforestation with terracing is mutually beneficial method of erosion control and multi-purpose tree establishment in dryland Ethiopia.



### **Reclamation agroforestry**

Physical and chemical constraints to plant growth severely limit the productivity of vast areas of land in the world. Water logging, acidity, aridity, salinity and alkalinity, and the presence of excessive amounts of clay, sand, or gravel are some of the constraints. According to an estimate 65 % (4,900 million ha) of the tropics is classified as 'wasted' because of these constraints.

**Management options involving these species include:** Planting or maintaining them either in block configurations for a few years, as in managed fallow systems planting them in association with crops in alley cropping or planting designs Establishing multipurpose trees (especially fodder and fuel wood species) for reclamation of severely eroded and degraded grazing land is another often-recommended technology.

### **Wind break and shelter belt**

Trees are planted in lines across the direction of damaging winds, to reduce wind erosion and wind or frost damage to crops. They can also provide shelter for animals in silvopastoral systems. There is no clear distinction in terminology, but windbreaks can usefully be considered as narrow, sometimes single-tree rows, while shelterbelts are wider than is necessary to achieve the shelter functions. These systems become agroforestry in the strict sense where the trees are managed for multiple purposes, over and above the shelter function.

Where wind is a major cause of erosion and moisture loss, windbreaks can make a significant contribution to sustainable production. When properly designed and maintained, a windbreak reduces the velocity of wind, and thus its ability to carry and deposit sand. It can improve the microclimate in a given protected area by decreasing water evaporation from the soil and plants.

Generally speaking, trees mitigate the effects of climate. This is particularly noticeable in dry zones. The trees have an effect on the air and the wind, on the humidity of the air and the soil, and light and temperature. The following tree species are known to make good wind breaks: *Balanites aegyptica*, *Acacia tortilis*, *Parkinsonia aculeata*, *Terminalia catapa*, *Dalbergia sisso*, *Acacia arabica*, *Acacia nilotica*, *Acacia senegal*, *Azadirachta indica*, *Leucaena leucocephala*. The qualities of a woody perennial used in this way are:

- adaptability on the local site
- drought resistant
- tolerance to salinity
- resistance to wind, browsing, pests, and diseases
- ease of planting
- regular habit
- fast growing
- leaf retention for maximum period
- little development of creeping roots/deep rooted
- Production: wood, forage, fruits, etc.



## **Alley cropping**

Alley cropping, also known as hedgerow intercropping, involves managing rows of woody plants with annual crops planted in alleys in between. The woody plants are cut regularly and leaves and twigs are used as mulch on the cropped alleys in order to reduce evaporation from the soil surface, suppress weeds and/or add nutrients and organic matter to the top soil. Where nitrogen is required for crop production, nitrogen-fixing plants might be the main components of the hedgerows.

The primary purpose of alley cropping is to maintain or increase crop yields by improvement of the soil microclimate and weed control. Farmers may also obtain tree products from the hedgerows – including fuelwood, building poles, food, medicine and fodder – and on sloping land, the hedgerows and prunings may help to control erosion.

Alley cropping is designed to be a sustainable alternative to shifting cultivation or expansion into unproductive farmland. It retains the basic principles of traditional fallowing, but keeps all the land productive at the same time. Alley cropping usually works best in places where people feel a need to intensify crop production but face soil fertility problems.

### **Species:**

Woody plants are introduced as hedgerows in farm fields to maximize the positive and minimize the negative effects of trees on crop management and yields. Without a doubt, trees compete with farm crops for soil nutrients, soil moisture and light. However, the right kind of trees at the right spacing, with proper management, may actually produce a net increase in yields in cropland.

The position and spacing of hedgerow and crop plants in an alley cropping system depend on plant species, climate, slope, soil conditions and the space required for the movement of people and tillage equipment. Ideally, hedgerows should be positioned in an east-west direction so that plants on both sides receive full sunlight during the day. The spacing used in field trials usually ranges from 4 to 8 meters between rows and from 25 cm to 2 meters between trees within rows. The closer spacing is generally used in humid areas and the wider spacing in sub humid or semiarid regions.

A farmer establishes an alley-farming field with certain goals in mind. He or she may use the alley farming fields for:

1. sustaining crop production,
2. maintaining or increasing soil productivity,
3. erosion control,
4. fodder production,
5. timber/wood production, and
6. a combination of these and other purposes

### **Ideally the MPTs used in alley farming should meet the following criteria:**

- ✓ can be established easily
- ✓ grow rapidly
- ✓ have a deep root system with few lateral branches near the soil surface





- ✓ resistant to drought, flooding, soil variability, other climatic hazards
- ✓ have a light, open crown that lets sunlight through
- ✓ high above-ground biomass, particularly leaf biomass production
- ✓ foliage has moderate to high and balance nutrient content
- ✓ foliage has desirable quality for use as mulch or as green manure
- ✓ ability to resprout quickly after pruning, coppicing or pollarding
- ✓ contain no toxic or allopathic chemicals in shoots and roots
- ✓ provide useful by-products such as fodder, food, stakes, fuelwood and timber
- ✓ some degree of resistance to fire
- ✓ are resistant to (and will not serve as hosts to) pests and diseases, particularly those of crops grown in the alleys.

For livestock systems some characteristics needed for trees also include palatability, high digestibility, and freedom from toxic or anti-nutritional factors.

### **Limitations:**

There are some features of alley cropping that counterbalance its advantage and hinder its widespread adoption. These include:

- ✓ Additional labor and skills that are required for hedgerow pruning and mulch application
- ✓ Loss of cropping area to the hedgerows (e.g. 20 hedgerows, each casting severe shade over an area 1 m wide and 100 m long, will cover 2000 sq.mts per hectare, or 25% of the total area).
- ✓ Difficulty in mechanizing agricultural operations
- ✓ Soil moisture dependent (Results suggest that alley cropping may not be effective under moisture stressed conditions)
  - Potential for a hedgerow species to become a weed and/or an alternate host for pests and pathogens, or harbor grain-eating birds

#### 4.2.1. Ecological importance

This refers to the environmental condition and ecological suitability of systems based on the assumption that certain types of systems can be more appropriate for certain ecological conditions; i.e. there can be separate set of Agroforestry systems for arid and semi arid lands, tropical low lands, highlands of humid. The variation here is dictated by differences in land location Environmental type, Agricultural production system, Socio economic and Ethnological differences. The management system also varies accordingly.

Agro ecological condition includes: climate, soil, physiography, and biotic factors. The species selection first must be adapted to the site condition. The climate, soil, and biotic factors affect the growth and performance of trees shrubs and other forms of vegetation directly while the physiographic factors affect the climate and the soil thus affect the vegetation From the point of view of selecting species for various agroforestry systems, several climatic parameters should be considered, such as annual rain fall, humidity, number of rainy days, mean minimum and mean maximum with extreme range of temperature.



#### 4.2.2. Socio economic importance

This refers to the level of inputs of management (low input, high input) or intensity or scale of management and commercial goals (subsistence, commercial, intermediate)

It has been defined as a tree growing, production –oriented activity conducted with the purpose of providing forest based products for the direct benefit of the local community that take part in the activity. The basic framework of the community forestry program is that any local community, through its active involvement and participation in a forest production activity is able to benefit directly from the produce that is made available.

Community forestry can take place on any piece of land, regardless of land use type. It is performed by the community at large (peasant associations, cooperatives and urban dwellers association), by schools and by individual farmers and families.

Agroforestry techniques involving planting multipurpose trees that are tolerant to these adverse soil conditions have been suggested as a management option for reclamation of such areas. For example, several genera of economically useful trees have been identified as capable of growing in saline-alkaline conditions, including *Casuarina*, and *Prosopis*. Acid tolerant trees and shrubs useful for agroforestry include *Gmelina arborea*, *Erythrina spp.* Tree species potential for soil amelioration in salt-affected soils include *Acacia nilotica*, *Acacia tortilis*, *Prosopis juliflora*, *Eucalyptus spp.*

<b>Self-Check -2</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List Some Agro forestry practices and technologies suitable for soil and water conservation (3pts)
2. **List some** economically useful trees and shrubs have been identified for agroforestry (3pts)

**Note: Satisfactory rating - 3 points**

**Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

#### Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_



Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Short Answer Questions

1. \_\_\_\_\_  
\_\_\_\_\_.
2. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

<b>Information Sheet-3</b>	Role of Agro forestry technologies for soil productivity and protection
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#### 4.3. Role of Agro forestry technologies for soil productivity and protection

Agro forestry is a system in which woody perennials (trees and shrubs) are grown in association with herbaceous plants (crops and pastures) and/or livestock in a spatial arrangement, in which there are both Ecological and Economic interactions, between the tree and non-tree components of the system. Vegetation in Agro forestry has positive effects for soil conservation purposes, both in the detachment phase and the transport phase. Trees aid soil stability by a combination of rain fall interception, regulation of run off penetration, provision of ground cover and soil organic matters through litter production and by capturing and recycling leached nutrients carried by sub surface flow & reduce wind speed to reduce wind erosion.

#### **Agro forestry practices important for soil conservation**

**A- Multi-storey cropping:** - trees, shrubs and herbaceous plants are grown together in a dense intimate spatial mixture. There may be large number of plant species in combination such as timber trees, mango, maize, green tea, sugar-cane, and annual crops. Planting is



done at any time, on an opportunistic basis when light is available. Multi story plantation practice makes the land more productive, improve soil fertility and reduce soil erosion.

**B- Taungya-** is the practice of growing crops on forest land and at the same time to establish inter-cropped trees. Intercropping continues for 1-3 years until competition from the trees (for light) prevents further growth of crops.

**C- Alley cropping:** - crops are grown in the space between rows of trees or shrubs. Tree/shrub rows are usually 4-10m apart and they are regularly pruned: pruning is either removed (for fodder and fuel wood) or retained on the soil. Alley cropping produces multipurpose biomass, increases soil fertility, reduces soil erosion, increases water storage within the soil profile.

#### **D- Trees on crop land**

This consists of trees (of *faidherbia albida* or *Accacia albida* and *moriga olifera*) grown on cropland in open, mixed spatial system. The trees may be planted or natural (i.e. left when the land was cleared).

**E. Trees on pasture** This is also called parkland system trees are grown on rangeland, in an open, mixed spatial system. The trees usually are natural & randomly spread. The tree provides shelter for grazing animals and often influences the soil and growth of grass beneath them.

<b>Self-Check -3</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. \_\_\_\_\_ is the practice of growing crops on forest land and at the same time to establish inter-cropped trees(3pts)
2. \_\_\_\_\_ crops are grown in the space between rows of trees or shrubs(3pts)
3. What are the role of Agro forestry technologies for soil productivity and protection (5pts)

**Note: Satisfactory rating - 5 points**

**Unsatisfactory - below -5 points**

You can ask you teacher for the copy of the correct answers.



## Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Short Answer Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Operation Sheet 1**

**Apply Agro Forestry technology for soil productivity and protection**

Objective To control soil erosion

To increase fertility of the soil

Materials, tools and equipment: Paper, pen note pad

Procedure:

- Wear safety cloths
- Select site
- Prepare land
- Plant different seedlings for agro-forestry
- Managing the planted seedlings
- Construct ditch and cut-off drain
- Construct house in selected area



<b>LAP Test</b>	<b>Practical Demonstration</b>
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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

**Instructions:** Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

**Task 1-** Apply Agro Forestry technology for soil productivity and protection



## Reference:

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