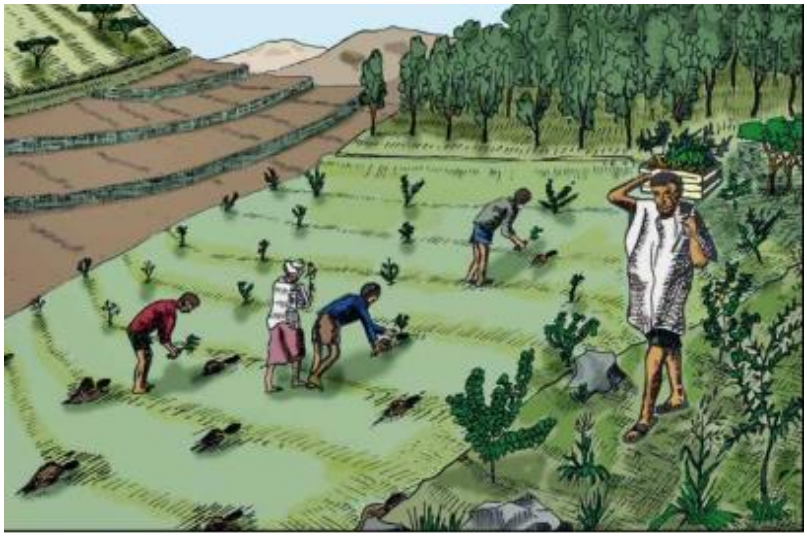
Crop production

Level-I

Based on March 2022, Version 4 Occupational standard



Module Title: - Apply Soil and Water Conservation Practices

LG Code: AGR CRP1 M06 LO (1-5) LG (22-26)

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Introduction to the Module

This module covers the information needed to identify and prepare for moisture conservation, carry out moisture stress area conservation activity, carry out irrigated area conservation activity, carry out farm land conservation activity, clean up and store materials and equipment, record and report work activities. Additionally, it discusses how the issue of environmental deterioration has outgrown all potential solutions and is in some regions of the nation growing rapidly. The fundamental goal is to make conservation planning simpler while also providing a solid scientific foundation for the actions to be taken. The main goal of the module is to improve the skills of Development Agents (DA), who work on farms and serve as the primary conduit between farmers and the Ministry of Agriculture.

LG #22	LO#1- Preparation for Moisture Conservation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying the required materials, tools and equipment
- Conducting checks on all materials, tools and equipment.
- Correct manual handling techniques of loading and unloading
- Selecting and checking (PPE).
- Identifying and providing OHS hazards.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify the required materials, tools and equipment
- Checks on all materials, tools and equipment with insufficient or faulty items.
- Correct manual handling and techniques for loading and unloading materials to minimize damage
- Select and check suitable Personal Protective Equipment (PPE) prior to use.
- Identify OHS hazards according to OHS requirements and workplace information.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-1

Introduction

The term soil and water conservation implies improved management of the two resources "soil" and "water", in order to maintain (support, increase) in a medium- to long-term perspective the production capacity of these resources, often measured in terms of crop yield. The proper planning of soil and water conservation technologies and its implementation depends on measurements, observations, estimations and perceptions made by different stakeholders like practitioners, technicians, politicians, scientists, development agents etc. Water is one of the most important natural resources and all forms of life are dependent on it. It is, therefore, very essential to properly conserve and manage this resource and regulate its use to obtain maximum benefits.

Water conservation is the physical control, protection, management and use of water resource is such a way as to maintain crop, grazing, forestland, wildlife and wildlife habitat for maximum sustained benefit. Water conservation is a measures designed to promote efficient to use of water and to eliminate waste of water.

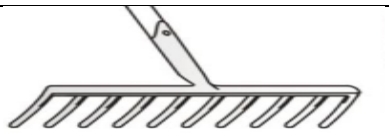
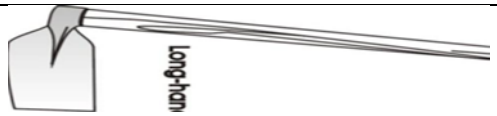
Soil conservation is all measures aiming at preserving soil resource in situ in quantity and quality, or curing damage caused by soil loss upslope or upstream. In most instance, soil conservation measures benefits of water conservation.

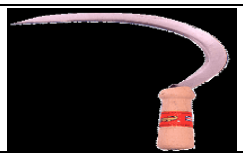
1.1. Identifying the required materials, tools and equipment

- **A tool** is any instrument or simple piece of equipment that you hold in your hands and use to do a particular kind of work
- **Equipment** is a set of tools or implements used to achieve a particular activity
- **Material** is the elements, substance, or parts of which something is made or can be made

Tools and equipments for soil and water moisture conservation include the followings and you need to know these tools and equipments by their name and identify physically. A list of tools an

Table 1.1 Materials, tools and equipment

Tools and equipments	**Purpose**	**Picture**
Spades	For digging, collecting the soil	
Shovels	For oil mixing	
Rope	To guiding measurement	
Rakes	Break up and level the soil	
Auger	Take soil sample	
Hand hoe	For digging	
Flat-pronged fork	To lift bare-roofed seedlings	
Tracing line	To trace straight lines.	
Hammer	For pegging	

Clinometers	To measure slop	
Ranging pole	To correct slope reading	
Measuring tape	To measure the distance	
Water level	To measure the angle	
Moisture tester	To measure soil moisture content	
Sickle	For cutting	

1.2. Conducting checks on all materials, tools and equipment.

- **Checking of all materials, tools and equipments**

A good care should be taken of the tools and equipments, which would then have a long life. It is not wise to keep workers sitting idle at critical periods of work because of shortage of tools.

Rules in handling tools and equipments are-

- ✓ Used all tools for what they are designed or constructed.
- ✓ Clean the tools and equipments always before storing them away.
- ✓ Store them in a neat dry place.

- **Checking and reporting of faulty and insufficient all materials, tools and equipments**

To identify all materials used in soil and water conservation and separate faulty once follow the following steps

- ✓ Check if all materials are clean of any contaminants
- ✓ Use a list of materials provided by your supervisor and then classify the materials according to their purpose

- ✓ Know the name of the materials listed in your supervisors list
- ✓ Go to store and identify all the materials physically one by one
- ✓ Describe the use or purpose of each material
- ✓ Separate a materials which doesn't have best match with handle, broken, have hole on containers, not sharp/can be easily broken, or can't function relative to the purpose of the work, or any other unspecified reasons.
- ✓ Count the number of faulty, functional or material that can be maintained very easily.

- ✓ Finally report to your supervisor the categories of material based on their purpose, the total number of each category, the number of faulty materials and if the functional materials are sufficient in number for the intended soil and water conservation activities.

1.3. Correct manual handling techniques of loading and unloading

Loading and **unloading** means the process of getting goods and equipment in and out of the stallholders' vehicles and lifting up or taking down the stall or pitch

To do the intended soil and water conservation materials should be transported from where they are stored to the working site. These materials will be counted and will be loaded on a transporting vehicle and unloaded in the working site.

- **Proper handling of materials during loading and unloading**

While loading and unloading we should take the necessary care not to break, holing, etc. and not to make any of these materials faulty for the next time

Properly handling materials can prolong the time of service they can give and minimize the cost of buying new materials in replacement to faulty once. During loading and unloading includes the following dos and undoes.

✓ **Loading**

- Do not through materials from ground on to the vehicle
- Do not overload the vehicle.
- Stack lighter loads on top of heavier loads.
- Spread the loads out evenly for balanced weight distribution.
- Secure and lash the loads properly.
- Ensure that the stacking arrangement is stable

✓ **Unloading**

- Do not through materials from vehicle on to the ground
- Ensure that the loads have not shifted during transportation before unloading.
- Ensure that all equipment used for unloading are in good working condition.
- Perform unloading on flat and firm ground.

Therefore, the first principle in loading and unloading materials is hold the material properly in both hands, keeping balance and safely placing the materials on vehicles or on ground, for these purpose at least two or more people are necessary one or more on the vehicle and one or more on ground. If we through materials from ground on vehicle we could break the glasses of the vehicle, we might hurt the loading surface and lead to fast depreciation of the vehicle. We might also create a problem when unloading materials improperly.

- **Basic Safety Procedures**

The following rules apply for loading and unloading hazardous materials:

- ✓ Secure packages, including palletized loads, against shifting within a vehicle during transportation. Securing can be accomplished through tying, blocking and bracing the load. Secure bottles of compressed gases to prevent damage to their valves.

- ✓ Load packages with orientation marks (up arrows) so that the marks remain pointed up.
- ✓ Do not allow any smoking or any source of ignition on or near the vehicle when loading/unloading flammable materials and set the handbrake on the vehicle before loading/unloading.

Note: Avoid lifting from the floor whenever possible. If you must lift from the floor, do not bend at the waist. The techniques shown below help the worker to keep the spine in a safer position while lifting from the floor.

1.4. Selecting and checking (PPE)

Definition

Personal protective equipment is defined as the Occupational Safety and Health Administration. It is "**specialized** clothing or equipment, worn by an employee for protection against injury by blunt impacts, chemicals, infectious materials etc."

Personal protective equipment is to include that prescribed under legislation, regulations and enterprise policies and practices.

- **Selecting personal protective clothing and equipment**

Suitable personal protective clothing and equipment is selected, used, maintained and stored in accordance with Occupational Health and Safety requirements

When you are selecting PPE, consider three key things

- ✓ **Type of exposure anticipated-such as-**
  - Splash/spray versus touch (ingestion, inhalation, injection, or dermal contact)

- Category of isolation precautions
- Durability and appropriateness of the PPE for the task

✓ **Dos and Don'ts of Glove Use**

- Work from "clean to dirty"
- Limit opportunities for "touch contamination
- Don't touch your face or adjust PPE with contaminated gloves
- Don't touch environmental surfaces except as necessary

✓ **Key Points about PPE**

- Do before going to worksite
- Use carefully – don't spread contamination
- Remove and discard carefully, after finishing work
- Immediately perform hand hygiene

Table 1.2 Personal protective clothing and equipment

PPE	Purpose	Picture
Boots/shoes	Foot protection	
Overalls	Body protection	
Gloves-	Protect hands	
Sun hat-	Head protection	

Goggles-	Eye protection	
Facemask-	Face protection	
Earmuff-	Hearing protection	

1.5. Identifying and providing OHS hazards.

A. Occupational health and safety (OSH)

Occupational health and safety (OSH) is a multidisciplinary field concerned with the safety, health, and welfare of people at work. The goal of occupational health and safety (OSH) programs is to foster a safe and healthy work environment.

Occupational health should aim at-

1. The **promotion and maintenance** of the highest degree of physical, mental and social wellbeing of workers in all occupation
2. The **prevention amongst w**orkers of departures from health caused by their working conditions.
3. The **protection of workers in their employmen**t from risks resulting from factors adverse to health.
4. The **placing and maintenance of** workers in an occupational environment adapted to his physiological and psychological capabilities and
5. To **summarize the adaptation of work**er to man and of each man to his job.

B. Hazard Identification and risk control

- **Hazard:** is anything (e.g. condition, situation, practice, behavior) that has the potential to cause harm, including injury, disease, death, environmental, property and equipment

damage in Soil and Water Conservation design, planning and implementation. A hazard can be a thing or a situation.

- **Hazard Identification:** is the process of examining each work area (Soil and water conservation area) and work task for identifying all the hazards, which are "inherent in the job".
- **Risk:** is the likelihood, or possibility, that harm (injury, illness, death, damage etc.) may occur from exposure to a hazard.
- **Risk Control:** is taking actions to eliminate health and safety risks as far as is reasonably practicable. Where risks cannot be eliminated, then implementation of control measures is required, to minimize risks as far as is reasonably practicable.

Every day workers all over the world are faced with a multitude of **health hazards, such as**:

- ✓ Dusts
- ✓ Chemicals
- ✓ Electricity
- ✓ Gases
- ✓ Noise
- ✓ Vibration
- ✓ Extreme temperatures.
- ✓ Solar radiation
- ✓ Soil-borne micro-organisms
- ✓ Fire hazard
- ✓ Sharp hand tools and equipment
- ✓ Manual handling
- ✓ Holes
- ✓ Slippery and uneven surfaces

Self-check-1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Choose the best answer (5 mark)

1. Which one the following tool is **NOT** used for digging
   A. Shear
   B. Hoe
   C. Spade
   D. Fork
2. Which tool or equipment you use when you want conserve water?
   A. Glove
   B. Lang hand hoe
   C. White board
   D. All

Test II: Short Answer Questions

Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What do you understand by preparing tools and equipments? (5 mark)
2. What is the difference between tools and equipments? (5 mark)
3. Describe some rules, which are used in handling tools and equipments during loading and unloading. (5 mark)
4. List some tools which are used soil and water conservation activity and describe about their functions. (5 mark)

Note: Satisfactory rating – 12.5 mark and above Unsatisfactory - below 12.5 mark

Operation Sheet-1

1.1 Techniques of loading and unloading

1.1.1. Techniques of loading

A. Tools and equipments

- Lifter
- ladder
- wheel barrow

B. Procedures/Steps

- Use PPE
- Clear any obstructions before you load the materials from one place to another



Lean the sack onto Your kneeling leg	side the sack up onto your kneeling leg	Slide the sack onto the other leg	As you stand up, keep the sack close to your body	Hold it both of your hand

- Place materials orderly and safely, by note throwing the materials on the vehicle.

1.1.2. Techniques of unloading

A. Tools and equipments

- Lifter
- Wheel barrow
- Ladder

B. Procedures/Steps

- Then group yourself in pair of two person or more persons
- Let one person or one group be on the vehicle and the other group on ground
- Check the load to ensure it is within lifting capacity and can safely be handled
- Stand close to the load with the feet apart, one foot behind and the other beside the load.

- Bend knees, grasp the load and lift by straightening the legs.
- Avoid reaching, bending forward to lift, twisting the back or bending sideways.

- Be able to see over or around the load before moving.
- Face the spot where the load is to be placed, bend the knees to lower the load, keeping the back as straight as possible and the load close to the body.
- Protect fingers from pinching before release of load.

- Let the group on ground take materials from store and give it for his counterpart on the vehicle, note material should be taken one by one, or if suitable two by two or more if suitable

- Let the group or person on the vehicle receive the material from the person on the ground and place it on the vehicle.
- Place materials orderly and safely, by note throwing the materials on the vehicle.

LAP TEST-1	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 Perform loading

Task-2 Perform unloading

LG #23	LO #2- Undertaking Moisture Stress Area Conservation Activity

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying, site selection and land preparation
- Identifying moisture stress
- Identifying conservation methods (Split)
- Undertaking work task.
- Carrying out interactions with farmers and customers.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify site selection and land preparation
- Identify moisture stress and other areas establishment activities and conservation methods
- Undertake work task in a safe and environmentally appropriate manner.
- Carry out interactions with farmers and customers in a positive and professional manner.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-2

Introduction

Agriculture will be the loser in the run for scarce water resources, as the output per unit water is of lower value than in other sectors. Moisture stress happens when the water in a plant's cells is reduced to not exactly ordinary levels. This can occur because to lack of water in the plant's root zone, higher transpiration rates than the moisture uptake rate by the roots. The major agro-ecological zones of Ethiopia were increased from time to time. On the other hand, currently food security problems increases in low moister stress areas due to climate change.

2.1. Identifying site and preparing the land

2.1.1. Identifying and searching information.

Information is shortly defined as the processed data. Site information may include but not limited topography, Soil, weather & Climatic, vegetation, land use, Water resources, Social and economic, etc. Sources of information for site identification may include but not limited are

- Organizational rules, regulation and guidelines
- Internet, related books and related materials
- Technical manuals
- sharing best practice (Best Management Practices)
- Workplace guidelines
- Recorded documents/logo/history

Water conservation measures are different for area. Therefore, it is important to know in which area you are located when you carry out soil and water conservation. Since Ethiopia has great climatic variety, from **dry to wet**, and many different altitudes, from **lowlands to highlands**, the same conservation technologies cannot be applied everywhere. Therefore, it is

necessary to know the characteristics of an area where soil and water conservation is to be implemented based on:

- **Agro climatic zones**: dry dega, weyna-dega, kola bereha
- **Soil characteristics**: like depth, texture, structure, fertility and organic matter, surface stoniness, drainage, soil suitability for different crops, erodibility,
- **Slopes:** useful on all slopes.

- **Type of degradation:** e.g. by water, by wind, chemical or physical deterioration

✓ Soil degradation can be classified into four main types of degradation: water erosion, wind erosion, chemical deterioration and physical deterioration.

✓ **Water erosion** means that soil particles are detached either by splash erosion (caused by raindrops), or by the effect of running water.

✓ **Wind** can suspend very fine particles and then transport it over great distances. Fine and medium size particles can be lifted and deposited, while coarse particles can be blown along the surface

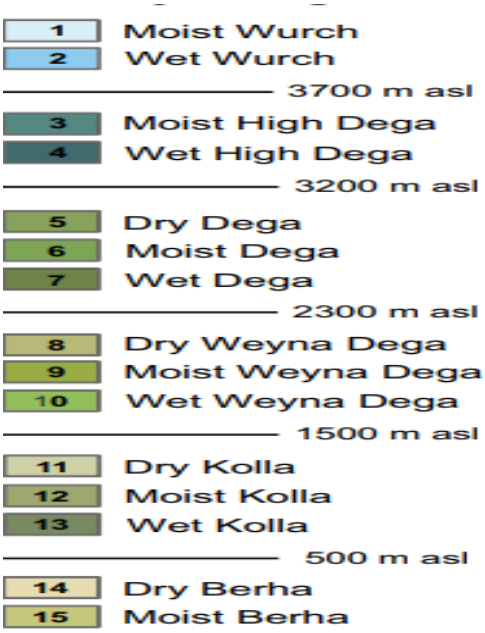
✓ **Chemical deterioration** as a type of soil degradation involves loss of nutrients or organic matter, salinisation, acidification, soil pollution, and fertility decline.

✓ **Physical deterioration** involves soil crusting, sealing and compaction and can be caused by several factors like compaction through heavy machines or animals.

- **Landform:** e.g. plateau, ridge, valley floor, slope length and steepness
- **Land:** ownership and land rights;
- Personal preferences of the land user concerned
- Expected short and medium term economic benefits and farmers planning horizon
- Costs for labor, equipment, agricultural material, availability and costs of wage

Generally, ‘dry’ is defined as having less than 900 mm of annual rainfall. ‘Moist’ is between 900 mm to 1400 mm, and ‘wet’ is above 1400 mm of annual rainfall.

Major Agro ecological zones in Ethiopia



2.1.2. Site Preparation

Site or ground preparation includes clearing of the indigenous vegetation and cultivating of the ground before planting. The extent of ground preparation for tree planting depends on the climate of the area, on the vegetation, on the type of soil and on the species to be planted. Generally, in areas where deficiency of water limits plant growth at certain times of the years, a more intensive and thorough preparation is required than in moister areas

- **The objectives of ground preparation are:**
  - ✓ To remove competing tree and grass vegetation from the site. The drier the area, the more complete removal of vegetation is necessary.
  - ✓ To create conditions which will enable the soil to catch and absorb rainfall. Surface runoff must be reduced to a minimum.
  - ✓ To provide good rooting conditions for the trees.

- ✓ To minimise the risk of fire. This may be an important consideration on sites with a tall and dense grass vegetation.
- ✓ To facilitate mechanised tending operations after planting. This usually involves removal of all tree stumps.

To sum up, the aim is to give the young trees a good start with rapid early growth, so that there would be no period of decreased growth after planting. Ground preparation, together with tending operations that are done after planting form the biggest block of expenditure in the total establishment cost of the plantation. Ground preparation and subsequent tending are interlinked: inadequate ground preparation may greatly increase weeding costs, whereas proper site preparation may decrease need for later tending

- **Methods for clearing land**
  - ✓ Manual methods
  - ✓ Mechanised clearing methods
  - ✓ Chemical methods
  - ✓
- **Ground cultivation before planting**

The extent of soil cultivation before planting depends on the vegetation of the site and on the species to be planted. As cultivation is one of the biggest items of cost in the establishment of plantations and water conservation it should be limited to the necessary minimum

- **No cultivation**

Sometimes it possible to plant vegetation in grassland sites by simply digging a hole and inserting the plant into it. This method can only give satisfactory results, if weeds are controlled after planting by frequent slashing.

2.2. Identifying moisture stress

Moisture stress: It indicates the action of lack / deficit or excess of water on plants. However, in general, stress is used to imply moisture/water deficits. The term moisture stress is generally used for moisture deficit conditions through it is applicable to excess moisture also.

Moisture stress is one of the most important elements influencing plant growth, development, and yield profitability, posing a substantial threat to sustainable agriculture. It does not affect all aspects of plant growth and development equally.

Plants absorb water to normal function like nutrient absorption, transpiration, metabolic activities leading to growth, development and yield. Whenever transpiration exceeds the water uptake, stress prevails in plants. Stress is due to higher transpiration and less absorption. Moisture stress affects all aspect of plant growth. It affects water relation in plants, photosynthesis, respiration, metabolic reactions, and hormonal reactions. Nutrition, growth, development and yield.

A number of factors; such as soil properties (soil texture, structure, organic matter, depth, density and salinity) influences the variation in soil water content, climate (precipitation, solar radiation, temperature, etc.), topography and land cover. These influencing parameters can regulate permeability, infiltration, water holding capacity and moisture loss rates. Currently, the practices like; crop type choice, agronomic practices, input fertilizers application and irrigation management practices are expected to vary the dynamics of soil moisture due to their impacts on the physical and bio-geochemical interactions within ecosystems.

Table 2.1 Effect of moisture stress in crop

Categories	**Soil Water Potential**	**Reduction in Leaf Relative Water Content (%)**
Mild Stress	-0.1	8-10
Moderate Stress	-1.2 to -1. 5	>10-20
Severe Stress	< -1.5	>20

2.3. Identifying conservation methods (Split)

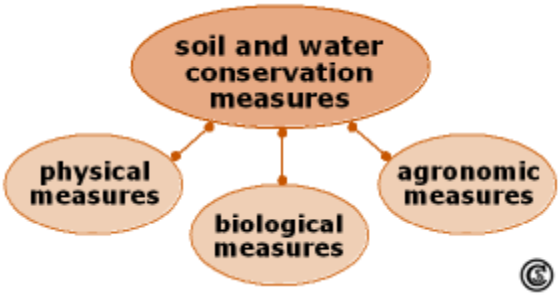
2.3.1. Soil and Water Conservation

There are always strong links between measures for **soil** conservation and **water** conservation, and this applies equally in semi-arid areas. Many measures are directed primarily to one or the other, but most contain an element of both. Reduction of surface run-off by structures or by changes in land, management will also help to reduce erosion. Similarly, reducing erosion will usually involve preventing splash erosion, or formation of crusts, or breakdown of structure, all of which will increase infiltration, and so help the water conservation.

2.3.2. Classification of Soil and Water Conservation Measures

A variety of soil and water conservation measures is well known. These technologies can be differentiated either by their main purpose or by type. As many among them fulfil several functions simultaneously, these are classified here by type

- **Physical** measures (also termed mechanical or technical measures)
- **Biological** measures (also termed vegetative measures)
- **Agronomic** measures (sometimes called best management practices)



I. Water conservation method

The objective of water conservation and management is to improve availability of water for plant use, hydropower generation and irrigation. Communities should prepare themselves both for long and short-term water conservation measures. Short-term water conservation measures and cut-backs are required of users during water shortage situations or when short-term problems

with the capacity of supply systems occur. Long-term water conservation measures, for example water demand management generally requires changes in water use systems and technology

- **Water resource developments**
  - ✓ Collecting and storage of surface water
  - ✓ Recharge of ground water. These two systems can be achieved by building dams, water harvesting systems, pond, and watershed
- **Flood control:** canals, weirs, dams etc.
- **Moisture control practice:** Tillage operation, Mulching, Conservation tillage and Crop rotation

II. water conservation practice

- Making better use of rainfall by:
  - ✓ Minimizing runoff , evaporation and transpiration losses
  - ✓ Increasing water storage capacity of soils
- Increasing efficiency of irrigation water use by:
  - ✓ More rational use of water
  - ✓ Applying more efficient techniques
  - ✓ Avoiding water losses
  - ✓ Using improved application Techniques
- Selecting best suited crops and cropping methods
  - ✓ Using crops of high water use efficiency
  - ✓ Cultivation of upland crops in paddy fields during dry season
  - ✓ Cultivation of less water demanding crops than rice
  - ✓ Multiple use / reuse of water
  - ✓ Avoiding percolation losses in ponds & reservoirs
  - ✓ Improved watershed development

2.4. Undertaking conservation work in safe and environmentally appropriate manner

Improved soil moisture conservation practices have been found to mitigate soil moisture stress in many water scarce areas of the world. Soil water is a vital component of agricultural production, essential to maximize both yield and quality.

Adoption of soil conservation practices such as conservation agriculture, organic residues, mulching, irrigation systems, rainwater harvesting, microorganisms, improved soil health, etc.
Most of soil moisture conservation practices can improved soil fertility in many instances under favorable circumstances following application of farmyard manure, crop residues, etc. due to improved microbial activities.
Research has been suggested that without application of best soil and water conservation practices, it will not be possible to achieve production targets needed to feed additional billions of people by 2050, as there is a direct relation-ship between soil and water conservation practices and maintaining and/or increasing productivity.

Soil and water conservation are so interrelated that they must be accomplished together. The soil acts as a reservoir that conserves water. Reducing both splash and runoff conserves soil. Contouring, contour strip cropping, rough surfaces created by tillage, and terracing all increase infiltration by holding water on the land. Any runoff that occurs is slower and carries less soil. Streams fed by seepage and slow runoff have more uniform flow and lower flood peaks than would occur from unprotected watersheds.

2.4.1. Factors that affects soil and water conservation

- **Topography**
- **Soil characteristics**
- **Soil moisture**
- **Vegetable**
- **Human behavior and animals**



Figure: 2.1: Soil and water conservation

2.4.2. Water conservation management methods

Conserving water by using wisely the rain that falls both in dryland and in humid areas is very important. Precipitation (P) is lost as it moves from the air to the soil because it is intercepted (I), or because it runs off (R). If the rainwater passes through the soil surface (infiltrates), it is stored in the soil to be used by crops unless it evaporates from the soil surface (E), is transpired by weeds or volunteer plants (T), or percolates below root depth (D).

Three of the five avenues of moisture loss runoff, evaporation, and transpiration by weeds cause water losses that can be significantly reduced. Water loss by deep percolation is important in many humid areas and on very coarse textured soils in dryland regions.

- **Decreasing runoff losses**

Some of the rain that penetrates the vegetative canopy runs off the land instead of soaking into the soil. Rainfall intensity, soil properties, land configuration, and vegetative cover affect **runoff**. Coarse-textured and well-aggregated soils have high infiltration rates; fine-textured, poorly aggregated soils have low infiltration and high runoff rates. Infiltration rates are usually higher at the beginning of a storm, when soils are dry, but drop off quickly as soils become wet.

Increasing slope gradient increases the amount and velocity of runoff; surface soil depressions hold water and permit local water, and even run on from adjacent areas, to be absorbed. Vegetation, both living plants and dead crop residues, reduces the number of raindrops that hit the soil directly, thus reducing soil crusting and maintaining higher infiltration rates. Contour cultivation, level terraces, pits, furrows, basins, strips crops, bunds, ridges, fanya juu, mulching and stone wall are the control measures to minimize runoff.

- **Reduce evaporation**

A saturated soil loses water by evaporation as fast as a free water surface. When surface soil is dry, evaporation is reduced to the rate that water vapor moves upward through the dry layer. Dark-colored soils absorb more heat than light-colored soils, so they are hotter and lose more water by evaporation.

Drylands with low relative humidity and high wind velocities lose a larger proportion of rainfall by evaporation than do humid regions. Vegetation, either living or dead, reduces evaporation by insulating against heat and deflecting wind away from the soil.

- **Reduce deep percolation**

Deep percolation losses are of little significance in non-irrigated dryland areas because the limited rainfall can usually be trapped in the root zone, except possibly in sands or in sites that receive run on water. Percolation losses are likely in humid and irrigated areas.

Deep percolation is a common avenue of water loss in humid regions, but this loss does not seriously reduce the amount of water available to plants unless the soil has a low water-holding capacity.

Sandy soils lose large amounts of water through percolation because some of them hold less than 2 in. (50 mm) of available water in the root zone. Reducing deep percolation losses in sands could increase water available to crops and thereby increase crop yields. Vegetable crop yields were increased by 35 to 40% on the fine sand, but only small increases occurred on the loamy sand soil.

Deep percolation leaches nutrients and makes soils more acid. Controlled runoff (without serious erosion) in humid regions actually may be less damaging than deep percolation, particularly where fertilizers and lime are expensive and hard to obtain.

- **Prevent unnecessary loss from storage**

Water that percolates below plant roots is lost to those plants. The limited rainfall in dryland areas seldom penetrates below root depth in medium- and fine-textured soils, even when the land is summer fallowed; in humid regions, considerable water is lost for plant growth by deep percolation.

2.4.3. Soil conservation management

Soil conservation is using and managing land based on capabilities of land itself, involving the application of the best practices to result to in greatest profitable production without damaging the land.

- **Objective of soil conservation**
  - ✓ Promotion of proper land use
  - ✓ Prevention of soil erosion and restoration of the fertility eroded
  - ✓ Maintenance of soil fertility
  - ✓ Reduction of water runoff and regulation of water resource
  - ✓ Prevention of water pollution caused by carried out off soil and debris
  - ✓ Enforcement of safe drainage and irrigation on slop land
  - ✓ Prevention of wind erosion
- **Soil erosion**

Soil erosion is the natural process in which the topsoil of a field is carried away by physical sources or the wearing away of the land surface by water, wind, ice, gravity, or other geological agents. It is a process of detachment, transportation and deposition of soil particles by erosive agents (water and wind). The current report on the extent of erosion in Ethiopia indicates

- ✓ **Types of soil erosion**
  - **Water erosion**
    - **i. Splash erosion**

Splash erosion: is also known as Raindrop erosion. Raindrops impacting the soil surface disperse. Splash the soil, displacing particles from their original position. Involve raindrop impact, splash of soil particles, and formation of craters. The depth of craters which is equal to the depth of raindrop energy penetration is a function of raindrop velocity, size, and shape.

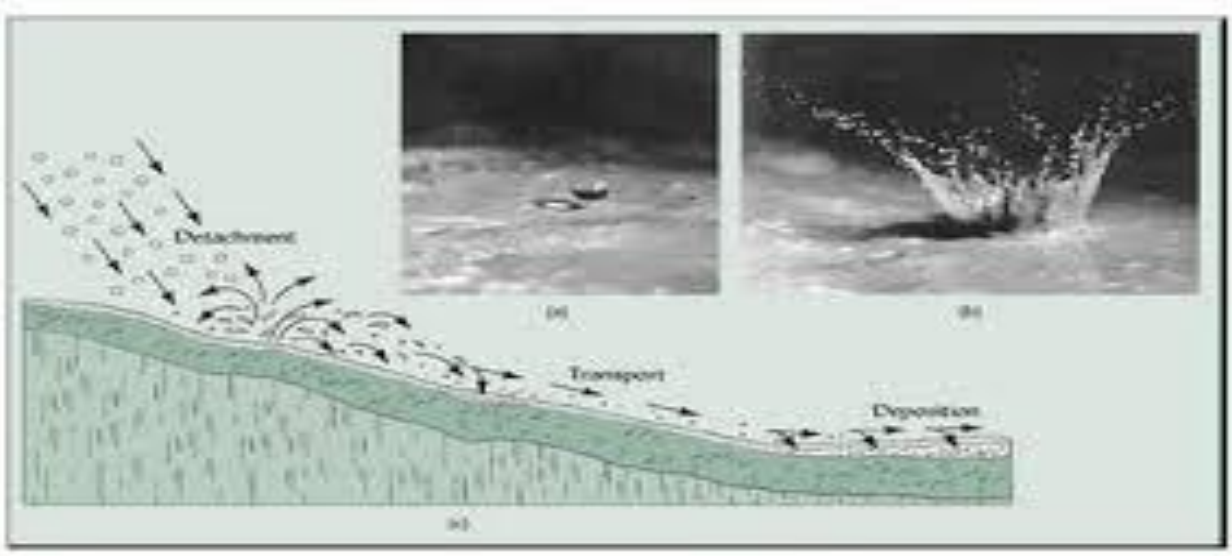


Figure: 2.2: Splash erosion

ii. Sheet erosion

It is the removal of a fairly uniform, thin layer of soil from the land caused by raindrop splash or water flowing across the surface.

Raindrops provide most of the energy for detaching soil particles and over-surface flow is the primary transport mechanism



Figure: 2.3: Sheet erosion

iii. Rill erosion

Rill erosion is a result of surface runoff and associated sheet wash.

It selectively removes fine material and organic matter. It results in numerous small channels caused by intermittent water flow during or immediately after a rain or when snow melt occurs. Several centimetres deep with relatively-steep sides, occur most frequently on recently-tilled land



Figure: 2.4: Real erosion

iv. Stream bank erosion

Stream bank erosion: is the scouring of soil materials and cutting of stream banks by water flowing in streams. Areas impacted by stream bank erosion usually are relatively small, but soils of those areas often are highly productive, thereby resulting in significant productivity losses.



Figure: 2.5: Stream bank erosion

v. Gully erosion:

Gullies are formed when runoff cuts rills deeper and wider or when the flows from several rills come together and form a large channel. Gullies are one of the most destructive forms of erosion, damaging farmland and difficult to reverse. Once a gully is created, it is very difficult to control, and costly to repair.



Figure: 2.6: Gully erosion

- **Wind erosion**

Wind erosion is also known as eolian erosion, is a dynamic process by which soil particles are detached and displaced by the erosive forces of the wind. In arid and semi- arid regions, annual rainfall is less, are more predominant by wind erosion. Wind erosion occurs when the force of wind exceeds the threshold level of soil's resistance to erosion. Geological, anthropogenic, and climatic processes control the rate and magnitude of wind erosion. There are three distinct kinds of soil movement by the wind depending upon the size of the soil particles.



Figure: 2.7: Wind erosion

i. Suspension

Suspension: is the movement of very fine particles, usually less than 0.1 or 0.2mm diameter, high in the air over a long distance. Soil moved by suspension is the most spectacular and easiest to recognize of the three forms of movement.

ii. Saltation

Saltation: the movement of middle size soil particles (0.05 to 0.5mm diameter) in a series of jumps over the surface. . Soil particles moved in the process of saltation cause severe damage to the soil surface and vegetation.

iii. Surface creep

Surface creep: is the rolling of coarse grains (0.5 to 1 or 2mm diameter) along the ground surface. The large particles which are too heavy to be lifted into the air.

✓ **Causes of Soil Erosion**

Political, economic, social conditions, climate, land use, management, and topography influence soil erosion. Poverty level directly relates with soil erosion in developing countries. There is no way to measure conservation practices for poor farmers that have limited or lacked resources. The risk of soil erosion is decreased by the elimination of implementing conservation practices and for year after year food production on small agriculture farms compels farmers to use over exploiting practices by Subsistence farming.

Deforestation

Energy fluxes, erosion control, moderation of climate and ecosystem stabilization are the essential ecosystem services provided by forest. Medications, wood, numerous other wood-based items and sustenance is also provided by wood. The major causes of denudation are urbanization, unnecessary logging and clear-cutting, construction of roads and highways, frequent fires and expansion of farming to marginal lands. As the human population continues to increase, there is a clear need for more food. In addition, the increases demand of agricultural products has created incentives to convert forests to farmland and pastures.

Once a forest is converted to agriculture, usually gone forever, along with many of the plants and animals that once lived there. The land availability for agriculture or other uses is done by deforestation that causes the permanent destruction of forests. Therefore, the cycle of soil loss continues by the movement of farmers in the forest, clearing more forest as well as soil fertility is also lost.

Intensive cultivation

Industrial agriculture that is also termed by the intensive farming or cultivation is attributed by maximum use of inputs such as low fallow ratio, labor and capital per unit land. Higher yields are produced with the use of less land and less labor that capable the farmer by more intensive agriculture. Even when there is not excessive soil erosion, soil quality can also be reduced by depletion in organic matter and natural supplies of trace elements as the result of intensive cropping.

- **Overgrazing**

In many livestock farms, the same piece of land for a long time is mostly concentrated by the herds of cattle and sheep. Soil displacement during traffic, repeated crushing or trampling and overgrazing is resulted by this confinement. Soil erosion on steeps slope or hillsides is increased when the protective cover is reduced by removing or thinning of grasses.

Acceleration of water and wind erosion, degradation of soil structure and reduction in organic matter content of soil is resulted by overgrazing.

Reduction in root proliferation and growth, soil compaction, drainage and water infiltration rate decreases by cattle trampling. Soil erosion in heavily grazing areas increase runoff by increasing stocking rate.

Wind erosion is susceptible to increase soil erosion in surface soils that disintegrate the particles by animal traffic in dry regions. Flowing water and wind preferentially removed the detached fine particles of surface sand. Loss of topsoil and nutrients by the conversion of natural ecosystem that caused higher rates of erosion by increasing continuous grazing that initially damage the land.

- **Cultivation of steep slopes**

Raindrop is absorbed into soil pore spaces as it falls on the soil. When all the pore spaces are filled with water soil becomes saturated and extra water will either stand on surface or flow down as runoff. The moving water will flow soil particles away and starts the process of erosion. As the intensity of rain increases, the runoff increases and the force exerted on soil particles also increases.

As the slope steepness increases, the velocity of runoff and force on soil particles also increases. The soils, which have less or no vegetation on the surface, are more vulnerable to erosion caused by flowing water. Amount of rainfall, slope steepness, vegetation and soil type are the major factors causing slope erosion.

- **Soil mismanagement**

The common cause of soil erosion is the expansion of agriculture on poor quality water irrigation, indiscriminate chemical input, and no vegetation degrade soils. Crop residues are

removed for fodder and biofuel and industrial uses, this practice leaves the soil bared from protective cover below a critical level and soil becomes vulnerable to erosion.

Runoff is increased by intensive cultivation causing soil erosion, and ultimately transporting nutrients and pesticides off-site and water and soil quality is reduced.

Urbanization

There is significant effect of urbanization because most of the productive agricultural land near cities has been converted into residential and commercial area. As a result, agricultural area is decreasing which ultimately affects the farmer's income as the natural resources are also decreased. Despite decrease in agricultural land, the limited land is used intensively for cultivation, which results in decreased soil fertility over the time

2.4.4. The common Soil and Water Conservation Measures

A broader field is that of soil and water conservation, since reduction in water loss through runoff is an integral part of soil conservation.

Therefore, soil conservation = maintenance of soil fertility.

- **Conservation measures on cultivated land**
  - ✓ Alley Cropping
  - ✓ Bench Terrace
  - ✓ Broad bed and Furrow
  - ✓ Conservation Tillage
  - ✓ Graded Bund
  - ✓ Graded Fanya Juu
  - ✓ Grass Strip
  - ✓ Level Bund
  - ✓ Level Fanya Juu
  - ✓ Mulch

- **Conservation measures on grassland**
  - ✓ Controlled Grazing
  - ✓ Cut and Carry
  - ✓ Grassland Improvement

Conservation measures on forestland

- ✓ Hillside Terrace
- ✓ Micro basin
- ✓ Tree Planting
- ✓ Trench

- **Conservation measures common to all land use types**
  - ✓ Area Closure
  - ✓ Check dam
  - ✓ Cutoff Drain
  - ✓ Gully Rehabilitation
  - ✓ Revegetation
  - ✓ Water Harvesting
  - ✓ Waterway

Alley cropping

Alley cropping is an agroforestry system in which food crops are grown in alleys between rows of hedges. The hedges follow the contour and consist of trees and shrubs such as Luciana or Pigeon peas. Leguminous perennials are more suitable as they fix nitrogen. Hedges can also be placed on conservation structures.



Alley cropping on a steep slope. Rows of trees and hedges alternate with strips of grassland or cultivated land. Controlled grazing with cattle is possible between the rows. Crops can be grown for some time until the soil is left fallow to improve fertility, supported by organic material from tree leaves and fixation of nitrogen through some trees.

Figure: 2.8: Alley cropping

- **Bench terrace**

A bench terrace is a conservation structure where a slope is converted into a series of steps, with a horizontal cultivated area on the step and steep risers between two steps. In Ethiopia, a bench terrace is usually developed from bunds and Fanya Juus over a period of 5–15 years through careful maintenance and buildup. Bench terraces are level along the contour in dry to moist agro ecological zones. In moist to wet agro ecological zones, they are graded to drain excess runoff sideways to the next river or waterway.



Figure: 2.9: Bench terrace

- **Broad bed and Furrow**

Roadbed and furrow is a soil management system applied to crop cultivation in waterlogging areas. On heavy soils like black cotton soils (Vertisols), a broad seedbed is heaped up with a furrow system in between the beds so that excess water can be safely drained out without disturbing the seedlings. At the same time the roots of the crop are raised above the groundwater table in the bed.



Figure: 2.10: Broad bed and Furrow

- **Level bund**

A level bund is an embankment along the contour, made of soil and/or stones, with a basin at its upper side. The bund reduces or stops the velocity of overland flow and consequently soil erosion. Level bunds are about 50–75 cm high and have a bottom width of 100–150 cm and a water retention basin on their upper side. Usually, tied ridges, placed in the basin about every 10 m help to prevent runoff from flowing sideways and to concentrate overflow at one point along the bund.



Figure: 2.11: level bund

- **Level Fana juu**

A level Fanya Juu (‘throw uphill’ in Swahili language) is an embankment along the contour, made of soil and/or stones, with a basin at its lower side. The Fanya Juu reduces or stops the velocity of overland flow and consequently soil erosion. By contrast with the Level Bund, the soil in a Fanya Juu is moved upslope for construction. The water retention basin is thus at the lower side of the wall. Tied ridges about every 10 meters are also used here to prevent runoff from flowing sideways.



Figure: 2.12: Level Fana juu

- **Check dam**

A check dam is a linear structure constructed perpendicular to concentrated flows across the waterway to control erosion by reducing the velocity of the flow. **Gabion** check dams (GCDs) are among the most diffused soil and water conservation practices.



Figure: 2.13: Gabion

- **Stone bund**

Stone bunds (SBs) are widely used as soil and water conservation (SWC) structures in the Amhara region in northern Ethiopia. These bunds are 0.2 to 0.7 m high embankments built of large- and medium-sized rock fragments in shallow trenches along contour lines



Figure: 2.14: Stone bund

2.5. Carrying out interactions with farmers and customers.

A Community Interaction Committee is constituted of faculties, DAs and other experts. The committee offers a participatory forum for all sectors of the community development and functions as sanctioning and coordinating body for community interaction strategies and policies. The committee is responsible for policy implementation, quality control and resource allocation, where applicable. It is also responsible for creating the opportunity for communities in society to have active participation in all stages of implementation equally.

Communities should have their own management frameworks for all their interactions on the development. These management frameworks are important things for the implementation of any community development programs, to participate community members actively on the implementation of the program plan. Communities should have Representatives or committee, which have a role of organizing and facilitating all the development programs on behalf of the whole community.

- **Methods of organizing the community**

There are different methods that you might be able to use in order to organize the community in which you work. You may be able to organize the community according to:

- ✓ Their place of work
- ✓ Common characteristics of the people
- ✓ The issue addressed
- ✓ Location or geography

Consulting relevant and appropriate people according to community guidelines and cultural protocols helps to towards conserving their natural resources. In some community, there are some influential elders that lead their community. Farmers who think that soil and water conservation increases crop production and who think that soil and water conservation is the farmers' responsibility hold a more favourable attitude towards soil and water conservation than those who think that farmers should be paid for such work or that it is the responsibility of some other agency.

Range of groups may include, but not limited to: Formal or informal groupings based on social activities and interests, family and community history Cultural backgrounds including ethnicity, Sex and age. Development agents do a lot of their work with, and through, groups of farmers or other rural people. These groups may be formal or informal, large or small, traditional or modern. The group ma y already exist, or the development agent may help form it. It may be open to anyone in the community, or just to certain people. The group may have many functions, or it may have only a single purpose.

- ✓ **Advantages of working with groups**

A group enables people to do things they could not achieve by themselves. For example, a group can get difficult things done quickly, or can overcome labour shortages at a critical time, such as harvesting. The group may be able to access services that are not open to individuals, such as credit, training, or extension advice. It is impossible for development agents to contact every farmer individually, by working with groups; the agent can serve a much larger number of people. Wide varieties of groups exist in Ethiopia. Almost every one belongs to one or more groups.

Here are some examples both traditional and modern.

- Debo
- Edir and equb
- Saving and credit associations
- Service cooperatives
- Grazing land users association
- Water users association
- Interest groups

Self-Check-2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. List at least the four control structure of soil erosion (8 mark)
   a. _____
   b. _____
   c. _____
2. Why Inspecting and maintaining SWC measures is important? (10mark)
3. Mention the objective of soil and water conservation (3 mark)
4. What the main soil erosion agents? (3 mark)

Test I: Multiple choice (6 mark)

1. The best management practice for erosion and sediment control is_____

A. Zero tillage

B. Vegetation

C. Mulching

D. Engineering structures

2. How ground cover or grasses can control soil erosion?
   A. By catching sediments
   B. By reducing velocity of runoff
   C. By minimize disturbance
   D. All

3. All are the factor that affect soil erosion EXCEPT
   A. Dust control
   B. Slope
   C. Soil structure
   D. Organic material

Note: **Satisfactory rating -1 5 mark** **Unsatisfactory - below 15 mark**

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

Operation Sheet-2

2.1 Technique to leveling bund

A. Tools and equipments

- Spade
- Axe
- Sickle
- Measuring meter
- Line level
- stone
- local grass and legumes

B. Procedures/Steps/Techniques

- Work out the gradient of the slope.
- Decide on the spacing of bunds. Use pegs to mark out where to begin building each bund down the slope.
- At the top of the slope, mark out a contour line (a line running at the same height across the slope) where you want to build the first bund.
- Scrap the soil from either side of the contour line, remove the grass so the soil can be compacted and pile soil and stones up to form an embankment running along the line.
- Compact the embankment and shape it so the top is level.
- Move down the slope to where you want to build the next bund and repeat step 3-5.
- Plant the grasses, fodder legumes and trees with the bunds to stabilize them and make them productive.

2.2 Techniques to graded bund

A. Tools and equipments

- Spade
- Axe
- Sickle
- Measuring meter
- Line level
- stone
- local grass and legumes
- tree seedlings

B. Procedures/Steps/Techniques

- Measure the gradient of the slope using a line level and check the soil type
- Go up water way or channel you want the bund to drain into, to the top of the slope.
- Start using the line level to mark out where to build the bund.
- Scrap the soil from either side of the line you have marked
- Remove the grass so the soil can be compacted and pile soil and stones up to form an embankment running along the line.
- Compact the embankment and shape it so the top is level.
- Move down the slope to where you want to build the next bund.
- Plant the grasses, fodder legumes and trees with the bunds to stabilize them and make them productive.

2.3 Techniques to build micro basin

A. Tools and equipments

- Spade
- Axe
- Sickle
- Measuring meter
- Line level
- stone
- local grass and legumes
- tree seedlings

B. Procedures/Steps/Techniques

- Mark a pattern on the ground, staggering the basins on a slope to control runoff.
- Dig a shallow basin around each planting site
- Piling the soil in to a ridge around the down slope side, 15 cm from the edge of the basin.
- Make the ridge 30-50 cm high and 60-90 cm wide.
- Plant the seedling.
- In dry areas, plant it in the middle of the basin.In moist areas, plant it in the ridge of soil you have built on the lower side of the basin so it does not get waterlogged.

2.4 Techniques to build a level bench terrace

A. Tools and equipments

- Spade
- Axe
- Sickle
- Measuring meter
- Line level
- stone
- local grass and legumes
- tree seedlings

B. Procedures/Steps/Techniques

- Measure the gradient of the slope using a line level.
- Check how deep the soil is.
- Using the table below, decide how wide the bench terrace should be.
- At the top of the slope, use a stick mark where to build the first terrace wall, by using line level.
- Measure the width of the bench and mark where to build next wall (point B in the diagram).
- Mark out a contour line from this point.
- Repeat this process to mark out the location of all the walls down the slope.
- Measure half the distance between between the first and second lines (point X in diagram 1 on the diagram below).
- Remove all the top soil from the whole area to be levelled, and pile it at a convenient place to one side.

LAP TEST-2	

Name…… ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 Perform level bund

Task-2 Perform graded bund

Task-3 Perform micro basin

Task-4 Perform terraces

LG #24	LO #3- Undertaking Farm Land Conservation

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Assessing indigenous soil and water conservation techniques.
- Conserving and maintaining in-situ soil and water conservation
- Prioritizing physical and biological soil and water conservation technique.
- Enhancing community awareness and participation.
- Identifying types and species of trees.
- Identifying physical soil and water conservation practice

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Assess indigenous soil and water conservation techniques
- Conserve and maintain in-situ soil and water conservation
- Prioritize physical and biological soil and water conservation technique
- Enhance community awareness and participation
- Identify types and species of trees
- Identify physical soil and water conservation practice considering soil type slope and construction materials

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-3

Introduction

Indigenous soil and **water** conservation is used to describe a practice or an idea which has either been generated locally or which has been introduce and then transformed and incorporated by the local people into their system to improve their livelihood.

Indigenous knowledge refers to the perception that farmers have about their natural and social environment, which they use to adopt, adapt and develop technologies to their local context. The rationale for undertaking certain traditional practices among others is recognition of problems by the local people.

Indigenous practices are aimed at arresting the local priority problems. Although they survived the challenges of changing bio- physical and socio-economic environments through a continuous responsive changes and adaptations, indigenous practices are **not perfect**.

Indigenous technologies: Technologies evolved as a result of a gradual learning process and emerge from a knowledge base accumulated by rural people by observation, experimentation and a process of handing down across generations' peoples' experiences and wisdom. Apparently the technology is dynamic and not static in nature, frozen in time or stuck in history.

An indigenous SWC technology clearly indicates that farmers are aware of soil erosion and have developed effective means to control it. However, the fact remains that most farmers do not undertake sufficient measures to control erosion effectively. In order to become effective:-

1. Farmer clearly perceives soil erosion and believes that it reduces yields. They are more concerned about the loss of water and nutrients associated with soil erosion than reduced depth of the soil itself.

2. Farmers' investments fall as the opportunity cost of their time and other resources rise: other activities may have a higher return than conservation investments. This is commonly the case for farmers with substantial off-farm income.

3. Farmers invest more if they have more resources at their disposal, other things being equal: those with bullocks and healthy family labor are more likely to invest than those without.
4. The tenure arrangements under which farmers operate affect investment levels: those who cultivate their own land are much more likely to invest in soil conservation than those renting or sharecropping someone else's land. Likewise, landlords leasing out their land do not appear to invest much in soil conservation.

5. Land quality also determines investment levels. Most farmers have more than one plot, and they invest in their most productive plot first. Those who have irrigated land invest less on their dry land plots than those without irrigated land.

6. Where it is technically feasible, farmers invest in soil conservation in a stepwise manner, strengthening structures annually as needed. This reduces the initial investment and postpones costs to the future.

7. Farmers prefer to invest in soil conservation individually or in cooperation with an adjacent farmer rather than in large, cooperative groups.

3.1. Assessing indigenous soil and water conservation techniques.

Prior to the 1974 revolution, soil degradation did not get policy attention it deserved. The famines of 1973 and 1985 provided an impetus for conservation work through large increase in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental

organizations. The use of food aid as a payment for labor replaced voluntary labor for conservation campaigns.

By most performance measures, soil and water conservation effort of the country ended up in remarkable failure. A large sum of money has been spent in the name of encouraging environmental protection, encouraging and coercing farmers to adopt conservation. Addition to this, these conservation measures have not been linked to indigenous conservation measures for which the local people are well acquainted. The return from these measures was in general negative at least in the short term. They take large proportion of area out of production. Introduction conservation measures through bund and terraces took up to 10% of the precious resource of farmers.

The proportion these measures take increased rapidly with increasing slope of the field. Nevertheless, the benefit these structures increase from infiltration and reduced soil loss do not outweigh the loss of land to conservation works and the reduced yields caused by vermin living in terraces, water-logging and disturbance of the soil profile. These structures also require frequent maintenance, which is high labor demanding. These all resulted in negative attitude towards conservation.

3.1.1. Policies towards soil conservation in Ethiopia

Polices related to land, the most important resource for the rural poor and of the national governments at different time played an important role in land management in Ethiopia

Planning for conservation practices is very important. The term “Soil and Water Conservation” implies improved management of the two resources “soil” and “water”, in order to maintain (support, increase) in a medium- to long-term perspective the production capacity of these resources, often measured in terms of crop yield.

Planning and implementing a technology is always a reaction to one or more (degradation) problems, which are identified through observations that are largely determined by the specific perception and knowledge of the observer.

Soil conservation programs must be well designed if they are to reduce erosion effectively and not fail. The planning is important to identify major areas of erosion and to select suitable conservation measures so that the farmers are willing to implement it.

- **Sequences in planning soil conservation**:
  - ✓ Beginning with through assessment of erosion risk using techniques of erosion hazard assessment such as, rainfall aggressiveness, erodibility, topography or practices.
  - ✓ Followed by land use plan by adopting land classification methods, so that the land is used in accordance with its capability.
  - ✓ Once the appropriate land use has been determined, the conservation measures proposed must be relevant to the farming system, and the nature of the erosion problem.
  - ✓ The final stage is to quantify the impacts of the proposed land use and associated conservation strategy on the crop production and environment.

  The sequence of events to be considered in planning a soil conservation strategy,
  - ✓ Land and water resource inventory
  - ✓ Land capability assessment and erosion sedimentation index
  - ✓ Potential land use and suitability and conservation needs
  - ✓ Conservation needs with land use potential
  - ✓ Options and priorities
  - ✓ Management actions
  - ✓ Quantify impacts on landscape and productivity
  - ✓ Evaluate impacts

3.2. Conserving and maintaining in-situ soil and water conservation

Definition:

In situ soil and **water conservation** is the storage of rainfall in soil at the place where it fall by increasing infiltration of rainfall into the soil and reducing runoff loss of rainwater.

It is process of preventing runoff and minimizing evaporation. In the semi-arid and dry sub humid tropics of rain fed agricultural systems water scarcity is a series problem, however in situ moisture conservation has able to solve this important bottleneck of agricultural productivity. In situ moisture harvesting focuses on the principle of properly using the harvested rainfall or runoff when the rainfall is scarce. This is especially true in arid and semi-arid areas where water is a limiting factor for agricultural activities or where the rainfall is erratic in its occurrence. The most common technology for this purpose is conservation tillage, which aims at maximizing the amount of soil moisture within the root zone.

A number of agronomic practices such as mulching, ridging, manuring, and other small farm structures such as field ridges/bunds, contour bunds, bench terraces within cropped area and others, could fall under in situ moisture conservation category. Soil and water conservation practices are important to improve crop yields by enhancing soil moisture, conserving rain water and controlling erosion.



Figure: 3.1: In situ soil and water conservation

Addressing the problem of moisture stress requires means of supplying additional water for crops to meet their Evapo-transpiration demand with the help of either irrigation or on-farm water harvesting techniques. In-situ soil water conservation, involves the use of methods that increase the amount of water stored in the soil profile by trapping or holding the rain where it falls.

There are farmers who traditionally use the aforementioned different types of in situ moisture conservation for crop production. However, the effectiveness of either of these methods is not known for wider application. Water harvesting is considered as a water management technique for collecting, storing, directing and distributing rain water and run off for any productive purpose. Water harvesting involves the transfer of runoff water from a catchment area that is not cropped to supplement the rainfall received directly on the area that is cultivated.

- **Water harvesting**

Water harvesting is an alternative approach to increasing the soil moisture available to a crop. It may be more widely applicable than irrigation, and may also have useful environmental benefits (especially as regards erosion control). It involves concentrating water that runs off the soil surface during a storm onto the growing crop. Water harvesting offers considerable hope for increasing production in arid and semi arid areas for which irrigation is not a viable option.
Dry land crop production is critically dependent on the amount of water available during the crop growing seasons. There are three main ways of increasing this:

- ✓ Increasing the storage of rainwater in the root zone of growing crop.
- ✓ Conserving stored soil water by minimizing run off and evaporation from the soil surface and transpiration by weed
- ✓ Maximizing the use of available water through improved management practices and the use of adopted crops and varieties

Run off rates varies between 2 and 32 % depending on the rainfall, soil cropping system, and management practices. Less frequent deep ploughing, incorporating organic residues, improve infiltration reduce runoff and increase soil water storage. On the other hand frequent ploughing destroys surface structure and results in the generation of high run off.

✓ Benefits of water harvesting

- Higher productivity (higher yield and lesser risk)
- Crop production in areas where it is normally not feasible
- Soil conservation (for macro catchments or cropping area only) i.e., less erosion.
- Pasture improvement = more livestock
- Improved re-afforestation = less desertification
- Suppression of salinity in soil = more productive land
- Water conservation (tapping unused water)
- Ground water recharge = more water available

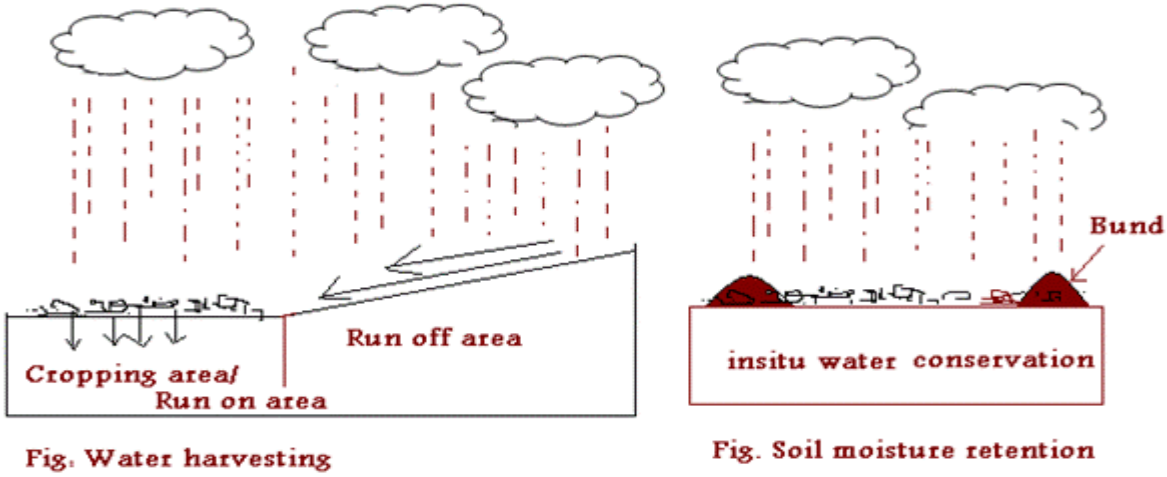


Fig. Water harvesting

Fig. Soil moisture retention

Figure: 3.2: water harvesting

3.3. Prioritizing biological soil and water conservation technique.

Biological soil and water conservation method is various ways of maintaining a cover of vegetation during the periods of high erosion risk. Biological method are an effective method of soil conservation. Several types of biological soil conservation methods exist.

Table 3.1: Major soil and water conservation measures used in Ethiopia

Agronomic or Biological Measures	Soil Management Strategies	Mechanical or Physical Method
Mulching	Conservation Tillage	Terracing
Strip Crop	Minimum tillage	Contour Bunds
Cover crops	Improved tillage	Infiltration Galleries
Improved fallows	No-till	Waterways
Intercropping	Contour tillage	Gully Controls
Planting Pattern/Time	Strip farming	Stabilization structures
Crop rotation	Stone check dam	cut-off drains
Mixed cropping	Gabion Baskets	Micro basins
Counter farming	Crop management	
Agroforestry	Stone lining	

- **Contour plowing**- retain water and reduce surface run-off
- **Fallow**- fertility improvement and source of fodder
- **Crop rotation**- fertility improvement and pest and disease control
- **Manuring**- soil fertility maintenance and the challenge of competition
- **Mixed cropping**, grass strips, trash lines (sorghum / maize straw and stubble
- **Agro-forestry**- perennial plants such as coffee, chat and multi-purpose trees

3.4. Enhancing community awareness and participation.

Indigenous knowledge is part of the lives of the rural poor. The livelihood of the rural poor depends almost entirely on specific skills and knowledge essential for their survival. Accordingly for the development process, indigenous knowledge is of particular relevance for the following sectors and strategies:

- Agriculture
- Animal husbandry and ethno-veterinary medicine
- Use and management of natural resources
- Primary health care, preventive medicine and psychosocial care
- Savings and lending
- Education
- Community development
- Poverty alleviation through self-help and societal care

However, the community must be able to understand essential knowledge required to effectively do the task, manage the task and manage contingencies in the context of the identified work role. These include:

- Understanding of the general principles and practices of sustainable micro-water harvesting
- Knowledge of the cultural and language groups represented within the local/regional community, and a respect for their values and beliefs
- An understanding of the key people and groups within the community who are able to influence community values

- Knowledge of the social, historical, political and economic context ofmicro-water harvesting, including types and nature of the structure
- Understanding specific limitations of work role, responsibility and professional abilities.

- **Community participation:** is the involvement community in doing certain tasks. The first and most obvious principle of community participation is that many people are involved. Community participation is critical to community success.
    - ✓ **Role of communities** – Both Water harvesting pans for dry areas and government support for upland rainwater harvesting describe rainwater

harvesting work in which communities have a strong role to play. Talking to community members who are participating in rainwater harvesting work locally would be valuable. This could also include discussion of what regulations or recommendations are in place to ensure responsible, sustainable management of soils and water as well as key stone natural resources.

3.5. Identifying types and species of trees.

Only crop is not sufficient to reduce the velocity of runoff. When trees are grown with crops this system gives much strengthen to soil through permeability of water, which is available for crop. As a result, water is also conserved. In agroforestry system, trees also add nutrient to the soil. Trees with deep rooting system improve ground water quality through capturing of nutrient, materials and these are deposited in surface and subsurface of soil.

3.5.1. Vegetative ISWC measures

- **Agro-forestry**

Perennial plants such as coffee, chat and multi- purpose trees such as moringa are planted at the foot of the bunds. Trees are important in soil conservation and soil improvement. The term agro-forestry is a collective name for land use system in which woody perennials (trees, shrubs) are growing in association with crops and /or live stock to achieve both ecological and economic interactions between trees and non-tree components of the system. Multi-purpose trees and shrubs for soil conservation; trees on soil erosion structure such as trees on terraces, trees on grass strips and trees as a barrier hedge are few role of trees for protection and fertility maintenance.

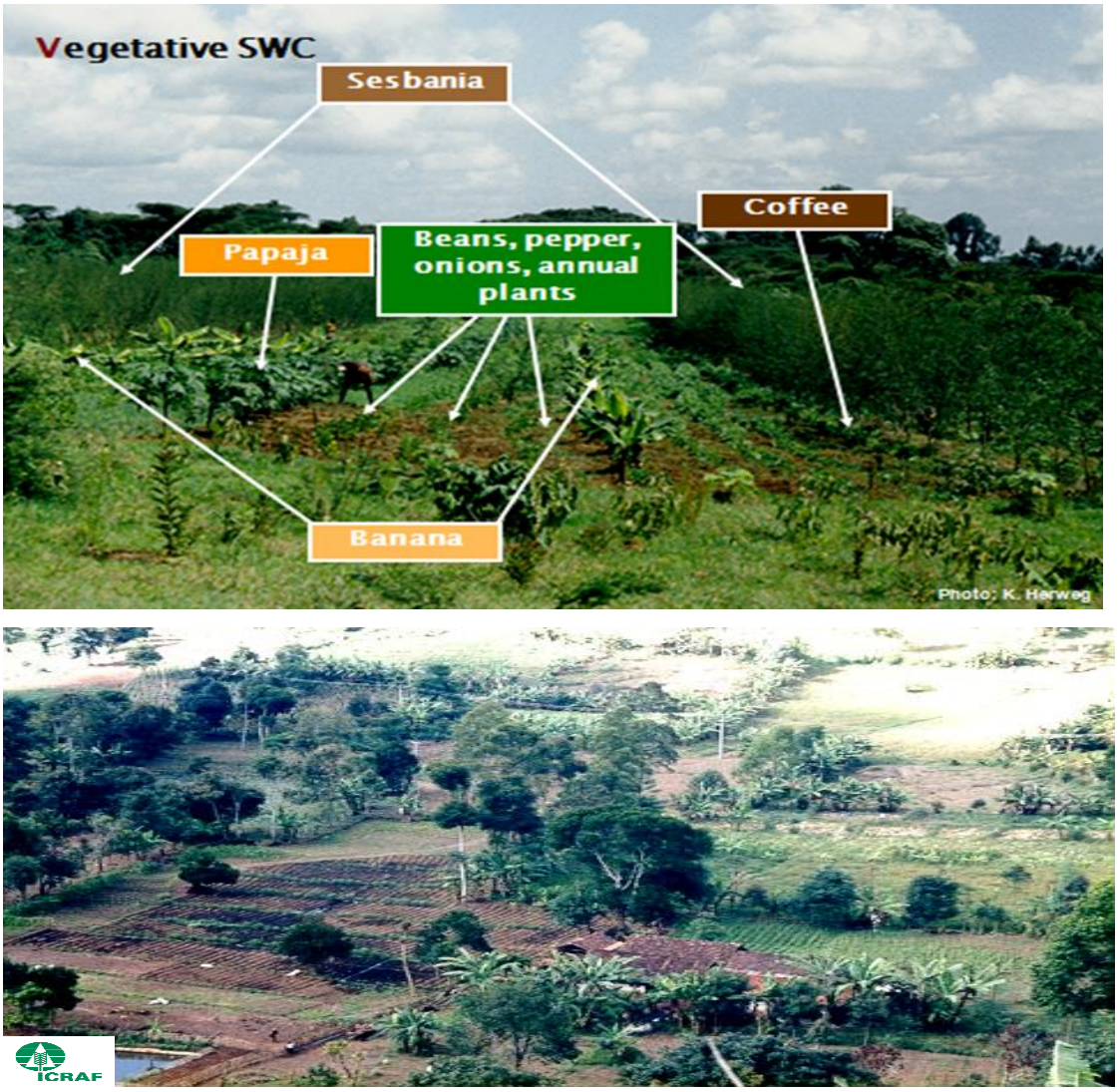


Figure 3.3: Agroforestry

- **Grass strip (fodder)**

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contours. Usually, grass strips are about 1 meter wide and spaced at 1m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, salty) on gentle slopes. Grass strips are planted along the contour or along Cut-off Drain.



Figure 3.4: Grass strip

Grass strips help to reduce runoff and to filter out sediments carried by runoff. They are suitable on soil with good infiltration and where the climate is not too dry for dense grass development. If grazing is totally prevented, the grass strips will effectively build up into terraces and provide good fodder for cattle, which can be used with cut and carry.



Figure 3.5: Cut and carry

Living windbreaks are known as shelterbelts. Field shelter by planting windbreaks is widely practiced on both agricultural and horticultural croplands and pastoral farmland. Windbreaks are placed at right angles to erosive winds to reduce wind velocity and, by spacing them at regular intervals; break up the length of open wind blow. In addition to reducing wind speed, shelterbelts result in lower evapotranspiration, higher soil temperatures in winter and lower in summer, and higher soil moisture; in many instances, these effects can lead to increases in crop yield.

3.6. Identifying physical soil and water conservation practice based on different factors

Factors such as **demographics,** the **institutional context**, other **economic activities**, and **agro-ecology**, which may be specific to each village, can impact farmers' adoption of SWC measures. Socio-economic factors such as age and farm size, wealth category and educational level and total family size have impacts on practicing SWC measures. Farmers' perceptions of soil erosion and its impact likely affect their implementation of SWC measures. Participatory technology development and farmers' participation in local level conservation activities were found to be important in achieving the intended objectives.

Mechanical field practices are used to control the movement of water and wind over the soil surface. A range of techniques is available and the decision on which to adopt depends on whether the objective is to reduce the velocity of runoff and wind, increase the surface water storage capacity or safely dispose of excess water. Mechanical methods are normally employed to support agronomic measures and soil management.

- **Combination of vegetative, agronomic and physical Indigenous SWC practices in Ethiopia**
  - **I. Konso Bench terrace (Konso)**

Common Name of SLM Technology: Terrace

Local name: Kawata (Konso)

Associated approach: Voluntary labor assistance and labor-share (Debo/Wenfel)

Definition

A stone embankment placed along the contour with land leveling in between two terrace walls to control soil erosion and increase rainwater retention. It is constructed by social organization (Debo) or labour wage (Parga). The purpose of the structure is to break the slope length and reduce flow concentration to control soil erosion and enhance moisture conservation.



Figure 3.6: Stone terrace

II. Stone terraces and check dams (DewaChefa, Amhara)

Common name of SLM Technology: Stone terraces

Local name: Kiter

Definition

It is majorly a structural measure constructed by stone across a gully or dissected farmlands to control erosion, trap runoff and sediment to create favorable conditions for crop cultivation.

The technology has been practiced for more than a century in the Dewa Cheffa woreda. The area is seriously affected by gully erosion and the technology is widely practiced by farmers. Unlike other check dams its construction starts from the bottom of the gully and proceeds upslope with varying dimensions. The height of the check dam depends on the depth of the gully and it is increased from year to year.



Figure 3.7: Stone terrace

Types of degradation mainly addressed by the technology include: Water erosion (loss of topsoil by water, gully erosion and chemical deterioration), fertility decline and reduced organic matter. The technology combats land degradation by reducing slope angle, reducing slope length, increasing infiltration, maintaining water stored in soil and sediment harvesting. Applying methods of soil improvement such as planting fast growing trees, green manure, trees and

shrubs, helps in further improving productivity of the gully.

III. Micro- basin

Locally by konso people named “kaha”, is constructed within the stone terraces during the land preparation activities, for the purpose of harvesting and concentrating water nearer to growing plants.

Micro-basins, half-moons and other micro catchment technologies are mainly used in dry areas for water conservation. In semi arid and sub humid areas micro basins are mainly found in forest areas and on steep slopes or very shallow soils. Such structures are often constructed manually, using earth and stones, outlined in lines of staggered formation. Runoff water is collected within the basin from the area above and impounded in the structure.



Microbasins are used for tree planting in this dry area. Pits are dug in the centre of the basin for optimum use of stored water. The farmer plants a tree after removing the plastic around the roots of the seedling. Soft earth is prepared beside the pit to accommodate the seedling in the pit. The microbasins are prepared in rows, always one microbasin in the lower row between the two microbasins in the higher row.



Figure 3.8: Micro basin

IV. Irob: dams to trap silt and water

The practice of trapping silt and harvesting water in narrow valley bottoms is developed by the Irob people in northern Tigray, on the border with Eritrea. Irob is a land of depths and heights, of droughts and floods, of frost and scorching sun. The altitude varies from 900 to 3200 m a.s.l, however most people live in areas situated between 1500 and 2700 m. Rainfall in the mainly habited area is low (200-600 mm annually) and highly variable in space and time.

The Irob used to be a pastoral people, moving with their goats and cattle from the mountains on the eastern escarpment of the Ethiopian highlands to the lower plains. It was not until two or three generations ago that the Irob began to give attention to crop production (Mengistu, 2002), because they could no longer obtain enough cereals in exchange to their livestock products.

The landscape is mountainous, rugged and stony, with steep slopes and deep narrow valleys curved out the plateau by flush floods making the land less suitable for cultivating crops. In

response to the ruggedness and the need for reclaiming land for crop cultivation, the Irob developed specific and site-appropriate methods of land management to capture soil and water. The innovative daldal technique is a best practice because it is an indigenous land management scheme that has been recognized by many Irob people and by others living under similar harsh conditions as a way of creating land to produce food and obtain a supply of clean water (Asfaha and Waters-Bayer, 2001).

V. Diversion ditch (Gorf meqlbesha boi)

Diversion ditch / cut-off drain: a graded channel with a supportive ridge or bank on the lower side. It is constructed across a slope and designed to intercept surface runoff and convey it safely to an outlet or waterway.

VI. Waterways (Gorf mafsesha boi)

Waterways: are needed to convey runoff safely from hill slopes to valley bottoms where it can join a stream or river.



This is a typical artificial waterway in an area with land scarcity. Therefore, it has been dug deep into the soil, with steep borders and a stone pavement with intermittent small checkdams at the bottom. At the top, a cutoff drain leads into the waterway from the left side, while, graded bunds are led into it from the cultivated land, alternating from each side.

Figure 3.9: Waterway

VII. Trash-lines

Prepared at the ridges of the bunds and micro- basins, using the straw & stubble from maize & sorghum. They serves as mulch (to reduce the rain drop splash effect & minimize evaporation), & to improve soil fertility along the bund & micro- basins through the eventual decomposition of the stubble.

Trash farming involves spreading the crop residues on the surface as normal mulching ploughing in and cultivating in the usual way**.**



Figure: 3.10: Trash -line

VIII. Mulching

It is the covering of the soil with dead plant residues; straw, banana leaves, maize stalk or grass. The cover protects the soil from rain drop and increase the infiltration rate as the pores of the soil are not clogged. It is useful in dry areas where insufficient rain prevents the establishment of a ground cover before the onset of heavy rain. In semi humid areas, the side effect is lowering soil temperatures and increased soil moisture are beneficial may increase yield. Mulching poses special problem for the arable farmer because tillage tools become clogged with residues, weed and pest control are more difficult.



Figure: 3.11: Mulching

IX. Contour cultivation.

Carrying out ploughing, planting and cultivation on the contour on gentle slope can reduce the soil loss by half compared with cultivation up and down the slope. On gentle slopes,or whenever the erosion risk does not warrant major earth moving works, it may be sufficient to slow down surface runoff by tillage operations on the contour.

Another protection method which may serve where the erosion is not severe is to use grass strips. Strip of grass+legumes are planted or close growing vegetation(grass)are left unploughed between bands of crop land. Surface runoff moving down the slope is intercepted by strips, the velocity is slowed and silt deposited in the grass strip.



Figure: 3.12: Contour cultivation

X. Crops

Early planting: early planting is important in East Africa, as much of the rain comes during the beginning of the rainy season. An early planting during the rainy seasons will develop and give protection against erosion. Choice of crop: on erodible soils the choice of crop for cultivation has to be considered. The soil loss through erosion varies according to the type of plant, providing that it is well established.

XI. Mixed cropping /Multiple cropping

Involves growing different types of crops simultaneously, such as maize ,sorghum , millet , wheat , barley , beans & sun flower as a component of land use intensification with no apparent spatial arrangement . The seeding rate depends on the level of soil moisture, which is assessed by the farmers. If the farmers assume that moisture is sufficient, more seeds are planted than under dryer conditions.

Selective thinning is practiced during periods of moisture stress within the growing period. The thinned plants & weeds serve as fodder for livestock. The aim of multiple cropping is the production from the land whilst providing protection of the soil from erosion. The method involves either sequential cropping, growing of two or more crops a year in sequence, or intercropping, growing two or more crops on the same unit of land at the same time. Multiple

cropping is a traditional practice often involves a mixture of the two. eg.maize +beans. The effects on erosion of multiple cropping of maize with haricot beans at Gunuo research station, Sidamo, and maize, sorghum, beans and peas in Harar Ethiopia also examined. Although multiple cropping led to reduced soil loss in both cases compared with monoculture in neither instances was the erosion below the soil loss tolerance level which was set at $1kg/m^2/y$.



Figure: 3.13: Mixed cropping

XII. Crop rotation

It may be cheaper on big commercial farm to apply fertilizer than to grow a legume,but the peasant farmer often has no choice-he can only afford to ease demand by rest crop(fallow) and rotation. Rotation is the simplest way to combine different crops grow them consecutively in rotation. Suitable crops for use in rotations are legumes and grass.

These provide good ground cover,help to maintain or even improve the organic status of the soil, thereby contributing to the soil fertility ,and enable a more stable aggregate structure to develop in the soil. These effects are often sufficiently long lasting as to reduce erosion and increased yield. Even if the frequency of rotation depends on the severity of erosion, rotational periods should be short. Usually a rotation in three year period is recommended.

XIII.Strip cropping

Rows of crops and protection effective crops are growing in alternating strips aligned on the contour or perpendicular to the wind direction in case of wind erosion. The soil which is removed from crop strips is trapped in the next strip down slope which is generally planted grass or grass+legumes strip.

The practice is good measure on permeable soil preferably not exceeding 15-20% slope. If wide strips of perennial grass+legumes cannot be alternated with a strip of annual crops,or grass cannot be rotated for normal strip cropping narrow strips of grass or grass+legumes can be used. Grass strips are widely used practice on slops 5-15% usually with the width of 1 or 2m but not exceeding 4m.





Figure 3.14 Strip cropping

XIV. Zero-tillage

Commonly practiced in Berta and Gumuz society of the Beneshangul Gumuz reginal state. Tillage practices serve as conservation agriculture. Sorghum, okra and maize cultivations are their common crops farming.





Figure 3.15: Zero tillage

XV. Cicata

It is the kind of soil fertility management techniques by rotating the fence (locally named in Afan Oromo "dalla") for animals on their land after 2 to 3 days. It is the cows dung and their urine maintains soil fertility. This practice is very common in Wollega and Beneshangul Gumuz regional state.

XVI. Multiple Cropping

Multiple cropping is a system where a single crop species is grown more than once or different crops are simultaneously planted on the same field during the same season a year. It is a popular practice among small farmers in developing regions.

Africa) because it allows an integration of food crops, farm animals, conservation grass buffers, and trees into the same piece of land. Either planting several crops extends the harvest season with earlier or later ripening crops while providing greater vegetative surface cover and diverse crop produce over a long period.

Under appropriate climatic (e.g., water supply) and soil conditions, multiple cropping isa source of year-round supply of grains, fruits, and vegetables. The advantage of multiple cropping is that it comprises all the interactive variables and factors of different plants and the environment. The number, selection, and combination of crops (e.g., corn, soybean, and vegetables) depend on local soil, climate, and ecosystem conditions.

Multiple cropping is advantageous because it:

- Allows the production of diverse food crops,
- Offers better soil erosion control by continuous growing of crops with variable biomass production and rooting systems,
- Reduces risk of total loss of crops from adverse climate conditions (e.g., drought resistant) or diseases,
- Provides diversified farm products from a small piece of land, reducing production costs.
- improves soil fertility and reduces soil erodibility by planting grass, grain crops, and legumes, reduces disease pressure and use of synthetic fertilizers, herbicides, and pesticides by dense planting and intensive management, and

Self-Check-3	Written test

Name…… ID…… Date…

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. List the physical ISWC practices in Ethiopia (10 mark)
2. The combined physical and biological SWC effective than physical measures alone. Why? (11 mark)
3. Describe impacts of erosion (on-site) and Sedimentation (off-site). (10 mark)

Test I: Multiple choice (9 mark)

1. Which on is catchement area during water harvesting ?
   A. Roof tops
   B. Small ground surfaces
   C. Large catchment areas
   D. All
2. Contour farming is very effective in in-situ water conservation and can reduce soil erosion by as much as 50% from up and down hill farming.
   A. True
   B. False
3. Which one agricultural soil water conservation practice
   A. Level bund
   B. Contour cultivation
   C. Terraces
   D. Micro basin

Note: **Satisfactory rating - 20 mark Unsatisfactory - below 20 mark**
You can ask you teacher for the copy of the correct answers.

Operation Sheet-3

3.1.Technique to build micro catchment

A. Tools and equipments

- Spade
- Axe
- Measuring meter

B. Procedures/Steps/Techniques

- Stake out the contour by using a line level or a water tube level
- Smooth contours if required
- Mark the tips along the contour at even spacing with a tape.
- Hold a string from each of both tips of a micro catchment
- Continue until all catchments in the upper row have been marked
- Lay out the next lower row
- Stake out size and excavate pit
- Clear the catchment of all vegetation
- Use the excavated soil from the pit to construct the bunds in two layers
- Wet and compact bund by foot or with a barrel filled with sand or water
- Fix a string at the beginning and end of each side of the bund and adjust it above ground at the selected bund height to ensure a uniform height
- Plant tree seedlings of at least 30 cm height after the first rain of the season

3.2.Techniques to build graded bund

A. **Tools and equipments**

- Spade
- Axe
- Sickle
- Measuring meter

B. Procedures/Steps/Techniques

- Stake out the contour by using a line level or a water tube level
- Smooth contours if required
- If the topography is very uneven, separate blocks of negarims
- Mark the tips along the contour at even spacing with a tape.
- Hold a string from each of both tips of a micro catchment.
- If held tight, they will meet at the lowest point of the catchment (apex)
- Mark the apex with a peg.
- Continue until all catchments in the upper row have been marked
- Lay out the next lower row :
- The apex of the catchment below is now a tip of the second row
- Repeat Step Three for all further rows
- Stake out size and excavate pit
- Clear the catchment of all vegetation
- Use the excavated soil from the pit to construct the bunds in two layers
- Wet and compact bund by foot or with a barrel filled with sand or water
- Fix a string at the beginning and end of each side of the bund and adjust it above ground at the selected bund height to ensure a uniform height
- Excavate the V shape wing can be range from 2m-5m which joins at right angle.
- Plant tree seedlings of at least 30 cm height after the first rain of the season

3.3.Techniques to control gully erosion by stone and gabion check dam

A. Tools and equipments

- Spade
- Axe
- Sickle
- Measuring meter
- Line level
- Stone
- Local grass and legumes
- Tree seedlings

B. Procedures/Steps/Techniques

I. Procedures to make stone check dams

- Make a set of wooden posts, 5-10 cm in diameter and 1.5-2.5 m long.
- Sharpen one end of each post to make it easy to hammer in to the ground.
- Hammer the posts 0.5-1 m apart, at least 60 cm deep in to the floor of the gully.
- The spacing between the posts depends on the height of the check dam: the higher the dam, the looser the posts.
- For a double row check dam, make two rows of posts, 50-60 cm between the rows.
- Weave thinner branches between the posts to form a wall.
- Dig the branches 50 cm or more in to the side of the gully.
- Pack brush and other debris behind the wall (or between the rows in a double-row dam).
- Tie the top of the structure with wire or rope, and anchor it to the ground using brushwood.

II. Procedures to make Gabion check dams

- Gabion boxes come in two standard sizes: 2 m long × 1 m wide × 1 m high, and 2 m long × 1 m wide× 0.5 m high.
- Dig a trench 1 m deep in the gully floor.
- The trench must be as wide as the gully and should be dug in to the wall to stop water from eroding around the sides of the dam
- Place gabion boxes in to the trench, fill them with stones and tie them with wire.
- Add another layer of gabions on top to raise the height of the dam.
- Make the sides of the dam higher than the middle.

LAP TEST-3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 Perform micro catchment

Task-2 Perform stone check dams

Task-3 Perform Gabion check dams

LG #25	LO #4- Cleaning Up And Storing Materials And Equipment.

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Handling and transporting materials, equipment and machinery.
- Storing or disposing off and recording waste material produced
- Cleaning, maintaining and storing tools and equipment.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Handle and transport materials, equipment and machinery
- Store or dispose and record waste material produced during soil and water conservation practice
- Maintain, cleaned and stored tools and equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the "LAP test"

Information sheet-4

4.1 Handling and transporting materials, equipment and machinery

Transporting: - is taking of material, tools, equipment and machinery from place of storage to place of work and vise versa.

Transporting can be:-Traditional method like **push carts, animal drawn carts, on animals and persons** and modern method like Lorries, tractors etc

Before transporting of materials, tools, equipments and machineries, it important to check whether they are functional or not. Materials, tools, equipments and machineries should be transported to the site of work timely and properly. Transporting activity should take place according to the instruction of your supervisor.

Materials handling: in agriculture is concerned with the movement and handling of materials and products in a systematic manner from point of origin to destination. Movement may be in any direction--horizontal, vertical or any combination of the two. Many hand tools for the soil and water conservation come with wooden handles which need special care **to prevent splitting and breaking**. At least twice a season sand them with a medium grit sandpaper and then rub in linseed oil to create a protective barrier. Wood handled tools need to be stored indoors and dried before storage.

Handling of agricultural materials and products is important, not only because of the work involved, but because of its effect on costs, product quality and management**.** Materials handling costs account for as much as 25 percent or more of the total production cost for certain agricultural crops. These costs can be lowered with efficient materials handling systems in which the components are integrated to provide a smooth flow of materials. If a handle fails or breaks, replacements can usually be found in hardware or garden stores. Generally, it is simply a matter of removing the old screws and installing the new handle with fresh hardware.

4.2 Storing or disposing off and recording waste material produced

After completion of all soil and water conservation activities, all containers, leftover fluids, waste and debris should be disposed safely and appropriately. Waste materials, which may be toxic to human beings or pollutants environmental conditions, should be properly disposed to minimize hazards.

Crop residues have good advantage if we properly manage them where as waste pesticides and chemicals have Hazardous effect on environment and animals. Crop residue is defined as the vegetative crop material left on a field after a crop is harvested, pruned or processed. As much as possible farmers are encouraged to work crop residues back into the soil or compost them for use as a soil amendment. Recycling crop residues helps prevent erosion and preserve or improve soil quality.

4.3 Cleaning, maintaining and storing tools and equipment

Cleaning is the removal of dirt and organic substances from surfaces of tools and equipments. The tools, equipments, and materials should be returned to store on completion of the work after they have been cleaned & checked. Any dirt (soil, and other) adhering with the tools and equipments should remove before storage. Similar tools should be stored separately without mixing with other tools which help you to identify easily.

More profound clean-up procedures require water in sufficient quantities. **Manual Cleaning** using brushes or scrapers is widely applied in small-scale operations although labor and time-intensive Tools and equipment should be stored and disposed according to the manufacturer's specifications, enterprise procedures and regulations. This is used to increases life span of tools and equipments and avoids scarcity of tools and equipments at critical periods.

Maintenance and storage of materials, tools and equipment is very important for their reuse, minimizing cost to buy other new materials, tools and equipment. Cleaning materials, tools and equipments after work has so many advantages, such as:

- To prevent from rust
- To be durable and long life span to use

Self-Check-4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. What is the advantage of cleaning and storing tools? (5 mark)

2. Why we dispose wastes? (5 mark)

3. How materials should be transported? (5 mark)

Test I: Multiple choice (5 mark)

4. The advantages of cleaning materials, tools and equipment is to keep the durability of materials

A. True

B. False

5. After completion of all soil and water conservation activities, which waste should be disposed

A. Plant debris

B. Soil

C. Seedling

D. Tools

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

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

Operation Sheet-4

4.1. Technique to disposing waste materials

A. Materials, Tools and equipments

- Spade
- Hoe
- Fork
- Rack

B. Procedures/Steps/Techniques

- Identify the disposal waste materials
- Select the site where the wastes are disposed
- Prepare hole or any suitable place where the wastes are disposed
- Safely collect any plant debris, leftover materials, broken tools and equipment
- Then disposed them into prepared hole or place

LAP TEST-4	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 Perform waste disposal

LG #26	LO #5- Recording and Reporting Work Activities

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Recording and documenting activities accomplishment.
- Reporting problems or difficulties in completing work.
- Recording materials, tools and equipment damages.
- Reporting work activities and outcomes.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Record and document activities accomplishment
- Report problems or difficulties in completing work to required standards or timelines
- Record materials, tools and equipment damages
- Report work activities and outcomes

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information sheet-5

5. 1 Recording and documenting activities accomplishment

Records can **establish proof of proper use** or they are helpful in finding the cause of error, if an error is made.

- **Important of recording**
  - ✓ They can also **provide information** to trace residue and /or damage problems.
  - ✓ Records can also **save money**.
  - ✓ They **allow the Farmer to compare the results** obtained from different chemicals.
  - ✓ For continuous monitoring of quality system
  - ✓ For specimen tracking throughout process
  - ✓ To identify failures in equipment
  - ✓ To revisit information; reference
  - ✓ For use as a management tool

5. 2 Reporting problems or difficulties in completing work

Reporting means informing related information to a person who concerns.

Reporting outcomes means announcing whether its goodness or badness about the work result. For example if we want to report the problems we can use the following table format. Many hand tools for the horticulture production come with wooden handles, which need special care to prevent splitting and breaking.

Table 5.1 Example of problems reporting format

No	Activities	Type of problem	Possible solution
1			
2			
3			
4			

5. 3 Recording materials, tools and equipment damages

During performing work, some tools, equipments and materials can be broken, detached the handle from the main part, so such damaged tools should be maintained if the problem is simple. The broken tools should be identified and store alone until maintained. When materials are broken highly and not be maintained by other experts, they should be disposed of according to supervisor's instruction.

5. 4 Reporting work activities and outcomes

On completion of crop work out comes like**, strengths of conservation, weaknesses of conservation, and problems occur during conservation should be reported** to you supervisor according to instructions and formats given from the supervisor. The work outcomes can vary depending on objective; it can be biological, physical or structural conservation. Reporting work out come helps you to get feedback by your supervisor so that you can leave your weakness and encourage your strength. It also helps the supervisor to get full information about the soil and water conservation. The reporting format may vary but it can be as follows.

Table 5.2 Reporting work activities and outcomes

S. No.	Work outcomes	Success	Failures	Other problems

Self-Check-5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below.

Test I: Short Answer Questions

1. Which outcomes can be reported during crop work? (10mark)

2. What is the advantage of recording? (5 mark)

3. How we can reduce damaging of materials and tools? 5 mark)

Test I: Multiple choice (5 mark)

1. From the following statement, which one is not the important of recording?
   A. provide information
   B. Save money
   C. Increase error
   D. Identify failure
2. Reporting work activities and outcomes can tell us one of the following
   A. Weakness of conservation
   B. Strengths of conservation
   C. Problems occur during conservation
   D. All

Note: **Satisfactory rating – 12.5 points** **Unsatisfactory - below 12.5 points**
You can ask you teacher for the copy of the correct answers.

Operation Sheet-5

5.1 Technique

A. Tools and equipments

B. Procedures/Steps/Techniques

LAP TEST-5	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1

Reference Materials

1. Books:

Mitiku, H., Herweg, K., Stillhardt, B., 2006. Sustainable Land Management. A New Approach to Soil and Water Conservation in Ethiopia. Mekelle, Ethiopia: Land Resources Management and Environmental Protection Department, Mekelle University; Bern, Switzerland: Centre for Development and Environment (CDE), University of Bern, and Swiss National Centre of Competence in Research (NCCR) North-South. 269 pp.

MOARD. 2010. Sustainable Land Management. Sustainable Land Management Project (SLMP), Natural Resources Management Sector, Ministry of Agriculture and Rural Development of the Federal Democratic Republic of Ethiopia. Indigenous and introduced technologies to be scaled up in the various agro-ecological and farming practices of Ethiopia.321pp.

Liniger, H.P., R. Mekdaschi Studer, C. Hauert and M. Gurtner. 2011. Sustainable Land Management in Practice. Guidelines and best Practices for Sub-Saharan Africa. TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT), Food, and Agriculture Organization of the United Nations (FAO).

Humberto Blanco and Rattan Lal.2008. Principles of Soil Conservation and Management. Current address:Kansas State University Western Agricultural Research Center-Hays 1232 240th Avenue Hays, KS 67 601 USA; The Ohio State University 2021 Coffey Road Columbus OH 43210 422B Kottman Hall USA.

R. P. C. Morgan. 2005. SOIL EROSION AND CONSERVATION. 3rd ed. published by Blackwell Publishing Ltd. ISBN 1-4051-1781-8 (pbk. : alk. paper): A catalogue record 2004009787.

Frederick R. Troeh, J. Arthur Hobbs, Roy L. D. 2004. Soil and water conservation for productivity and environmental protection. 4th ed. p. cm. ISBN 0-13-096807-2 (alk. paper).

2. **Web addresses**

https://www.google.com/search?q=in+situ+water+conservation&rlz=1C1CHWL_enET1020ET1020&oq=&aqs=chrome.1.35i39i362l8.5187510j0j7&sourceid=chrome&ie=UTF-8 (access date: 09/2022)

https://www.google.com/search?q=soil+and+water+conservation+methods+pdf+in+ethiopia&rlz=1C1CHWL_enET1020ET1020&sxsrf=ALiCzsZyuXenZSy1_iHJimARgLMNmCattw%3A1662314351371&ei=b-cUY5qsFobbgAbpiqvQBg&oq=siol+and&gs_lcp=Cgdnd3Mtd2l6EAEYAjIHCCMQsQIQJzIHCCMQsQIQJzIHCCMQsQIQJzIFCAAQkQIyBQgAEJECMgUIABCRAjIFCAAQkQIyBQgAEJECMgQIABBDMgQIABBDOgoIABBHENYEELADOgQIIxAnOgsIABCxAxCDARCRAjoICAAQsQMQgwE6CAgAEIAEELEDOgsILhCABBCxAxCDAToOCC4QgAQQsQMQgwEQ1AI6BAgAEAM6BQgAEIAEOgUILhCABDoLCC4QgAQQxwEQrwE6BAgAEAo6BwgAEIAEEApKBAhBGABKBAhGGABQ1SpYnqABYNrbAWgBcAF4AIABzx2IAed3kgENMi0xLjIuMC4xLjktNJgBAKABAcgBCMABAQ&sclient=gws-wiz (access date: 09/2022)

https://www.google.com/search?q=water+conservation+in+ethiopia&rlz=1C1CHWL_enET1020ET1020&sxsrf=ALiCzsad1Zi5XO6x6yN1c-gONtVDZL97yw%3A1662314465574&ei=4ecUY-jQIseDgQa364WYBQ&oq=wa&gs_lcp=Cgdnd3Mtd2l6EAEYAjIECCMQJzIECCMQJzIECCMQJzIECAAQQzIFCAAQkQIyBwguENQCEEMyBQgAEJECMgQIABBDMgQIABBDMhAILhCxAxCDARDHARDRAxBDOgoIABBHENYEELADOgcIIxDqAhAnOgoIABCxAxCDARBDSgQIQRgASgQIRhgAUIcyWI-PAWC12gFoA3ABeACAAfoGiAGPEpIBBTUtMS4ymAEAoAEBsAEKyAEIwAEB&sclient=gws-wiz (access date: 09/2022)

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The experts who developed the learning guide

No	**Name**	**Qualification**	**Educational background**	**Region**	**Phone number**	**E-mail**
1	Gosa Shura	MSc	Horticulture	Oromia	+251-923041032	gossashura@gmail.com
2	Tilahun Getu	MSc	Biotechnology	Amhra(3)	+251-918726766	tile21eme@gmail.com
3	**Degefa Guluma**	**MSc**	**Soil science**	**Oromia**	**+251-913440464**	**deguluma@gmail.com**
4	Bayisa Abeshu	MSc	Agronomy	South west Ethiopia	0921434086	Bayoabeshu@gmail.com
5	Berhanu Asefa	BSC	Plant science	South west Ethiopia	0922182673	berhanuasefa@gmail.com
6	Fikadu Tilahun	BSc	Plant science	Afar	0917363367	fikadutilahun80@gmail.com
7	Wendimu Terfa	BSc	Plant science	Oromia	0911266570	gurachoterfa@gmail.com
8	Yimam Mohammed	BSc.	Plant science	Oromia	0913624360	leylasalo@gmail.com
9	Eyaya Tigabie	MSc	Agronomy	Afar	+251-921944452	eyayatigabie@gmail.com
10	Taka Magarsa	MSc	Horticulture	Oromia	+251917210371	takamagarsa430@gmail.com
11	Elias Mohammed	BSC	Horticulture	Oromia	+251946706670	reweda1@gmail.com