CATHOLIC RELIEF SERVICES

Understanding Natural Resources

A SMART Skills Manual

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Skills for Marketing and Rural Transformation (SMART) skills

SMART Skills manuals:

- Introduction to SMART skills for rural development
- Organizing and managing farmer groups
- Understanding natural resources
- Managing natural resources
- Marketing basics
- Seven steps of marketing
- Promoting innovation

Purpose of this manual

To introduce you to:

- The basic science behind key natural resources
- The key concepts related to water, soil, plant and ecosystem health
- The management of natural resources in a local environment

Manual content

Nine lessons:

- Why are natural resources important?
- The water cycle
- Managing water
- Watersheds and watershed management
- Soil composition
- Soil fertility and nutrients
- Plant health
- Life systems in nature (ecosystems)
- Sustainable use of natural resources

Lesson 1:
The importance of natural resources

Outcomes and overview

After this lesson, you will be able to:

- Explain what a natural resource is.
- Explain why natural resources are important.

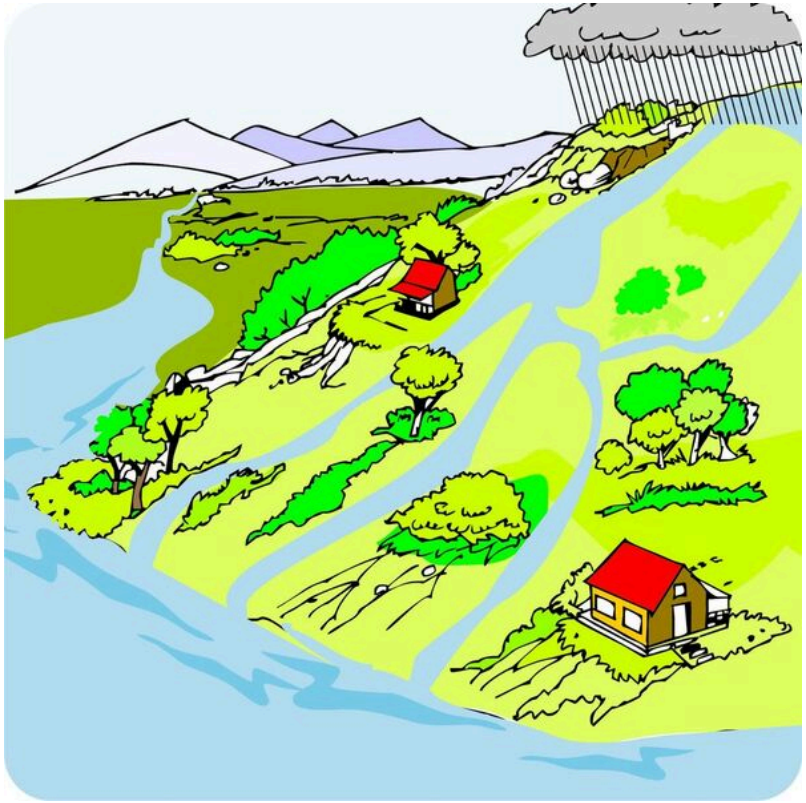
Lesson 1 covers the following content:

- What are renewable and non-renewable natural resources?
- Managing natural resources

What is a natural resource?

A **natural resource** is any asset that we can obtain from our environment:

- Water
- Soil
- Plants
- Wind
- Animals
- Minerals
- Energy of the sun



Renewable natural resources

A **renewable natural resource** is a resource that can regrow, or a resource of which the supplies can be replenished through natural processes, e.g. plants, animals, insects, wind, etc.

If the renewable resources in an area are **overexploited** for a long period, they may become **endangered** or even **disappear.**

Non-renewable natural resources

A **non-renewable natural resource** is a resource that can be used up, one that will not replenish itself.

Examples

- Oil
- Coal
- Minerals
- Rocks

The use of these resources should be monitored and managed according to their availability.

Managing natural resources: Maintaining healthy ecosystems

All living and non-living things interact with one another and **co-exist** in a **balance.**

Disturbing this balance by **overexploiting natural resources** usually has broad and **adverse effects** on everything in the entire ecosystem.

Managing natural resources: Building sustainable livelihoods

Farmers rely on the entire ecosystem (water, soil, nutrients, plants, animals and everything else in it) for their livelihood.

Sustainable livelihoods are good management practices that help farmers safeguard the environments.

Lesson 2:
The water cycle

Outcomes

After this lesson, you will be able to:

- Explain the water cycle and the different way in which water circulates on our planet.
- Identify the key problems associated with water and water movement and some of the causes of these problems.

Overview

Lesson 2 covers the following content:

- The water cycle
- Water movement
- Erosion
- Mudslides
- Flooding
- Causes of floods
- Pollution
- Drought

The water cycle

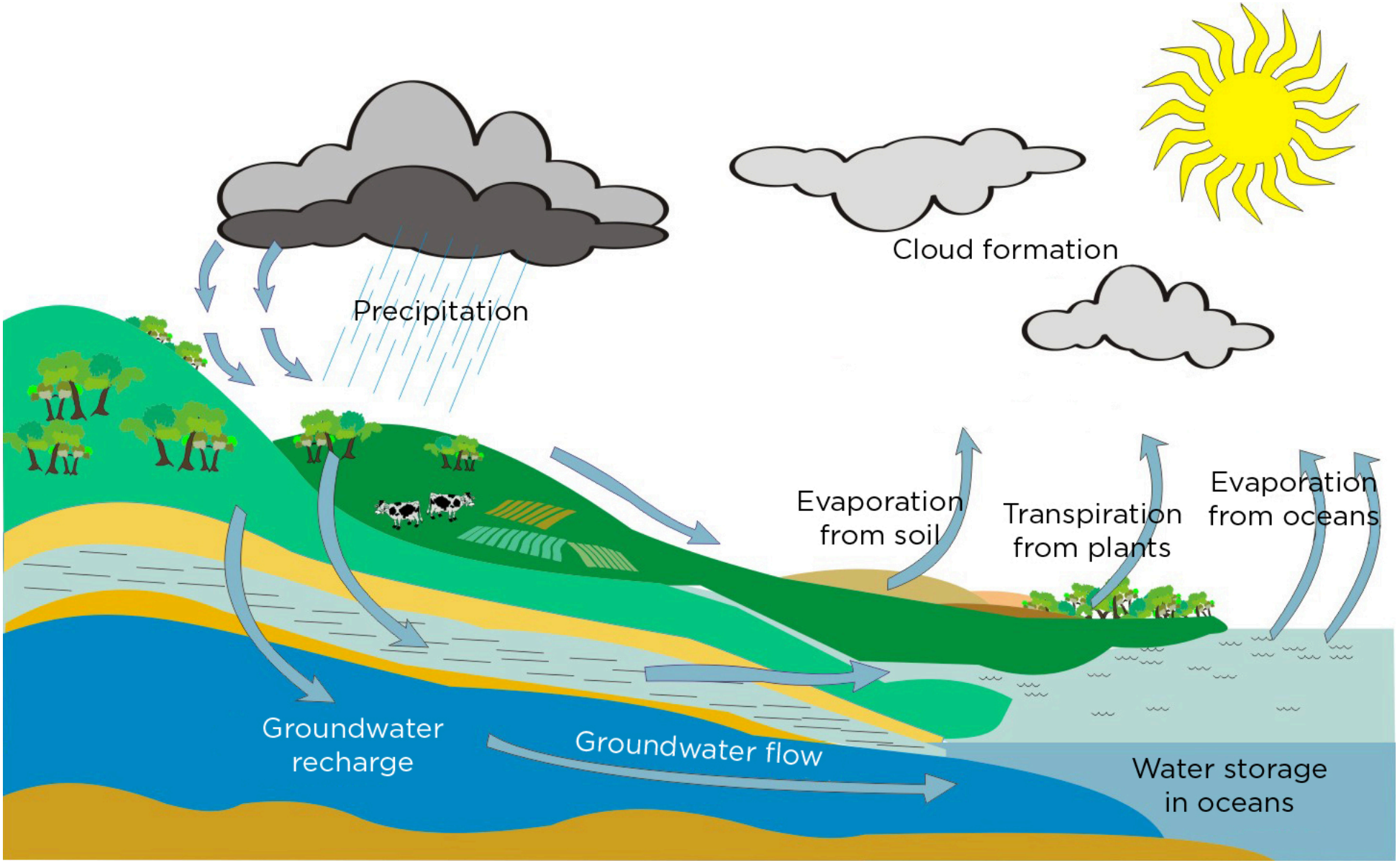
The **water cycle** refers to the constant movement of water on, above and below the surface of the Earth.

In the cycle, the water moves from the small stream that the farmer uses to irrigate a field to large rivers and the ocean.

The water also goes through different changes:

- Liquid (rivers)
- Solid (ice)
- Gas (vapor)

The water cycle illustrated

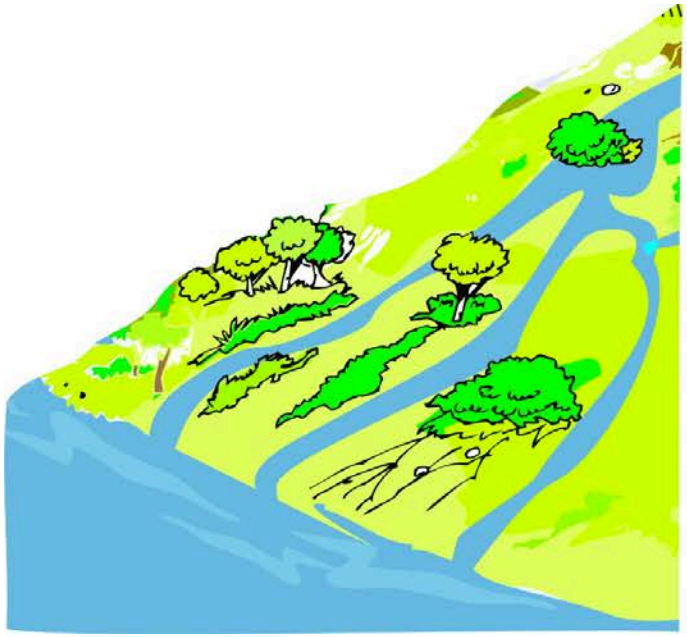


Water moving off the land

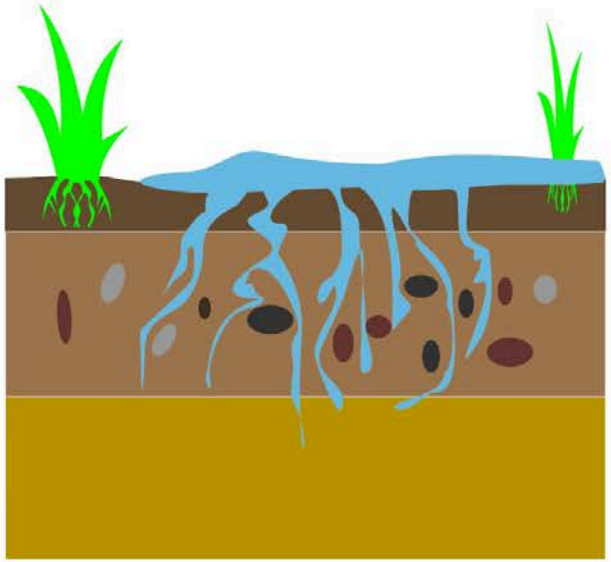
After it rains, the water that falls on the fields can do a combination of the following three things:

Surface runoff:	Water can move across the surface of the field and go into a ditch, stream or a river.
Infiltration:	Water can seep into the soil and go underground. Some water may be taken up and used by plants, which transpire the water through their leaves back into the atmosphere.
Evaporation:	Because of effects of the heat and the sun, water can also vaporize and return to the atmosphere.

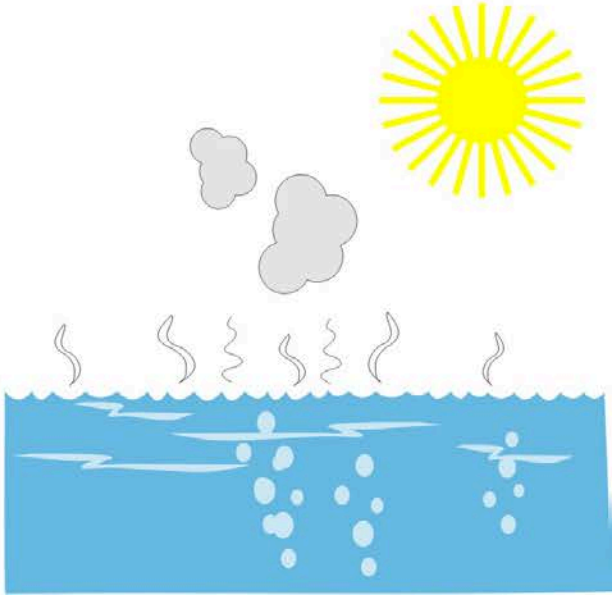
Water movement illustrated



Surface runoff



Infiltration



Evaporation

Consequences of uncontrolled water flow

Uncontrolled water flow may lead to problems, such as:

- Erosion
- Mudslides
- Flooding
- Pollution

All the water that runs off the fields could have been used for production or in your homes, gardens or fields.

Erosion

Erosion is caused by:

- Water running off the soil surface too quickly; and
- Carrying away the soil from fields, grazing lands and other unprotected areas.

Erosion and topsoil

- The best layer of soil for growing crops is the topmost layer, called the **topsoil**.
- When water carries topsoil off the field, productivity goes down quickly, because the topsoil stores much of the nutrients and minerals crops need to thrive.

Mudslides

- If trees, grass and other plants are removed on steep slopes, there are no plant roots to hold the soil in place.
- During heavy rains, the soil can fill up with water and **slide downslope** as **mud.**
- When a large area of land is affected, this movement turns into a **mudslide.**

Flooding

- If large amounts of water run off the fields too quickly, they accumulate in rivers, lakes and dams.
- If there is more water than these **natural reservoirs** can hold, it will inevitably **spill over the banks** and **cause flooding.**

Flooding (Continued)

Soil that is washed away can be deposited on the beds of rivers and reservoirs.

They can hold less water and, therefore, they:

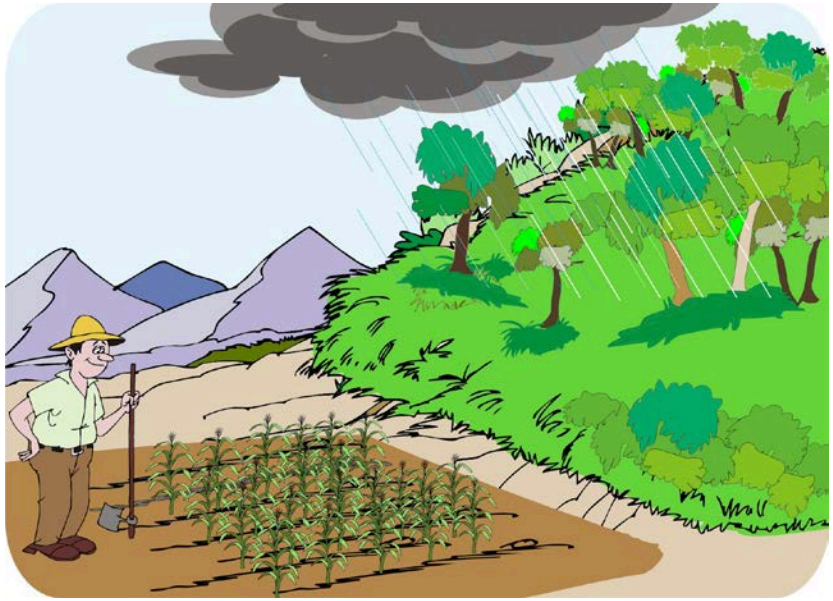
- Dry out more quickly
- Flood more often.

Causes of floods

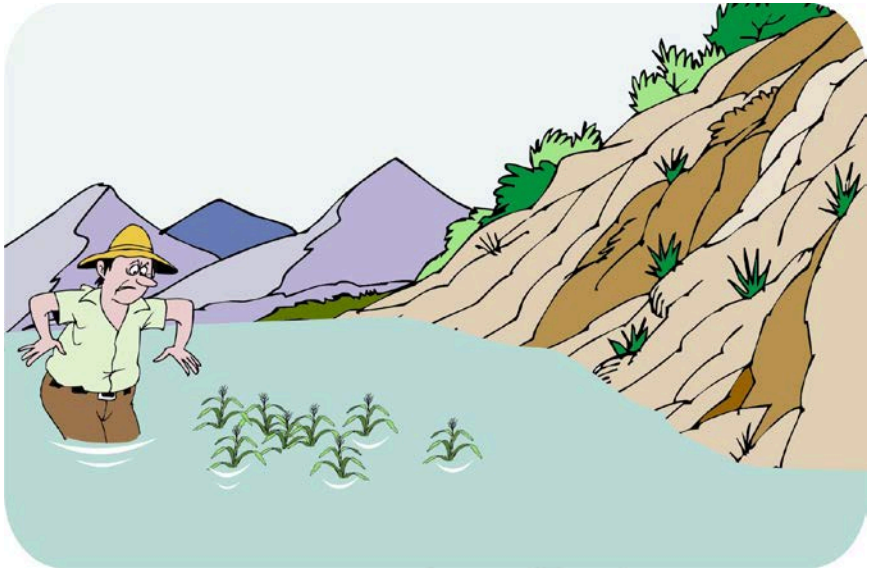
Apart from heavy rainfall, floods are also caused by:

- **Removal of trees and/or vegetation cover from slopes**
  Without cover, large quantities of water flow off the slope very quickly and end up in streams or rivers. These water reservoirs fill up beyond capacity and overflow, causing flooding.
- **Soil erosion**
  When the topsoil layer has been reduced by erosion, the remaining topsoil cannot hold as much of the rainfall as before.

Causes of floods: Slopes with and without vegetation



Trees and other vegetation on a slope



A slope without vegetation

Pollution

When water runs off the soil too quickly, it also carries with it everything that was in the surface, including:

- Trash
- Disease organisms
- Other **pollutants**

Pollution (Continued)

Dangerous chemicals and manure can **pollute the source of drinking water** for the community and can kill off organisms that live in the water.

Reducing runoff can greatly reduce the level of pollution.

Drought

Apart from lack of rainfall, drought can also be caused by:

- **Less rainfall than normal** or **poor distribution of rainfall**
- **Not enough topsoil to store water** between rain events
- A **hardpan** (i.e. a tightly packed, very hard layer of soil) preventing water from seeping into the soil below
- **Not having adequate soil cover**
- Certain **types of soil not holding** water as well as others
- Some **crops needing less water** than others

Examining the multiple causes of drought

Farmers should investigate the **multiple causes of drought,** in order to pick the **appropriate solution.**

Lesson 3:
Managing water

Outcomes

After this lesson, you will be able to:

Identify and explain the different strategies for managing water, including:

- Capturing rainfall
- Increasing infiltration
- Preventing landslides

Overview

Lesson 3 covers the following content:

- Capturing as much rainfall as possible and using it effectively
- Reducing evaporation and increasing infiltration
- Preventing landslides by using trees and grasses to stabilize the soil

Purpose of managing threats from water

- Make sure that **excess water** moves off the slopes **slowly** and **safely**
- **Capture more of the rain** in the soil where it falls, or in small dams
- **Store** and **use water** for **irrigation** if possible.

Capturing as much rainfall as possible: Collect surface water

Collect surface water runoff in **dams** and use **water harvesting techniques** to trap rain and direct it into a storage structure.

Capturing as much rainfall as possible: Slow runoff and increase infiltration: Ground cover

Runoff can be slowed down and infiltration into the soil can be increased by using different types of **ground cover.**

Ground cover can be provided:

- Naturally by trees, grass and other **vegetation types**; or
- By laying non-living material, e.g. lines of stone or trash along a **contour.**

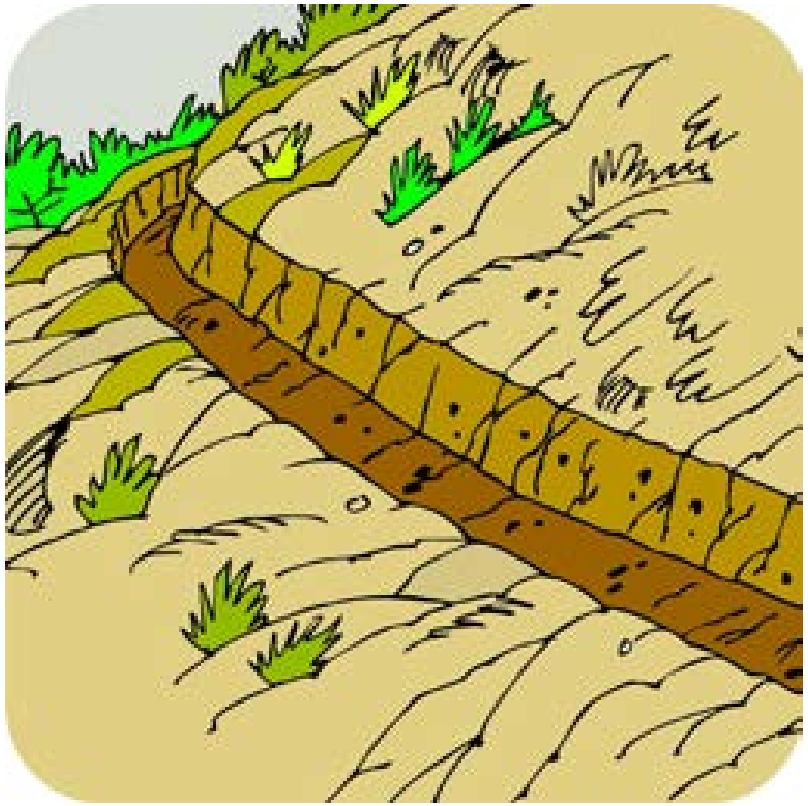
Capturing as much rainfall as possible: Slow runoff and increase infiltration: Contours

A **contour** is an imaginary line that runs horizontally across a slope and that stays at the same level (i.e. it does not go up or down the slope).

Capturing as much rainfall as possible: Build contour trenches

Runoff can also be slowed down or stopped by building **contour trenches** along a slope.

Contour trenches may include shallow pits – known as **infiltration pits** – that trap additional water.



Capturing as much rainfall as possible: Increase the amount of water that the soil can hold

Strategies used to increase the amount of water that the soil can hold:

- Preserve as much of the soil on the field as possible by **reducing erosion**.
- Remove plough pans by breaking up hardened layers of soil.
- Increase the amount of **organic matter** in the soil to increase the water uptake.

Reducing evaporation and increasing infiltration: Mulching

Mulching, which refers to covering the soil surface with dead plant material, has the following benefits:

- Greatly **reduces evaporation of water** from the surface of the soil.
- **Reduces weed growth**
- Increases the **organic content** of the soil
- Slows down the movement of water across the soil surface, which **increases water infiltration.**

Preventing landslides:
Using trees and grasses to stabilize the soil

Making sure that steep hillsides remain covered with trees and other plant life is the best way to protect against mudslides.

Plant **roots hold the soil together**, especially on sloping land.

Tree roots are particularly good, because they are stronger and go deeper than the roots of smaller grasses and shrubs.

Lesson 4:
Watersheds and watershed management

Outcomes

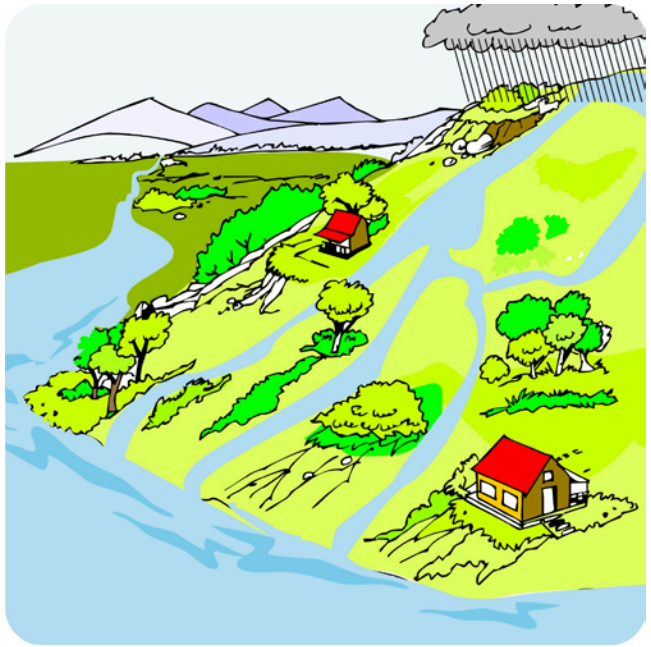
After this lesson, you will be able to:

- Explain what a watershed is.
- Identify the reasons for the importance of water management across the entire watershed.
- Identify the root causes of erosion and ways of addressing it.
- Describe ways of identifying and addressing problems on the watershed level.

Overview

Lesson 4 covers the following content:

- Managing water across the entire watershed
- The causes of soil erosion
- Reducing wind and water erosion
- Identifying problem areas in a watershed
- Managing rainfall within a watershed
- Upstream and downstream issues



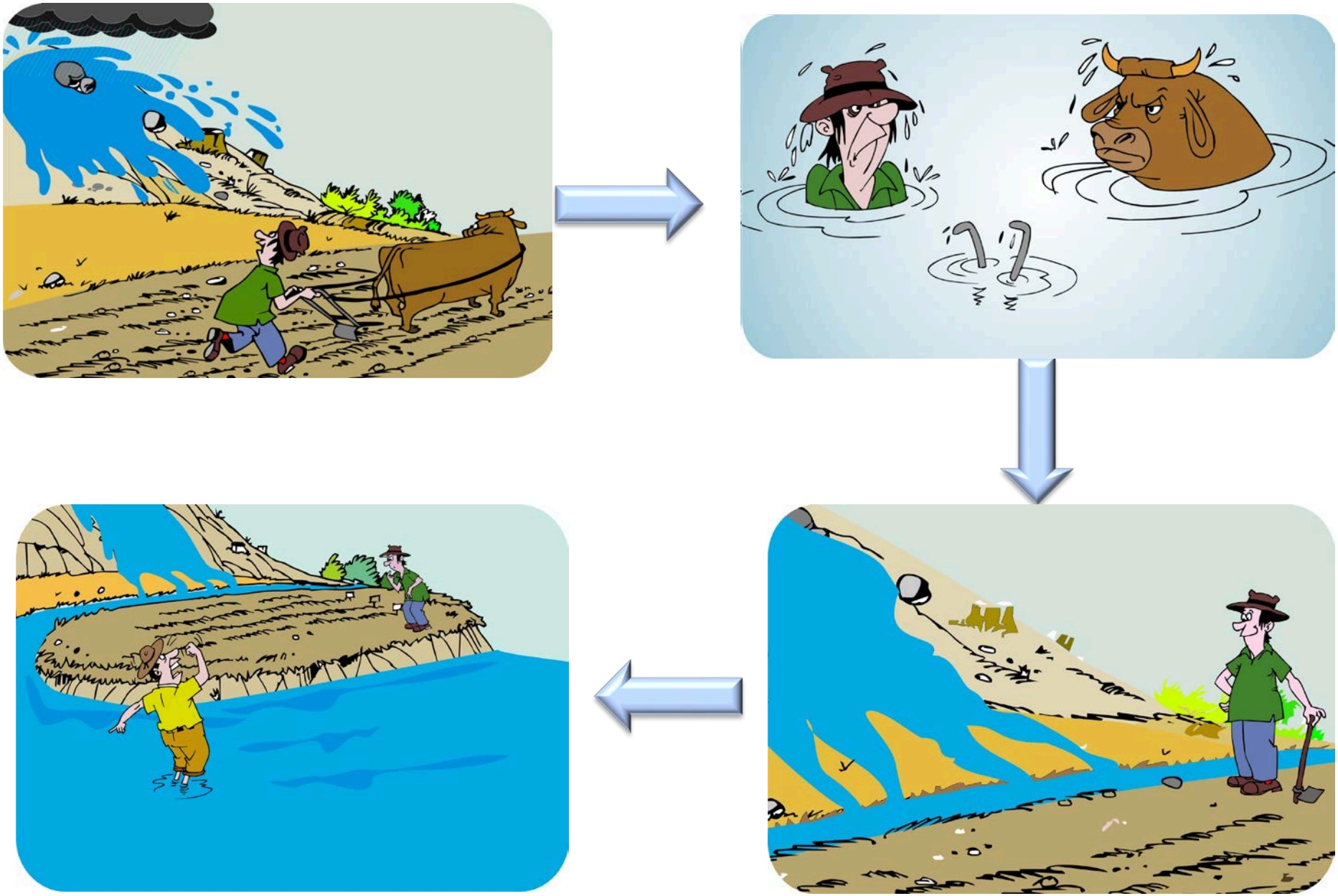
What is a watershed?

A **watershed** is an area from which all the rainfall drains into the same place (e.g. a stream, river or ocean).

Regardless of size, there are few basic **management concepts** are useful for all watersheds, including:

- **Identifying problem areas** within a watershed
- **Managing rainfall** across the entire watershed

Considering and managing the entire watershed



Causes of erosion

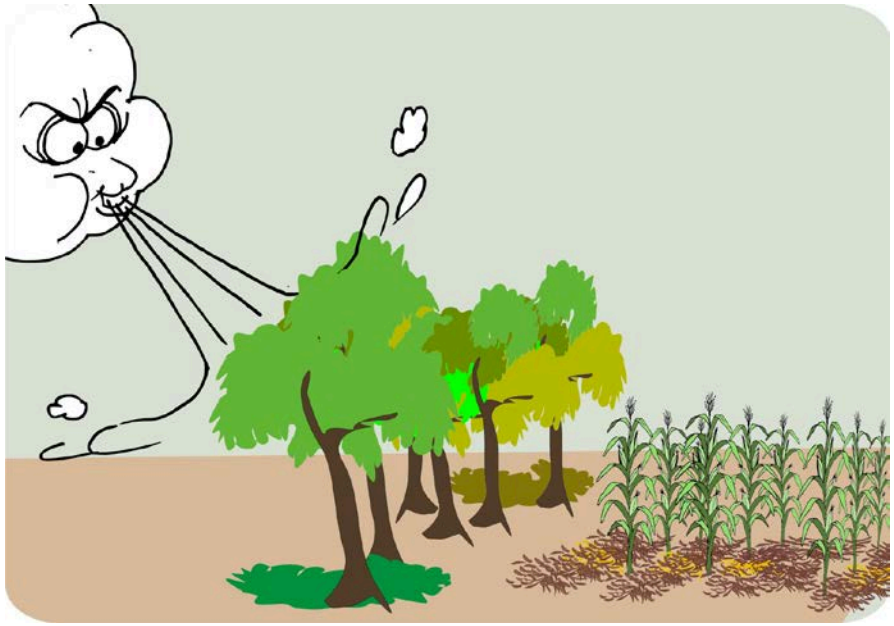
- Weather
- Slopes
- Soil cover
- Type of soil cover
- Soil type

Reducing erosion: Two main strategies

Physical intervention:	• Building terraces, dams and reservoirs • Plugging gullies • Using zai holes as planting areas
Biological intervention:	• Planting windbreak lines of trees • Planting grass strips the contour line • Using crop to cover for the soil • Crop rotation

Wind erosion

Wind erosion results from strong winds blowing over unprotected, exposed lots of land.



Reduce wind erosion by:

- Placing wind breaks: lines of trees or tall plants planted perpendicular to the incoming wind direction
- Covering the soil with live plants or mulch

Water erosion

Water erosion results from water running rapidly over the soil surface, carrying with it soil particles.

Reducing water erosion

Reduce water erosion by:

- **Building trenches** along the slope contour, which will capture and channel excess water away from the field
- **Placing barriers** along the slope contour
- **Placing gullies** when you notice large crevices in the earth
- **Covering the soil surface** with mulch or live plants

Identifying hotspots in a watershed

Look for the following signs of erosion or risk of erosion:

- Areas of **bare soil on a slope** with no vegetation
- Places where **gullies are forming**
- Areas where **plant roots are exposed**

Identifying hotspots in a watershed (Continued)

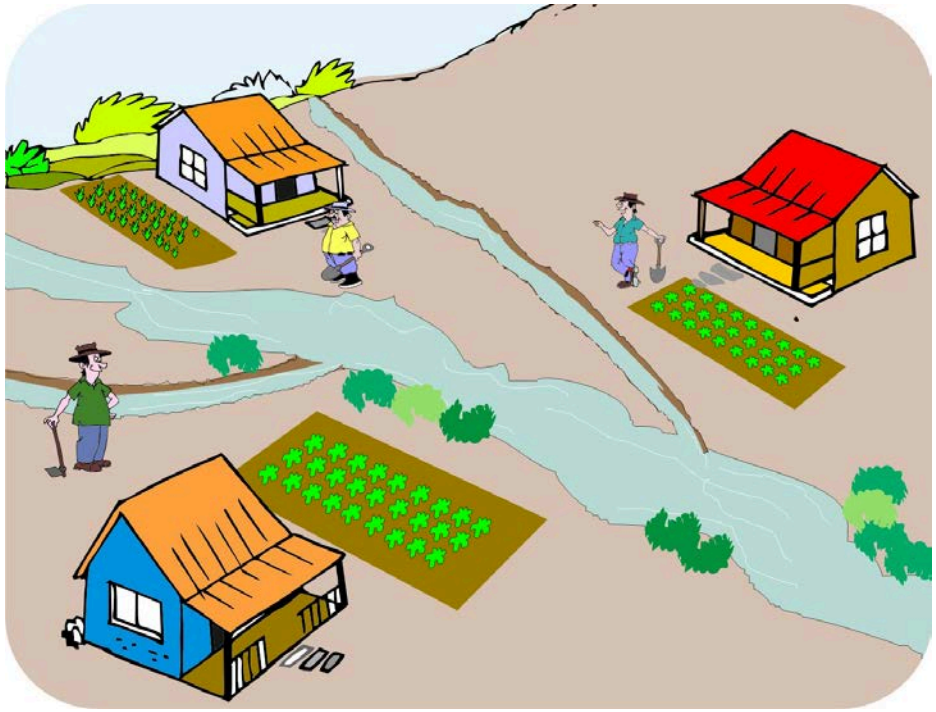
Look for the following signs of erosion or risk of erosion:

- Areas where the **soil surface is covered with stones**
- Areas where **plowing brings up subsoil** or stones
- Areas where **heavy rain turns streams muddy**

Managing rainfall within a watershed

The most effective way to manage soil and water resources is to **work across the entire watershed**. This approach makes it possible to:

- **Eliminate soil erosion** almost completely
- **Capture the maximum amount of rainfall** – either in the soil or in small dams.



Tools for managing rainfall within a watershed

Three of the most common tools for managing water movement are:

- **Keeping the soil covered** at all times by using grass, trees or crops
- **Covering the soil with dead plant matter** protects against evaporation of water from the soil surface
- **Creating barriers** along the contour lines of a slope, such as stone barriers or live barriers
- **Digging contour trenches** along the contour lines of a slope.

Upstream and downstream users

Downstream users:

People who use water after us are downstream users. They have to receive enough clean water that is safe to use.

Upstream users:

People who use water from a river before us are upstream users. They have to respect the rights and needs for other water users.

Upstream and downstream issues

- Surface or **ground water is used many times** by different upstream and downstream users before it reaches the ocean or evaporates.
- The **rights and needs** of upstream and downstream water users should be respected at all times.
- Various **national** and local laws regulate water use –particularly surface water in streams, rivers and dams.

Lesson 5:
Soil composition

Outcomes

After this lesson, you will be able to:

- Describe what topsoil is and why it is important.
- Explain the role of organic matter in plant growth.
- Assess different strategies for replacing organic matter in the soil.
- Identify and describe the different types of soil: and, slit, clay and loam.

Overview

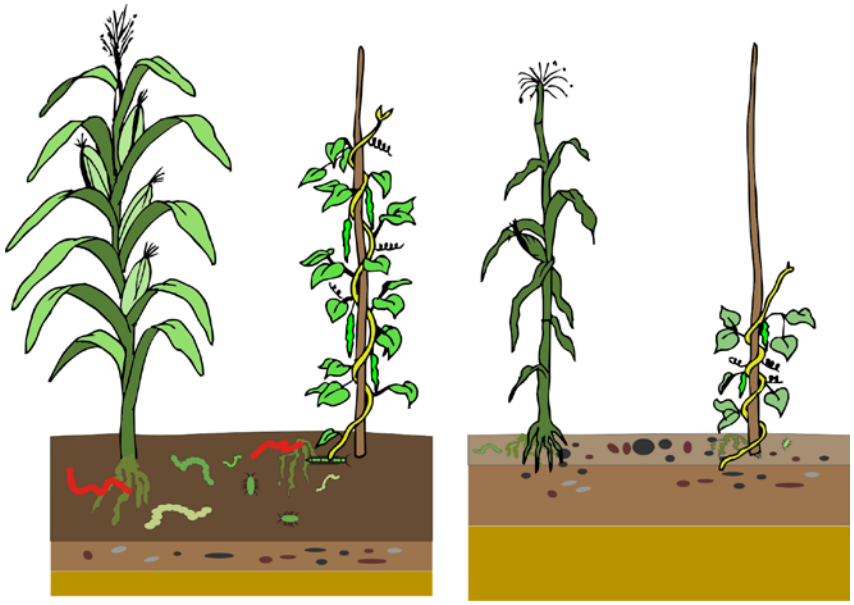
Lesson 5 covers the following content:

- The nature and function of soil
- Topsoil layer
- The importance of organic matter
- Protecting the existing organic matter
- Replacing organic matter
- Soil texture
- Characteristics of sandy soil, clay soil, silty soil and loam soil

Nature and function of soil

Soil:

- Is the **home of plants,** providing them with **water** and **nutrients** (food)
- **Anchors the roots of plants,** thereby keeping them stable
- Is made up of different **layers** of which the darker layer – known as ***topsoil*** – is the most important for plant growth



Topsoil layer

Topsoil:

- Has **more organic matter** than the layers below
- Holds many of the **essential nutrients** that plants need
- Contains **pathways for roots** to grow

Topsoil layer (Continued)

Topsoil

- **Holds the water** and **air** that plant roots use to survive
- **Traps more moisture** – because of more organic matter – and drains excess water faster after heavy rainfall

Increasing the number of soil animals in topsoil

You can increase the number of soil animals – e.g. earthworms, beetles and termites) to transform organic matter into rich topsoil by:

- Limiting the use of agro-chemicals
- Increasing plant organic matter
- Adding compost to the soil
- Producing vermiculture (worm compost)
- Growing green manure
- Rotating crops

Signs of depleting topsoil

- Digging in the field shows that the soil closest to the surface is made up of a very thin dark layer or **no dark layer** at all
- Fields producing **very low crop yields** or only scattered, hardy weeds
- The **soil level on sloped land** has built up and is **higher on one side** of tree trunks or fence posts than the downslope side
- **Soil surface being rocky and full of stones,** sometimes called an “armor layer”

Dealing with a plowpan

A **plowpan** is a thin, hard compact layer of soil right below the topsoil, which forms when plowing or hoeing the soil to the same depth each year.

Plowpan are undesirable, because they can:

- Block root growth
- Limit oxygen access to roots
- Slow down or prevent water from seeping through the topsoil

The best to prevent plowpans from forming is to:

- Work the soil to different depths
- Avoid tilling the soil altogether

Importance of organic matter

Organic matter:

- Provides the **essential nutrients** that plants need to grow, e.g. nitrogen (N), phosphorus (P) and potassium (K)
- **Builds up the structure of the soil** so that it is easier for plants to grow in it
- Provides food for the soils' **micro and macro-fauna,** which in turn, increases the soil's capacity to hold water (like a sponge).

Using commercial fertilizer

Commercial fertilizer can:

- Increase soil fertility
- Trigger new plant growth, thereby giving the organic matter that can be introduced back into the soil.

Using commercial fertilizer: Disadvantages

Adding commercial fertilizer has some disadvantages, in that it:

- Is expensive
- Does not contain all the nutrients plants need
- Does not improve the soil structure or its capacity to hold water
- Kills important soil animals and contaminate downstream water sources when applying too much artificial N-P-K fertilizer

Protecting existing organic matter

Do not use burning to clear land for crops.

- Burning weeds and vegetation takes organic matter out of the soil.
- Unburned soils have twice the number of important nutrients and twice the number of soil animals.
- Burned soils also degrade faster, producing meager – if any – crops.

The best strategy is to adopt a minimum tillage system.

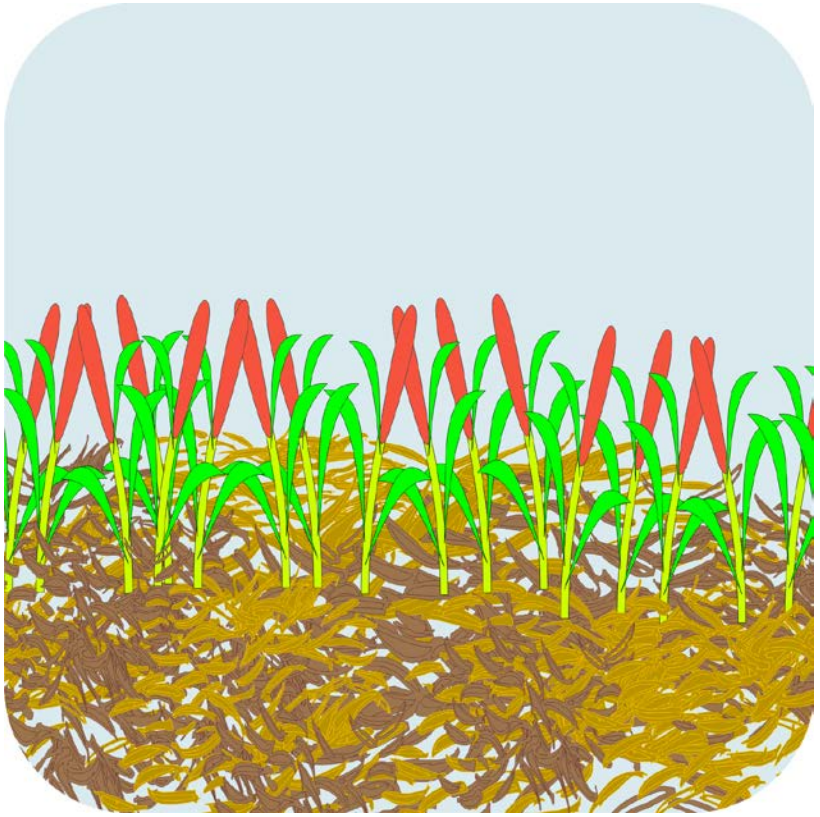
Protecting organic matter and soil cover from livestock

- **Control free grazing** by carefully **tending to your livestock,** making sure that they **do not overgraze an area** or destroy valuable vegetation
- **Apply cut and carry forage:** harvest the forage (i.e. the plants that animals eat) and take it to penned or tied animals
- Identify **areas away from crops where animals can graze freely**

Replacing organic matter: Mulch

Mulch:

- Is made by **collecting various residues of dead plants** (leaves, stalks, fruits) and leaving this layer of dead plant matter on **the surface of the soil**
- Helps **control weeds**
- **Adds nutrients** and **keeps the soil damp** longer.



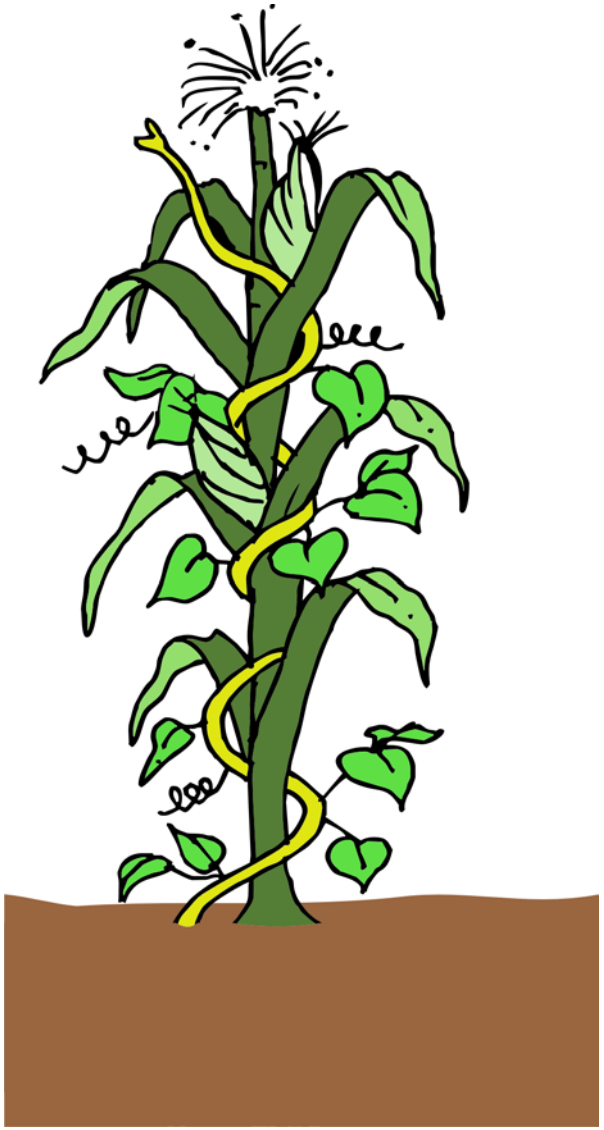
Replacing organic matter: Green manure

Green manure:

Crops or plants that are grown to improve soil fertility, because they increase nitrogen, which is one of the essential minerals in the soil.

Green manure crop

- A green manure crop can be grown **next to a cereal crop** (like maize, sorghum or millet).
- Other times, the dead leaves, roots and stems of a green manure crop can be **left on the soil surface** before planting the cereal.
- The green manure crop can also be **incorporated directly into the topsoil.**



Replacing organic matter: Livestock manure

When animals are penned at night on a bed of straw, their wastes can be:

- Collected with the straw from time-to-time
- Mixed into topsoil
- Added to a compost pile

Replacing organic matter: Compost

Compost is a mix of organic refuse materials:

- Soil
- Dead leaves
- Stalks and other plant material
- Vegetable scraps
- Ash from cooking fires, eggshells
- Animal manure

Replacing organic matter: Compost and humus

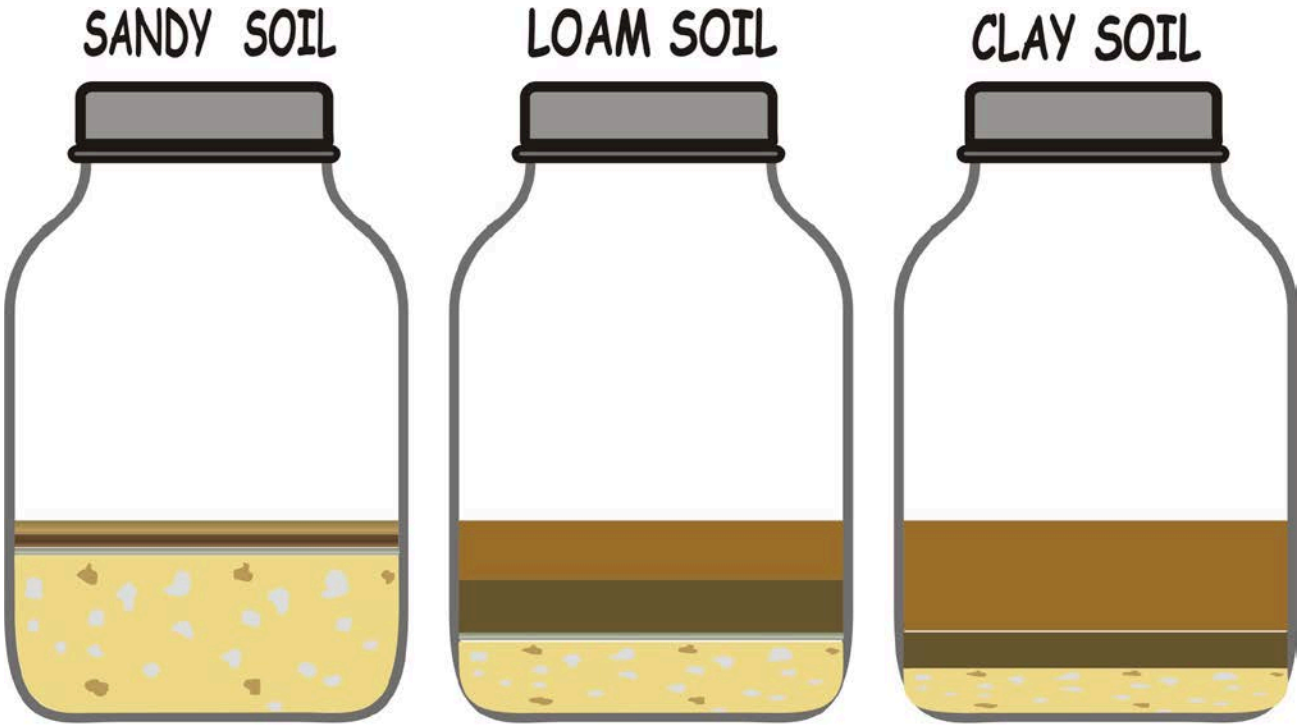
Compost breaks down into a rich, dark mixture called **humus.**

Humus is:

- Is full of richly concentrated nutrients
- Can be applied to planting holes with a seed or mixed into the soil near the roots of growing plants

Soil texture

Soil texture refers to the size of the particles in the soil, which varies from place-to-place.



Different soil textures

- **Sand:** Large soil particles
- **Clay:** Very small particles
- **Slit:** Particles that are between sand and clay in size
- **Loam:** Soils that have a more or less equal amount of sand, silt and clay

Characteristics of sandy soil

Sandy soils:

- Are often found near river beds or coasts
- Are gritty, rough and light in color
- Have grains that do not stick together and do not provide solid grounding for plant roots
- Are easy to work, but water drains through it quickly
- Are not very fertile and, therefore, most plants have a hard time growing in sandy soil

Improving sandy soil

Sandy soils can be improved by:

- Adding a lot of organic matter: plant residue, leave, roots and manure
- Growing a cover crop and working it back into the soil
- Chopping a cover crop with a machete and leaving it on the surface as mulch
- Using commercial fertilizer to produce the first plants
- Adding large amounts of manure or compost to the soil
- Planting leafy trees or bushes around the plot borders

Using sandy soils: Planting in a zai hole

Zai holes are a technique used in dry areas with sandy or clay soils.

- A hole of about one meter in diameter is dug and filled with compost to retain the water and provide nutrients.
- The seed or seedling is planted.
- The soil is molded so that it captures water flowing over the surface of the field into the Zai hole.

Characteristics of clay soil

Clay soils:

- Are made up of the smallest particles
- Can be brown, black or red
- Are a hard mass when dry and crack on the surface
- Hold water so well that they become muddy when wet
- Drain poorly
- Are generally very fertile
- Can be hard to plow when wet, because wet clay particles stick together so well
- When it is very wet, plant roots have a difficult time getting enough air

Improving clay soil

Clay soils can be improved by:

- Adding organic matter, which helps to bind it together and form clumps called **aggregates.** The channels that form around the aggregates provide better water drainage and air circulation as well as the space that the roots need to grow
- Digging drainage ditches, planting crops on ridges next to **furrows** to improve the drainage in clay soils
- Using tillage to break up the clay, so that plants can grow

Characteristics of silty soil

Silty soils:

- Are neither clayey nor sandy: they are somewhere in-between
- Do not get as muddy as clay
- Are very fertile
- Can become compacted if cultivated when wet
- Do not crack at the surface when dry

Characteristics of loam soil

Loam soil:

- Contain a balanced mix of sand, silt and clay and, therefore, they are one of the best soils for agriculture
- Retain water and drain well
- Are easy to plow
- Have a good balance of soil moisture, air and nutrients
- Hold nutrients
- Provide an ideal home for soil animals

Lesson 6:
Soil fertility and nutrients

Outcomes

After this lesson, you will be able to:

- Define nutrients.
- Identify the nutrients that are most important for plant growth.
- Explain the two main types of fertilizers.
- Use the different application techniques for commercial fertilizer.

Overview

Lesson 6 covers the following content:

- Nutrients and micronutrients
- Using fertilizers
- Commercial (inorganic) fertilizers
- Applying commercial fertilizers (how and when)

Macronutrients and micronutrients

Plants need the following macronutrients in large amounts to grow:

- Nitrogen
- Phosphorus
- Potassium

Water and carbon dioxide provide the following macronutrients that are required by *all* plants:

- Carbon
- Hydrogen
- Oxygen

Other major macronutrients: calcium, magnesium and sulfur.

Characteristics of NPK: Nitrogen (N), phosphorus (P)and potassium (K)

Nitrogen (N)

- Plants that receive plenty of nitrogen grow large and their leaves are dark green.

Phosphorus (P)

- Helps roots to grow and flowers and seeds to develop.

Potassium (K)

- Helps strengthen the stalks and stems and plants to resist disease and drought.

Using fertilizers

Fertilizer replaces the nutrients in the soil that were used by the previous crop and maintains the balance of nutrients in the soil.

Because both macro and micronutrients have unique interactions with the soil, they need to be applied differently, for example:

- **Nitrogen** may be applied on the soil surface if rains are near (called “top dressing”), or it should be mixed into the soil to keep it from evaporating.
- **Phosphorus** needs to be applied near the roots.

Organic fertilizers

Organic fertilizers:

- Are considered **organic,** because they come from plants and animals
- Are **produced on the farm,** e.g. compost, vermiculture (worm compost), animal manure or green manure
- Are **less expensive** than commercial fertilizers
- Require **more time** and **labor**

Inorganic fertilizers

Inorganic fertilizers:

- Are **inorganic,** because they are taken from minerals and ores
- Are **commercially produced**
- Are **more expensive** than organic fertilizers

Applying commercial fertilizer

- Too much fertilizer will “burn” or kill plants and pollute nearby water bodies
- Too little fertilizer will result in low yields.
- Most bags also have **written instructions** for **handling** and **storage**.

Fertilizers can be dangerous to humans and animals if not stored and applied properly.

Applying commercial fertilizer: Basal application

- **Mix fertilizer into the soil** at the **base of the plant –** often right before or after planting.
- If your soil lacks **phosphorus,** it is important to **apply it at planting time.**
- **Apply phosphorus** in the soil **at a depth where roots will be able to reach it.**

Applying commercial fertilizer: Top dressing application

- The fertilizer is **spread evenly over the field** and **applied on top of the soil** after seeds become plants and **while the crop is growing.**
- **Nitrogen** and **potassium** are most often applied in this way.
- **Wait until rainfall is moderate** and **constant** before you apply nitrogen fertilizer.

Applying commercial fertilizer: Split applications

Split applications are top dressing in smaller amounts at different times while the crop is growing.

- With split application, **fewer nutrients are lost** and you can **apply the nutrients when the crop needs them the most.**
- If the soil is sandy, you need to apply fertilizer in split applications, because **sandy soils drain easily** and the water can sweep the nutrients away
- If a soil has more clay, you can apply fertilizer less frequently.

Where to apply fertilizer: Banding

Banding

- Apply the fertilizer in a band in the soil beside the row of plants.
- The plants will take up more nutrients, compared to broadcasting and you will use less fertilizer.

Note: if you apply the fertilizer too close to young roots, it can burn them

Where to apply fertilizer: Side dressing

Side dressing

- Use this method when the plants are up out of the ground and growing
- Scatter dry fertilizer on one or both sides of a row, about 15–20 cm from the plants and then mix the fertilizer into the soil.

Where to apply fertilizer: Foliar applications

- **Dissolve the fertilizer in water** to make a weak solution.
- **Apply with a sprayer** to the leaves of the plant.

If the solution is too strong, it will burn the plant leaves.

Where to apply fertilizer: Foliar sprays

- Foliar spraying is used for **applying nitrogen** as **urea fertilizer** and for some micronutrients.
- Do **not** apply foliar sprays when it is windy.

Lesson 7:
Plant health

Outcomes

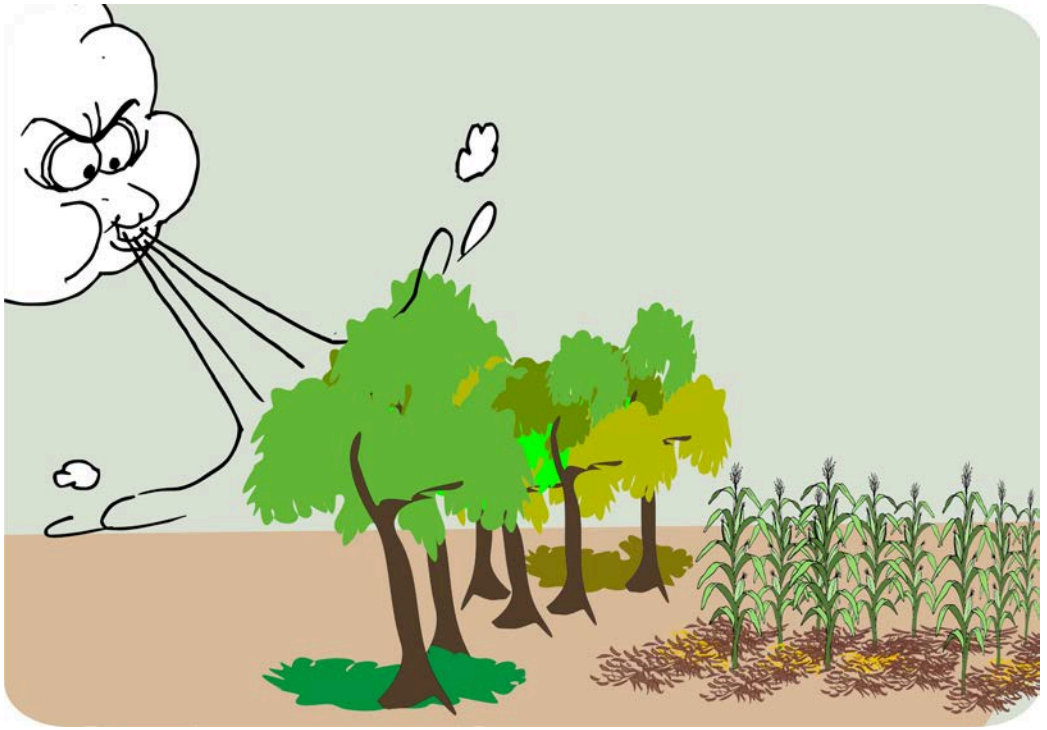
After this lesson, you will be able to:

- Explain what plants need to grow and thrive: air, water, light, soil and nutrients.
- Assess the challenge of securing sufficient amounts of nutrients.
- Identify the threats posed by pests and disease.

Overview

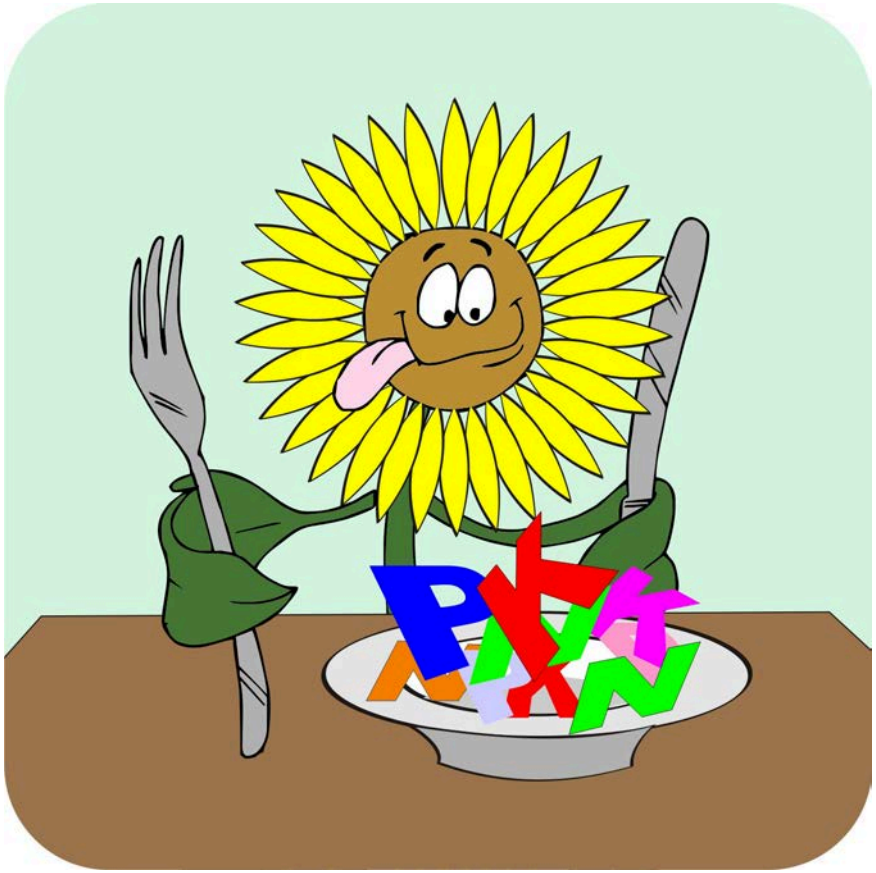
Lesson 7 covers the following content:

- Plant nutrient, water, light, soil and air needs
- Pests and disease



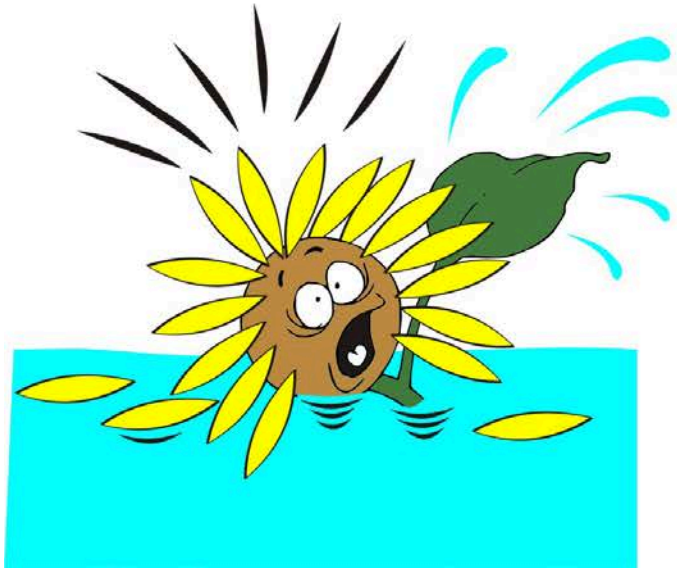
Concepts important for plant nutrition

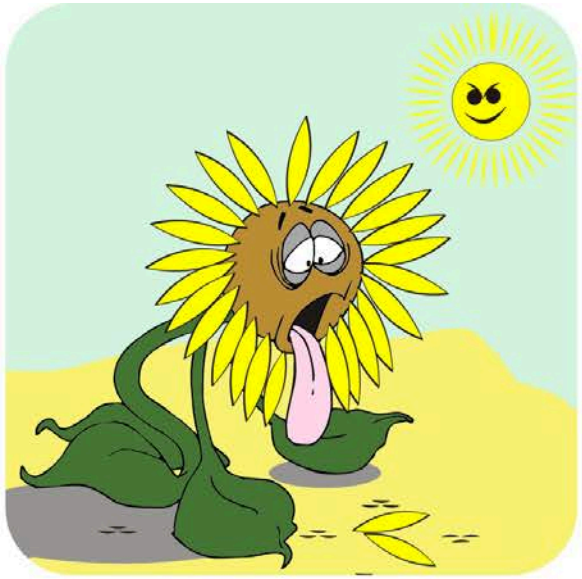
- Most limiting nutrient
- Nutrient movement
- Nutrient deficiency
- Nutrient sources
- Nutrient availability
- Soil pH: A scale that measures the acidic or alkaline properties of soil



Plant water needs

- **Consistent access to water** is important.
- **Regular access to moderate amounts of water** is essential for health plant growth.
- **Plants need moist soils,** in order to access nutrients like nitrogen.





Plant light needs

- Plants need **energy (light) from the sun** to grow.
- Plants **transform light energy into chemical energy.**
- Different crops need **different amounts of light** and **different total hours of light** (or darkness) in a single day.

Plant soil needs

Soil:

- Provides a **place for the plant roots to "anchor"**
- **Holds the plant in place** for proper **growth**
- Provides the **water** and **nutrients**
- Provides the **needed air**

Water, nutrients and air are absorbed by the **roots** of plants.

Plant air needs

- Like humans, **plants breathe air.** – Without oxygen, plants will die.
- **Plants take in oxygen** through their leaves and roots, **giving out carbon dioxide.**
- **Plants are also affected by air pollution,** e.g. by a factory's discharge of dust into the air or dusty rural roads.
- In some cases, air pollution may be directly harmful to plants (e.g. sulfur and other pollution).

Pests and diseases

Pests may include:

- Insects of various kinds
- Larger animals like rats or rabbits that like a particular kind of plant

Diseases also come in many forms, including:

- Viruses or bacteria
- Many other types of micro-organisms that hinder plant growth and development

Lesson 8:
Life systems in nature (ecosystems)

Outcomes

After this lesson, you will be able to:

- Explain how all living things are connected in food webs and ecosystems.
- Describe the different roles of “producers” and “consumers” play in food webs.
- Demonstrate an understanding of the importance of maintaining diversity in healthy ecosystems.

Overview

Lesson 8 covers the following content:

- What happens in the food web
- Broken food webs
- Managing healthy ecosystems

The ecosystem

- An **ecosystem** consists of all **living organisms** (plants and animals) and **non-living things** (air, water, sun, soil) taken together.
- In this ecosystem, **all living things are dependent and connected** to one another.
- They continually **exchange the nutrients and energy essential for supporting life.**

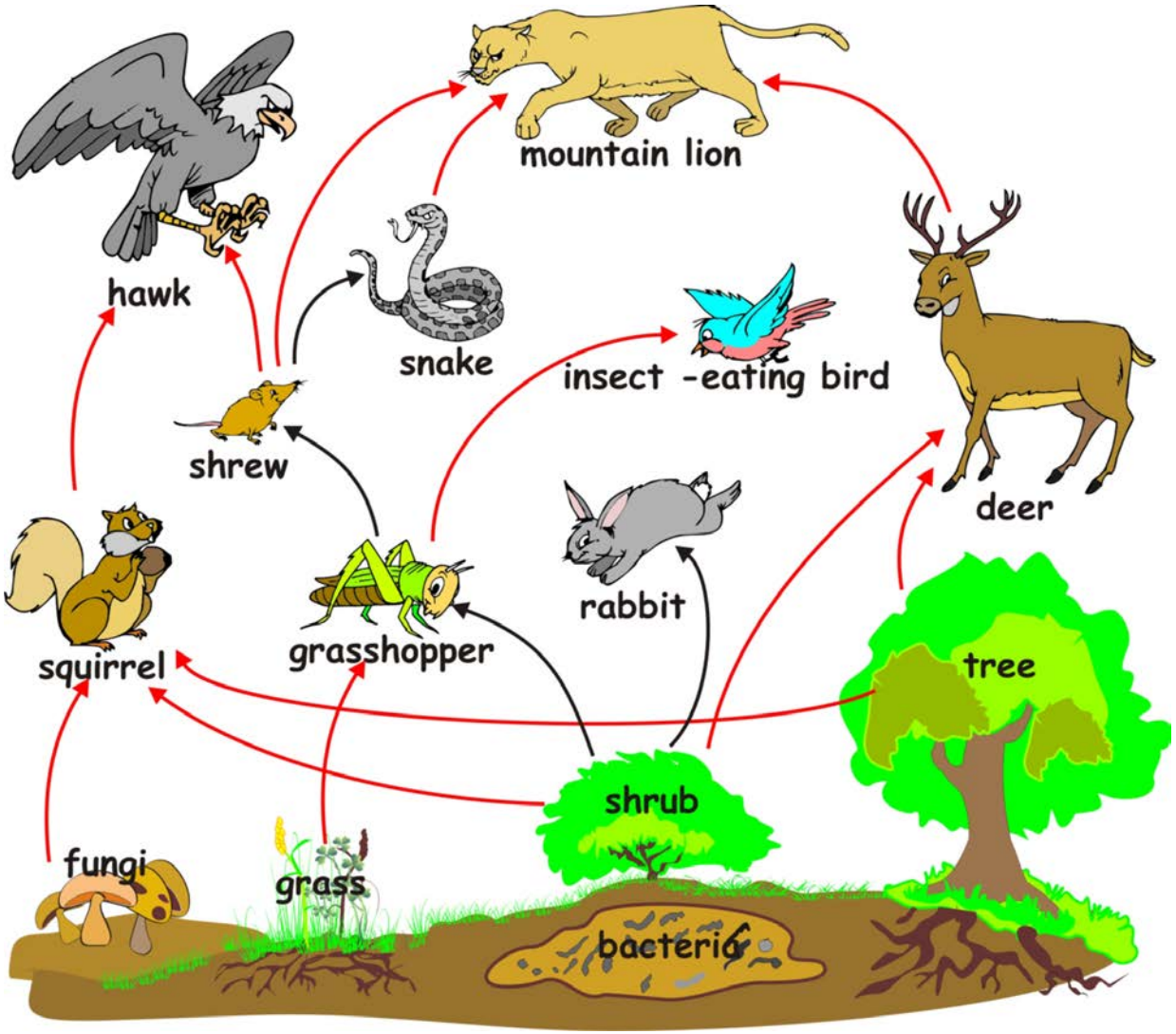
We are also a part of this environment and our actions affect how it functions.

The food web

- When growing, plants take up **minerals from the soil and the air** to make **organic matter** (i.e. the matter that makes up a living thing).
- When plants are eaten, some of their matter is absorbed and utilized by the organism that has eaten it. The same thing happens when an animal eats another animal.
- So when one organism eats another, both **energy** and **matter are transferred** from one to the other and, in this way, a food web is created.

Food web diagram

A **food web diagram** shows the flow of energy and matter from producers to primary consumers and from primary consumers to secondary consumers.



Producers and consumers in the food web

Producers

Plants, through a process called **photosynthesis**, plants can produce **chemical energy from sunlight,** which is why they are called producers.

Consumers

- Animals are the consumers in the food web.
- We can distinguish between **primary consumers** (e.g., cows), secondary consumers and omnivores (i.e. animals that eat both plants and other animals are called omnivores).

Broken food webs

Examples

If we cut down most of the trees, the birds will not have a place to make their nests or to sleep in safety away from predators. They will settle elsewhere. With a lot less birds around to eat insects, the population of insects will explode. With more insects eating our crops, our crop yields will go down.

Wild cats and snakes eat rats. If we kill all the wild cats and snakes the number of mice and rats will increase a lot, and they will eat much more of our stored grain.

Broken food webs illustrated

Managing healthy ecosystems

Maintaining a **balance of species** in our environment can prevent problems related to booming populations of species (e.g. having too many insect pests or rats).

In **unbalanced ecosystems,** the existence of many life forms is under threat.

Increasing and protecting the **diversity** of living creatures in our environment usually increases the productivity of our environment.

Managing healthy ecosystems: Diverse environments

A diverse environment:

- Provides multiple sources of vital energy and nutrients
- Is home to more organisms and, therefore, provides more economic opportunities.
- Supports diversity in predator organisms in the environment, which improves pest control
- Increases livelihood options
- Makes harvesting healthier grains possible by decreasing the need for chemical control of insects and other pests.

Lesson 9:
Sustainable use of natural resources – bringing it all together

Outcomes

After this lesson, you will be able to:

- Identify the consequences of environmental degradation and the good practices of preventing and combating environmental degradation.
- Demonstrate an understanding of the basics of land use management.
- Explain ecosystem services and the steps taken to preserve these functions.
- Explain climate change and the effects of global warming.

Overview

Lesson 9 covers the following content:

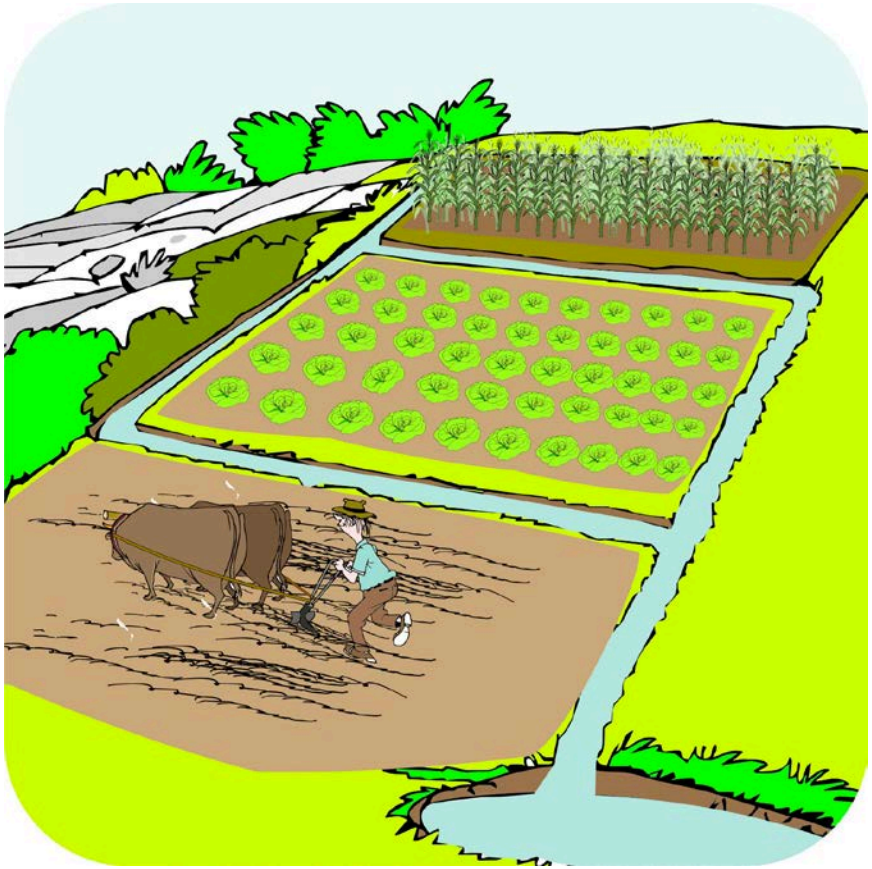
- Consequences of environmental degradation
- Good practices for farming and natural resource management
- Basics of land use management
- Ecosystem services
- Climate change
- Effects of global warming
- Farmers and climate change
- Protecting resources and livelihoods for future generations

Consequences of environmental degradation

- Allowing our soil, water and other natural resources to become **polluted** and **degraded,** could seriously threaten our capacity to generate food and income.
- Allowing the **diversity** of our local natural resources **to degrade,** will reduce the capacity to withstand adverse events (like droughts and floods)
- As the **number of people** in an area grows, we will need to **extract** more from our natural environment.

Good practices for farming and natural resource management

- Protect the soil at all cost.
- Capture and use rainfall.
- Make sure all excess water "walks; not runs" off the slope.
- Maintain a wide diversity of living organisms.



Basics of land use management

- **Cover steep slopes** with trees and grass at all times.
- **Prevent erosion** across the entire watershed.
- Make sure that **excess water moves slowly from higher to lower parts** of the watershed.
- Use and **manage rainfall** carefully.
- Ensure that **runoff from the land does not carry pollution** downstream.

Ecosystem services

- **Provisioning:** Providing water and food for all living organisms
- **Regulating:** Maintaining stable microclimates across the globe and looking at threats to agricultural yields, which affects the spread of pests and diseases
- **Supporting:** Cycling nutrients and pollination of crops and wild plants by bees and other insects
- **Cultural services:** Providing rural and wilderness areas for use for spiritual and recreational purposes

Climate change

- There is substantial scientific evidence that the earth is slowly getting warmer, a process called **climate change** or **global warming**.
- The change resembles a **greenhouse effect**. – The sun heats up the air inside, the air cannot escape and gets even hotter. Therefore, the temperature inside the greenhouse is much higher than the temperature outside.
- In rural areas, the **reduction of plant life** and **loss of organic matter in the soil** are often the biggest contributors to global warming.

Effects of climate change

- Higher temperatures can lead to **wells and streams drying up**
- Due to lower temperatures, **certain crops cannot grow at the same altitudes** anymore
- Climate change may bring **unpredictable and heavier rains** more frequent and/or **severe droughts**

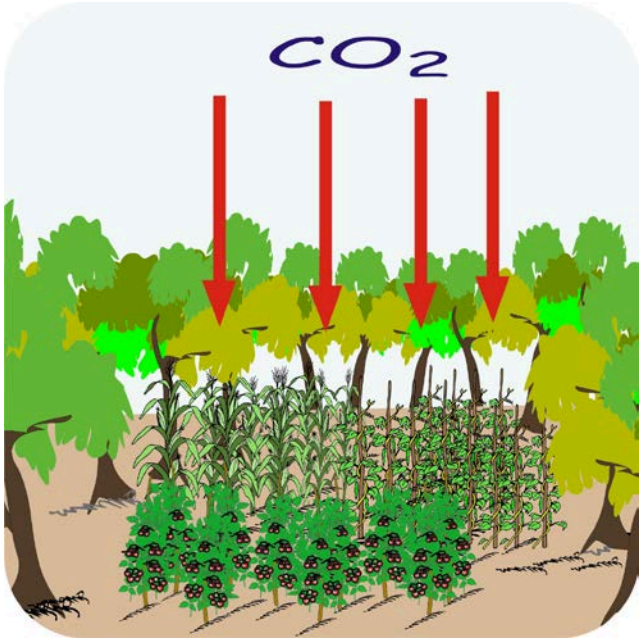
Effects of global warming

- Desertification
- Loss of agricultural land
- Altered patterns of crop or livestock
- Altered patterns of pests and diseases
- Flooding of coastal area
- Migration

Farmers and climate change

Farmers can contribute to reducing the effect of climate change by taking the following steps:

- **Increasing plant growth**
- **Increasing the content of organic matter**
- **Changing the types of crops** grown or **livestock** raised
- Building or improving **irrigation systems**
- **Planting trees** and **cover crops** to increase the number of growing trees



Protecting resources and livelihoods for future generations

- We received natural resources as a **gift** from our ancestors.
- **We are the current "caretakers" of these resources** and we should use them responsibly.
- It is our duty to pass them on in a good condition to the next generation.

Protecting resources and livelihoods for future generations (Continued)

We need to **teach our children** to follow our example and **preserve natural resources** for future generations.

Module summary

In this module, you have learned:

- The importance of natural resources
- The water cycle and water management
- Watersheds and watershed management
- Soil composition and different soil textures
- Soil fertility and nutrients
- Plant health
- Life systems in nature (ecosystems)
- The sustainable use of natural resources