TVET CERTIFICATE III in crop production

SOIL EROSION CONTROL

CRPSE302 Control soil erosion

Competence

Credits: 10

Learning hours: 100

Sector: Agriculture and food processing

Sub-sector: Crop production

Module Note Issue date: June, 2020

Purpose statement

This module describes the skills, knowledge and attitude required to control soil erosion. It is designed fortraineeswho have successfully completed nine years basic education or its equivalent and pursuing TVET Certificate III in Crop Production or any other related qualifications. At the end of this module, trainees will be able to prepare for soil erosion control operations, identify the soil erosion types, causes

and effects, apply cultural soil erosion control measures and apply mechanical soil erosion control measures. Qualified trainees deemed competent may work with others for regional, national and international professional work under maximum supervision.

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Learning Unit 1 – Prepare for soil erosion control operations

LO 1.1 – Identify occupational, health and safety (OHS) hazards and risks for reporting to the supervisor.

- Content/Topic 1 Definition of Hazard

The term hazard is often defined as a risk or danger in many dictionaries. In occupational safety, hazard can refer to a source of potential damage; in simple words, this refers to something that can cause harm to a person. A hazard can cause harm or adverse health effects to a person.

Examples

Hazard: Different elements such as chemicals, excessive noise, fumes, electricity, etc. act as hazards in a workplace.

Risk refers to the chance or possibility of suffering loss or harm. In occupational safety or workplace safety, risk refers to the probability that harm or injury might occur when you are exposed to a hazard.

- *Content/Topic 2:Types of hazards associated with erosion control*

Chemical hazards

A chemical hazard is a type of occupational hazard caused by exposure to chemicals in the workplace. e.g. fertilizers, lime

Physical hazard

Physical hazard is agent, factor or circumstance that can harm without contact.

e.g. dust, machinery,

Biological hazard

A **biological hazard**, or biohazard, is a biological substance that poses a threat to the health of living organisms, primarily humans.

e.g - bacteria, viruses, insects, plants, birds, animals, and humans, etc.,

- Content/Topic 3Hazard risks

Sources **of biological hazards** may include bacteria, viruses, insects, plants, birds, animals, and humans. These sources can cause a variety **of** health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer and so on.

Physical hazards include exposure to slips, trips, falls, electricity, noise, vibration, radiation, heat, cold and fire. The following table summarizes the sources **of physical hazard** exposure and their health effects.

Types	Possible Sources	Health Effects	Prevention
Noise	Noisy machines	Hearing loss, Stress, Annoyance	Buy quieter machines and equipment. Build enclosures and barriers to stop noise from reaching people. Wear ear protection. Reduce exposure time.
Whole- Body Vibration	Working on a vibrating platform, driving farm tractors or	Back disorders, Wide range of health conditions.	Vibration isolator mounted seats for vehicle operators. Vibration isolator mounted rotating machines. Vibration absorbing covering on floors

	other heavy vehicles, especially on rough terrain		where people stand and work for a long time.
Hot Environments	Working near furnaces. Summer outdoor work	Heat stroke, Heat Syncope (fainting)	Dress in light loose clothing to allow sweat evaporation. Acclimatize yourself at a slow pace before starting full work. Pace your work or play to avoid over-exertion. Drink plenty of water frequently even if you are not thirsty. Take rest in a cool place or shade if you feel very hot. Ask for training to recognize symptoms of heat stroke. Seek immediate medical help if you notice that someone might be getting heat stroke.
Cold Environments	Working outdoors in cold weather. Working in cold storage.	Hypothermia, Frostbite, Trench foot	Dress properly. Learn to recognize hypothermia symptoms. Seek medical help if you notice someone developing hypothermia. Seek warm shelter if you start shivering excessively or feeling confused.
Hyperbaric (High Pressure) Environments	Diving	"Bends" or decompression sickness, joint pain, breathing or	Make sure that you have proper training and equipment.

		ear disorders.	
Hypobaric (Low Pressure) Environments	High altitude work	Disorders of the lungs, Mountain sickness (headaches, nausea, vomiting)	Do not over-exert. Stop climbing if breathing problem continues. Seek first aid
Non-Ionizing Radiation	Exposure to electro magnetic waves, lights and lasers. See the chart below.	Does not produce ions in the body chemicals. Reach by causing heat and other effects	Stay away from sources, use recommended personal protection, seek first aid and medical attention.
Ultraviolet	Sunlight, Arc welding, Blacklight lamps, Germicidal lamps	Skin Cancer, Eye damage, Retinal damage	Avoid midday sun (11 am - 3 pm). Seek shade when outdoors. Apply sun protection cream on exposed skin. Wear appropriate clothing to prevent UV exposure to the skin. Avoid staring at sun or bright light sources.
Light, Lasers	Lasers, Welding	Retinal damage	Never, ever look into a laser beam.

- Content /Topic 4Assessment of hazard risks

Risk assessment is a term used to describe the overall process or method where you:

Identify hazards and risk factors that have the potential to cause harm

(hazard identification).

Analyze and evaluate the risk associated with that hazard (risk analysis, and risk evaluation).

Hazard identification and elimination and risk assessment and control" uses the following terms:

Risk assessment – the overall process of hazard identification, risk analysis, and risk evaluation.

Hazard identification – the process of finding, listing, and characterizing hazards.

Risk analysis – a process for comprehending the nature of hazards and determining the level of risk.

Notes:

(1) Risk analysis provides a basis for risk evaluation and decisions about risk control.

(2) Information can include current and historical data, theoretical analysis, informed opinions, and the concerns of stakeholders.

(3) Risk analysis includes risk estimation.

Risk evaluation – the process of comparing an estimated risk against given risk criteria to determine the significance of the risk.

Risk control – actions implementing risk evaluation decisions.

Note: Risk control can involve monitoring, re-evaluation, and compliance with decisions.

When should a risk assessment be done?

There may be many reasons a risk assessment is needed, including:

- Before new processes or activities are introduced.
- Before changes are introduced to existing processes or activities, including when products, machinery, tools, equipment change or new information concerning harm becomes available.
- When hazards are identified.

How do you plan for a risk assessment?

In general, determine:

- What the scope of your risk assessment will be (e.g., be specific about what you are assessing such as the lifetime of the product, the physical area where the work activity takes place, or the types of hazards).
- The resources needed (e.g., train a team of individuals to carry out the assessment, the types of information sources, etc.).

- What type of risk analysis measures will be used (e.g., how exact the scale or parameters need to be in order to provide the most relevant evaluation).
- Who are the stakeholders involved (e.g., manager, supervisors, workers, worker representatives, suppliers, etc.).
- What relevant laws, regulations, codes, or standards may apply in your jurisdiction, as well as organizational policies and procedures.

Assessment of risks

Assessments should be done by a competent person or team of individuals who have a good working knowledge of the situation being studied. Include either on the team or as sources of information, the supervisors and workers who work with the process under review as these individuals are the most familiar with the operation.

In general, to do an assessment, you should:

- Identify hazards.
- Determine the likelihood of harm, such as an injury or illness occurring, and its severity.
  - Consider normal operational situations as well as non-standard events such as maintenance, shutdowns, power outages, emergencies, extreme weather, etc.
  - Review all available health and safety information about the hazard such as Safety Data Sheet (SDS), manufacturers literature, information from reputable organizations, results of testing, workplace inspection reports, records of workplace incidents (accidents), including information about the type and frequency of the occurrence, illnesses, injuries, near misses, etc.
  - Understand the minimum legislated requirements for your jurisdiction.
- Identify actions necessary to eliminate the hazard, or control the risk using the hierarchy of risk control methods.
- Evaluate to confirm if the hazard has been eliminated or if the risk is appropriately controlled.
- Monitor to make sure the control continues to be effective.
- Keep any documents or records that may be necessary. Documentation may include detailing the process used to assess the risk, outlining any evaluations, or detailing how conclusions were made.

When doing an assessment, also take into account:

- The methods and procedures used in the processing, use, handling or storage of the substance, etc.
- The actual and the potential exposure of workers (e.g., how many workers may be exposed, what that exposure is/will be, and how often they will be exposed).
- The measures and procedures necessary to control such exposure by means of engineering controls, work practices, and hygiene practices and facilities.
- The duration and frequency of the task (how long and how often a task is done).
- The location where the task is done.
- The machinery, tools, materials, etc. that are used in the operation and how they are used (e.g., the physical state of a chemical, or lifting heavy loads for a distance).
- Any possible interactions with other activities in the area and if the task could affect others (e.g., cleaners, visitors, etc.).
- The lifecycle of the product, process or service (e.g., design, construction, uses, decommissioning).
- The education and training the workers have received.
- How a person would react in a particular situation (e.g., what would be the most common reaction by a person if the machine failed or malfunctioned).

  It is important to remember that the assessment must take into account not only the current state of the workplace but any potential situations as well.

  By determining the level of risk associated with the hazard, the employer, and the health and safety committee (where appropriate), can decide whether a control program is required and to what level

Identification of hazards

Overall, the goal is to find and record possible hazards that may be present in your workplace. It may help to work as a team and include both people familiar with the work area, as well as people who are not - this way you have both the experienced and fresh eye to conduct the inspection. In either case, the person or team should be competent to carry out the assessment and have good knowledge about the hazard being assessed, any situations that might likely occur, and protective measures appropriate to that hazard or risk.

To be sure that all hazards are found:

- Look at all aspects of the work.
- Include non-routine activities such as maintenance, repair, or cleaning.
- Look at accident / incident / near-miss records.
- Include people who work off site either at home, on other job sites, drivers, teleworkers, with clients, etc.
- Look at the way the work is organized or done (include experience of people doing the work, systems being used, etc).
- Look at foreseeable unusual conditions (for example: possible impact on hazard control procedures that may be unavailable in an emergency situation, power outage, etc.).
- Determine whether a product, machine or equipment can be intentionally or unintentionally changed (e.g., a safety guard that could be removed).
- Review all of the phases of the lifecycle.
- Examine risks to visitors or the public.
- Consider the groups of people that may have a different level of risk such as young or inexperienced workers, persons with disabilities, or new or expectant mothers.

How do you know if the hazard will cause harm (poses a risk)?

Each hazard should be studied to determine its' level of risk. To research the hazard, you can look at:

- Product information / manufacturer documentation.
- Past experience (knowledge from workers, etc.).
- Legislated requirements and/or applicable standards.
- Industry codes of practice / best practices.
- Health and safety material about the hazard such as safety data sheets (SDSs), research studies, or other manufacturer information.
- Information from reputable organizations.
- Results of testing (atmospheric or air sampling of workplace, biological swabs, etc.).
- The expertise of an occupational health and safety professional.
- Information about previous injuries, illnesses, near misses, incident reports, etc.
- Observation of the process or task.

Remember to include factors that contribute to the level of risk such as:

- The work environment (layout, condition, etc.).
- The systems of work being used.
- The range of foreseeable conditions.
- The way the source may cause harm (e.g., inhalation, ingestion, etc.).
- How often and how much a person will be exposed.
- The interaction, capability, skill, experience of workers who do the work.

The methods of hazard control

Once you have established the priorities, the organization can decide on ways to control each specific hazard. Hazard control methods are often grouped into the following categories:

- Elimination (including substitution).
- Engineering controls.
- Administrative controls.
- Personal protective equipment.

The important to review and monitor the assessments

It is important to know if your risk assessment was complete and accurate. It is also essential to be sure that any changes in the workplace have not introduced new hazards or changed hazards that were once ranked as lower priority to a higher priority.

It is good practice to review your assessment on a regular basis to make sure your control methods are effective.

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What are methods of hazard control?

Once you have established the priorities, the organization can decide on ways to control each specific hazard. Hazard control methods are often grouped into the following categories:

- Elimination (including substitution).
- Engineering controls.
- Administrative controls.
- Personal protective equipment.

Is there a procedure for identifying risks?

There is no one way to assess risks, and there are many risk assessment tools and techniques that can be used. Choose the method that best matches your situation. In all cases, the risk assessment should be completed for any activity, task, etc. before the activity begins.

Step	Action	Deliverable
1	Identify hazards and their potential for causing harm.	An inventory of hazards.
2	Rank hazards by priority.	This list will be useful in planning further action.
3	Determine hazard elimination or risk control measures.	A record of hazard elimination or risk control measures at various locations. Adequacy of hazard elimination or risk control measures.

		A list of controls required or recommended by legislation, standards, best practices, or organizational policies.
4	Eliminate the hazard, or implement risk controls.	Controls are in place and functioning appropriately.
5	Measure the effectiveness of controls.	Monitor periodically to confirm controls continue to function.
6	Make changes to improve continuously.	Monitor for improvements.

Sample Risk Assessment Form
Name of person doing assessment:
Date:
Activity / Procedure being assessed:
Known or expected hazards and risks associated with the activity:
Possible consequences: What are the possible consequences? How likely are these consequences to occur? What is the possible severity of the harm?
Who is at risk?
Measure to be taken to eliminate the hazard or lower the level of risk:
Is there a risk of the control measures failing? What would the consequences be?
Training requirements:
Level of risk remaining:
Action to be taken in an emergency:
References, if any:
Signature of Assessor:

……

LO 1.2 – Select PPE according to the desired operation.

- Content/Topic 1: Importance of PPE

  PPE: is used to prevent exposure to infectious materials. In other words, it acts as barrier to stop the spread of germs. Infectious materials can be air born in the form of droplets, or happen through contact routes.

- Content/Topic 2 :Categories of PPE used in agriculture

  Personal protective equipment (PPE) include thesoap, hand cleansers, disinfectants,waste disposal bags, face mask, overall, waterproof hat, goggles, respirator, rubber gloves, long pants, rubber boots

PPE	Protects	Hazards
Safety Glasses	eyes	chemical liquid splashes, dust
Hard Hat	head	falling material
Ear Protection	hearing	excessive noise
Gloves	hands	corrosives, toxic materials
Respirator	lungs	toxic gases, vapours, fumes or dust
Clothing	skin	toxic or corrosive materials
Footwear	feet	corrosive, toxic materials

- Content /Topic3:PPE Selection criteria

During selecting PPE, one should consider the following criteria:h name of LO,Please.

- **Potential hazards/Working environment**: one have to assess the environment by identifying all available hazards
- **Compatible/Available PPE to the hazard**: one match PPE to the hazards
- **Level of protection/Effectiveness of PPE to the hazards**: Ability of PPE to protect the exposed person to varieties of infections.
- **Fitness/Size to properly fit the user**: Not too small or not too large compared to the size of the user.
- **Use or task to perform**: PPE used by a farmer during tillage activities is different from those used during pests and diseases control.
- **Durability of PPE**: Has long life span
- **Awareness of limitation/Frequency to be used**: It should be reusable after properly cleaning.
- **Cost of PPE**: Even though the PPE should protect the user, it should not be expensive

LO 1.3 – Proper identification of environmental implication of soil erosion control measures for discussion with supervisor

- Content/Topic 1:**Definition of environment and environmental impact assessment**

Environment :

Environmental impact assessment (EIA): is a process of evaluating the likely environment impact of a proposed project or development, taking into account inter-related socio-economic, cultural and human health impact, both beneficial and adverse.

- Content/Topic 2:Impact of soil erosion control on environment

- Improve land aesthetic
- Improve soil stability
- Ecosystem preservation
- Forestation
- Carbon sequestration
- Water preservation
- Soil conservation

Learning Unit 2 – Identify the soil erosion types, causes and effects

LO 2.1 –Identify soil erosion types according to site characteristics

- Content/Topic 1 :Definition of soil erosion

Soil: is the mixture of minerals, organic matter, gases, liquids, and the myriad of organisms that together support plant life.

The functions of soil like:

- It is a medium for plant growth;
- It is a means of water storage, supply and purification;
- It is a modifier of the atmosphere;
- It is a habitat for organisms that take part in decomposition of organic matter and the creation of a habitat for new organisms

Erosion: is the action of exogenic processes (such as water flow or wind) which remove soil and rock from one location on the Earth's crust, then transport it to another location where it is deposited.

Soil Erosion: generally, refers to detachment and transportation of soil and soil material from the place of origin by water, wind, ice or gravity and deposition to another place.

- Content/Topic 2 :Indicators of soil erosion

When you are by a soil look for one or more of these signs of erosion:

a) Bare soil
b) Plants or rocks on pedestals exposed roots
c) Small benches of soil behind obstacles
d) Surface soil crusts
e) Increased tendency of runoff water to flow together into a network of connected channels
f) Deposits of soil where the field's slope changes
g) Decreased thickness of topsoil
h) Exposed subsoil at the soil surface
i) Visible rills or gullies
j) Silt-clouded water or sediment deposits in surface water bodies and irrigation canals
k) Poor plant growth

- Content /Topic3 :Types of soil erosion

i. According to Origin: Soil erosion can broadly be categorized into two types i.e. geologic erosion and accelerated erosion.

a) Accelerated

Accelerated erosion is largely the consequence of human activity. The primary causes are tillage, grazing, cutting of trees, recreational activity and buildings.

b) Natural or geological or background

Natural erosion is a natural process that forms part of the lifecycle of sites, resulting from the action of wind or water.

ii. According to Erosion Agents: Soil erosion is broadly categorized into different types depending on the agent which triggers the erosion activity.

a) Water Erosion: Water erosion is seen in many parts of the world. In fact, running water is the most common agent of soil erosion.

b) Wind Erosion: Wind erosion is most often witnessed in dry areas wherein strong winds brush against various landforms, cutting through them and loosening the soil particles, which are lifted and transported towards the direction in which the wind blows.

c) **Glacial Erosion**: Glacial erosion, also referred to as ice erosion, is common in cold regions at high altitudes.

d) **Gravitational Erosion**: Although gravitational erosion is not as common a phenomenon as water erosion, it can cause huge damage to natural, as well as man-made structures.

Content/Topic 4 :Forms of soil erosion

i. Forms of water erosion

a) Splash

Splash erosion is the first stage of the **erosion** process. It occurs when raindrops hit bare soil. The forces that influence splashing are:

- The raindrop mass and velocity,
- Surface slope (gradient and aspect) and
- Soil characteristics (hydraulic conductivity, moisture content, roughness, particle size, elasticity, and associated mass of the surface).

The following are some basic principles to be considered in splash erosion:

✓ Soil splashing is resulting from the impact of water drops directly on soil particles.

✓ The falling drops break down soil aggregates and detach soil particles and the fine materials

- ✓ From the soil are removed, less fertile sands and gravels remain behind.
- ✓ The principal effect of splash erosion is to detach soil and transportation of the detached soil takes place then after.
- ✓ The number and size of drops and the velocity of drops determine the impact of raindrops per unit area.
- ✓ The soil may be splashed into the air up to a height of 50 to 75 cm depending upon the size of rain drops. At the same time the soil particles also move horizontally as much as 1.50 m on level land surface.
- ✓ Continuous bombardment in a rainstorm by millions of raindrops causes damage by beating the bare soil into a flowing mud.

Factors affecting the direction and distance of soil splash

Factors affecting the direction and distance of soil splash are:

- ❖ Presence of wind,
- ❖ Land slope,
- ❖ Soil surface conditions (vegetative cover and mulches).

Splash erosion is the worst form of water erosion as it gives a start for the other forms of erosion.

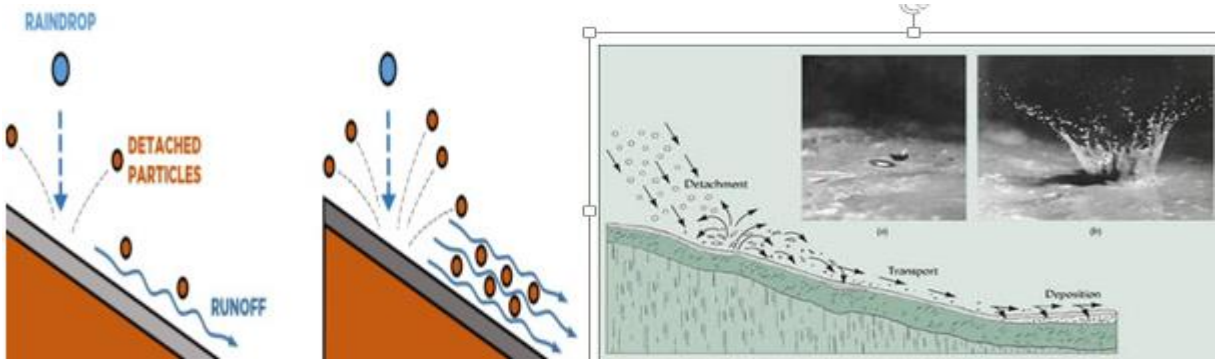

Figure :Splash erosion

b) Sheet erosion

Sheet Erosion: Sheet erosion may be defined as more or less uniform removal of soil in the form of a thin layer or in “sheet” form by the flowing water form a given width of sloping land.

Under such conditions, there occurs relatively uniform removal of soil from all parts of the area having a similar degree of slope.

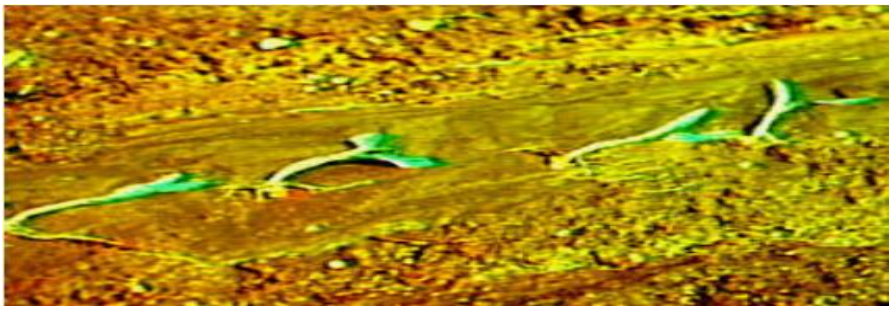

Figure: Sheet erosion

The following signs are indicators of sheet erosion:

- ✓ Roots are exposed
- ✓ Stones are exposed
- ✓ Soils become more of gravel
- ✓ Deposits of eroded soils at bottom slope
- ✓ Sub soil becomes mixed with topsoil
- ✓ Crop yields fall gradually

c) Rill erosion

Rill erosion is the removal of soil by runoff water with the formation of shallow channels that can be smoothed out completely by normal cultivation.

Rills are shallow drainage lines that are less than 30cm deep.

Figure :rill erosion

d) **Stream Bank Erosion (River bank erosion)**

Stream erosion is the scouring of soil material from the stream bed and cutting of the stream banks by the force of running water.


Stream bank erosion is often increased by the removal of vegetation,overgrazing, or tillage near the banks. Scouring is influenced by the velocity and direction of the flow, depth and width of the stream, soil texture and alignment of the stream.

e) Gully erosion

Gully erosion is the removal of soil along drainage lines by surface water runoff. Gully erosion produces channels larger than rills.

Figure: gully erosion

The stages of gully erosion

The three stages of gully **development** (waterfall erosion, channel erosion along the gully bed, and landslides on gully banks) will continue unless the gully is stabilized by structural control measures and revegetation.

Factors affecting gully formation

The factors affecting gully formation can be categorized into two groups, man-made factors, and physical factors.

i. Man-made factors

Improper land use

The rapidly-increasing populations usually migrate upland to occupy forests or rangeland. Most migrants cut trees, burn litter and grasses, and cultivate hillsides without using conservation measures.

Forest and grass fires

On slopes, the soil that is exposed after forest and grass fires is usually, gullied during the first rainy season.

Overgrazing

Overgrazing removes too much of the soil's protective vegetal cover and trampling compacts the soil; thus the infiltration capacity of the land is reduced. The increased run-off, caused by the insufficient water holding capacity of the soil, produces new gullies or enlarges old ones.

Mining

Underground (block cave) mining is another factor that can cause gullying. Initially, cracks in the ground and soil creep (a kind of gravity erosion) are observed in the mining areas. Then, during rainy seasons, gullies are formed. Gullying in open-pit mining areas is also a big problem in many countries.

Road construction

If road cuts and fill slopes are not revegetated during or immediately following road construction, gullies may form on both sides of the road.

Livestock and vehicle trails

Gullies are also formed on livestock and vehicle trails that run along hillsides. This is because the traffic on them compacts the soil and reduces the water holding capacity.

Destructive logging

In forest regions, logging with tractors down slopes can lead to gully erosion, because the run-off becomes concentrated along the skid trails. Highland logging with slack cables also causes gullying on forest land.

ii. Physical factors

The main physical factors effecting the rate and amount of surface run-off are precipitation, topography, soil properties and vegetative cover.

1. Precipitation

(a) Monthly distribution of rainfall

In areas that do not have uniform rainfall, the vegetation (especially grass) dries up during the prolonged dry season (3 to 5 months or more). If the land is not properly used, or if forest or grass fires occur during the dry period, it cannot sufficiently hold rainwater and so the increased surface run-off in the rainy season produces large scale landslides and gullies.

(b) Rainfall intensity and run-off

There is a relationship between rainfall intensity, rate of run-off, density of vegetative cover, and the size of a catchment area. This relationship is generally expressed in equations.

If the amount of rainfall is more than the holding capacity of the soil, there will be an increase in surface run-off, followed by surface erosion and gullying.

(c) Rapid snowmelts

Rapid snowmelts turn into high run-off. This increased surface run-off acts as a cutting agent and produces gullies. Like prolonged rains of moderate intensity and short intensive rain storms, rapid snowmelts cause destructive floods.

2. Topography

The size and shape of a drainage area, as well as the length and gradient o£ its slopes have an effect on the run-off rate and amount of surface water.

3. Soil properties

The seven soil classes are based on soil texture: sand, loamy sand, sandy loam, loam, silt, loam, clay loam and clay. The infiltration rate increases from clay to sand , but resistance against erosion decreases.

4. Vegetative cover

The role of vegetative cover is to intercept rainfall, to keep the soil covered with litter, to maintain soil structure and pore space, and to create openings and cavities by root penetration.

In general, it is management and protection rather than the type of the vegetative cover which determines its effectiveness in gully control.

f) Mass movement

Mass Movement is any one of several processes that move sediment downhill. The different typesof mass movement include

(i). Landslides,

(ii). Mud flows,

(iii). slump,

(iv). Surface creep.

Gravity is the number one cause of mass movement. Mass movements can vary from being rapid or super slow it all depends on the type.

(I) Land slide

Landslides are the most destructive type of mass movement. Landslides occur when rock and soil slide quickly down a steep slope. Landslides can contain Huge masses of rock, soil, and smaller sediment. Most landslides occur where roads have cut through hills or mountain ranges.

(II) Mudflows

Mudflows can be very dangerous. Mudflows are a mixture of water,
rock, and soil rapidly flowing downhill. Mudflows usually occur after a heavy rain in a normally dry place. Mud flows can contain as high as 60 percent of water. Sometimes when soil has lots of clay with a high water content, mud flows can occur even on a very gentle slope, under certain conditions clay soils turn into liquid making it easier to flow downhill.

(III) A slump

A slump is when a mass of rock and soil attached to an even bigger mass of rock and soil suddenly slip down a slope. A slump occurs when water soaks the bottom of a slope and erodes it until that part of the slope finally collapses. A slump is different than a landslide because unlike the landslide a slump all moves down the slope at the same time in one huge mass.

(IV) Surface creep

Creep is a very slow process where rock and soil move very slowly downhill. Creep can even occur on gentle slopes. Creep occurs when water freezes and thaws on cracked layers of rock underneath the soil. When creep occurs it is so slow that you can barely notice it. After a creep goes through the land it causes trees, telephone poles, and fence posts to have bends and creepy curves.

g) Solufluction

Solifluction is a geomorphic process that involves the slow movement of water-saturated soil down a slope and usually occurs on frozen subsoil or during freeze-thaw activity. The term originates from the Latin words *solum* and *fluction*, which mean "soil" and "to flow," respectively.

ii. Forms of wind erosion

The term wind erosion refers to the damage of land as a result of wind removing soil from an area. Most often, wind erosion occurs on flat land in dry or sandy areas. For example:

- ✓ Rock formation in various location sculpted by wind erosion
- ✓ Dunes, particularly in deserts, off of which sand is blown
- ✓ Various rock or sand structures created via wind blowing off rock and sand around them

The effects of wind erosion

Wind erosion may have the following impacts:

• Soil fertility is reduced because of the loss of the plant nutrients that are concentrated on fine soil particles and organic matter in the topsoil. This reduces the soils capacity to support productive pastures and sustain biodiversity.

• Erosion at the base of bushes and plants can result in the plant being isolated and ground cover being thinned out.

• The erosion of light-textured topsoil can expose dense clay subsoils.

Wind erosion processes

(a) ***Suspension*****:** Fine particles less than 0.1 mm in size are moved parallel to the surface and upward into the atmosphere by strong winds.

(b) ***Saltation:*** Movement of particles by a series of short bounces along the surface of the ground, and dislodging additional particles with each impact. The bouncing particles ranging in size from 0.1 to 0.5 mm usually remain within 30 cm of the surface. Depending on conditions, this process accounts for 50 to 90% of the total movement of soil by wind.

***(c) Soil creep*:** The rolling and sliding of larger soil particles along the ground surface. The movement of these particles is aided by the bouncing impacts of the saltating particles described above. Soil creep can move particles ranging from 0.5 to 1 mm in diameter, and accounts for 5 to 25% of total soil movement by wind.

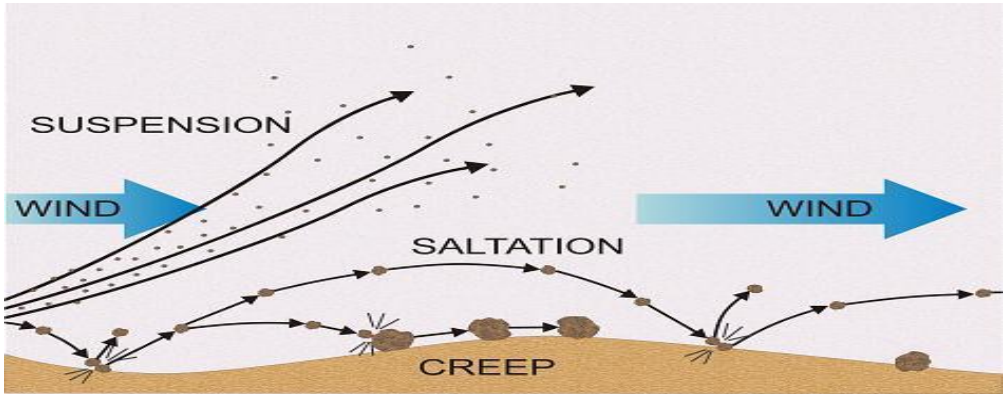

Figure : Forms of wind erosion

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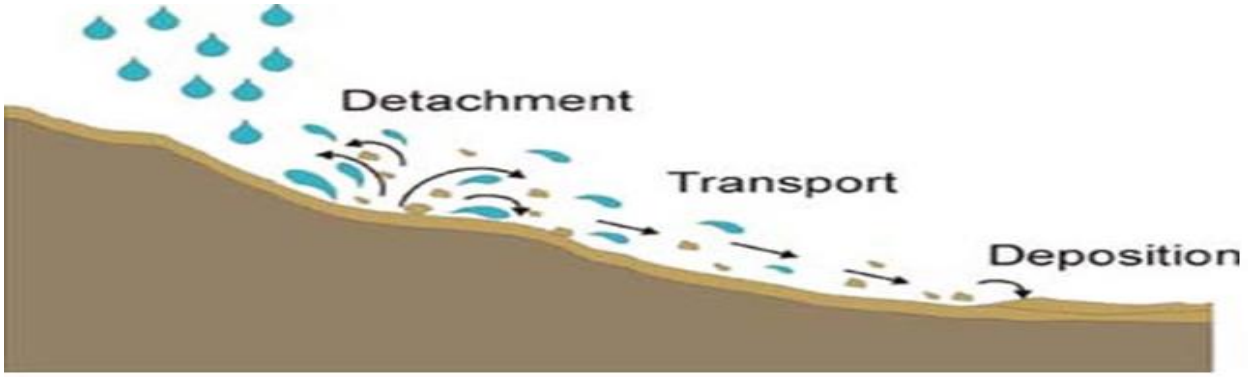
LO 2.2 – Assess soil erosion causes referring to soil erosion effects

- Content/Topic 1 :The process of soil erosion

The process of soil erosion is made up of three parts:

- **Detachment:** This is when the topsoil is actually "detached" from the rest of the ground.
- **Movement:** This is when the topsoil is relocated to another area.
- **Deposition:** Where the topsoil ends up after movement process.



- Content/Topic 2 :Causes of soil erosion

1. Natural causes

Not only human action can cause degradation to occur, but also natural causes such as :

a) Rainfall

When it rains in the hilly areas, the soil gets washed away towards the plains.

The frequency, intensity and duration of rainfall are fundamental factors in determining the amount of runoff produced in a given area. As both the volume and velocity of runoff increase, the capability of runoff to detach and transport soil particles also increases. Where storms are frequent, intense, or of long duration, erosion risks are high.

b) Wind

When strong winds blow, the topsoil along with the organic matter is carried away by the wind. This happens more often when the land is not covered with grass or plants. Such conditions are very common in desert and semi-desert regions where strong winds blow very frequently.

c) Soil

The erosion potential of any area is determined by four principal factors: the characteristics of its soil, its vegetative cover, its topography and its climate. Although each of these factors is discussed separately herein, they are inter-related in determining erosion potential.

Soil Characteristics

Soil characteristics influencing erosion by rainfall and runoff are those properties which affect the infiltration capacity of soil and those which affect the resistance of the soil to detachment and transport by falling or flowing water. The following four characteristics are important in determining soil erodibility:

Soil Texture (particle size and gradation): soils containing high percentages of fine sands and silt are normally the most erodible. As the clay and organic matter content of these soils increase, the erodibility decreases. Clay acts as a binder for soil particles, thus reducing erodibility.

Organic Matter Content: Organic material is the “glue” that binds the soil particles together and plays an important part in preventing soil erosion. It also influences the infiltration capacity of the soil.

Soil Structure: The way soil particles are held together, affects the soil's friability, the ease with which soil particles are detached by raindrops and runoff, and the resistance of the soil to the growth of roots and shoots.

Soil Permeability: Permeability is the soil’s ability to transmit air and water. Soils that are least subject to erosion from rainfall and surface runoff are those with high permeability.

c) Topography

The size, shape and slope characteristics of a watershed influence the amount and rate of runoff. As both slope length and gradient increase, the rate of runoff increases and the potential for erosion is magnified.

2. Artificial Causes

a. Deforestation

Humans have taken land from the forest to cultivate in order to feed the ever-increasing population and to build houses, industries, etc. Cutting down of trees on a large scale for these purposes is **deforestation**. The roots of trees hold the soil together, thus preventing the soil from getting uprooted. When large areas of the forest are cleared, the topsoil gets eroded by wind and flowing water..

b. Overgrazing

When cattle are allowed to graze on the same field repeatedly, all the available grass, including the roots are eaten by them. This makes the topsoil vulnerable to wind and flowing water, leading to soil erosion.

c. Mining

Mining is an economically important industry for many countries but it comes at a cost. Mining can result in the pollution of natural resources, harm to the biodiversity of habitats, and erosion of the land.

d. Overexploitation

Overexploitation occurs when arable land is used beyond its fertility potential without substituting the loss of nutrients by fertilizers or appropriate fallow periods.

Overexploitation can lead to a variety of erosion features such as gully erosion, landslides and alternation of discharge and should thus be prevented in order to provide sustainable use of the soil.

e. Unadjusted irrigation activities

The implementation of irrigation techniques can lead to degradation, when the technical know-how and/or the appropriate instruments are missing. Degradation, primarily in form of salinization, occurs in this case due to a bias between water inflow and outflow or the use of salty water.

f. Socio-economic and political causes

Various socio-economic as well as political causes can lead to land degradation. As mentioned earlier, population growth is a major cause of degradation, since it might

contribute to overgrazing, overexploitation and deforestation (if no appropriate and adapted land use practices are applied).

LO 2.3 –Assess soil erosion effect and severity according to soil erosion types

- Content/Topic 1 : Effect of soil erosion

1. Agricultural effects

a) Soil compaction

Soil compaction can be a serious form of soil degradation resulting in decreased crop production and increased risk of soil erosion. Soil compaction can reduce water infiltration into soil, crop emergence, root penetration, crop nutrient uptake and water uptake — all of which can reduce crop yields.

b) Degradation of soil fertility

Losing topsoil to erosion contributes to a loss of inherent soil fertility levels of nitrogen, P, K, and thus to a decline in potential crop yield.

c) Flooding

Land is often transformed from a forest or other natural landscape, such as floodplains and wetlands, into a crop field or pasture. The converted land is less able to soak up water, making flooding more common.

d) Crop destruction

Erosion is generally associated with yield reductions. The erosion-induced reduction in crop yields is attributed to loss of rooting depth, degradation of soil structure, decrease in plant-available water reserves, reduction in organic matter, and nutrient imbalance.

e) Perturbation of cropping techniques

Soil degradation refers to the environmental processes that destroys soil structure, affects its fertility, and undermines the quality of water.

Soil endures physical, chemical, and biological changes depending on the factor that drives degradation. The key items that expedite degradation are as follows: water, wind, ice movement, and gravity.

Due to rapid urbanization and overwhelming agricultural practices (tillage, the use of pesticides, and inappropriate irrigation practices), soil salinity and acidity levels increase to a point where the fields no longer possess the desired fertility for farming.

f) Water pollution

Soil eroded from the land, along with pesticides and fertilizers applied to fields, washes into streams and waterways. This sedimentation and pollution can damage freshwater and marine habitats and the local communities that depend on them.

2. Socio-economic effects

a) Infrastructure destruction

Soil erosion can cause physical damage to infrastructure—destroying buildings, roads and other forms of urban development.

b) Loss of lives

Trees and grasses which protect soil in areas of erosion will die and this makes the soil still more susceptible to further erosion.

The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species.

c) **Reduction of law materials for industry**

Industries that are dependent on farm product suffer from inadequate supply of raw materials because of the effect of soil erosion on plant growth and yield.

LO 2.4 – Keep records as required by supervisor

- Content/Topic 1:Importance of records keeping

Importance of farm records

1. Farm records are used to evaluate the performance of any farm or farm entreprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earned
5. farm records enable the farmer to obtain loans from banks and their financial institution
6. farm records tell a farmer where they are gaining progressively or loosing

- Content /Topic2:Content of record form

  - Content of record form

✓ Site location/address

  - Driving sources of soil erosion

✓ Human population(demography)

✓ Land development

✓ Agriculture

✓ Transport

✓ Natural events

✓ Climate change

  - Pressures

✓ Land cover changes

✓ Precipitation

    - State

✓ Soil loss

✓ Soil erosion

✓ Mass movement

✓ Change in soil quality (depth)

- Impact of soil erosion

✓ Direct impact

- Changes in soil function
- Loss of soil fertility
- Contamination of surface and ground water

  - Indirect impact

- Population welfare
- Size and distribution
- Biodiversity (soil
- Habitats and species)
- Crop yields
- Desertification
- Water stress

Learning Unit 3 – Apply cultural soil erosion control measures

LO 3.1 – Collect data according to site location and condition

Content /Topic1:**Data on Climatic condition**

a) Rainfall (5 years back) :……

b) Wind velocity (5 years back) :……

c) Temperature :……

Data on site location

Site configuration:……..

Slope:……

Vegetation:……

Contour line :……

Geographic coordinate:……..

Contour interval:……

Soil texture:……

Soil depth :……..

LO 3.2 – Identify cultural soil erosion control measures based on collected data

- Content/Topic 1 :Cultural soil erosion control Methods

1. **Cover crops**

   Cover crops are fast growing plants which grow close to the ground. Cover crops have many leaves and are mainly crops from the legumes family. In this way the soil surface is protected from the intensity of raindrop.

Figure: Cover crops

Selecting the correct cover crop depends on:

- How much cover will the crop supply
- Can the crop be harvested the next season
- The importance of weed control
- Soil improvement
- Nutrient conservation
- Date of seeding

2. Mulching

Mulching is the covering of the soil surface with dry plant materials or inorganic material.

Figure:Mulching

❖ **Role of mulching**

✓ Protects the soil from erosion

✓ Reduces compaction from the impact of heavy rains

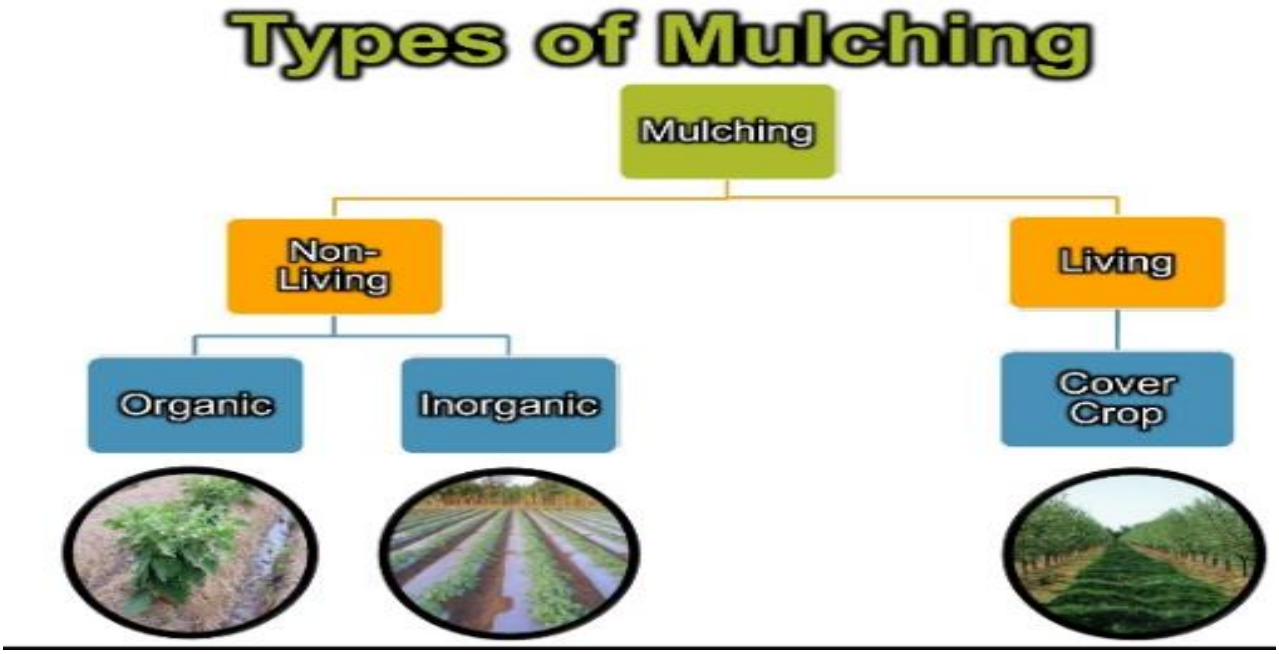
✓ Conserves moisture, reducing the need for frequent waterings

✓ Maintains a more even soil temperature

✓ Prevents weed growth

✓ Keeps fruits and vegetables clean

❖ **Types of mulching**



3. **Multiple cropping**

Multiple cropping is a form of Ecological Intensification that is potentially highly sustainable when two or more crops are grown at the same time or in a sequence.

It does this by balancing three key ecological processes: competition, on the one hand, and commensalism (one plant gaining benefits from the other) or mutualism (both plants benefitting each other) on the other.

If **multiple cropping** — the practice of planting more than one **crop** in a field during different seasons — results in better coverage, in space and time, of the soil, then **erosion** will be reduced.

4. **Strip cropping**

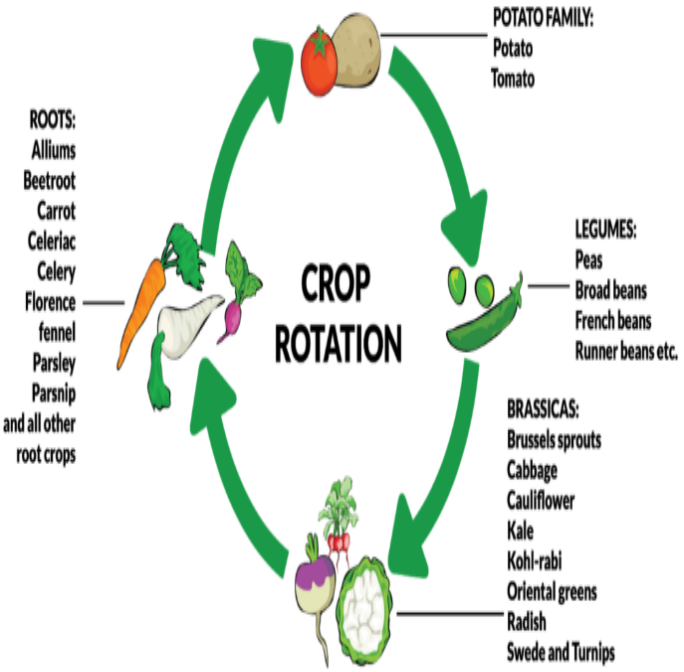
Strip cropping is a method of farming used when a slope is too steep or too long, or otherwise, when one does not have an alternative method of preventing soil erosion.

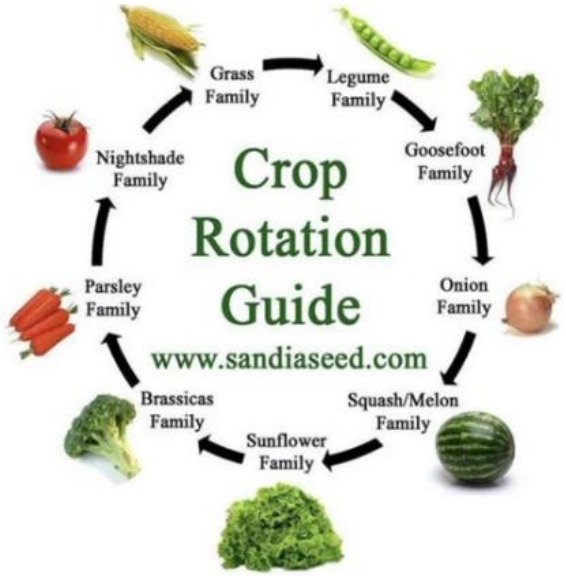
The strip control erosion by reducing the speed of running water at the same time they trap soil that may escaped.


5. **Crop rotation**

Rotations: the growing of two or more crops in sequence on the same piece ofland.

Crop Rotation: Rotating in high-residue crops — such as corn, hay, and small grain — can reduce erosion as the layer of residue protects topsoil from being carried away by wind and water.





Good crop rotation is a systematic succession of the three general classes of farm crops, namely, cultivated crops, grain crops, and grass crops.

Purpose of Rotations

(1) A rotation of crops provides for maintaining the **soil in good tilth.**

(2) Supplies **organic matter and nitrogen.**

(3) Prevents destructive outbreaks of insect pests.

(4) Reduces plant diseases.

(5) It provides for the economic destruction of weeds.

(6) Maintains **crop yields**.

(7) Distributes the labor of men and horses.

(8) **Saves labor** in the cultivation of land.

(9) Keeps the soil occupied.

(10) It provides for a balanced removal of plant food.

(11) Systematizes farming.

(12) May control the spread of **toxic substances.**

Principles of Crop Rotation

Good crop rotation should contain

(1) An inter-tilled crop.

(2) A cash crop.

(3) Crops to feed.

(4) A crop to supply humus and nitrogen.

6. **Soil organic manure application**

   Using compost in highly erosive areas can decrease erosion and allow quicker establishment of vegetation.

   Compost controls erosion by:

- Increasing water infiltration in to the soil surface.
- Reducing runoff and soil particle transport in runoff.
- Increasing plant growth and soil cover.
- Reducing soil particle dislodging.
- Increasing water holding capacity of soil which reduces runoff.
- Buffering soil pH which can increase vegetation establishment and growth.
- Alleviates soil compaction by increasing soil structure.
- New vegetation can be established directly into compost.

7. Grass strip

A grass strips is narrow band of grass planted along the contour. The dense cover slow down surface runoff from the strip above the crops.

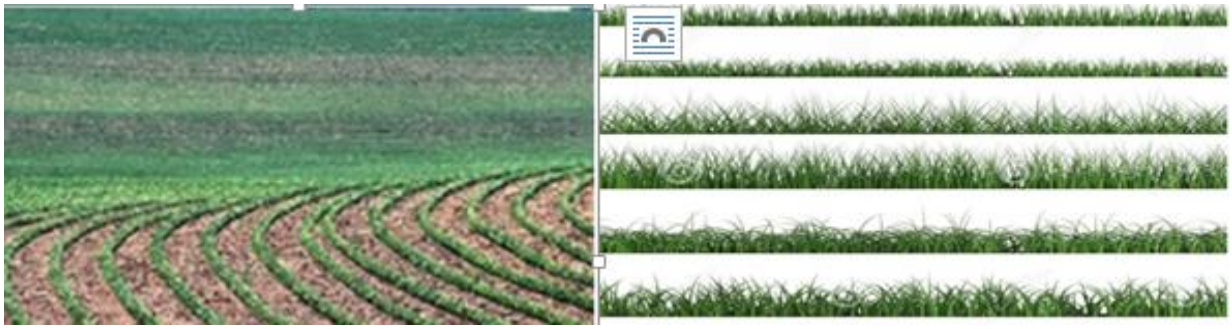


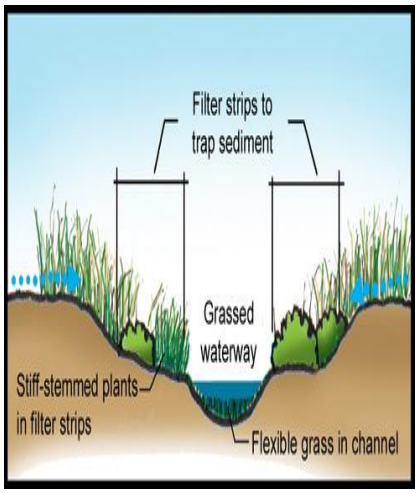
Figure: Grass strip

8. Grassed waterways

A Grassed Waterway means a natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff to improve water quality.

Purpose of grassed waterways

- ✓ To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- ✓ To prevent gully formation.
- ✓ To protect/improve water quality



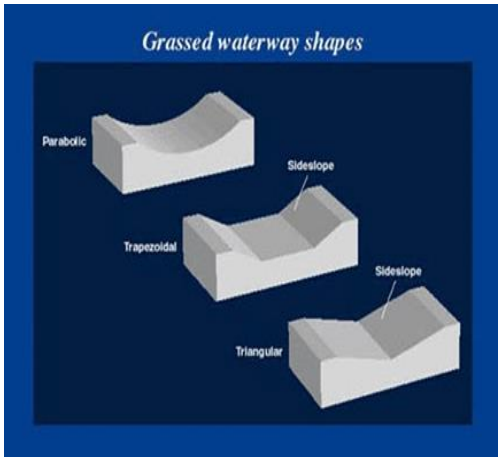


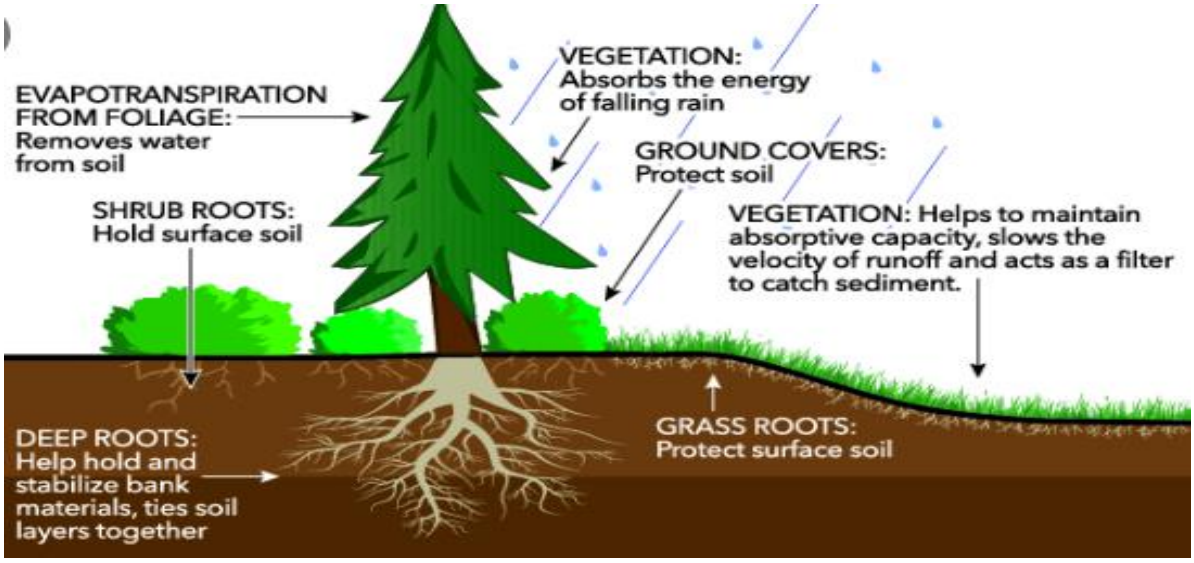
Figure: Grassed waterway

Waterways should be:

- Covered with jute mat or straw before seeding
- Seeded before the end of August
- Lined with geotextile and quarry stone on steep slopes
- Fertilized and mowed annually
- Not used as a roadway
- Repaired or reseeded when necessary

9. Afforestation

Afforestation means planting trees. As we know, the roots of the trees help to hold the soil layer firmly,it is evident that it helps not to make the soil loose and prevents erosion. Thus, by planting more and more trees, the top layer of the soil becomes less prone to erosion by wind, water or anything likely.



Afforestation works will be realized in degraded forest lands, in the spaces in the forest and the out, around cities, road sides, field sides and pond, lake and dam catchments.

Afforestation practices are the most effective erosion control methods that include direct-seeding, planting seedlings, and natural and/or artificial regeneration activities.

10. Contour farming

Contour farming includes ploughing, planting and weeding along the contour. Planting rows on the contour helps channel small runoff streams across, rather than down.

11. Agroforestry

Agroforestry refers to land-use systems in which trees or shrubs are grown in association with agricultural crops, pastures or livestock, and in which there are both ecological and economic interactions between the trees and other components.

The main components of agroforestry systems are trees and shrubs, crops, pastures and livestock, together with the environmental factors of climate, soils and landforms. Other components (e.g. bees, fish) occur in specialized systems.

Agroforestry systems can include the following benefits:

1. They can control runoff and soil erosion, thereby reducing losses of water, soil material, organic matter and nutrients.
2. They can maintain soil organic matter and biological activity at levels satisfactory for soil fertility.
3. They can maintain more favourable soil physical properties than agriculture, through organic matter maintenance and the effects of tree roots.
4. They can lead to more closed nutrient cycling than agriculture and hence to more efficient use of nutrients. This is true to an impressive degree for forest garden/farming systems.

5. They can check the development of soil toxicities, or reduce exiting toxicities-both soil acidification and salinization can be checked and trees can be employed in the reclamation of polluted soils.
6. They utilize solar energy more efficiently than monocultural systems different height plants, leaf shapes and alignments all contribute.
7. They can lead to reduced insect pests and associated diseases.
8. They can be employed to reclaim eroded and degraded land.
9. Agro forestry can augment soil water availability to land use systems. In dry regions, though, competition between trees and crops is a major problem.
10. Nitrogen-fixing trees and shrubs can substantially increase nitrogen inputs to agro forestry systems.
11. Trees can probably increase nutrient inputs to agro forestry systems by retrieval from lower soil horizons and weathering rock.
12. The decomposition of tree and pruning can substantially contribute to maintenance of soil fertility. The addition of high-quality tree prunings leads to large increase in crop yields.
13. The release of nutrients from the decomposition of tree residues can be synchronized with the requirements for nutrient uptake of associated crops. While different trees and crops will all have different requirement, and there will always be some imbalance, the addition of high quality prunings to the soil at the time of crop planting usually leads to a good degree of synchrony between nutrient release and demand.
14. In the maintenance of soil fertility under agro forestry, the role of roots is at least as important as that of above-ground biomass.
15. Agro forestry can provide a more diverse farm economy and stimulate the whole rural economy, leading to more stable farms and communities. Economics risks are reduced when systems produce multiple products.

The common species used in agro-forestry system are:

- ✓ *Calliandracalothyrsus,*
- ✓ *Cedrelaserrata ,*
- ✓ *Greviellerobusta ,*
- ✓ *Leucaenadiversifolia ,*
- ✓ *Moringaoleifera*

- ✓ *,Alnus acuminate,*
- ✓ *Sesbaniasesban,*
- ✓ *Cajanuscajan ,*
- ✓ *Grevilliarobusta.*

12. Contour ridges

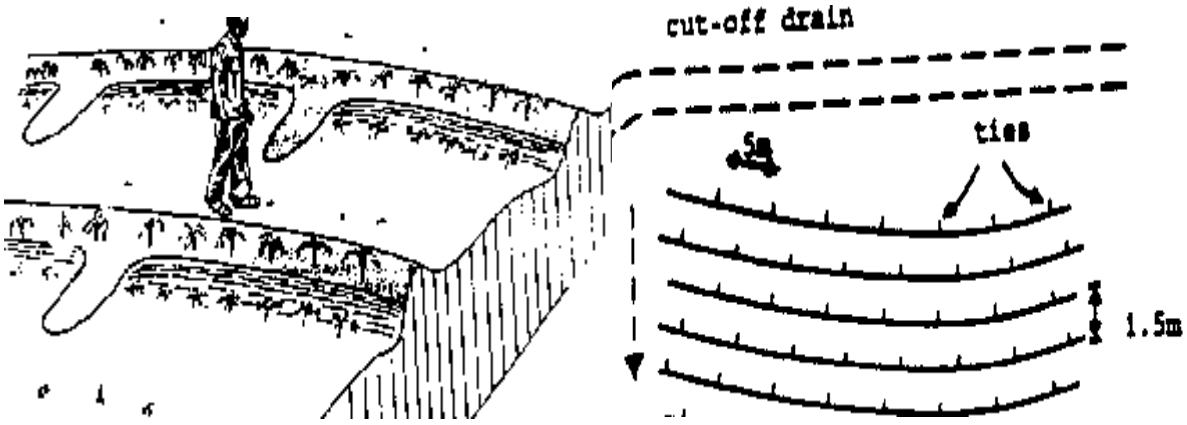
Contour ridges are small earthen ridges, 15 to 20 cm high, with an upslope furrow which accommodates runoff from a catchment strip between the ridges. The catchment strip is usually uncultivated, but, where contour ridging is used to control erosion rather than for water harvesting, the whole area may be cultivated.

Ridges may be from 1.5 to 10.0 m apart, but, as this is a micro-catchment system andthe catchment is a function of the distance between ridges, the precise distance should be calculated for the expected rainfall of the region.

Small earthen ties are made within the furrows at 4 to 5 m intervals to prevent lateral flow.

The objective of the system is to collect local runoff and store it within the soil profile in the vicinity of the plant roots. Micro-catchment contour ridging is usually not designed to accommodate overflow, so the system should be protected with a cutoff drain.

The tied contour ridging system is used for tree planting (with a wider distance between ridges) and crop production. Crops are planted on the ridges as well as in the furrows.



Advantages

This low cost technology has the potential to increase food security in below normal rainfall years. The system can be implemented using either a mechanised or manual labour approach. As with other water harvesting methods, it is more likely to be successful in areas which experience severe dry spells and/or highly variable rainfalls. The technology reduces soil erosion and increases soil moisture content.

Disadvantages

The unusual cropping system of planting on ridges and next to furrows, but leaving the catchment unplanted, is thought to be a disincentive for adopting this technology. Further, the labour-intensive approach is not thought to be attractive in the areas where the technology has been tried.

13. Inter-cropping

The practice of **intercropping**—growing more than one **crop** per season can benefit the soil in several ways.

Advantages of Intercropping system are:

1. Reduction in soil runoff and controls weeds;
2. Intercropping with cash crops is higher profitable;
3. It acts as an insurance against failure of crops in abnormal year;
4. Inter-crops maintain the soil fertility as the nutrient uptake is made from both layers of soil;
5. Inter-cropping gives additional yield income/unit area than sole cropping;
6. It helps to avoid inter-crop competition and thus a higher number of crop plants are grown per unit area;
7. Inter cropping system utilizes resources efficiently and their productivity is increased
8. Intercrops provide shade and support to the other crop.

Disadvantages of Intercropping system are:

1. Yield decreases as the crops differ in their competitive abilities;
2. Management of I/c having different cultural practices seems to be difficult task;
3. Harvesting is difficult;
4. Higher amount of fertilizer or irrigation water cannot be utilized properly as the component crops vary in their response of these resources;
5. Improved implements cannot be used efficiently.

14. Minimum or no-tillage

Crops are grown from year to year with zero or minimum soil disturbance through tillage in this system. In Minimum tillage, soil disturbance is kept to minimum level. In Zero tillage or No-Till system, no soil disturbance is done season in season out.

The Benefits

This system comes with many advantages;

1. Water retention- retains and increase the amount of water in the soil.
2. Organic Matter increase- Plant remains are left on the soil surface to rot and add to the organic matter content in the soil.
3. Cycling of nutrients- When the remains of the previous crops are left to rot and mix with soil, the nutrients they had accumulated is returned to the soil.
4. Reduce Soil erosion- The minimum or no soil disturbance strengthens soil structure which resist movement of soil by rain water.
5. Micro- Organism enhancement – The minimum soil disturbance ensures that the small organism in the soil thrive and multiply. Their activities of breakdown of materials in the soil is enhanced.
6. Saves money – The reduced activities means money is saved on fuel, man power and hire/use of machinery.
7. Faster Crop Maturity- the crops are planted immediately the rains are on which means they germinate and mature faster compared to systems where ploughing is done after the rains. More so because of the extra moisture the soil had.
8. Soil Evaporation reduction- The organic matter and plant remains cover the soil ensuring no loss of soil moisture. If the rains are insufficient, the crop will continue growing due to the extra moisture.
9. Easier Weeds control – after sowing, the weeds which germinate are easily controlled using a non-selective herbicide. After several years of the system, the soil cover increases reducing temperature in the soil. The weeds don't grow except the planting line where soil will be exposed to the sun.
10. Improved soil fertility – the activities of minimum soil disturbances, improved organic matter and enhanced soil matter improved soil fertility. This results in better crops for improved productions.

11. Better profits- all the costs saved in the farm operations lower cost of production leading to increased profits.

Disadvantages

- ✓ No incorporation.
- ✓ Increased dependence on herbicides.
- ✓ Slow soil warming on poorly drained soils.

- Content/Topic 2 :Selection criteria of cultural erosion control methods

(a) Effectiveness

The most effective form of erosion control is to minimize the area of disturbance, retaining as much existing vegetation as possible.

(b) Costs

The cost-effectiveness of erosion control measures based on an ecosystem services approach. The economic appraisal consists of an assessment (i.e. quantification and valuation) of the on-site and off-site impacts of soil erosion, and its mitigation, on ecosystem services. Many erosion control measures result in negative financial and economic returns. This explains why farmers are generally reluctant to implement erosion control measures without compensation.

(c) Availability

In farming activities, farmers prefer to buy and use available locally farming tools. This selection also depends on their financial means to access on the tool and equipment.

(d) Feasibility

Tools and equipment also may be selected depends on how well they perform a given agricultural activity. It may also be selected depends on how well it minimizes the farming cost. eg. Farming by using machine (tractor) works well the land and minimizes cost compared to that of using work force (manpower).

(e) Durability

Tools and equipment with long lifespan are more preferable than those with low lifespan.

(f) Compatibility

Farmers select tools differently depend on the agricultural to be done. Tools used in land clearing are different from tools used in first tillage and second tillage respectively. Likewise, tillage tools and equipment are different from those harvesting and handling.

……

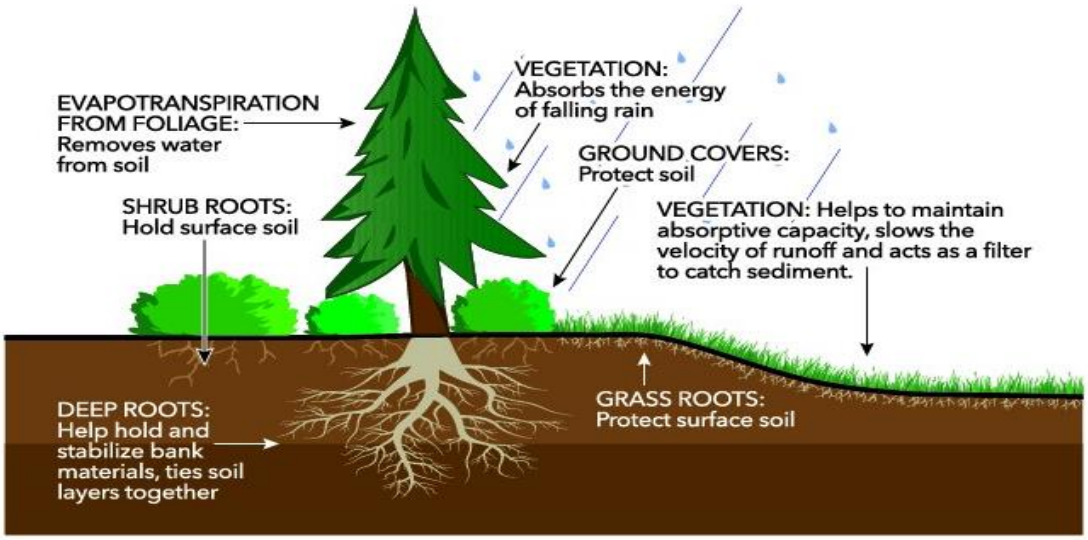
LO 3.3 – Implement suitable cultural soil erosion control measures according to collected data and following procedures

- Content/Topic :Perform selected cultural soil erosion control measures.

1. Cover crops and erosion

Cover crops can successfully decrease, or almost completely eliminate, soil loss from various production systems. They do this by:

- Providing coverage of the soil surface and protecting it from rain and wind
- Rooting into the soil profile and improving soil structure
- Encouraging water infiltration to the soil profile



EFFECTS OF VEGETATION IN MINIMIZING EROSION

2. Mulching

Mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or gravel are placed on exposed or recently planted soil surfaces. Mulching is highly recommended as a stabilization method and is most effective when used in combination with vegetation establishment. Mulching can stabilize soils, and reduce storm water runoff velocity.

3. Multiple cropping

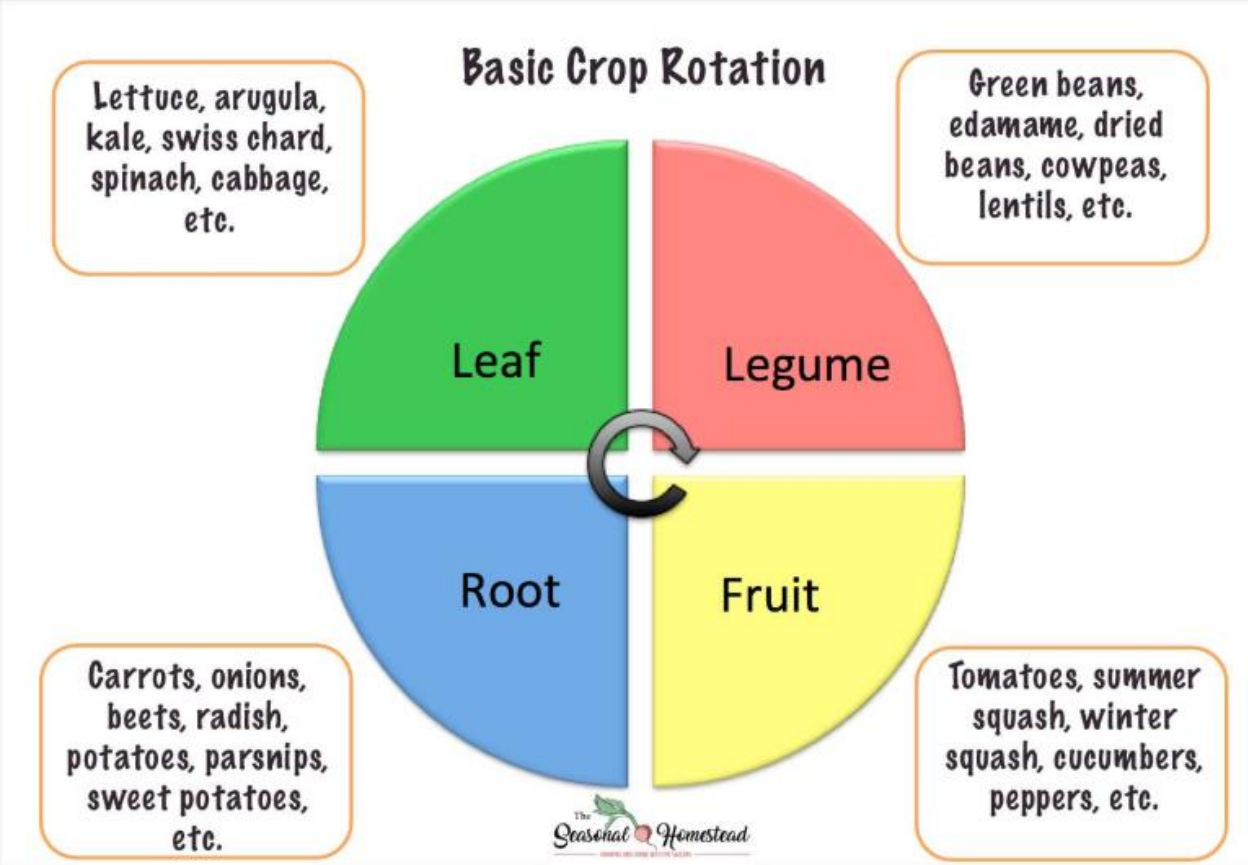
The practice of planting more than one crop in a field during different seasons, results in better coverage, in space and time, of the soil, then erosion will be reduced. When there are more leaves to absorb the impact of rain drops, and more roots to hold the soil in place against the force of water running off the field, there will be less erosion.

4. Strip cropping

Strip cropping is a method of farming used when a slope is too steep or too long, or otherwise, when one does not have an alternative method of preventing soil erosion. Strip cropping alternates' strips of closely sown crops such as hay, wheat, or other small grains with strips of row crops, such as corn, soybeans, cotton, or sugar beets.

6. crop rotation

- On sloping lands, crop rotations can help reduce soil erosion.
- Rotations help improve soil health by adding diverse biological activity.
- Grass and legumes in a rotation protect water quality by preventing excess nutrients or chemicals from entering water supplies.
- Rotation**s** help improve soil health by adding diverse biological activity. Grass and legumes in a **rotation** protect water quality by preventing excess nutrients or chemicals from entering water supplies.



6. Soil organic manure application

Compost controls erosion by:

- Increasing water infiltration in to the soil surface.
- Reducing runoff and soil particle transport in runoff.
- Increasing plant growth and soil cover.
- Reducing soil particle dislodging.
- Increasing water holding capacity of soil which reduces runoff.
- Buffering soil pH which can increase vegetation establishment and growth.
- Alleviates soil compaction by increasing soil structure.
- New vegetation can be established directly into compost.

Application of organic manure refer to the module of fertilizer application

7. Grass strip

Instructions to be followed while planting grass strips:

✓ Width of the strip is 1 meters, spacing between the grasses strips is 10 m

- ✓ Spacing between grass culms/sods is 20 cm on the same line and 25 cm between lines in the same strip
- ✓ The grass tillers/sods are in a staggered fashion and filling quickly
- ✓ Planting material for the grass-strip is perennial grass and in according to fitness to agro-climatic zones of the site.
- ✓ Alignment of the grass strips strictly along the couture
- ✓ The strip has no grasses of stoloniferous which runs into adjacent land as weeds.
- ✓ The preferred grass species is one with strong tillers that are standing erect and making bunch to resist soil erosion and form into live-bund terrace gradually.
- ✓ The grasses are cut and harvested for livestock feed before they flower
- ✓ No open space exists in the grass strip after about 2 months of establishment
- ✓ No other plant is found within the grass strip
- ✓ The legumes to be alternated with rows of grasses are adaptable to the agro-climatic zone. Legumes such as Lablab purpureus (Lablab), Desmodiumintortum (Greenleaf disodium), Desmodiumuncinatum (Silverleafdesmodium), Macrotylomaaxillare (Axilliaries), Macroptiliumatropurpurium (Ciratro) and Medicagosativa (Alfalfa) will grow effectively in all the Kayonza-23, Gatsibo-8, Karongi-12 and Karongi-13 conditions. Only check that Greenleaf desmodium is not planted in above top half portion of the wet Highland Karongi site

8. Grassed waterways

General recommendations for establishing grassed waterways include:

- Locate grassed waterways in areas of concentrated water flow.
- Establish grassed waterways after wheat harvest.
- Select a mixture of sod-forming grasses.
- Make the cross section of the waterway either trapezoidal or parabolic, and never V-shaped.
- On the average, the waterways are constructed in the form of inverted trapezoid with average floor width of 40 cm with both sides sloping at 2:1 (V: H) ratio respectively. The width and depth changes and gets wider as it progresses towards its outlet
- Never install rocks, straw bales etc. that extend above the floor of the waterway.

The width and depth changes and gets wider as it progresses towards its outlet.

9. Afforestation

Application techniques of afforestation:

- ✓ In the Command area catchment and Water Catchment, the fruit species include: Citrus medeca, Casimiroaedulis, Citrus lemun, Magniferaindica, Prunusdomestica(plum), prunuspersica (peach), citrus sinensis (orange).
- ✓ The tree/shrub seedlings are species are of recommended type or substitutes checked for fitness by professionals
- ✓ The fruit seedlings are grafted and healthy looking with acceptable shoo-to-root ratio.
- ✓ The seedlings are of proven forage, or fruit or commercial timber quality
- ✓ The seedlings exhibit shoot to root ratio of 2:1
- ✓ The seedlings have a minimum height of 45 cm (from collar-point to tip)
- ✓ The seedlings are planted when moisture built-up is at optimal level (there is moisture up to 20 cm depth from the bottom of the pit)
- ✓ The seedlings planted at the lower side of the riser of the improved bench terraces and bunds
- ✓ The spacing between the fruit seedlings planted at the lower side of the improved bench terraces and soil bunds
- ✓ The spacing between the fruit seedlings in lands of above 40% are in a staggered system and 6 meters to one another
- ✓ The spacing between forage and timber species planted in the lower sides of the improved bench terraces and soil bunds is 1 meter to one another on the same line
- ✓ The fibrous roots are pruned with a pruning ax so that the roots of the trees do not compete with shallow-rooted adjoining crops.

10. Agroforestry

Application techniques of agroforestry:

- ✓ The agroforestry species being under cropped are adapted to this agro-climatic zone.
- ✓ The legumes planted over the fields in green manuring are plowed under before they flower.
- ✓ These tree species are perennials and could only be cut along with the grass maintaining about 10 cm height.
- ✓ Tree species are not poisonous to crops

- ✓ Select multipurpose species
- ✓ In the case of green manuring by legume planting, the green residue is incorporated to the soil while fresh and before planting for the second cycle
- ✓ Spacing between trees is 5-10 m
- ✓ The common species used in agro-forestry system are:

  Calliandracalothyrsus, Cedrelaserrata ,Greviellerobusta , Leucaenadiversifolia ,Moringaoleifera ,Alnus acuminate,,Sesbaniasesban,Cajanuscajan ,Grevilliarobusta.

11. Inter-cropping

Firstly, the additional soil cover provided by the second crop helps reduce erosion. Secondly, the plants help soak up extra water and nutrients.

12. Contour tillage

This is the practice of tilling sloped land along lines of consistent elevation in East –West direction for purpose of conserving rainwater and to reduce soil losses from surface erosion. It is important to note that ploughing up and down a slope accelerates soil erosion.

13. Contour ridges

Suitable conditions

Contour ridges for crop production can be used under the following conditions:

- ✓ Field from flat up to 5.0%.
- ✓ Field Rainfall 350-700 mm.
- ✓ Area with rills or ondulations should be avoided.
- ✓ The distance between the ridges should be adapted depending on rainfall amount.

Layout and construction

Step One

Contours are surveyed by a simple surveying instrument such as a water tube level or line level (see appendix). The real contour should be smoothed to obtain a better alignment for agricultural operations.

Step Two

Contour key lines should be staked out every 10 or 15 metres. The alignment for the ridges is then marked in between the key lines according to selected spacing. On uneven terrain, the contours may come closer together at one point or widen at other points. It is necessary to stop lines where the contours converge or to add short extra lines in between where the contours diverge.

Step Three

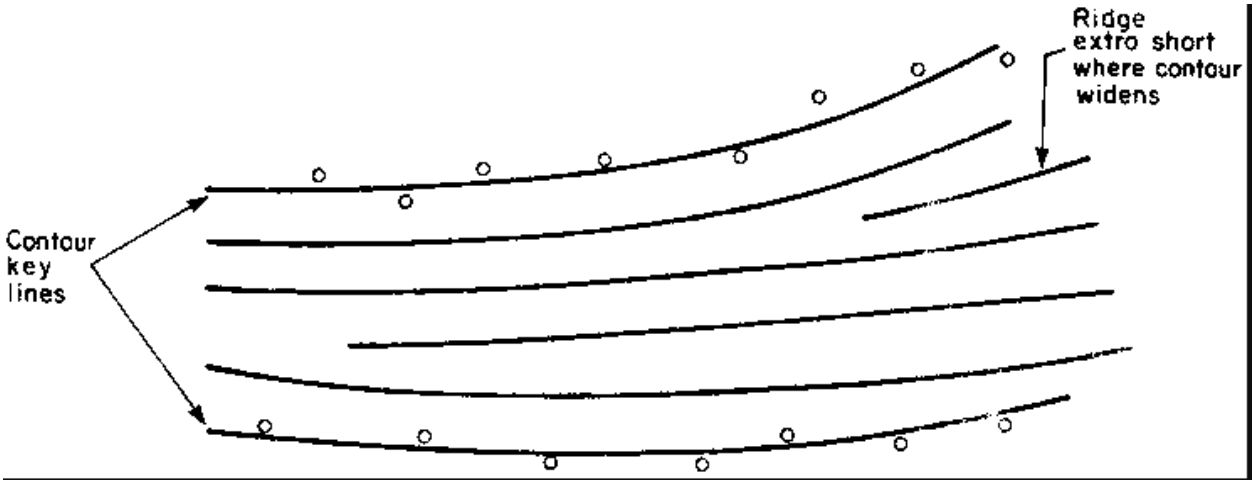
The furrows are excavated usually by means of a hoe or are ploughed parallel to the marked alignments for the ridges. The excavated soil is placed downslope, next to the furrow, and the ridge is formed.

Step Four

Small cross-ties are built at intervals of about 5 metres dividing each furrow into a number of segments. The ties are 15-20 cm high and 50 - 75 cm long.

Step Five

A diversion ditch should be provided above the block of contour ridges if there is a risk of damage caused by runoff from outside the system. The diversion ditch should be 50 cm deep and 1-1.5 m wide, with a gradient of 0.25%. The excavated soil is placed downslope. The ditch should be constructed before the contour ridges are built to prevent damage from early rains.



14. Minimum or no-tillage

While conservation tillage methods strive to increase soil and water qualities, the no-till system's benefits surpass that of both minimum tillage and conventional tillage systems. No-till's success in reducing runoff and erosion is due to increased crop residue and surface organic matter.

LO 3.4 – Maintain developed soil erosion control measures according to their requirements

- Content/Topic 1 :Maintenance practices

Pruning of fixing plants

Pruning is done for one of many reasons:

· To remove dead or injured members. This should be done any time dead or injured parts of a plant are visible.

· To check the growth of plants where space is limited.

· To thin plants that have become too dense to admit light and air to the areas in which they have planted, or plants on which interior branches, leaves, and fruit do not receive enough light.

· To encourage root growth and to prevent dieback of the branches.

· To rehabilitate trees that suffer from neglect, poor growing conditions, or diseased parts.

· To encourage fruit, wood, or foliage production, or to stimulate the growth of larger branches and fruit.

LO 3.5 – keep record as required by supervisor

- Content/Topic 1 Importance of record keeping on soil erosion control

1. Farm records are used to evaluate the performance of any farm or farm entreprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earned
5. farm records enable the farmer to obtain loans from banks and their financial institution
6. farm records tell a farmer where they are gaining progressively or loosing

Content/Topic 2 : Record keeping form content

Site

location/Address:……

.

Land size:……

Types of cultural erosion :……

control practices to apply :……

Number of manpower:……

Narrative site description:……

Schedule cultural erosion control practices implementation:……

Number of beneficiaries:……

Content /Topic3 :Types of working evidence collected

Drawings: a plan of a site is a "graphic representation of the arrangement of buildings, parking, drives, landscaping and any other structure that is part of a development project".

Sketch: a simply or hastily executed **drawing** or painting, especially a preliminary one, giving the essential features without the details.

Photo/Picture: is an image that is taken by camera.

Learning unit 4: Apply mechanical soil erosion control measures

LO 1.2 – Collect data according to site location and condition

Content/Topic 1 : **Data on site location and conditions**

Record of site location and climatic conditions

- **site location**

Site configuration: ……

Slope: ……

Vegetation: ……

Contour line: ……

Geographic coordinate: ……

Contour interval: ……

Soil texture: ……

Soil depth: ……

- Climatic condition

Rainfall: ……

Wind velocity: ……

Wind direction: ……

Learning Outcome 4.2: Identify mechanical soil erosion control measures based on collected data

Content/Topic 1 :Mechanical soil erosion control methods

- **Trenches**

Contour trenches are ditches dug along a hillside in such a way that they follow a contour and run perpendicular to the flow of water. Trenches help reduce

- Soil erosion
- Retain water during scanty rainfall.
- Improve ground water levels by increasing filtration.

- **Contour Ditches**

Contour ditches are horizontal ditches dug on the slope of a hill to catch the rainwater running down the hill. Because the ditch is on the contour of the hill or horizontal, the rainwater fills it evenly. The concept is that when it rains, water will run down the hill and fill the ditch and, because the soil is chiefly clay, the water will sit in the ditch for several days and be available for the roots of the fruit trees.

- **Bunds**

Bunds are heaps of soil constructed along the contours and planted with grasses on top. The heaped soil reduces the speed of running water and encourages sedimentation. The grassroots bind the soil particles together preventing the bunds from being washed away.

The main functions of contour bunds are:

1. It reduces the length of slope which in turn reduces the soil erosion.
2. The water is impounded for some time and gets recharged into the soil which helps in crop cultivation.

The limitations of contour bunds are:

1. The contour bunds are suitable for those areas, which receive the annual rainfall less than 600 mm
2. It is not suitable for clayey soils
3. Contour bunding is not suitable on the land slopes greater than 6%.

The limitations of the system are:

- Due to crossing of farm implements, the bunds are disturbed and some soil is lost.
- Proper maintenance is required at regular interval.

Graded bunds are recommended in heavy and medium rainfall areas. The grade to be provided to the bund may vary from 0.2% to 0.3%.

- **Gabions**

Gabions are obstacle put across gullies to reduce erosion. They are made by boxes covered with galvanized wire mesh and filled with stones. The boxes are placed in the gullies and the wire mesh prevent stones from being washed away. They also prevent the gabions from collapsing. Gabions are used at gully heads. Roadside embankments and riverbanks. They are long lasting and tough once reinforced with the wire mesh.

Gabion river and stream erosion benefits are:

- Rapid construction and immediate use
- Dissipate flowing water energy
- Semi flexible building blocks for channel stabilization.
- Have an irregular surface to diffuse and reduce river bank scouring
- Gabions are able to use smaller rock for river bank protection, when larger rip rap is unavailable
- Much cheaper, more flexible and greener than concrete
- Can be installed in wet or dry conditions
- Free draining, with no hydrostatic pressure issues

Gabion are cylinders that are filled with earth which are used in building structures such as dams or dikes consist of wire mesh baskets filled with cobble or small boulder material.

The fill normally consists of rock material but other materials such as bricks have been used to fill the baskets. The baskets are used to maintain stability and to protect stream-banks and beds.

Gabions need to be checked for broken wires and repaired if necessary to protect stone contained in the gabions from being removed by the force of water passing the cage

- **Stone line**

The stone lines are arranged along the contour to act as a barrier that slows down the speed of water and soil, improve infiltration, mitigate landslides and trap sediment thereby reducing the extent of erosion.

- **Filter strips**

These are stripes of grass planted across cultivated area. The stripes reduce the speed of running water from the cultivated plot. Also carried from the cultivated plot, is deposited at the upper side of the stripe. The soil deposited is later spread over again the cultivated land.

- **Trash lines**

This involves placing crop residues and trash along the contours to slow down surface run-off and trap the eroded soil. As water move continuously, soil is trapped leading to a builder of a bench terrace along the trash lines. To ensure that the trash is not washed away, pegs are put on the lower side to provide support.

- **Ridges**

Ridges are hips of soil put across a garden to reduce surface run-off. Ridges are different from bunds in a way that no grass is planted on top. Ridges are commonly used in the growing of carrots, Irish-potatoes and sweet potatoes.

- **Weirs**

A weir is an underground tank where water collects. The top of the weir is sealed. Water from roof tops and surface run-off is directed into the weir through gutters and drainage channels. At the entrance of the weir, a sieve should be installed to prevent rubbish from entering the weir. Also a sump should be dug along the drainage channel to retain soil particles. A pump can be installed to pump water. Alternatively, a pulley with a bucket tied on the rope can be installed. This will be lowered into the tank to draw water.

- **bench terraces**

Bench terraces are a soil and water conservation measure used on sloping land with relatively deep soils to retain water and control erosion. They are normally constructed by cutting and filling to produce a series of level steps or benches.

Advantages

Effectively controls soil and water runoff and erosion.

Traps sediment in the drainage ditches built along the terrace.

Reduces slope length.

The velocity of water running down the slope is greatly reduced.

Improves soil fertility over the long run.

Limitations

Initially disturbs the soil, reducing productivity in the first 2-3 years.

Needs intensive labor and investment for construction and maintenance.

Needs skills for proper construction.

Terraced fields with an interval slope consume much land.

The advantages and disadvantages of radical terraces

No	Advantages	Disadvantages
1	Erosion control	High cost
2	Stabilisation of fertility	Loss of cultivable area
3	Increase of agriculture production	Difficult technique
4	Allow agriculture mechanization	Tedious implementation
5	Forage or fodder production	Tedious ploughing
6	Increase of exploitation area	
7	Facility of irrigation	
8	Soil and water retention	
9	Rational and economical utilization of agricultural	
10	Improvement of soil structure and texture	

Comparison of radical and progressive terracing

Radical terracing	Progressive terracing
The radical terraces are constructed one and for all	It result from protection of soil by anti erosive ditches covered by grasses maintaining the soil which farms the progressive terraces after few years
It required more investment and less work after	It is more economical but needs time to establish
The fertilizer/manure is fully used	They are not fully used
Its establishment is limited by type of soil and soil	The progressive terraces may be established any where
The cultivations is easy	The cultivation is difficult
Its effect against erosion just after completion	Its takes more time for controlling erosion

- **Progressive terraces**

Progressive terraces are formed by establishing contour bunds with soil or stones in combination with ditches and vegetation. The progressive terraces are formed in time by the natural process of erosion and sedimentation.

Locations and conditions for use

Generally speaking, bench terraces are particularly suited to countries or communities with the following macro conditions:

- Severe erosion hazards.

- Areas with small holdings and a dense population.

- Areas where there are food shortages or high unemployment rates.

- Areas where crops require flood irrigation.

For micro or site conditions, bench terracing is suitable in the following cases:

- Where there are relatively deep soils.

- On slopes not exceeding 25 degrees.

- On sites which are not dissected by gullies and not too stony.

Bench terraces are much more cost-effective if there is potential for mechanization, irrigation and for growing high-value crops.

Technical width for terraces:

Slope (%)	12-25	25-35	35-45	45-55
Terrace width	6m	5m	4m	3m

Source: RADA-PASNVA, 2007: Uburyobwogufatanezaubutaka

Improved bench terraces are constructed in 16 - 40% slope categories but not in higher slope categories than 40%. This is average slope range. From this, the width of the terraces can be computed for a given slope.

Their effectiveness varies in the way we space the bench terraces for each slope category. For 20% slope, at 1.5 m vertical interval, the spacing will be every (100/20) x 1.5 = 7.5 meters while the spacing for 39% slope would be (100/39) x 1.5 = 3.85 meters. Please note that you may use a vertical interval of 1.5 meters only if the soil depth allows you to cut at least 75 cm soil depth before reaching the C horizon.

Types of radical		Slopes(%)	Vertical interval(m)
Irrigation or Level bench terraces		12-55	1.5
Graded/ Upland bench	Soil bunds	6-16	1
	Improved bench terraces	16-40	1.5
	Narrow-cut bench	40-60	2

- ✓ **The soil not suitable for bench terracing:**

- Very sandy soil
- Sticky clay soil
- Bedrock
- Impermeable soil
- Soil that oozes

Content/Topic 2 :Selection criteria for mechanical erosion control measures

a. Effectiveness

The most effective form of erosion control is to minimize the area of disturbance, retaining as much existing vegetation as possible.

b. Costs

The cost-effectiveness of erosion control measures based on an ecosystem services approach. The economic appraisal consists of an assessment (i.e. quantification and valuation) of the on-site and off-site impacts of soil erosion, and its mitigation, on ecosystem services. Many erosion control measures result in negative financial and economic returns. This explains why farmers are generally reluctant to implement erosion control measures without compensation.

c. Availability

In farming activities, farmers prefer to buy and use available locally farming tools. This selection also depends on their financial means to access on the tool and equipment.

d. Feasibility

Tools and equipment also may be selected depends on how well they perform a given agricultural activity. It may also be selected depends on how well it minimizes the farming cost. eg. Farming by using machine (tractor) works well the land and minimizes cost compared to that of using work force (manpower).

e. Durability

Tools and equipment with long lifespan are more preferable than those with low lifespan.

f. Compatibility

Farmers select tools differently depend on the agricultural to be done. Tools used in land clearing are different from tools used in first tillage and second tillage respectively. Likewise, tillage tools and equipment are different from those harvesting and handling.

Learning Outcome 4.3: Implement mechanical soil erosion control measures according to collected data and following procedures

Content/Topic 1 :Perform selected mechanical soil erosion control measures

- **Trenches**

Contour or staggered trenches are adopted in high rainfall hilly areas of lands with slope steeper than 5-12% or nay slope with badly eroded soil. Length of staggered or Contour trench will be 3-40 m according to slope.

Recommended dimensions:

- Length: 4 m
- Depth: 50 cm
- Width: 40 cm
- After four meters in length 50 cm have to be left for (Intebeyaagronome).

The excavated earth must be stabilized by fixing the grass. In addition for stabilization of soil, steps are to be taken to plant the area with fast growing tree and grass species.

Materials needed:

A-Frame level:

- wood
- string
- weight (rock)

Trenches:

- stakes
- shovels
- picks tractor (slope dependent) crops

Establishment activities of trenches

- Cuttings
- Transport
- Planting
- Identification of contour lines,
- Digging of trenches
- Grass planting on risers **ditches**

Construction

- Once the contours have been marked the farmers can begin to excavate the trench.
- To maintain structural rigidity on the uphill slope of the hill, the shovel should be applied to the contour with the user faceing downhill, not along the contour, so that the uphill face of the trench is not structurally compromised.
- Place the excavated soil downslope along the edge of the trench.
- Pack excavated soil to create a berm on the downhill border of the trench.
- Plant native grasses, legumes, or perennials on the berm. These varieties have a root system capable of providing adequate structure to the berm.
- Apply mulch to berms to prevent erosion while the plants take root.
- If possible, trenches should be dug in the dry season so that the rain does not destabilize or wash away the berm before vegetations can provide stabilization

- **Bunds**

Construction of bunds

- The embankment is 1 m high on the up-slope side Height minimum of 52 cm.
- Top width of the bund 0.6 m. Base ranges between 1 and 1.2 m. Water is trapped behind this wall and percolates into the soil.
- Soil accumulates behind this bund and overtime makes a level bench-like terrace.
- Top soil is removed and hipped at some place before the cutting and filling is completed
- The removed and hipped top soil is evenly distributed on the top surface f the constructed terrace
- The final top surface of the terrace is now freely draining sideways all along its length

✓ **Contour Bunds**

Contour bunds are laid out in those areas which have less rainfall and permeable soils. The major requirements in such areas are prevention of soil erosion and conservation of rain water in the soil for crop use. To maximize the conservation of rainwater in the soil, no longitudinal slope is provided to the field strip. In such a system of bunding, the bunds are designed to be laid out on contours with minor adjustments, wherever necessary.

✓ **Graded Bunds**

Graded bunds are laid out in areas where the land is susceptible to water erosion, the soil is less permeable and the area has water logging problems. A graded bund system is designed to dispose of excess runoff safely form agricultural fields. A graded bund is laid out with a longitudinal slope gradient leading to outlet. The gradient can be either uniform or variable. The uniformly-graded bunds are suitable for areas where the bunds need shorter lengths and the runoff is low. The variable-graded bunds are required where bunds need longer lengths, owing to which the cumulative runoff increases towards the outlets. In these types of bunds, variations in the grade are provided at different sections of the bund to keep the runoff velocity within the desired limits so as not to cause any soil erosion.

- **Gabion**

Procedures of making gabions

- First a trench is dug into the building site and sides.
- The trench is lined with wire netting and the gabions constructed with stones.
- At the collect, the wire netting is closed tightly over the gabions.
- The upstream side of the gabions is then lined with geotextile to trap silt and fine plant material.

- **Stone line**

A single line of stones, or a stone bund, depending upon the availability of stones, is laid along a contour. The resulting structures are up to 25 cm high with a base width of 35 to 40 cm. They are set in a trench of 5 to 10 cm depth which increases stability.

Establishment activities

- Collection of stones
- laying of stones

Stone lines of about 25cm high and 40cm wide are built along contours to intercept the running water. During constructions, the stones should be put in a trench 10cm deep to prevent stone lines from being washed away by runoff. The lines can be made continuous or of short section of between 10-20m.The following factors favor successful use of stone lines in an area.

(a) Topography of the area.

(b) Slopes of below 2%.

(c) Availability of stones in the vicinity.

- **Filter strips**

They are grasses which are planted along the contour on cultivated land to reduce the amount of water flowing across the slope. It is well meant to bar soil being transported along with the water (rainfall).

- If planted with coarse-culm and perennial grass species and protected from grazing, it builds up into terraces.
- They are suitable for physically obstructing erosive run-off in slopes of 0 – 6%.
- It is good to know that the grasses are perennial that do not require replacement every year
- Grass species of coarse culm such as Gamba-grass, Rhodes and Phalarisaquatica and elephant grass are best suited for the purpose
- They are planted strategically between fields and surface waters (rivers, streams, lakes and drainage ditches) to protect water quality.

They slow runoff from fields, trapping and filtering sediment, nutrients, pesticides and other potential pollutants before they reach surface waters. They can also be planted around drainage tile inlets for the same purpose.

- **Trash lines**

Trash lines are made from crop residue, grasses and other organic materials collected from the field. They are arranged along the contour in an interval of 5 m, height 20 cm and width of 0.5 m, and are often used in slopes of 0 – 6 % slope interspaced between grass strips.

- **Weirs**

Weirs, also known as check dams, are small dams used to collect water runoff from agricultural fields. Weirs are often the size of a drainage ditch, with a 60 cm channel in the center for water drainage.

- ✓ The width of the weir is along the entire width of the waterway, gullies
- ✓ The top of the weir is indented a little at the middle portion to serve as a spill way for water flowing in the gullies or water ways leaving behind the soil/silt.

The weir is made by weaving strong brush wood or gabion and is firm to resist the force of water pushing it downhill or the weir which is made of live plants, has all the live plants well and evenly spaced and trimmed short to filter the silt and sieve of the water without causing any scoring.

- **Bench terraces**

Basic techniques

- For level terraces: use contouring or levelling techniques.

- For upland bench terraces: use graded-contouring techniques.

Types of radical		**Slopes(%)**	**Vertical interval(m)**
Irrigation or Level bench terraces		12-55	
Graded/ Upland bench	Soil bunds	6-16	1
	Improved bench terraces	16-40	1.5
	Narrow-cut bench	40-60	2

The farmers are careful to isolate the topsoil, then they re-work the subsoil to create the required reverse-slope bench, after which the topsoil is spread over the surface. The riser is planted with short runner grass for stabilization, all within the same period.

- ✓ **Establishment activities of bench terraces**

- Cuttings of grasses
- Transport of grass cuttings
- Planting of grass cuttings
- Land surveying (slope determination, soil structure and texture analysis)
- Construction of bunds (risers) with soil from upper and lower sides
- Level terraces bed (surface soil moved from upper to lower part of terraces)
- cutting subsurface soil, leveling and refilling surface soil - Make lips on edges of terraces
- Compact risers
- Plant grasses including agro-forestery trees.
- Input/ application of farmyard manure and liming

The flattening of embankment for level terraces

The flattening of embankment follows these operations:

- Leave a space of a width of 20cm reserved for agroforestry trees
- Mark the base of a terrace of a width of 50cm on the line
- Put plugs in adjacent a continuous line of lumps (40cm wide and 60cm length)
- Put the earth to a depth of 20cm above the turf (clod's grass)
- Put another line of lumps while piling earth above the clods
- Respect the slope slightly oblique slope and the recovery of vegetation on the mounds to expose the outside
- Continue to alternate lines and mounds of earth until the end of the construction of the embankment is to say the inward slope of 0.5-1%.

- **Progressive terrace**
  - ✓ **Design of progressive terraces**

Design of progressive terraces consists of considering the following factors:

- The slope
- The surface to knock
- The soil structure and texture
- The uses of land after terracing

In this case, the spacing for progressive terraces, for instance, for a slope of 45 % would be (100/45) x 2 = 4.44m. Likewise, the spacing for 60% slope would be (100/60) x 2 = 3.33 m.

a) Width and length of the platform

- The picketing must start at the top of the hill,
- Length of terraces: 200-400 m
- Longitudinal slope: 2/1000 maximum
- Difference in level between two ditches: 0.60-2.00 m
- Between the two ditches, leave 3m to 40m according to the slope of the land,

Table 1: Estimated distance between the ditches compared to the slope

Slope	2%	5%	10%	15%	20%	25%	30%	35%	40-100%
Width distance	20-40	15-22	10-16	9-14	8-13	6-10	5-9	4-8	3-7

Source: RADA-PASNVA, 2007: Uburyobwogufatanezaubutaka

b) Width and length of Anti-erosive ditches

The recommended dimensions are the following:

- Length: between 4-10m
- Depth: 50cm
- Width: 40cm
- After 4-10meters in length 50cm are let (nicknamed “the chair of agronomist)

✓ **Procedure of *constructing contour line ditches, the embankment***

Site selection

Work should begin with the protection of the highest-lying fields. Areas will be chosen which, although already suffering from the effects of erosion, can still be cultivated. It is pointless constructing ditches on land where all the topsoil has already been lost through erosion.

It is up to the engineer in charge of the works to advise the farmers on the selection of appropriate sites.

Siting of the ditches

Once the siting of the first contour line of posts has been completed, we go on to mark the second and so on, using different coloured posts for each line, to avoid confusion.

- **Plotting the dimensions of the ditch**

This entails marking the position in which the ditch should be dug and the boundaries it should keep within.

- **Preparing the surface soil of the ditch site**

Once the site of the ditch has been traced out, the next task is to prepare the ground by scraping the surface, clearing it of vegetation and then breaking up the surface soil.
The site of the retaining bank is also worked over with the pickaxe in order to break up the soil. This is particularly useful if trees are to be planted on the bank as water is then more easily absorbed and it also encourages the roots to establish themselves.

- **Excavating the ditch**

The excavation of the trench is commenced at the middle of its plotted siting.

The soil is broken up, using the pickaxe, to a depth of about 20 cm and the earth removed by shovel. In a single movement, the earth is thrown by the shoveller to the place where the embankment is to be constructed. A worker is capable of shovelling earth a distance of 3 m in a single throw, on average.

The middle of the ditch is dug out in the same way as before, in 20 cm sections until the required depth, as specified by the gang foreman, is reached.

- **Checking the dimensions of the ditch**

Upon completion of the ditch-digging, the gang foreman should inspect the work and check that the actual dimensions of the ditch correspond to those which were foreseen.

In order to do this, a tracing line is stretched across the top of the ditch, with four coloured marks along it. The two outer marks indicate the overall width of the ditch and the two inner ones the width of the base of the ditch.

Using a graduated rule, or surveyor's rod, the gang foreman checks the depth of the ditch straight down from the two central marks.

If the ditch is too shallow, it must dug out to the required depth. Should it have been dug too deep, the ditch should be left as it is.

- **Constructing the retaining banks**

The earth which has been excavated in the digging of the ditch should be backfilled downhill.

The purpose of a retaining bank, like that of a ditch, is to stop the flow of run-off water. It must, therefore, be strong enough to withstand the thrust of the run-off water. This is ensured by compacting the backfilling material.

Learning Outcome 4.4: Maintain developed soil erosion control measures according to their requirements

Content/Topic 1 :Amendment

A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal is to provide a better environment for roots.

Quick Facts of soil amendments

- ✓ On clayey soils, soil amendments improve the soil aggregation, increase porosity and permeability, and improve aeration, drainage, and rooting depth.
- ✓ On sandy soils, soil amendments increase the water and nutrient holding capacity.
- ✓ A variety of products are available bagged or bulk for soil amendments. However, soil amendments are not regulated. Many are extremely high in salts.
- ✓ With Colorado's large livestock industry, manure and manure-based compost are readily available. These are often high in salts, limiting application rates. Use with caution.
- ✓ Plant-based composts are low in salt. These may be applied at higher application rates, more effectively improving the soil. Plant-based composts are typically higher in price.

a) Factors to Consider When Choosing an Amendment

There are at least four factors to consider in selecting a soil amendment:

- How long the amendment will last in the soil,

- Soil texture,
- Soil salinity and plant sensitivities to salts, and
- Salt content and pH of the amendment.

Laboratory tests can determine the salt content, pH and organic matter of organic amendments. The quality of bulk organic amendments for large-scale landscape uses can then be determined.

b) Longevity of the Amendment

The amendment you choose depends on your goals.

- Are you trying to improve soil physical properties quickly? Choose an amendment that decomposes rapidly.
- Do you want a long-lasting improvement to your soil? Choose an amendment that decomposes slowly.
- Do you want a quick improvement that lasts a long time? Choose a combination of amendments.

c) Type of amendment to use

- **Lime:** Having finished levelling, the bench terraces are advised to apply directly liming to restore nutrients. The most used are hydrated lime and travertine. The experience has shown that the dosage vary from 2000kg to 2500kg per hectare depending on soil types.
- **Travertine:**It is a form of limestone deposited by mineral springs, especially hot springs. Travertine often has a fibrous or concentric appearance and exists in white, tan, cream-colored, and even rusty varieties. It should be broken up before being supplied to the soil.
- **Organic matters**

Manure: Fresh manure can harm plants due to elevated ammonia levels. To avoid this problem, use only aged or composted manure.

Compost: Compost refers to decomposed organic matter. It is not regulated, so there is no standard about the state of decomposition. In commercially available products the term "compost" is often used generically, and does not infer that the product has been through the actively heating, decomposition process.

Content/Topic 2 :Fixing plants

A line of thick, tall grass should be planted and maintained above the ditches in order to restrain soils from upslope. The protection of the risers and outlets is the same as that for bench terraces.

Steps must be taken to encourage vegetation to establish itself where it is required. This can either be vegetation which seeds itself naturally, cultivated plantations or, alternatively, the area can be grass-seeded. The fixing plants/grasses are the following :

- Rhodes grasses
- Gunia grasses
- Buffel grasses
- Phalaris
- Tall fescue
- Cocks foot

Content/Topic 3 :**Water retention ponds di-Silting**

Periodically, the sediment should be removed from the ponds and re-applied to the field uphill from the pond. Removal should take place prior to tilling of the soil, so it can be incorporated into the soils of the new crop.

Content/Topic 4 :Repair the eroded area.

It's the activity of reconstructing the damaged infrastructures such as:

- ✓ Trenches
- ✓ Ditches
- ✓ Bunds
- ✓ Gabions
- ✓ Stone line
- ✓ Filter strips
- ✓ Trash lines
- ✓ Ridges
- ✓ Weirs
- ✓ Bench terraces
- ✓ Progressive terraces

- **Cleaning anti erosive ditches**

Every year, before the start of the rainy season, the farmer must check the condition of the retaining ditches. The main causes of deterioration of the ditches are:

- The run-off of rainwater, leading to gullying of the ditches' embankment;
- The base of the embankment being eroded away by the flow of water (diversion network);
- Backfill material becoming packed down;
- Gaps forming in the banks due to the water overflowing;
- Damage caused by animals crossing over the structures.

The correction consists, therefore, of:

- Checking that the embankments are still horizontal. Surveying rods can be used for this in the way described earlier in the section dealing with the construction of ditches;
- Reinforcing any places where the structure has become weak, by adding earth and compacting as required;
- Filling in any gullies or gaps with earth and compacting well.

A close and constant watch should be kept on the slopes to ensure that the protection afforded by grass or vegetation remains adequate.

Learning Outcome 4.5: Keep record as required by supervisor

Content/Topic 1 :**Importance of record keeping on soil erosion control**

1. Farm records are used to evaluate the performance of any farm or farm entreprise within a given period of time
2. Records are an aid to managerial control
3. farm record provide figure for farm planning and budgeting
4. Farm records tells a farmer how is being earned
5. farm records enable the farmer to obtain loans from banks and their financial institution

farm records tell a farmer where they are gaining progressively or loosing

Content/Topic 2 : Record keeping form content

Site location/Address:……

Land size:……

Types of mechanical erosion control practices to apply :……

Number of manpower:……

Narrative site description:……

Schedule mechanical erosion control practices implementation :……

Number of beneficiaries :……

Content /Topic3 :Types of working evidence collected

Drawings: a plan of a site is a "graphic representation of the arrangement of buildings, parking, drives, landscaping and any other structure that is part of a development project".

Sketch: a simply or hastily executed **drawing** or painting, especially a preliminary one, giving the essential features without the details.

Photo/Picture: is an image that is taken by camera.

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