Unit 3:
Using natural resources wisely

Introduction

In Unit 1 we examined the natural resources of water, soil, biodiversity and natural energy that we have available to use to our advantage. In this unit you will discover how to use these resources sustainably (wisely) not only in day-to-day living, but also when you design a food or other garden in your area. Why is this important? As the number of people increases, our effect on the Earth becomes bigger and resources are coming under more pressure. Abuse of resources is causing major problems which in turn is impacting on our lives on many levels, including that of food security.

When we reflect on how we use our natural resources at present and what we can do to use them more sustainably, one place that we can go to for answers is to the rich indigenous knowledge our ancestors passed on to us. They enjoyed food security, because they knew how to use their natural resources wisely. What did our ancestors for example know about managing water resources? Read the following story on *Sweet Water*, and decide for yourself!

Sweet Water ("Amanzi amnandi").
(Water fit for household use)

Even before the time of the Zulu King Shaka, sweet water was called "amanzi amnandi". Shaka's mother was called Nandi and it is said that because it was not considered respectful to use the queen mother's name in this way, Shaka referred to sweet water as "amanzi amtoti".
*(**Comment:** This is how the town of Amanzimtoti, south of Durban, got its name).*

Before they use it many people of Nguni origin will first sniff, smell and taste water, collected from a river, spring or well for their daily household needs.
*(**Comment:** Water quality scientists today still have people smell and taste household water. Our Human senses give us very good clue as to whether water is good, clean and fresh).*

Historically, water was usually collected in areas where people could hear it running over stones or dripping down rocks.
*(**Comment:** This water collects oxygen and well-oxygenated water helps natural biological processes that cleans the water).*

A water source would always be approached with care so as not to frighten crabs and other small water animals. When disturbed, their movement would stir up sediment (mud from the bottom of the stream or river) and the water collector would have to wait for the sediment to settle. The surface film (top) of the water was brushed aside for "sweet water" to be collected.
*(**Comment:** Sediments and surface films have a higher number of disease-causing bacteria than the middle waters of pools and rivers. Today scientists take water samples below the surface film, being careful not to suck up sediment. In this way, they obtain consistent (always the same) and reliable measures of bacterial contamination).*

Clay pots were filled with water and covered with a collecting bowl, a piece of skin or a mat made from incema grass. The water would thus stay cool and fresh.
(***Comment:*** *Water absorbed through the sides of a porous clay pot will cool the contents. Most water bacteria cannot reproduce in cool, dark conditions. In earlier times, great care was taken to scour out the white build-up of calcium in water pots, so any harmful microorganisms living there were removed. Also of note is that when the grass "lids" and head rings for carrying pots became old they were simply thrown away (discarded) and new ones were woven. Discarded lids did not pollute the river like today's bottle tops and plastic waste).*

There were many other customs and traditional practices surrounding water. Children were warned that urinating in a river would change them to the opposite sex!
(***Comment:*** *This myth was probably sufficiently frightening to prevent people urinating in streams and rivers. This would have limited a disease like bilharzia. The bilharzia parasite is passed on from human urine and faeces to small water snails. From these, its life cycle directs the disease back to people through the river water).*

It is also said that it was not advisable to collect water from a river after heavy rain at the start of the annual rainy season. Indigenous common sense told people to put out pots to collect rain-water. River water would again be collected four days after the rains stopped and the water had cleared.
(***Comment:*** *Heavy rains wash human and animal waste into rivers. This means that the harmful bacteria in the waste are also washed into the water. When people drink it they become ill. In KwaZulu-Natal, health workers have to warn rural people not to collect river water after heavy rains since few remember the earlier Nguni practice of collecting rain-water only four days after the rains have stopped).*

Today human and livestock numbers have increased vastly, catchments have become degraded and rivers are often polluted dumping places. Why are the indigenous practices discussed above relevant for us today? Learning about historical water collection and storage practices can develop a respect for our ancestors and might also help our understanding of water quality issues.

(Adapted from Share-Net, 1996)

Reflect

Reflect for a moment on the Nguni way of managing water. Do your cultural group offer specific ways to manage water? Why is indigenous knowledge so important for us, even today? How can indigenous knowledge help us to manage our natural resources in such a way that it will enhance food security?

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In this unit we are going to explore how you will be able to grow and eat more, using less!

This unit consists of the following sections:

3.1 Eating more using less (low input principles)
3.2 Water management
3.3 Soil management
3.4 Managing biodiversity
3.5 Managing energy resources
3.6. Thinking about a design plan for your homestead garden

Specific outcomes and learning outcomes

The specific outcomes for this unit are:

- to determine the impact of natural resource use on the environment and people, and
- to explore various knowledge systems for an alternative resource management option.

Learning outcomes	Assessment Activities	Actual time spent
	Workbook activities	
3.1. Eating more; using less (low input principles) 3.2 Water management 3.3 Soil management 3.4 Managing biodiversity 3.5 Managing energy resources 3.6 Thinking about a design plan for your homestead garden	Start-up activity (30 min) 3.2 Audit of catchment areas (1h) 3.3 Selecting water-wise plants and animals (30 min) 3.5 Make a line level (1h) 3.6 Using a line level to measure a slope (30 min) 3.9 Causes of soil erosion in your area (2 h) 3.10 The wise use of biodiversity in your area (1 h) 3.13 Making a solar cooker (1 h) (Optional) 3.14 Creating a design plan (4 h)	
	Assignment Assignment 1: Information for this assignment is contained in Tutorial Letter 101. (3h)	

The table above shows you the **learning outcomes** that you will notice are linked to the six sections which are addressed in this unit, and also to the list of assessment activities for the unit. A time estimate is shown for the completion of each activity. This will help you to plan the use of your time. When you have completed the activities, write down the actual time you spent on them.

Key concepts

Sustainable use of resources
Natural resources
Low input
Deforestation
Insulated
Solar energy
Greenhouse effect
Pollution
Fossil fuels
Acid rain
Erosion
Water table
Catchments
Riverine vegetation
Sink
Swales
Used water
Grey water
Irrigation
Soil erosion
Desertification
Tillage methods
Biomass
Green manure
Gulley
Mulch
Fire break
Fire guard
Perennial plants
Legumes
Compost
Permaculture

Start-up activity

Complete this activity in groups or on your own in your workbook

Aim: Gain an understanding that the Earth is as fragile as an eggshell, when the resources it provides us with are not used sustainably.

Fragile means it can break very easily, as the shell of an egg breaks when you do not work with it carefully

Time: 30 minutes

What you will need

Two balloons, a streamer, three pieces of string, each 30 cm long, an A4 sheet of paper, a paper clip and an uncooked egg (a whole raw egg).

What you must do

1. Work in small groups, and use the materials provided to build a structure to protect the egg.
2. This structure should be strong enough, so that when the structure, with the egg in it, is dropped from a height of 2 meters by a member from another group, the egg should not break.
3. After you have done this activity, each person should answer the following questions.

Questions

1. Did your egg break, or was the structure effective in protecting the egg during the fall?
2. An egg can easily break. Are there any lessons from this activity that we can learn regarding our Earth? What is the link between an egg that can easily break, and our Earth and its resources?
3. Why is it important that we take good care of planet Earth and its resources? Reflect on this question.

You will gain a much better insight into human activities that impact negatively on natural resource as you work through this unit. We'll also examine the sustainable management of natural resources and how this links to food security.

3.1 Eating more using less (low input principles)

Before we focus on how to implement low input methods when we are thinking about starting a homestead garden, a flower garden or any other project that uses natural resources, it is important to consider what *low input* means.

3.1.1 What does low input mean?

Low input is a way of thinking and living that encourages people to think about things and do in different ways than they have before. When we apply the low input method to the use of natural resources, this new way of thinking and living will result in using fewer resources, to get more and better results. Let us look at this more closely.

Life requires input – without input there wouldn't be life! We must have 'inputs' of food, water and air, or our bodies will not provide us with 'outputs'; for example, energy for life processes. We must ask the question, "Do we need to make a big input to get a big output?" The answer is *No*! For our purposes low input means using the natural resources that are available to us in such a way that they are sustainable (low input) for maximum benefit concerning food security (high output). In other words, we are going to examine how to use less (use fewer resources) and eat more by producing more food. Low input *is not* specifically for the poor or the rich. It is for anyone who cares about the Earth's resources and leaving this Earth a better place, not only for the next generation, but also for our own future.

The low input method considers all impacts from each system, including the psychological, social, environmental and economic systems on sustainability. In other words, the choices that we make in life can affect ourselves, other people, the soil, the water, the air, biodiversity, energy resources and the local economy. Your role as a facilitator is to empower the people you work with, by helping them to gain an understanding that we are part of the cycle of nature. This means that all things are connected, and that what happens to the Earth, happens to all the living things on the Earth.

> *Do you remember what **psychological** means? If you do not, refer back to Unit 2*

In 1885 the American Indian, chief Seattle, said the following, in a letter to the President (adapted):

What are people without the plants and animals in the natural environment? If all the plants and animals were gone, people would die from a great loneliness of spirit, for whatever happens to the plants and animals, also happens to people. All things are connected.

Examples of low input thinking

One example of a low input method would be to consider the impact of additional watering of your plants. If you put the additional time, energy and water into the plants, will they give you a higher yield? Is that higher yield worth your time, energy and water expenditures? Sometimes the answer will be *Yes.* At other times the answer will be *No.* It depends on your situation.

Another example is that you may decide to divert a stream to build yourself a fishpond that will improve your income, your diet and your water supply. However, if you divert the stream completely, without allowing the water to continue to flow in its original direction to people downstream, the impact on their lives could be very negative and their reactions may not be worth your inputs. Instead you may think of changing your design to eliminate or reduce such negative impacts.

3.1.2 Basic principles of low input

Before you start using the low input method, you need to consider a number of principles:

- **Focus on local resources**

You need to use what is available in your area, such as local trees and other plants and animals. Using local resources often takes less input (such as water, fuel, money and time). Resources such as local foods, trees, animals, and cultures are becoming lost and their importance is being forgotten.

- **Focus on solutions; not on problems**

It is easy to get side-tracked by problems concerning the availability of, access to and utilisation of natural resources. However, you need to stay focused on helping people move towards creative solutions for these problems. We will examine many solutions. Also, very often the people whom you work with will come up with creative solutions themselves.

- **Encourage creativity**

Help people think in different ways and develop common sense approaches when addressing problems regarding natural resources. You, and the people whom you work with, may discover new solutions to old problems through your creative thinking and discussions.

- **Help people explore different ways of thinking and doing**

There is an old saying: “There is more than one way to skin a goat”. This means that there is more than one way of doing things. When you consider natural resources for food security, take aspects such as the situation, the culture of the people, and the time of year into consideration. There are many outside influences that will guide you.

- **Look to nature for lessons**

Nature can teach us a lot from its systems, its way of interacting, its way of promoting health and survival without outside human inputs. We can gain ideas, understand issues better and build inspiration from time spent in nature.

- **Seeking diversity**

Natural ecosystems consist of many different plant and animal species interacting with one another. For example, different types of plants grow together to protect themselves against pest and disease attack. Animals feed off a variety of different plants at different times. We need to apply this principle of diversity when we decide on which plants to use for our homestead gardens.

When we want to successfully use low input methods, we need to consider all the resources in the area. We need to manage all the water resources including the grey water and potential roof catchments. We need to take into account the organic waste resources for soil health, the plants and animals from the wild and the alternative energy resources that are available. These topics are the focus of the rest of this unit.

3.2 Water management

Imagine it is the year 2015... and the Earth does not have sufficient fresh water. How will we and the natural environment that supports us, survive? Reflect for a moment on this question. What human actions might cause water to be so polluted and so unavailable that the Earth, and all things living on it will suffer? What can we do to manage this scarce resource?

3.2.1 How do we disturb the water cycle?

We explored the water cycle in Unit 1. Now we will look at human actions that cause the water cycle to be disturbed:

- **Polluted (poisoned) air**

  If we pollute our air with chemicals, the burning of plastics and tyres, veld fires, or exhaust gases from cars, then precipitation (rain, dew, snow) will pick these harmful particles up along the way.

- **Clearing the land**

  Removing all the ground cover by cutting trees and other plants, means that the rain does not slowly seep into the soil, but runs off the surface of the soil instead. Water is also unable to evaporate into the air without trees and other plants. Sweeping the soil is another problem that can cause it to become compacted and hard and also preventing rainwater from seeping into the soil. Covering the earth with tar and cement surfaces also prevents the water from sinking into the soil.

What are some of the results of disturbing the water cycle?

- **Acid rain**:

  Precipitation that combines with certain pollutants (poisonous substances) in the air, causes the rain water to destroy plants, buildings, and is also bad for human health. The term *acid rain* is mostly used in 'industrial' countries that use a lot of fuel and chemicals, of which South Africa is one. Acid rain caused by industrial countries also affects other countries as well, as it moves along with the air currents.

- **Erosion and floods**

  When plants are removed and surfaces are covered with tar and cement, or the soil is compacted, water runs off the earth, taking with it the top layer of soil. Some of this run-off, fills up our drainage ditches, causes dirt and chemicals to build-up in our rivers, and poisons our unprotected wells.

- **Low water table**

  In Unit 1 you learned that the water table is defined as the upper boundary of the underground water. What should the normal water table in South Africa look like?

  - **Normal rainy season water table:** The water table differs depending on the season for example during the rainy season in South Africa the soil should become completely saturated by the end of the rainy season. At this point, the water table would reach as high as the soil's surface.

  - **Normal dry season water table:** During the dry season, the water table eventually lowers as water is lost to evaporation and absorption. Many deep-rooted plants and trees, such as perennials, are able to tap into the water table to survive until the arrival of the next rains.

What is the impact of human activity on the water table? The water does not have time to sink into the soil because of the impact of human beings and the design of buildings. The result of this is that the ground water does not fill up, leaving living organisms, including humans, without sufficient water.

Activity 3.1 Healthy and unhealthy water tables

Complete this activity on your own in this study guide

Look at Figure 3.1 below, and answer the questions that follow.

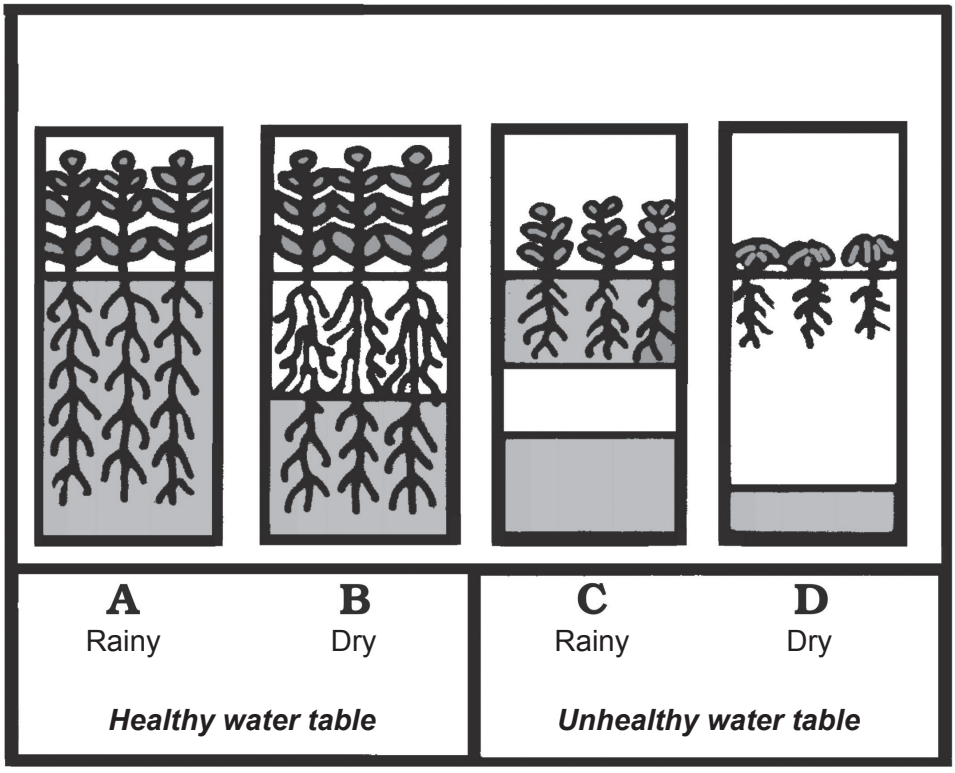

Figure 3.1. Human impact on the water table

Questions

1. Write a paragraph in which you interpret the figure above.

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2. Name at least five factors that could lead to the unfortunate situation depicted in sketch D.

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3. Suggest ways to prevent the unfortunate situation shown in sketch D.

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Comments on Activity 3.1

The shaded area in each box represents the level of the water table:

- **Box A** shows how the soil *should* look towards the end of the rainy season. The water table is fully saturated and the roots are able to go deep into the earth.
- **Box B** shows the dry season when the water table begins to lower. However deep rooted plants and trees can still survive.
- **Box C** shows the water table at the end of the rainy season, where there has been a lot of human interference. You can see that the soil's surface has absorbed some moisture, but it has not seeped to the bottom layers. This results in plants not being able to grow successfully, because of limited water. These trees and other plants are very vulnerable in any dry period.
- **Box D** shows what problems result during the dry season when not enough water seeps into the soil during the rainy season. The plants and trees have not had a chance to reach the lower levels of the water table so they can't survive dry periods. In this situation the water table and ground water have not had a chance to fill up which will create problems such as wells drying up and rivers running dry. This makes it more difficult to find useable sources of water.

3.2.2 How do we disturb catchments?

In Unit 1 you learned that a watershed and its catchment consist of the land from which rainwater flows into wetlands, streams or rivers. What happens when we disturb our catchments?

Activity 3.2 Audit of a catchment in your area

Complete this activity in groups in your workbook

Aim: Use a checklist to identify the human activities in a catchment in your area

Time: One hour

What you must do

Work in groups and use the checklist in your workbook to observe what happens in your catchment area.

Example of a checklist

1. Describe the settlement pattern in the catchment (developed, developing or informal).
2. List land activities in the catchment (what people do and how the land is used)
3. Note the distance of human activities from the banks of rivers, streams or erosion gullies.
4. Note the condition of the riverbank vegetation. Observe any **alien plant** and erosion problems)
5. How do people dispose of waste? Are there landfills or rubbish dumps?)
6. Note any loss of indigenous vegetation (in other words, changes due to farms and plantations such as pines and bluegums).
7. Note wetland and groundwater disturbance/contamination.
8. Other observations.

Questions

Answer the following questions in your workbook.

1. Has the catchment been changed and **degraded** over time?
   Speak to older community members to find the answer.
2. Do the wetlands release clean water all year long?
3. Explain how the **riverine vegatation** (plants along the river) provides flood protection.
4. Is there pollution that might be prevent the river from meeting human needs and from supporting animal life?
5. How do the people in the catchment dispose of waste?
6. Rank the quality of your catchment according to the following score.

What are alien plants?

Alien plants *are also called exotic plants. Examples are pines, bluegums and blackwattle. They were brought into an area by people.They grow in our natural areas and use large amounts of water.*

Indigenous plants *grow naturally in an area. They use less amounts of water than alien plants.*

BAD	NOT SO GOOD	GOOD

7. What influence can the quality of your catchment have on the quality of the lives of the people in your area?
8. How can the quality of the catchment in especially rural areas influence food security?

Reflect

9. Reflect on the above activity and respond to the following questions:
    - What worked well?
    - What did you find most difficult?
    - What changes would you make to this activity in the future?
    - What have you learned from your experience?

Comments on Activity 3.2

Many of the river catchments of southern Africa have been changed by historical land use practices, settlements and industrial growth to cater for a rapidly growing population. Why does it matter if catchments are abused? Wetlands in catchments filter and hold water, slowly releasing it into the surrounding habitats and communities. The natural riverine vegetation performs this function in catchments. The roots of the plants form an enormous sponge which serves not only to store the water in the rainy season but also to filter and release it during the dry season.

How does a **sponge** *work?*

Many people use a sponge to wash their bodies with. If the sponge is put into water it quickly absorbs the water and then slowly releases it.

A number of factors have contributed to degradation of catchments of waterways, these include:

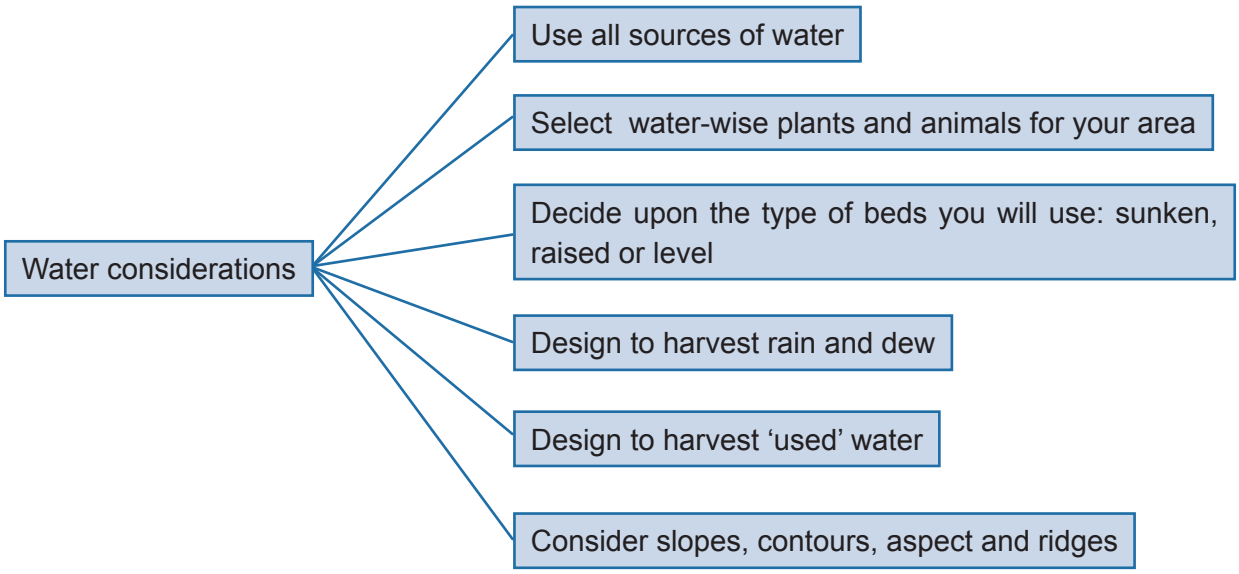
1. The drainage of wetlands
2. The destruction of vegetation in mountain catchments (through fires and farming)
3. The removal of riverine vegetation
4. The increase in erosion
5. The leaching of fertilisers from farmlands
6. The inflow of **effluent**

Catchments must therefore be managed carefully and a balance must be kept between land use and the conservation of sensitive areas. We therefore need to use catchments sustainably. Everybody can play a role in doing this. It is not only the responsibility of other people! This will ensure a good quality of life and a safe and healthy environment.

3.2.3 Water considerations when designing your homestead garden

In the final section of this unit you will design a plan for a homestead garden in your area. When you understand how to follow nature's lead in managing water you can use it to your own advantage. At the same time you will be protecting the water cycle so that it can continue to function effectively. In this section we will examine practical and wise water considerations to bear in mind when designing your garden.

You need to consider the following:



Something to do
Before you continue reading, discuss the six low input water considerations named above and suggest how each one can be implemented. Some of you may have valuable inputs to make in this regard. When you work with households encourage them to share their own valuable experiences. The next section includes suggestions for implementing the six low input water considerations.

Use all sources of water

First we need to consider all sources of water. What does this mean?
We normally think of sources of water as rain, dams, rivers, marshy areas (wetlands), and ground water. But are these our only sources of water? Think again! Can the water we use for washing dishes, clothes, our bodies, our homes, our cars, be used again? You therefore need to realise that we have many sources of water that could be used to help us grow foods.

Select water-wise plants and animals for your area

As part of water management, it is important to learn what types of plants and animals are suited to the area in which you live. Some plants need a lot of water. Others prefer dry sandy areas. People often blame other factors, such as the weather, or drought, crop failures or poor animal health, but often it is because people have selected a crop that will not do well under local conditions.

Activity 3.3 Selecting water-wise plants and animals for your area

Complete this activity on your own in your workbook

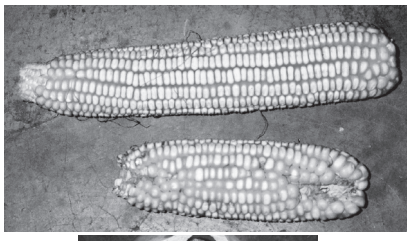
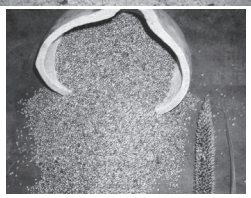
Aim: To identify suitable, water-wise choices of plants and animals in an area

Time: 30 minute

What you must do

1. In groups discuss and make a list of examples of crop plants and farm animals that have high, medium and low water needs.
2. Which of the plants and animals that you listed would be suitable for your area?
3. Do people in your area make water-wise choices in their selection of plants and animals? Give a reason for your answer.

Comments on Activity 3.3

High water needs (marshy areas such as wetlands)	Medium water needs	Low water needs
Bananas, sugar cane, fish, ducks  	Maize, exotic plants (from other countries), vegetables, most cattle    	Indigenous vegetables such as cowpeas, bambarra nuts, sorghum, millet, peanuts, pumpkins, tomatoes and many indigenous trees like the marula, chickens, Nguni cattle     

There are many more examples which you might have included in your answer.

Decide upon the type of beds you will use: sunken, raised or level.

You need to decide what type of beds you should make for dry or wet areas. Preferably you will design and make your beds at one go and never make them again, so some thought needs to go into what the area looks like in the dry and wet seasons.

Dry areas: Sunken planting beds (basins)	Wet areas: raised planting beds	Level planting beds
Basins help to collect water and guide it down to the roots of the plants. These can be large basins for larger trees and plants or small basins for smaller plants. Some people like to have sunken beds for their whole garden, but make sure that your soil can handle that, since there is a lot of rain that will gather in the beds which might flood and drown your plants! After digging a hole the size you need for your tree, seed or seedling, plant the item low in the hole so that the earth you replace in the hole is less than you took out of the hole. Adding compost to your bed means that even less of the hole's original soil goes back into the hole. Extra soil can be used to create a ridge around the basin, or you can use the displaced soil somewhere else. You can help to strengthen the basin by placing stones, soil or other material in a circle around the hole (or semi-circle, if you are on a slope), and/or by using a stone mulch in the basin, which is very useful when there are chickens around. Always add mulch as the last step so that the soil is always covered! If you are using a stone mulch, you could also add a layer of organic matter before putting on the stones, to add a little more nutrition for the tree or other plants.	If your soil has plenty of water, or the crops you have chosen do not like water, you would choose just the opposite of sunken beds. Raise your beds above the surface, so that the water runs away from the plants.	You may not need raised or sunken planting beds. Planting level with the earth, so that the whole area gets the same amount of water, may be the best option for your land. **What is mulch?** *Mulch is a layer of leaves, grass, husks or other organic matter that is placed on the soil between the plants. We will examine mulch in more detail in the next section.*

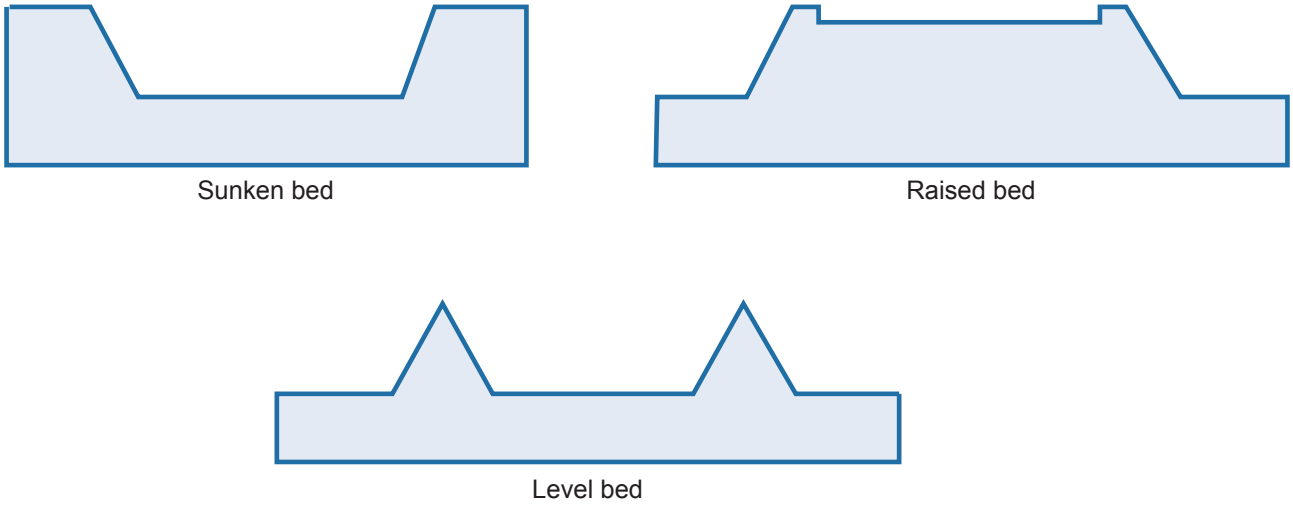


Figure 3.2 Sunken, raised and level beds

Design to capture rain and dew

A lot of water goes to waste in the rainy season, when it runs off our roofs, our roads and down our drains. This water can be captured! We have already given you some examples a little earlier. Here are a few more examples of the capturing of rain and dew:

- **Water tanks**: Houses and other buildings can be designed so that all the water from the roof flows into water tanks. The tanks can have a tap so that people can use the water from the tank. It is helpful to use roof gutters to catch the water off the roof and guide it into the tank.

- **Other containers**: If you cannot install a tank, capture the water in whatever you have – large clay pots or drums.

- **Pits or banana circles**: At the end of any drain, appropriately sized pits filled with organic matter and planted with bananas or other appropriate plants and trees around the edge will stop the water from flowing away. In this way a wet, fertile area for clumps of plants will have been created.

- **Road drains**: All roads should have drains at appropriate intervals to guide water into pits or trees or other areas that can soak up the water. Removing water as it goes down the slope prevents it from building up and causing flooding at the bottom.

Swales: Swales are trenches that are dug to capture and manage water runoff, and increase rainwater infiltration. How do you make a swale?

  - Dig a trench along the contour of the land. The trench size and length will depend on the slope of the land. You will dig deeper, longer trenches for steep places.

  - Make a ridge along the downhill side of the trench using soil from the trench.

- Fill the trench with organic matter to help cover the soil and absorb the rain water.
- Plant along the ridge using strong-rooted, permanent plant species, preferably foodplants! Continue planting permanent species to fill about a metre below the ridge, using smaller plants close to the ridge and larger plants, like trees or shrubs, further down.

  As rainwater flows down the slope it will enter the trench, spread out, and be allowed to sink into the soil. As this water is absorbed by the soil underground, it will provide the roots of the plants with the nourishment that they need, without washing the soil away in the process.

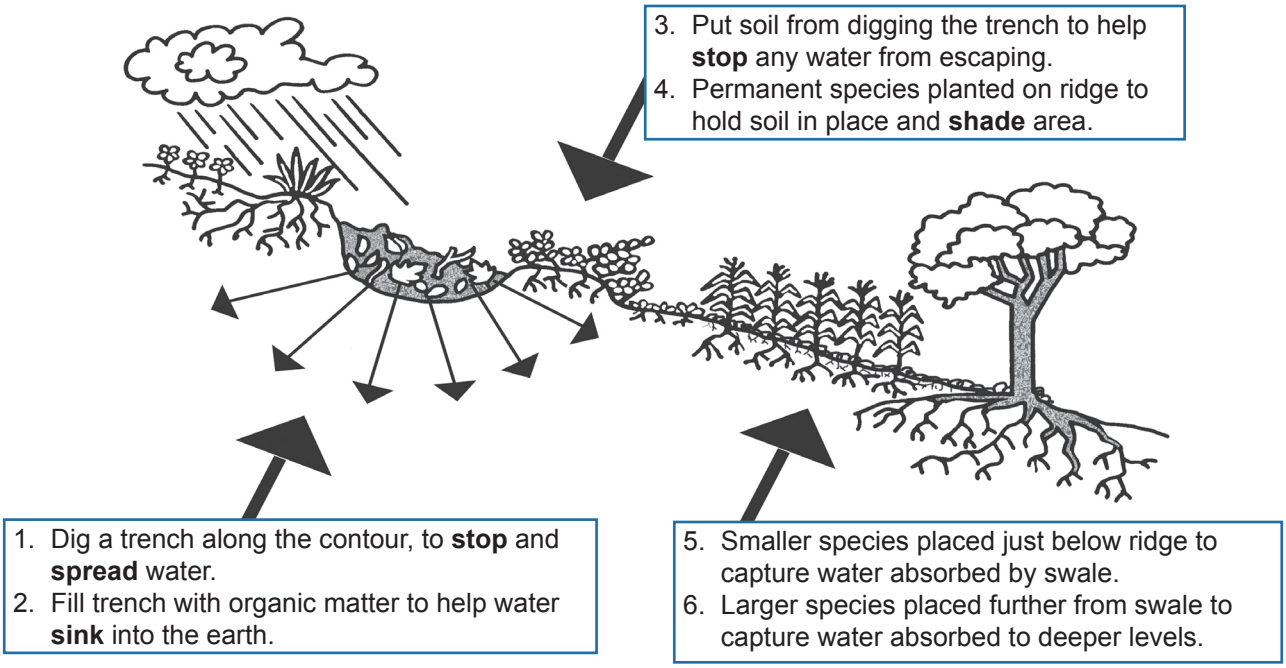


Figure 3.3 Water-wise with swales (Low Input, p 85)

Design to capture 'used' water

Used water is referred to as **grey water**. Take a look around your home, your place of work, and your community and ask: *Is there any water that is being wasted? Is there standing water anywhere? Is there water that could be used more than once? Is there any water that could be directed into a homestead garden or be used to water trees?* Often the answer to this is *Yes!* There is lots of water going down the drain or thrown on bare ground that could be used to produce food and perhaps make money! However before you use your grey water, bear in mind, at the very least, the following:

- **Consider what might be in the water.** If people are throwing dangerous chemicals down the drain, like chlorine bleach (Jik) or chemical cleaners (Vim and Handy Andy), the grey water might kill the trees and other plants. In this case you can change to natural cleaners such as natural soaps and wood ash that works like a scrubbing powder, sand, or other local solutions.
- **Consider the type of plants and trees to include in your design.** Do not use grey water on short leafy green vegetables such as spinach or marogo, since the leaves might then not be safe to eat. You can use grey water on climbing plants such as beans, or fruit trees and other plants where the food is not very close to the ground. The soil will filter the water and the roots of the plant will take up what they need and will produce delicious food!

- **Borehole / Wells / Taps**: Areas where people draw water will often have standing water or wet areas that can be used to grow plants. Standing water can breed malaria-carrying mosquitoes, so it is important to get this water to sink into the ground. By planting suitable plants you soak up the water, thereby preventing mosquitoes from breeding. Choose plants and trees that are suitable for moist conditions. If it is a community water site and there is a question over whose produce it will be, then the community can agree to sell it and put the proceeds towards the maintenance of the pump. They can also use all the produce for community projects, such as caring for orphans, widows, people with illnesses, and/or for the elderly.
- **Bath water**: Drains from bathing areas are very easy to convert into small gardens. Simply direct the flow to where you want it and plant! Even if people urinate in the bath, this urine is full of urea, which is something that many people buy and add to their fields! (Note: this does not mean that people should urinate on the plants, since this might kill them. Urea must be dissolved in water, and taken up by the roots first, for plants to be able to utilise it).
- **Wash water**: Many people travel long distances to collect water, which is then used once to wash the laundry or the dishes and then throw it away onto the bare ground. Don't waste this water! It can be used to grow food, clean your home or community, or water trees that can give you wood for fuel and building supplies. It takes the same amount of work to throw water onto growing plants and trees as it does to throw it on the bare ground, but you will get so much more from it.

How can you redirect water?

You can use plastic bottles, bicycle tire tubes, old garden hoses, and various other odds and ends that are often lying around

Activity 3.4 Be water-wise with dish drying racks

Complete this activity on your own in this study guide

Most people in Malawi build a tall 'Tandala' rack to dry their dishes. A Tandala rack is shown in the figure below.

Figure 3.4 A Tandala Rack

Questions

1. Do people in your area a use similar structure to dry their dishes? Explain what they do.

.....

.....

2. Describe how you will use this rack for growing food plants?

.....

.....

.....

Comments on Activity 3.4

People from Malawi put their dishes onto the Tandala rack soaking wet and the clean water drips onto the ground. This area is perfect for growing plants that like moisture and a bit of shade. The rack is a good choice for growing sweet potato vines. The water will drip down from the wet dishes, and allow the sweet potatoes to grow well until the next rainy season.

Consider slopes, contours, aspect and ridges when designing your homestead garden

You will recall that in Unit 1 we discussed contours, slopes, aspects and ridges. It is important to take the shape of your land into consideration, as this will affect your farming/ gardening and how you use the land. Now we will actually measure the slope using a line level. A line level is a home-made instrument that can be used to measure contours (the levels across a slope).

To practise working with a line level, you first have to build one. Then you will need to practise measuring contour lines. These are lines that are on the same level on a slope (that is, on the same elevation above sea level).

What are slopes and contours?

In Unit 1 we examined slope and contours. You will remember the following:
Slope tells us how steep or flat our land is.
Contours are imaginary lines across a slope, indicating the steepness of the slope.

Activity 3.5 Using a line level

Complete this activity on your own in your workbook

Aim: Make a line level to measure contours and slope

Time: 1 hour

What you will need

20m fish line; a line level; two lengths of wood about 2 metres long (marked at 30, 40 and 50 cm from one end; a measuring tape.

Note: A spirit or line level is a small plastic tube that you can buy from the hardware, and is often used by builders.

What you must do

1. Using a measuring tape and a pencil, mark each piece of wood (pole) carefully along its length in 10 cm marks. Number these marks from the bottom.
2. The two pieces of wood are then linked by exactly 10 meters of string (after you have tied the string to the poles), which should be tied to each pole so that it can be slid up and down the pole.
3. Hang the spirit or line level in the middle between the poles. When the string is horizontal, the spirit level is also horizontal or level and the air bubble will be in the middle of the transparent tube. When you have assembled your line level, it should look like the picture in Figure 3.5 below.

Note: To use the line level to mark contours the string is placed at the SAME HEIGHT (on the same mark) on both pieces of wood.

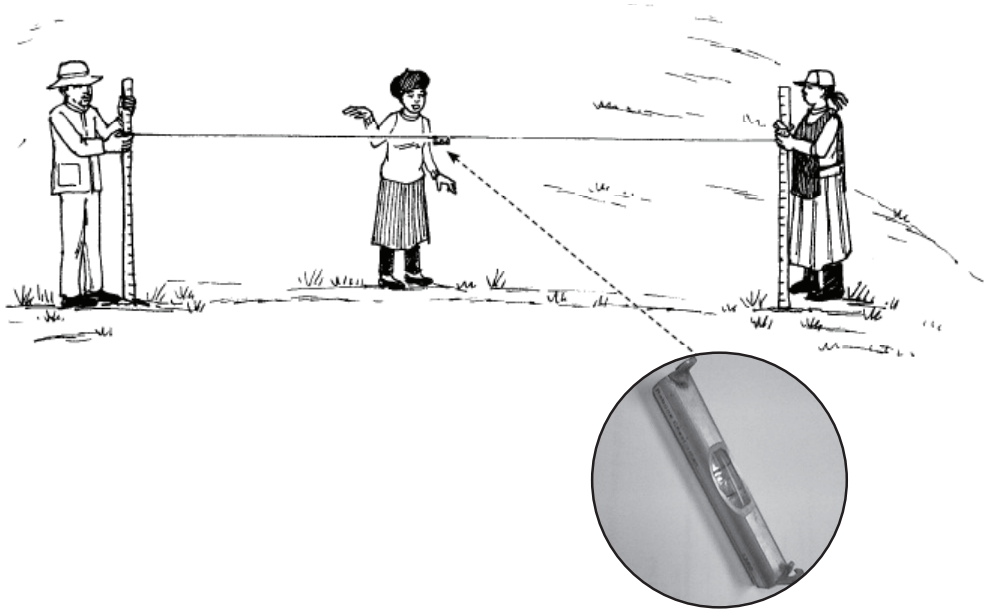


Figure 3.5 Using a line level to mark contours.
(Note that the string is tied at the same height on each pole. The bubble of coloured liquid in the line level is in the middle when the poles are at the same height.)

It is common to start marking contours at the top of the slope where you are working. You start by marking the first contour. Once you have done that, you need to move down to where you will make the second contour. How far apart the contours are depends on the steepness of the slope. Figure 3.6 below shows you how to mark contours in a field.

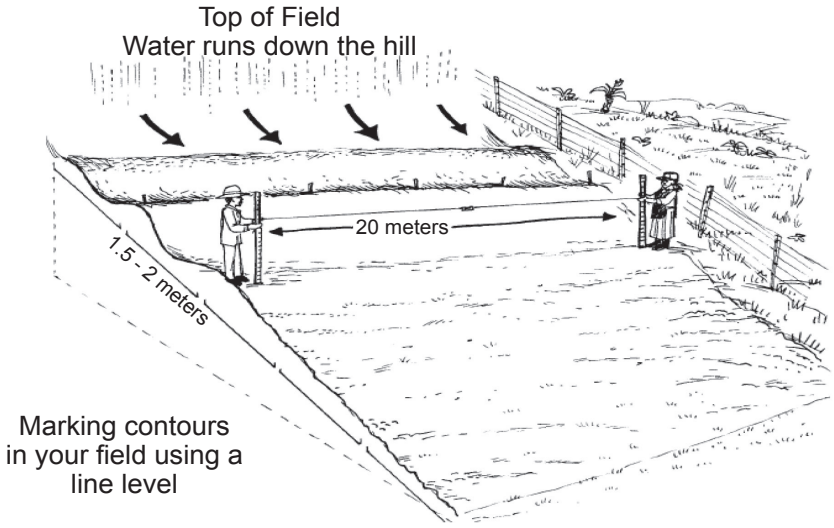


Figure 3.6 How to mark contours in a field

Activity 3.6 Using a line level to measure slope

Complete this activity on your own in your workbook

Aim*:* Use a line level to measure slope

Time: 30 minutes

What you must do

1. Two people should hold the poles you used in the previous activity.
2. Place the poles down the slope 20 metres apart.(See Figure 3.6 above) The string should be on the same mark from the bottom of the pole towards the top (on both poles) when you start. The people holding the poles must make sure that they keep the poles standing straight up (in other words, that they are upright).
3. One person now stands between the two poles in order to look at the spirit or line level.
4. The person on the higher ground moves the string down the pole until the line is level, that is, until the bubble is in the centre of the transparent tube of the spirit level.
5. When the line is level, count the number of marks you have moved the string down. Each mark shows a 1º slope. For example, if you have to move the string down five marks you have a 5% slope. Once you know the percentage you can go back and look at the table (See Annexure B - Conversion of angles to degrees of slope and distance between contours) to work out how far apart the contours need to be. For a 5º slope as in this example contours are about 19 meters apart**.**

The figure below gives you an indication of how to measure slope with a line level.

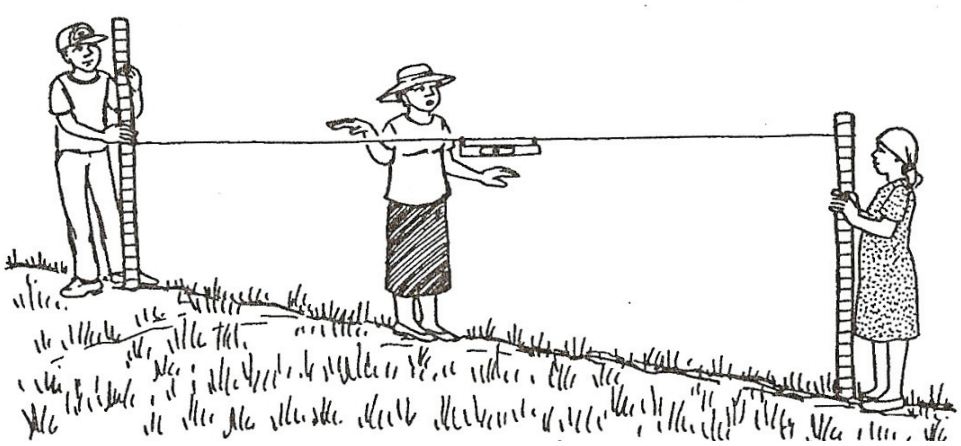


Figure 3.7 How to measure slope with a line level

Why is it important to measure slope? Land that has a slope needs special attention to make sure you do not cause erosion. Using a mulch helps to hold soil in place, but with steeper slopes you will want to make sure that you have some permanent contours or terraces using rocks and strong rooted plants to keep the soil in place.

Summary: The four S's in water management

To summarise the section on water considerations for your garden we can say that if we allow the water cycle to function properly, it will be able to give us all the clean water that we need to survive. How can we do this effectively? The answer is to remember the four S's:

The four S's

- *Slow or stop*
- *Spread*
- *Sink*
- *Shade*

Refer to the previous section for more information

- **Slow or Stop** – slowing down the speed of the water gives the water more time to enter the soil. Ways to slow water include using 'check dams' made from rocks, logs, sticks, old maize bags filled with dirt. Be creative! Another way to slow down water is to catch it from roofs, roads, or other surfaces from which the water is running off. It can be caught in drums, clay pots, pits, or pond. You will have to consider if the water is free from chemicals or other harmful substances or not. This will then determine how you will use the water.
- **Spread** – Now that the water has been slowed down, you want it to spread out enough so that there is not too much water in just one place. Spread the water out across the slope (along the contour) in preparation for the next step, which is a process known as sinking.
- **Sink** – If the soil is healthy with lots of insect tunnels, micro-organism activity, organic matter, and there are plenty of roots in the soil, the water will be able to sink into it. This sinking process helps to filter the water so that it is clean by the time it reaches the ground water table. Sinking will depend on the type of the soil – clay soil absorbs water slowly whereas sand absorbs it very quickly. Knowing where there is clay soil can be to your advantage if you want to create a pond or tank in which to collect the water.
- **Shade** – Now that the water has sunk into the soil, you want to keep it there by using mulch, ground covering plants, and bushes or trees that provide shade.

3.2.4 Low input irrigation

When the word *irrigation* is used, most people think of systems that need money, labour and time to lead fresh water to the plants. This might be an appropriate choice in some places, but for most places, you will first want to use the water capturing methods listed above. In addition to these, there are many low-input irrigation methods that have been tested and shown to work well. Whatever method you choose for irrigation, you will want to bear in mind the following guidelines:

Guidelines for low input irrigation

- Water where it counts; water the roots.
- Plants absorb most water from their roots. They can absorb some moisture from the air through their leaves, but the bulk of their water intake is through the roots.
- Avoid over- or under-watering.
- Using the correct amount of water will depend on the type of soil you have, what design you've made, what types of plants you've selected and the age of the plants and trees.
- Try to water just before wilting starts.
- Don't give plants frequent, short, shallow watering; rather water less frequently but give the plants a thorough soaking.
- Use furrows or paths to guide the flow of water.

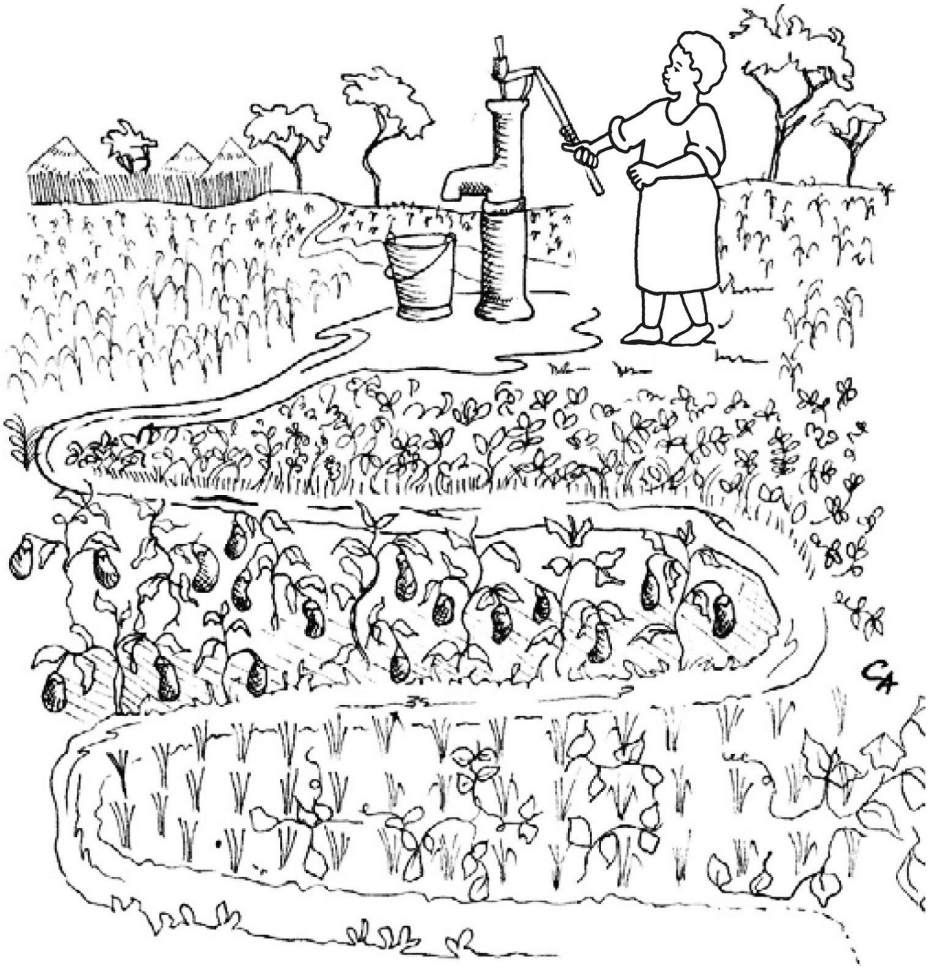


Figure 3.8 Low input irrigation

Prevent the formation of salts

When using any irrigation method, you will want to prevent the water from evaporating into the air very quickly and leaving salts on the surface of the soil. These salts make it difficult for many types of plants to grow. In very hot, bare areas this risk of quick evaporation and salt deposits is the greatest.
Ideas to prevent salting include the following:

- Mulch garden beds to reduce evaporation by up to 90 percent.
- Improve soil water's holding ability by adding compost, which will attract worms.
- Plant the right trees in the right place to provide the garden with shade and wind protection.
- Do not over-water the area; only give it as much as it can absorb.
- Group plants according to their water needs to prevent under or overwatering.
- Water in the morning or evening to reduce water loss through evaporation.
- Deep watering once or twice a week is much more efficient than sprinkling every day. This will also make plants more drought-tolerant
- Avoid watering on very windy days.
- Avoid fine mist sprays or any sprinkler that sends water high into the air.
- Set up sprinklers and sprays to water plants at their base.

Low input drip irrigation methods

The following are some ideas for getting water to the roots of plants, to reduce evaporation of the water into the air, and to reduce the amount of time, water, and energy spent on irrigating. Most of these drip irrigation methods can be used from time to time with the green manure teas, compost tea or animal manure teas as described in the section on soil in this unit. Low input drip irrigation methods include the following:

- Using unglazed traditional clay pots buried in the ground up to their rim and then filled with water allows water to seep into the ground very slowly.
- Bottles without a lid, such as beer or wine bottles, can be filled with water and then pressed tightly into the ground, mouth side down. The water from the bottle will slowly enter the soil.
- Plastic bottles and tin cans can also be used in a similar way. For this method you make two or three very tiny holes in the bottom of a plastic bottle or tin can.

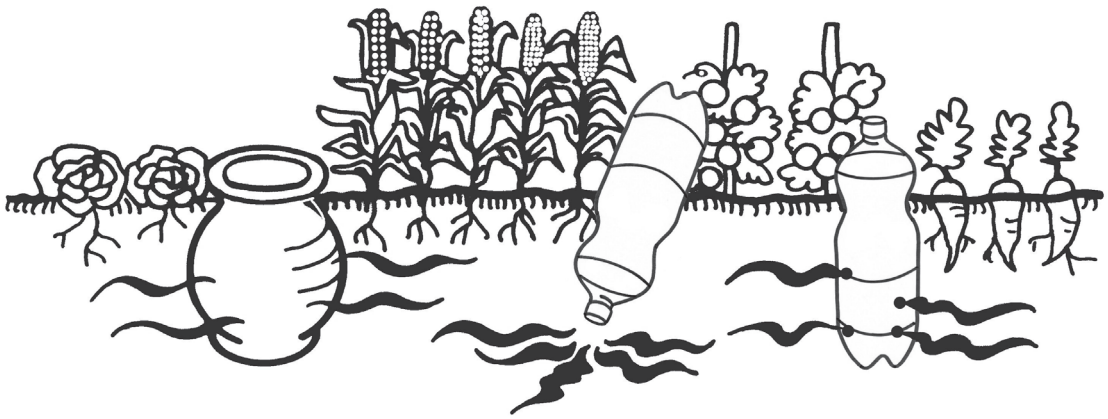


Figure 3.9 Drip bottles for irrigation

3.3 Soil management

Imagine it is the year 2015 and the Earth does not have sufficient healthy soil. How will we and the natural environment that supports us, survive? Reflect for a moment on this question. All living things rely on and eventually return to the soil. The health of our soil is directly connected to our own health. Whatever we do to the soil we are eventually doing to ourselves. If the soil becomes ruined, this will affect the nutritional value of our food. If we are able to learn from nature about methods that help the soil we will have taken the first step towards making our lives better.

How does nature keep soil healthy?

In undisturbed areas there is a natural cycle which keeps soil healthy. Refer to the cycle of nature in Unit 1.

In David Patient's *Positive Health Manual*, he compares the soil to a savings account. The more we put into it, the wealthier we become. But if we continue to take from it, without making any deposits, we will eventually end up broke and hungry.

3.3.1 How do we abuse soil?

You may be aware of practices that have a negative influence on soil. Complete the next activity to give structure to your thoughts on this topic.

Activity 3.7 Interfering with the balance in soil

Complete this activity on your own in this study guide

Take a minute to think what human beings are doing to interfere with the balance in soil.

1. Compile a list of these negative activities.

.....

.....

.....

2. Which of the negative activities, that you or the group listed, are relevant in your area?

.....

.....

3. Reflect on how these negative practices can be changed by household members.

.....

.....

Comments on Activity 3.7

Your list may include some of the following:

- Paving the earth
- Sweeping the earth
- Chemicals in the soil
- Unnecessary digging of the soil
- Disturbing useful insects
- Burning the bush or any organic matter
- Compacting the soil
- **Mono-cropping** forests and agricultural areas
- Clearing away plants and trees
- Overgrazing
- Soil erosion

What is mono-cropping?

Planting large areas with only one kind of crop, for example maize (mealies)

You may be aware of many more negative practices than those we discussed.
Please share your ideas with others in your group and suggest solutions that you know can work.

What do we find if we look closer at farming or gardening practices that affect soil structure?

Farming or gardening practices that affect soil structure

There are many practices that harm soil structure such as:

- Burning vegetation (plants), which causes ash to form, or using mineral fertilizers, results in the over-activity of the soil microorganisms. At first the microorganisms multiply quickly because they are stimulated by the ash or fertilizer. They then start dying from a lack of food. We can compare this to a grassy area that has a fence around it where too many goats are grazing. What will happen to the goats after a time? The herd will quickly decline for lack of fodder.

- Heating of the soil surface through fire or prolonged sunlight. The ground dries up and the microorganisms are killed.

- Destruction of the crumbly structure of the soil through the splashing of raindrops on bare soil that is subjected to the frequent traffic of heavy, wheeled machinery.

- Too much water, too often causes permanent flooding. In such circumstances soil organisms and plants die from lack of air.

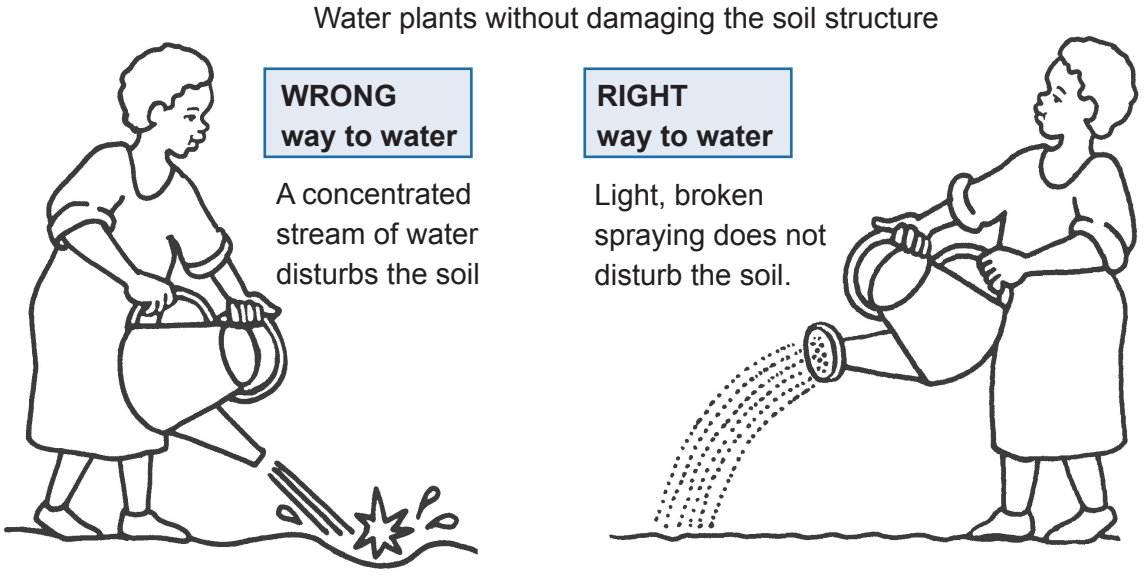


Figure 3.10 The potential destruction of soil structure through incorrect watering.

The unnecessary poisoning of the soil

Chemical products such as pesticides and fertilisers which many gardeners and farmers use to kill harmful organisms and weeds, poison the soil.

Activity 3.8 The effects of chemicals on soil

Complete this activity on your own in this study guide

1. Look at the statements below and decide whether they are true or false.

- Chemicals are expensive to make. During manufacturing a lot of the earth's resources such as fuel are used……
- Chemical fertilisers do not feed the soil, they provide a treatment like 'medicine' for the plant or animal so it can survive in poor soil……
- Chemicals can be toxic to human beings, especially to children, the elderly and those with weak immune systems such as with HIV/AIDS sufferers……
- Special training is needed in how to handle chemicals without getting poisoned or burned……
- Chemicals can poison the environment, especially our water sources and soil……
- Chemicals can kill beneficial insects, worms and micro-organisms either directly or by the effect that chemicals have on their environment……
- Insect pests can develop resistance to chemicals (pesticides) i.e they are not affected by them.....
- Chemicals build up in the food web (refer to Unit 1), and people as top level consumers, ingest these chemicals, thereby poisoning themselves. (This also applies to other animals)……
- There are better options for designing our agricultural systems and homes so there is no need for these chemicals in the first place!.....

2. Suggest options that are better than using chemicals for your gardening or farming activities.

……

……

……

Comments on Activity 3.8

Hopefully you said that all of the statements above are true. You will learn more about other options, instead of using chemicals, in Module 5.

What else can go wrong with soil, and what solutions are there?

Soil health is influenced by more than just soil structure. When people live and farm in an environment, they usually change it to suit themselves and use the resources available to them. When we are managing a resource, we are consciously looking at, thinking about and caring for that resource. We need to be able to identify the warning and danger signs of overuse or incorrect use.

3.3.2 Desertification and soil erosion

We often read of or hear about soil erosion and desertification, but what exactly are they and what causes them to happen?

What is desertification and how does it develop?

Desertification can be defined as land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including variations in climate and human activities.

What are arid regions?

Arid regions are very dry areas with little rainfall

How does desertification develop? It is usually said that desertification develops because of a poor climate. There are however, more important causes such as the following:

- Overgrazing and over cultivation
- Incorrect tilling methods
- Poor irrigation techniques
- Burning of the area
- The tilling of soils which are not suitable for agriculture
- The clearing of vegetation and deforestation (We will examine deforestation later in the unit.)

Vegetation (plants) plays several roles in controlling the movement of water, both in the ground and over the ground (known as run off). When vegetation is removed the soil is bare. When more and more plants are removed each raindrop hits the ground like a bullet. The raindrops then loosen the soil particles that are blown or washed away. First the topsoil is lost. This is full of nutrients. The subsoil that remains is less fertile and it is difficult for plants to grow in it. The land becomes like a

desert. We therefore place our environment and ourselves in danger of much more severe floods and droughts, more extreme temperatures and worse soil erosion when we promote or accept these practices.

What is soil erosion and how does it develop?

Soil erosion is the loss of soil and its nutrients which impact negatively on plant growth.

How does soil erosion develop? Erosion can be caused by water or wind. Erosion caused by water is a problem in the wetter parts of South Africa such as Kwazulu-Natal. Erosion caused by wind is a problem in the dry areas such as Limpopo Province and the Karroo.

There are several factors that make erosion worse and these include:

- Bare soil
- Steep slopes
- Heavy rainfall
- Cultivation on steep slopes
- Cultivation down the slope instead of on the contour
- Sandy soil, which washes away more easily than do clay soils)
- Soil that is ploughed too much, and washes away more easily.

Why are we concerned about soil erosion? South Africa loses almost three tonnes of soil from each hectare of cultivated land each year. Natural processes create only 0,7 tonnes of soil on each hectare. We are thus steadily losing soil, which is not being replaced (in other words, replenished). This affects farming and living in rural areas in a very profound (serious) and negative way.

Figure 3.11 Disadvantages of bare landscapes, compared to the advantages of having vegetation in the landscape

Forms of erosion

Erosion can take the form of:

- sheet and rill erosion
- gullies and dongas.

It is important that you are able to identify these types of erosion and then to be able to recommend protective and erosion control measures. Below are some examples of forms of erosion and the control measures that can be used.

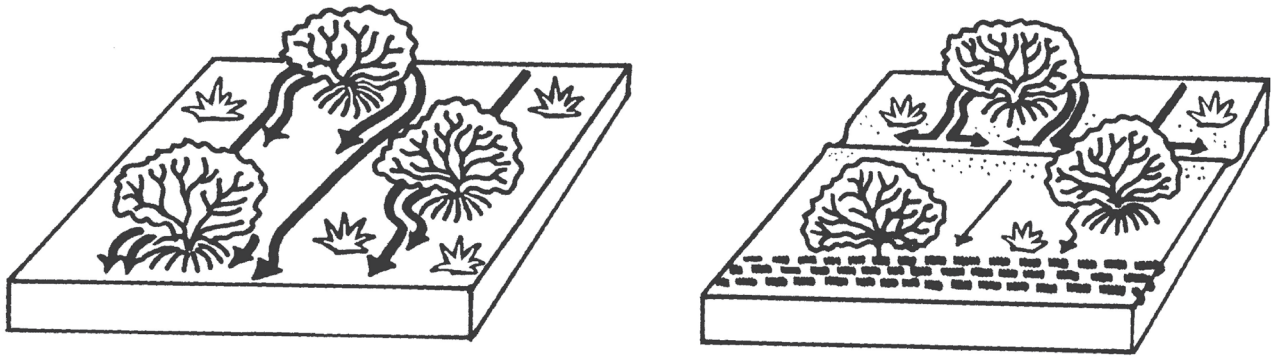
With **sheet flow and rill erosion** you will see bare earth that looks compacted. You will often also see collections of lines of organic matter and small stones, that look like **swales**. You may also see plants poking out of the ground with some of their roots exposed.

How can we address sheet flow and rill erosion? The lines of organic matter which you sometimes see, can help to show you where contour lines or structures can be built.

With the problem of exposed roots (plant pedestals) you will need to slow the run-off and increase infiltration of water into the ground. Examples of structures that can help you do this are:

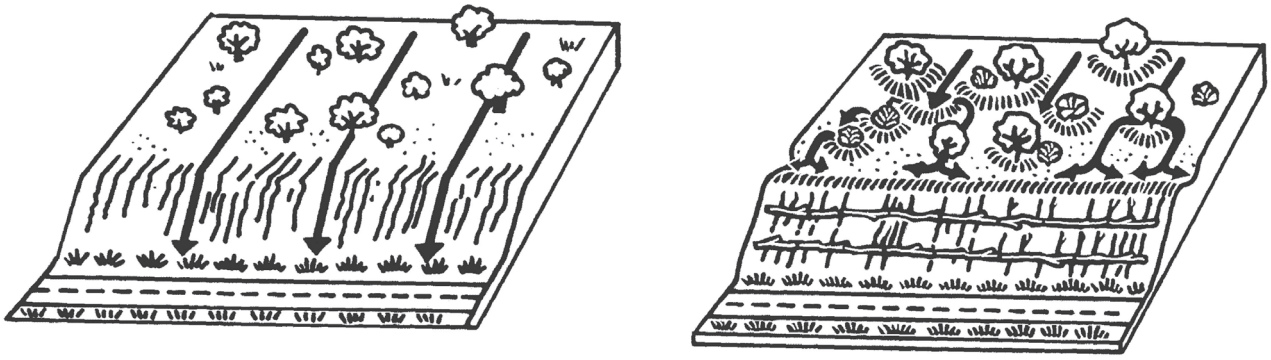
- Berms (contour bunds and ditches, swales)
- Basins and infiltration basins
- Imprinting (small hollows] created in the ground for seeds to germinate
- Increased vegetation.

First you need to ensure that the sheet flow (water running on the surface) is spread out and that it can infiltrate above the rills. Berms and basins, vegetation and mulch can all be effective. Then try to ensure that the water can spread out and infiltrate within the rill itself, with a series of very small check dams constructed of branches and rock piles laid across the cut.



A. B.

Figure 3.12 Sheet flow erosion
A. Sheet flow erosion indicated by arrows
B. A contour ditch and small infiltration pits that help to control sheet flow erosion.



A. B.

Figure 3.13 Rill Erosion
A. Rill erosion indicated by arrows
B. Berms and basins and small check dams that control this type of erosion.

With **dongas/gullies** the run-off concentrates in channels or drainages. Now you will see the more familiar patterns of erosion: rills, gullies or dongas, and the head points of dongas/gullies. You may also see the cutting and collapsing of banks, deposits of different sediment sizes and exposed roots.

Within the gully, the flow needs to be spread and infiltrated as much as possible using permeable barriers. In larger gullies or dongas, strong barriers like **gabions** need to be constructed.

Using gabions to control water flow in a donga or gully

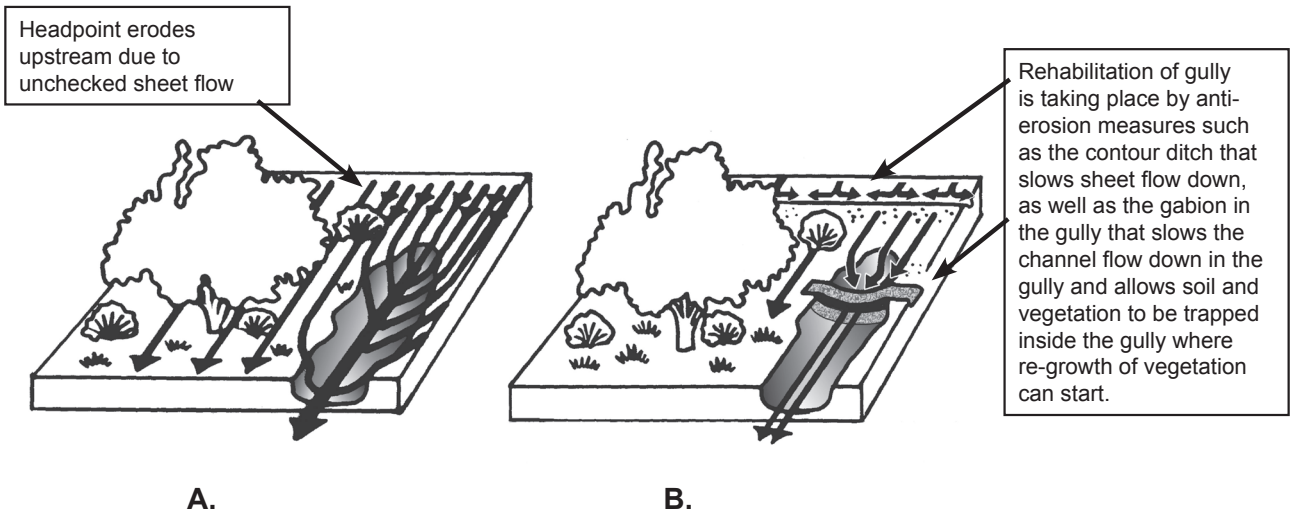


Figure 3.14 Rehabilitation of a typical gully
A. Formation of a typical gully with a head point that increases uphill over time
B. A contour ditch above the gully and gabion structures in the gully that help to control this form of erosion.

Activity 3.9 Causes of soil erosion in your area, and possible solutions

Complete this activity in groups in your workbook

Aim: Identify soil erosion in your area and suggest possible solutions

Time: 2 hours

What you will need

At least two people whom you can talk to and who will be prepared to walk around the areas with you and discuss causes of, and possible solutions to the problem of, soil erosion.

What you must do

Read through the notes on soil erosion and control measures above. Look for signs of soil erosion in your area. Look around the homesteads, croplands and grazing lands.

1. Using your notes, identify places where soil erosion happened. Make drawings and, if at all possible, to take a few photographs.
2. Describe the type of soil erosion that you can see. Is it sheet, rill or gully erosion?
3. What do you think are the causes of this erosion? Talk to people in your area about the erosion. Ask them for ideas about causes. Walk around the area and see if you can identify any causes.
4. Also talk to people about what can be done to control erosion. Make a list of their suggestions.
5. Write down some ideas of your own on how to control the erosion that you have seen. You will need to refer back to your notes as well.

Reflect

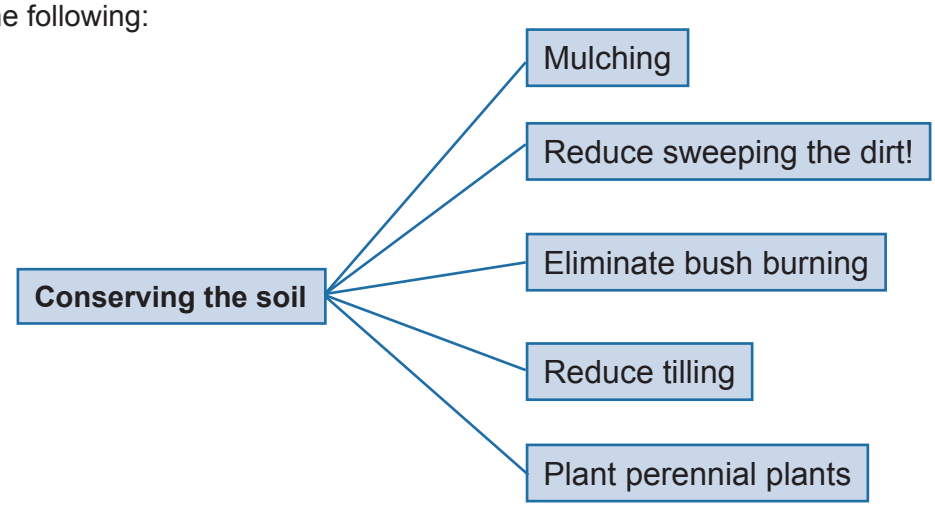
6. Reflect on the assessment and analysis of resources activity and write answers to the following questions:
   - What worked well?
   - What did you find most difficult?
   - What changes would you make to this activity in the future?
   - What have you learned from your experience?

3.3.3 Soil considerations when designing your homestead garden

You are now aware of soil problems concerning the structure of soil and are also aware of soil erosion. What positive soil practices can we apply that will conserve soil and also improve soil structure.

Practices to conserve soil

When we look at the bigger picture of how to conserve soil we can summarise this by saying that we need to do the following:



Mulching: Dead or alive nature is always covered!

Nature is always covered! You know that mulching means placing a layer of leaves, grass, husks or other organic matter on the soil in between the plants. Dried leaves, stones, sawdust, and /or live vines are examples of mulch.

Mulching has many benefits, as follows:

- It keeps the soil cool and moist, even when the weather is hot. This reduces the number of times that you need to water plants in the dry season.
- It creates a soft layer of soil that is easy to plant directly into during the rainy season or when irrigating. No digging is needed! You can just make a small hole for the seed or seedling, depending on the situation.
- It keeps the soil protected from rain and wind so that it is not washed or blown away.
- It keeps the plants protected from being splashed with soil when it rains or during watering.
- It retains water during periods of drought, and protects the soil against flooding in the wet season.
- A heavy layer of thick mulch prevents unwanted plants from growing in between the plants.
- Best of all, mulching means less work each day!

Why doesn't everyone mulch with all these great benefits?

Many people are very wary about mulching their soil for the following reasons:

- **They fear that mulch is dirty.** This is not true as uncovered soil is actually dirtier! It is dusty in the dry season and muddy in the rainy season.
- **They fear that mulch will bring snakes.** However snakes do not want to be around human beings. They prefer to be up in a tree, under a nice pile of rocks or sticks, or in a hole.
- **They fear that mulching will bring termites that will hurt our plants.** Think, for a moment, about termites and what they do in nature. Their job is to decompose the dead or dying organic matter and convert it back into soil. Their job is not to eat live healthy plants. However, if we sweep away and burn all the termites' food, they are going to look for the other things they can find to eat, such as wood!

Reduce sweeping the dirt!

Sweeping removes organic matter from the topsoil, which, in turn, removes the food and protection the soil needs to stay healthy. Sweeping makes the earth hard and does not allow water to sink into it, causing erosion through wind and rain. When large areas are swept, it reduces the amount of land that we can use for growing food.

Eliminate bush burning

Most people will agree that burning the veld is harmful to:

- the air that we breathe;
- insects and micro-organisms that are trying to keep the soil healthy; and
- plants that are used for foods, medicines, fuel and thatching.

I am afraid that a bush fire will destroy everything I have. I therefore need to construct a ***fire guard*** *or* ***fire break****.*

The hardest part is to get people to stop burning the bush! There are many ways to start reducing burning. We need to begin with ourselves, then next with the people who are closest to us. We need to help others understand the cycle of nature, the importance of the things that they are burning and the harm that the smoke does to organisms that breathe the air.

Reduce tilling

Hoes and other implements affect the decomposition stage of the cycle of nature. They disturb it by disturbing the insects, worms and micro-organisms that are busy working in the soil. So why would you want to disturb them? It is much better to feed the soil's creatures with organic matter and not to disturb them.

Nature does its own tilling by means of plant roots that grow down and let water and air into the soil. Soil organisms make tunnels in the earth. We can mimic what nature does by inter-planting trees and other deep rooted plants; interplanting root crops such as yams or ground beans (*nzama*); allowing chickens to scratch around the mature plants; and by keeping the soil covered with organic matter to protect and feed the insects and worms.

A good way to clear the land is to do it carefully. Try to protect useful plants, used for foods, medicines, crafts and building supplies. Also protect leguminous plants that feed the soil. Dig only where you have to, and dig only small sections.

Plant perennial plants

Another way to conserve soil is to have some plants and trees that stay in the soil every year without replanting. These are known as perennials and they are excellent for many reasons:

- You only plant them once, but harvest for many years;
- They are usually very tolerant of fluctuating weather conditions such as flooding and droughts;
- The roots help water go down deep into the water table, which helps to retain water in our soil throughout the dry season;
- Their roots hold the soil and their stems trap organic matter;
- The taller perennials can block the wind.

You are now aware of practices to conserve soil, but how can we improve soil structure?

Practices to improve soil structure

Control run-off.
Structures that can slow down run-off water and help the water sink into the ground are needed. (Refer back to the section on water management.)

Adapt tillage methods
As we explained above, it is possible to farm in such a way that ploughing is minimised (in other words, it is used less often). This is called minimum or no-till farming (farming without ploughing). This process reduces the damage caused by ploughing the land over and over again.

Make use of fallow intervals
This means leaving areas of land, which are unexploited (in other words, not used) during cropping. This will allow plant species to re-occupy the unused areas. After some years, any badly structured soil will improve considerably.

Cultivate soil-enriching crops such as legumes
One nutrient that all plants including food plants need, is nitrogen. A legume is a type of plant that co-exists with a special type of bacteria that grows on its roots. These bacteria are able to 'fix' nitrogen in the soil, and change it to a form of nitrogen that the plant (the legume) can use. Human beings and other animals eat these plants and obtain nitrogen in this way. Some of this 'fixed' nitrogen leaks into the soil, thereby enriching it for the next group of crops that will be planted.

Examples of legumes are:

- **Edible legumes**: beans, peas, ground nuts and ground beans (see Annexure C)
- **Non-edible legumes**: acacia species (*msangu, mtete, etc.),* tephrosia, leuceana, cassia (some of which can be eaten by animals), and the rooibos tea plant.

Spread animal manure

You can use animal manure to enrich the soil in a food or flower garden. You must always be careful when handling fresh manure, since manure is made up of the waste products that the body did not want or need, such as harmful bacteria and worms.

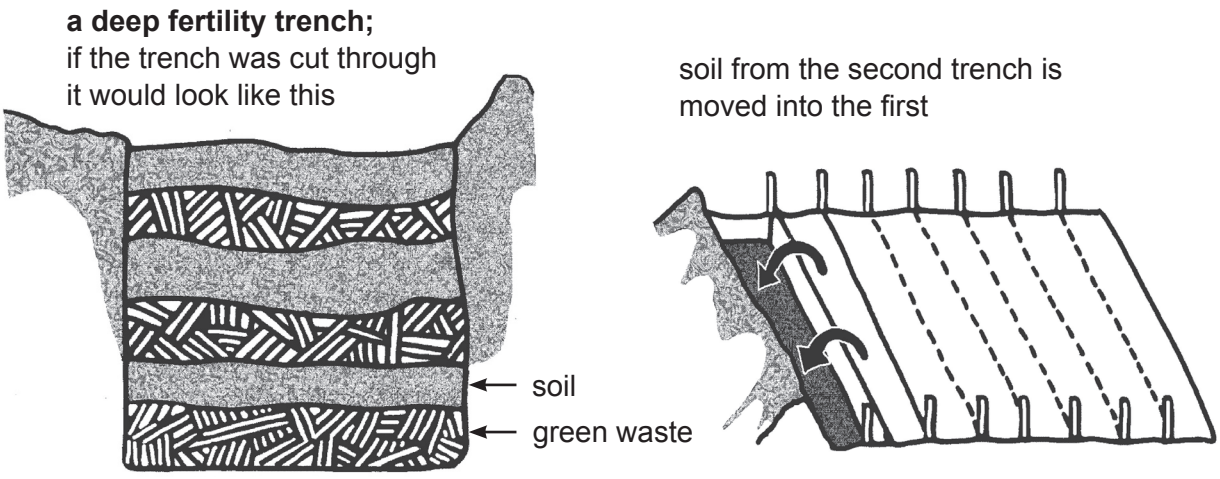
Encourage diversity (the growth of different kinds of plants).

Soil structure improves when the soil is occupied by the roots of many different plants.

- Roots move the soil around.
- Roots create a network of living matter that dies and rots to create humus (compost).
- Roots, when they die off, leave tunnels in the soil that increase the aerated areas and this helps with drainage (water moving through the soil layers) of the soil.
- Roots help to control leaching, which will increase and hold minerals in the soil.

Bury organic matter, straw and manure in the soil.

This produces humus, which improves soil fertility and soil moisture. This is an essential part of soil water management. Figure 3.15 shows you two ways in which you can add organic matter into the soil.



A. Fertility trenches **B. Double digging**

Figure 3.15 Two examples of incorporating organic matter into the soil:
A. Fertility trenches (left) and B. Double digging (right).

Use low input composting

Many projects and individuals decide to use compost to improve soil fertility and structure, but, there are many other ways to improve fertility and structure. Before choosing composting as a method for your land, consider other options and choose that which is best for the site. It may be better for you to combine mulching with a variety of materials, inter-planting leguminous plants and trees, integrating animals, and reducing tillage instead of composting. Most sites will have some level of composting

integrated into them, but composting alone is not the answer to most of the soil problems that we are experiencing! Composting is a way of copying natural decomposition. Nature mulches the soil with a variety of different dead plants, trees, animals, and insects and then when moisture is present from dew or rain, the organic matter disappears into the soil very quickly. There are many different ways to make compost. None is really right or wrong, so choose the way that works best for your lifestyle. Most importantly, just get all organic matter back into the soil!

What are pesticides and herbicides?

Pesticides are chemicals used to kill harmful insects and other organisms.
Hebicides are chemicals used to kill harmful plants, especially weeds

How does the soil work? Before talking about methods of composting, it is useful to review what happens inside the soil. Can we compare the process of composting, to digestion in the human body?

- **Breaking down:** Insects and animals break down the organic matter into smaller pieces just as we use our teeth to chew (in other words, break down) food into smaller pieces.
- **Digestion:** The smaller pieces mix with chemicals in the soil and release the nutrients from the food. This is similar to the chemicals (enzymes) in our saliva and other juices in our stomach that mix with our food.
- **Absorption:** The nutrients enter the plants and trees through the roots so that the plant can have energy to grow, breathe, and protect itself from disease. This is similar to the way in which we absorb nutrients in our intestines.
-

In Unit 4 you will make compost with your households. To prepare you for this, the figure below summarises how compost can be made.

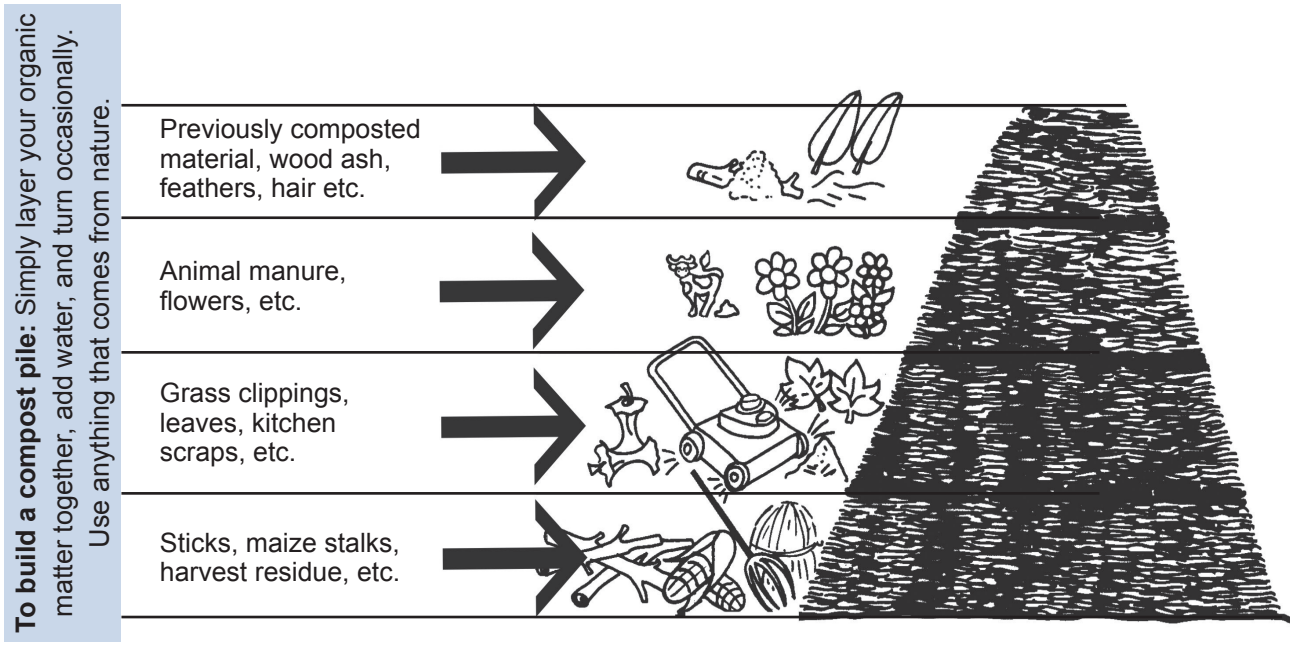


Figure 3.16 Making compost

3.4 Managing biodiversity

What happens when we do not use our biodiversity wisely? It can result in a loss of biodiversity, which is called *environmental degradation*. This will have a negative influence on many apects our lives including food security.

3.4.1 Abusing biodiversity

As you know, the Earth and the sun provide us with many resources and processes, including biodiversity. (Refer to Figure 1.27 In Unit 1). When we abuse (that is, do not use wisely) any of these resources or processes the balance in nature is upset which will impact in a negative way on everything we do. This includes our farming and gardening activities. Which in turn will influence food security. Remember, what we do to the creatures (plants and animals) of the Earth, we do to ourselves. All things are connected.

One of the serious problems concerning the abuse of biodiversity that we have to deal with in South Africa is deforestation.

What is deforestation?

The destruction of forests is called *deforestation.*

Forests are destroyed:

- for firewood
- to make way for urban development
- by logging companies for financial benefit, for the sale of wood for furniture and other products
- to make way for roads, tree plantations, farming and mining
- by flooding from human-made dams

What are plantations?

Plantations are large areas planted with one kind of exotic tree (mono-culture), such as pine trees and eucalyptus (bluegum) trees which are exotic (not from South Africa)

What happens when we cut down forests?

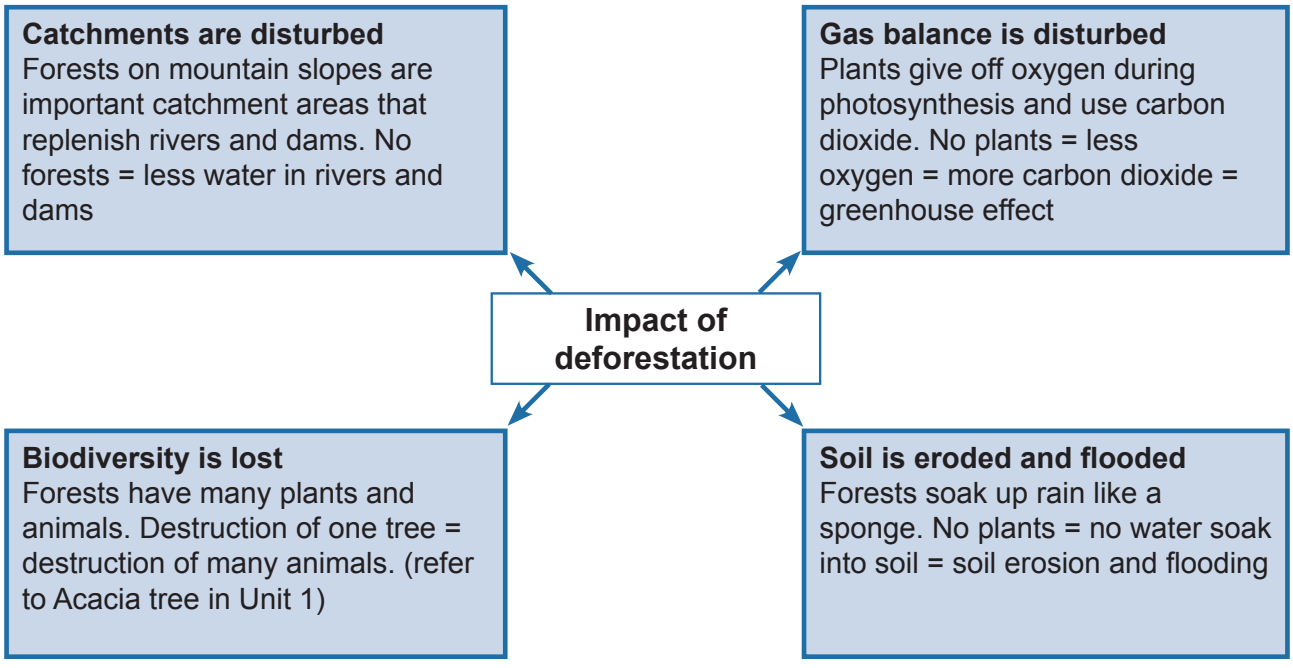


Figure 3.17 The disaster of deforestation

Human beings not only destroy forests, but also grasslands, wetlands, catchments and other natural areas. Why does this matter? When we destroy natural areas we destroy the habitats of plants and animals and their food chains which result in their death. This means that less biodiversity is available to provide us with resources for food, medicines and building materials.

3.4.2 Considerations when using biodiversity

In Activity 1.13 in Unit 1 Lesidi's visit to his uncle in Calvinia confirmed that the natural environment provides abundant indigenous plants, seeds and animals that can be used to enhance food security. Is this also true for the area in which you live? Consider those living resources that have traditionally been used in your area. The following activity will give you the opportunity to talk to older and other knowledgeable people in your community, to find out what living resources are available in your natural area and how you should harvest them wisely.

Activity 3.10 The wise use of biodiversity in your area

Complete this activity on your own in your workbook

Aim: Identifying wild plants, seeds and animals in your area which can be used to enhance food security, either directly or indirectly.

Time: 1 hour

What you must do

1. What plants do you and your family or households in the group use from the wild? Think about what you eat, what your animals eat, what you build with, what you use for craftwork, medicines, and traditional ceremonies.
2. If you do not use any plants from the wild, talk to an older person in your family, group or community and find out what kind of plants were used in the past and which of those are still available today.
3. Complete a table like the one below in your workbook, to indicate the utilisation of plants from the wild by you, your family, household, other group members or the community.

	Plants from the wild (English name)	Plants from the wild (traditional name)	How can the plant be used sus-tainably?	What are the plant's needs? How should I take care of it in my garden?
Food for humans				
Food for farm animals or pets				
Building material				

Craftwork				
Medicines				
Ceremonies				

Questions

1. Is there a difference in the way the plants are used at present and how they were used in the past? Why do you think this is so?
2. Are the plants from the wild still as plentiful as they were in the past? Give a reason for your answer.
3. Why have most people stopped using wild plants?
4. Reflect on how plants from the wild could be used to enhance food security.

Reflect

Reflect on the assessment and analysis of resources activity and provide answers to the following questions:

- What worked well?
- What did you find most difficult?
- What changes would you make to this activity in the future?
- What have you learned from your experience?

What do you regard as good and bad practices regarding biodiversity? (You have made a number of suggestions in the previous activity, but if we take a closer look at this issue, we may find many wrong perceptions!)

Activity 3.11 Good and bad practices with regard to biodiversity

Complete this activity on your own in this study guide

1. Look at the following practices related to biodiversity, and decide whether you think they are good or bad practices.

ACTIVITY	GOOD PRACTICE	BAD PRACTICE
Clearing for farmland, eg cutting down forests and other plants		
Clearing all plants around the house		
Collecting only dead wood as firewood		

Cutting live branches of trees for firewood		
Keeping too many animals in a small area		
Not hunting female animals who are nursing their young		
Removing an entire plant from the veld, when mass collecting food and medicinal plants		
Sweeping the area around the house every day		

2. Reflect on the influence the bad practices will have on people in communities and in particular on food security. Keep your place in the cycle of nature in mind when you answer this question.

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Comments on Activity 3.11

There are many examples of good and bad practices that can have an impact on biodiversity. Discuss this in your groups, and decide which of the following are useful in your area:

Table 3.1 Examples of good and bad practices related to biodiversity

ACTIVITY	GOOD PRACTICE	BAD PRACTICE
Clearing for farmland, for example, cutting down forests and other plants		We are removing the habitats of wild plants and animals, and in this way we are upsetting the cycle of nature. Soil is left bare, which will wash away during heavy rains.
Clearing all plants around the house		Compacting the soil; soil erosion; soil becomes poor.
Collecting only dead wood as firewood	Do not harm the living trees. This shows respect for the cycle of nature and our place in it.	
Cutting live branches off trees for firewood		This will harm the tree, and lead to its death, influencing other organisms living off it as well. See Acacia example in Unit 1.

Keeping too many animals in a small area		Leads to overgrazing, which in turn will lead to a shortage of food for the animals and soil erosion.
Not hunting females animals who are nursing their young	Will allow the species to keep on producing young preventing it from becoming extinct.	
Removing the entire plant from the veld, when mass collecting food and medicinal plants		Can lead to the extinction (dying out) of species.
Sweeping the area around the house		Compacting the soil, causing soil organisms to die, and soil to become impoverished.

3.4.3 Consider permaculture groups when you choose plants for your area

Whether you decide to use plants or seeds from the wild or any other plants or seeds, or even a combination of wild and other plants, you should consider permaculture principles and permaculture groups.

What is permaculture? **Permaculture** is short for *permanent culture.* It can be defined as 'design of our environment based on ecological principles'. (Mollison, 1992). It is one method used in sustainable conservation agriculture.

Permaculture, if used correctly, provides the maximum yield for minimum effort and costs. We can copy what nature does, and plant a variety of plants, and keep a variety of animals. This means that you should choose plants for food, medicines, building materials and other uses, to assist you in staying healthy and prosperous. Permaculture encourages people to work together and help each other to grow better food.

Permaculture works according to the principle that there are seven groups of plants that need to be included in your homestead garden. Refer to table 3.3 on the next page.

These are:
- Food for us
- Food for the soil
- Diggers
- Groundcover
- Climbers
- Supporters
- Protectors

What is agroforestry?

Agroforestry is a form of agriculture using trees. It involves raising crops or grazing animals among mainly planted trees to conserve soil and improve crop yields. At the heart of any agroforestry project are multi-purpose trees which provide fruit, fodder, wood, other products and shade and which grow quickly on poor soil.

What is conservation agriculture?

It is a group of methods that include permaculture, organic and sustainable farming.

Table 3.2 Permaculture: Seven groups of plants for a garden

1. **Food for us**. Based on food groups that you have learned about in Module 1.
2. **Food for the soil**. We covered this in the section on soil. This includes legumes such as beans and peas and using dead plant and animal matter such as compost, mulch and manure in your garden.
3. **Diggers**. Deep rooted plants will reach deep into the earth's soil and bring minerals up to the surface. Examples of diggers include: cassava, sweet potatoes, yams and trees.
4. **Groundcover**. This protects the soil from the sun, and helps to hold moisture, and keep "weeds" (plants in the wrong place) down. There are many types of groundcover available. These include: sweet potato vines, pumpkin, cucumbers, and anything else that will vine or spread across the soil. Mulch is also a form of groundcover.
5. **Climbers**. These plants grow up and provide us with another area of food production. Examples of climbers that you can use include: beans, passion fruit, loofah, and cucumbers.
6. **Supporters**. These are strong plants that provide support for the climbers and make the most of the space available. They could be trees, bushes, crops with strong stalks such as maize or sunflowers. A supporter could also be a house, wall or fence on which other plants may grow.
7. **Protectors**. Anything that helps to protect your garden, such as thorns, smelly plants or other plants that could protect your produce from thieves or plant-eating animals. The protectors could also function to attract predators like frogs, birds and lizards that will eat the insect pests.

Keep these seven groups of plants in mind, when you design your garden.

Activity 3.12 Plants for the seven permaculture groups

Complete the following table, by providing examples of plants that you will use in the seven different permaculture groups. We have given you an example of each in the shaded column.

Food for us	Food for the soil	Diggers	Groundcovers	Climbers	Supporters	Protectors
Fruits	Lima beans	Sweet potato	Pumpkin	Tomato	Sunflower	Garlic

Comments on Activity 3.12

There are many examples, but the following figure will give you a good idea.

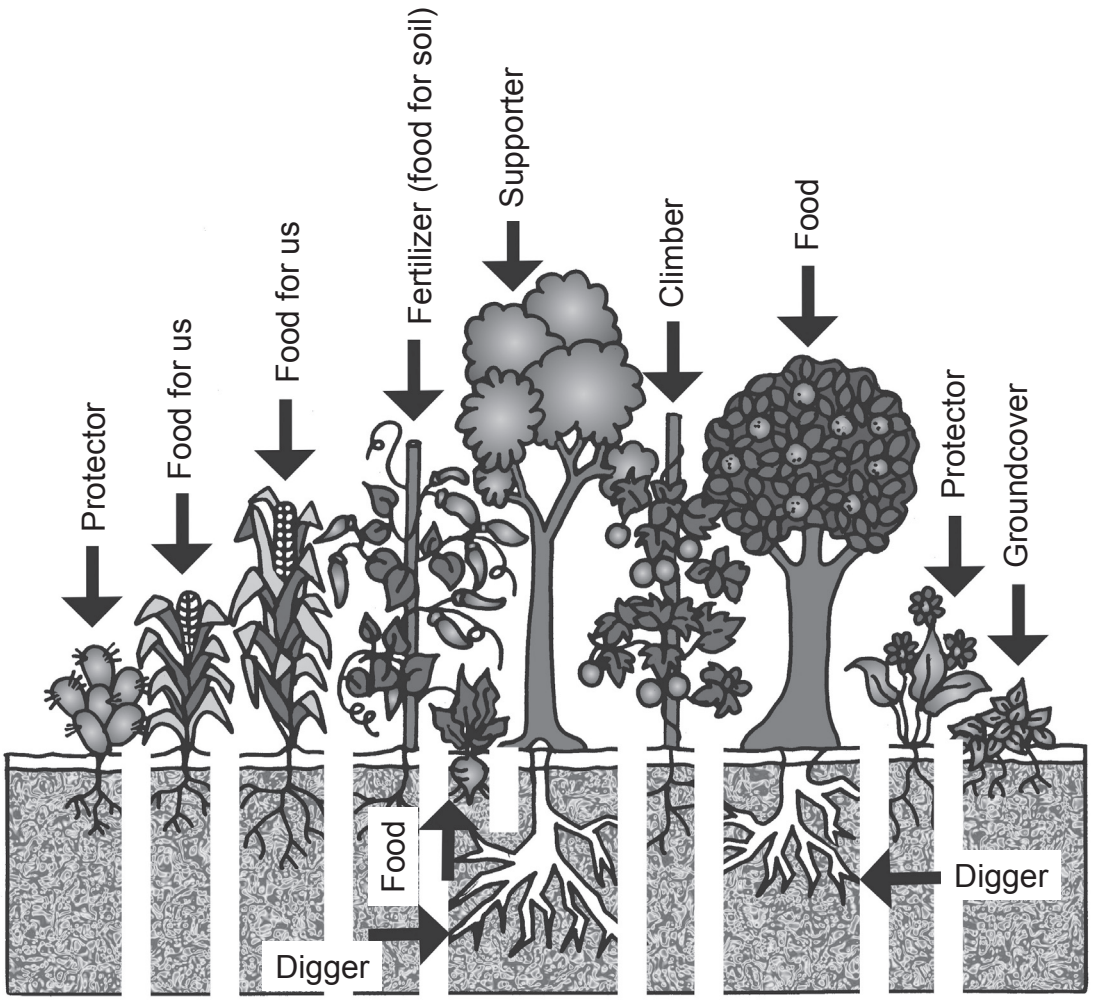


Figure 3.18 Planting according to permaculture principles

3.5 Managing energy resources

What happens when we do not use our energy resources wisely and what can we do to manage them in such a way that we will not run out of energy in the near future?

3.5.1 Abusing energy resources

We are fast depleting (using up) energy sources, such as coal, oil and gas. The use of these energy sources also contribute to serious environmental damage, such as the greenhouse effect**,** and widespread pollution of air, land and water. Using too much firewood, contributes to deforestation, which causes other environmental problems. If we want to look after our world, we have to conserve energy, we have to shift from using fossil fuels, which are non-renewable energy sources, towards renewable energy sources such as the sun, wind and water (refer to Unit 1).

You are aware of the serious energy crisis we are facing in South Africa. Who is responsible for adressing this issue? Is it only government, or the municipalities, or should every South African citizen contribute to saving energy? The answer is of course that government and municipalities should play a major role, but that every one of us needs to make a serious effort to minimise our energy use and to come up with creative ideas to do so.

3.5.2 Consider using renewable energy to cook your food

What are some creative ways to save energy when we cook our food?
The following are short descriptions of a few types of energy-saving options.

Paper charcoal "briquettes"

You know how important recycling is. In nature waste is recycled continuously. Here is an interesting way of re-using paper and other materials such as dried leaves to be used as fuel for cooking. You can make charcoal-like products using recycled paper:

- Soak the paper in a bucket of water until it is soft. This usually takes a half day. Thicker paper takes longer to soften, so soak it overnight.
- When the paper is soft, pull out a large handful and squeeze the water out and make it into a ball.
- Let the paper balls dry in an airy place, preferably in the sun to speed up the drying time. After 1-3 days, depending on the drying conditions, the balls should be dry. They become very light weight when they are ready. Store the paper charcoal in a dry place, in an old bag or basket until you need it.

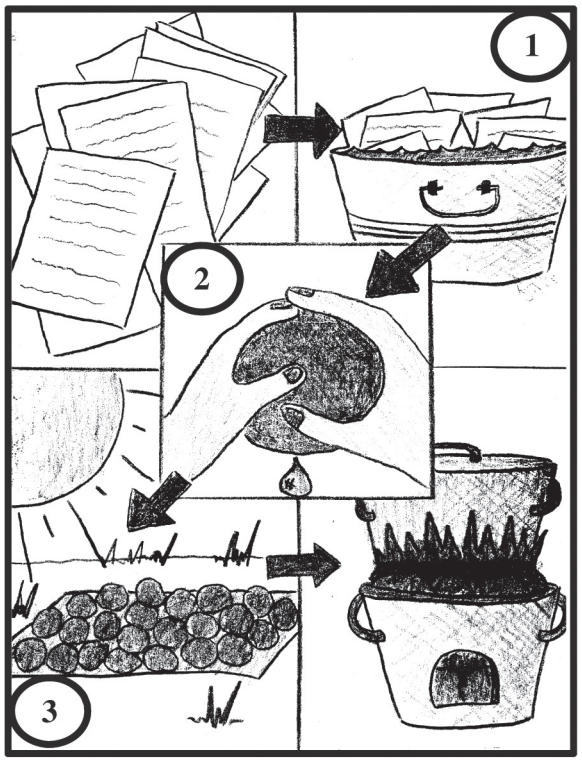
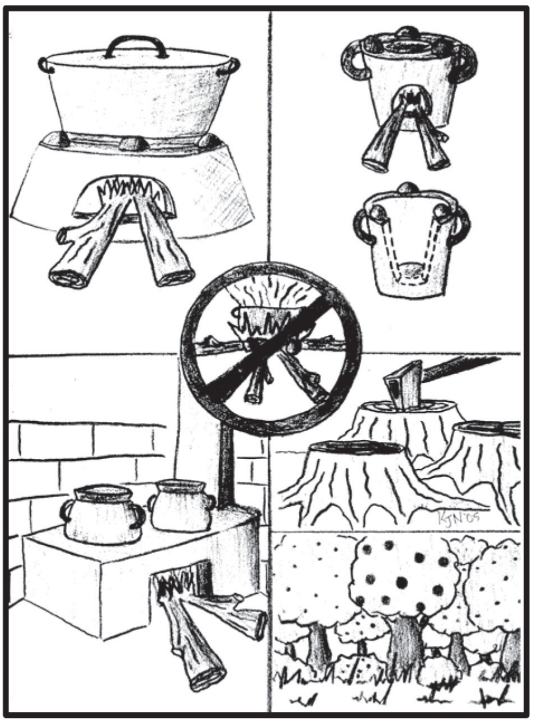


Figure 3.19 Making paper charcoal briquettes
(Adapted form Nordin, 2005)

Note: The paper charcoal produces a lot of ash, so using the type of stove that has holes for the ash to drop away from the fire is helpful. There are many things that you can cook with paper charcoal, but we recommend cooking food in a covered pot because of the amount of ash it produces. Do not use the paper charcoal for grilling food directly on the fire – there may be chemical ink on the paper.

Fuel efficient stoves



One problem is the way that wood is burned - burning wood can be done sustainably if we are careful not to overuse the supply.
There are many styles of improved wood stoves, the basic idea of any of the improved wood stoves are:

- to control the amount of air flowing toward the wood
- to guide the flames to the centre of the pot's base, and
- to hold the heat for as long as possible

Figure 3.20 Cooking with fuel efficient stoves
(Adapted form Nordin, 2005)

Basket cookers / food warmers / food coolers

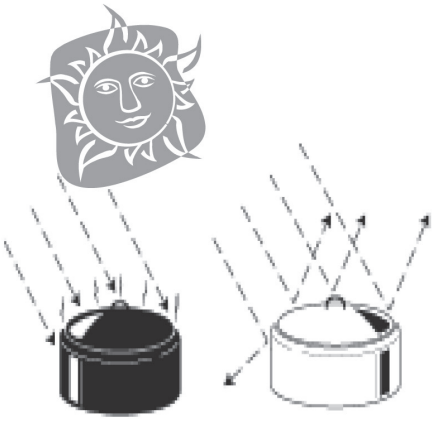
Basket cookers work by conserving the temperature of an item for a long time. You have to initially make the food the temperature that you want to keep it. Basket cookers can be used to keep hot food hot or to keep cold food cold – so these Food Warmers are also Food Coolers!

How do these warmers/cookers work?
The basic idea is to put the item to cool or heat into an insulated basket or box. For the basket cooker shown in this picture, use a woven basket and line the bottom and sides of the basket with clean, dry material – this could be dried banana leaves, clean used paper, dried grass, or scraps of cloth. Leave a space in the middle of the dry material for the pot or other item. Make an insulated cover, again using dry material. You can use an old sack, cloth, or anything that will hold the dry material. The cover will be tucked into the inside edges of the basket to trap as much heat as possible.

Figure 3.21 Basket cooker with insulated cover

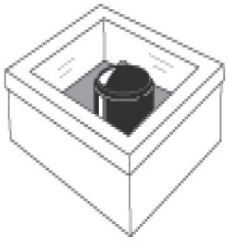
Solar cookers

There is plenty of sun in Africa and much of it is under-utilised. Using the sun to cook is very simple and solar cookers can be made from a wide range of material.



- The sunlight is the "fuel". A solar cooker needs an outdoor spot that is sunny for several hours and protected from strong wind, and where food will be safe. Solar cookers don't work at night or on cloudy days.
- Convert sunlight to heat energy: Dark surfaces get very hot in sunlight, whereas light surfaces don't. Food cooks best in dark, shallow, thin metal pots with dark, tight-fitting lids to hold in heat and moisture.
- Retain heat: A transparent heat trap around the dark pot lets in sunlight, but keeps in the heat. This is a clear, heat-resistant plastic bag or large inverted glass bowl (in panel cookers) or an insulated box with a glass or plastic window (in box cookers).

- Capture extra sunlight with shiny silver: One or more shiny surfaces are used to reflect extra sunlight onto the pot, increasing the amount of sunlight hitting the pot. Shiny surfaces can be made from a sturdy support such as cardboard or tin sheet that are covered with anything silver such as that found on the inside of many types of food packaging or aluminium foil. Attach the silver material with glue, tape, a stapler or using other creative local ideas.



The next activity will demonstrate how the sun can be harnessed to heat water or cook food.

Activity 3.13 Making a solar cooker (Optional)

Complete this activity in groups or on your own in your workbook

Aim: Demonstrate how the sun can be used as an energy source to heat water

Time: 1 hour

What you will need

A cardboard box, aluminium foil (or silver paint), plastic (transparent) paper or clingwrap, a cold drink can that is painted black, water, scissors and glue.

What you must do

1. Decide upon a design for your solar cooker using the box, foil and plastic.
2. Fill the black can with water at room temperature, and place it in the solar cooker.

3. Decide upon a suitable place to put the solar cooker, where it will receive sufficient sunlight.
4. Leave it in the sunlight for 2 hours. Then touch the can with your bare hands, and feel the temperature. (Be very careful not to burn yourself. Some solar cookers are very effective!)
5. Answer the following questions:

Questions

1. What is the function of the aluminium foil?
2. What is the function of the clingwrap (or sheet of plastic)?
3. Why should the can be painted black?
4. Touch the can. What is your observation?
5. Write a paragraph on the advantages of solar cookers.

Figure 3.22 Making a solar cooker

Reflect

6. Reflect on the activity and write answers to the following questions:

- What worked well?
- What did you find most difficult?
- What changes would you make to this activity in the future?
- What have you learned from your experience?

3.6 A design plan for your area

You are now aware that you should consider improved water use, slope, aspect and ridges, healthy soil, wise use of biodiversity, permaculture groups, and alternative energy sources when you want to start a food or any other garden.

In this section we will look at farming practices that help farmers improve their natural resource management by using the principles, approaches and processes we have discussed so far in Module 3. The area being farmed could be your homestead, school or community garden.

Techniques for intensive food production and rainwater harvesting will be introduced through case studies and examples. These case studies will give you an idea of how natural resources can be used effectively and sustainably for the benefit of improving people's livelihoods.

Mr Phiri and MmaTshepho and a group of rural women used the concept of "their four corners" to make plans and take decisions to improve there livelihoods and provide better food for health. See below the simple concept of using "my four corners" for a homestead garden in a community.

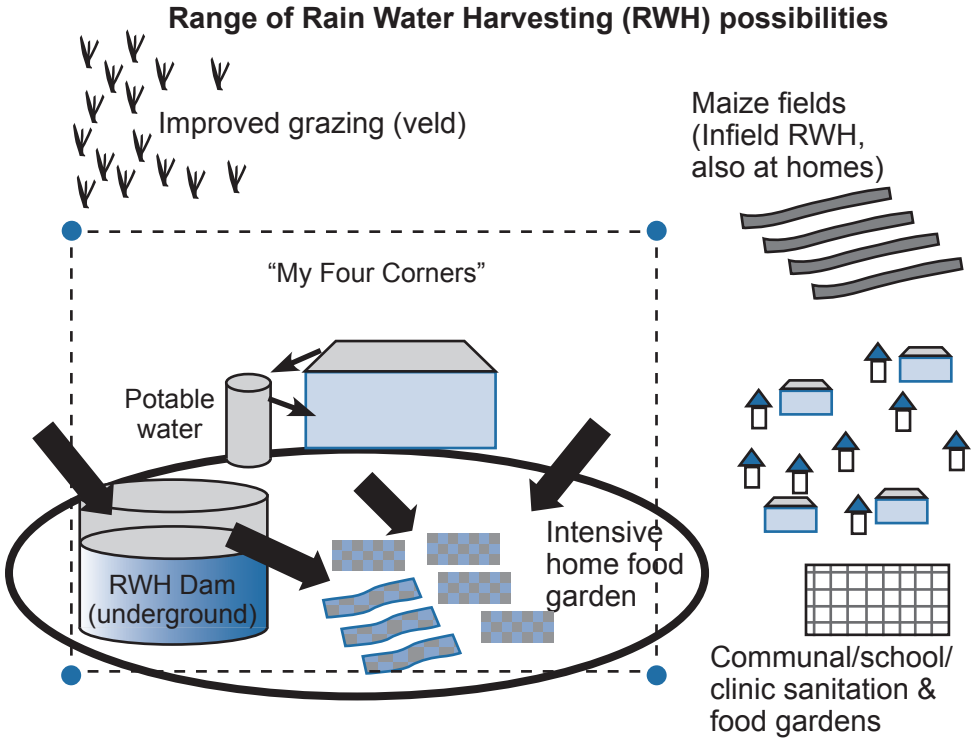


Figure 3.23 The four corners of every homestead and different ways of using resources.
(Adapted from DWAF, 2008)

The rural women's group, whom Mma Tshepho worked with, declared 'War on Hunger'. The first strategy involves what they call: 'My Four Corners', meaning their own homestead yards. They feel that in their own yards they are fully in control – they can take decisions without having to consult other members, and they can move at their own pace. In their 'four corners' their potential additional water sources and their uses are:

- recycling of household water (e.g. water used for washing can be used to grow plants);
- surface run-off can be turned into 'run-on' and channelled to ditches around her garden beds – preferably intensive beds like deep trenches;
- an underground Rain Water Harvesting (RWH) tank, as supported by DWAF (Department of Water Affairs and Forestry) can store enough water for year-round vegetable and fruit production of 100m^2, or for other productive uses; and
- clean water harvested from the roof into an above-ground water tank can be used for drinking and cooking.

The DWAF Homestead RWH Programme supports the rural household within its 'Four Corners.'

3.6.1 Farming with Water Case Study: Mr Phiri

Mr Zephaniah Phiri Maseko has lived and worked on his family land holding (3 hectares), in one of Zimbabwe's driest regions for over 30 years. He has created his own "garden of Eden" and over the years has taught many others to do the same.

The farm is on a north to east sloping face of a hill (providing good winter sun). The top of the hill is a large, exposed rock (a granite dome) that creates a lot of storm water run-off. The average annual rainfall in the area is around 570mm. Droughts occur often.

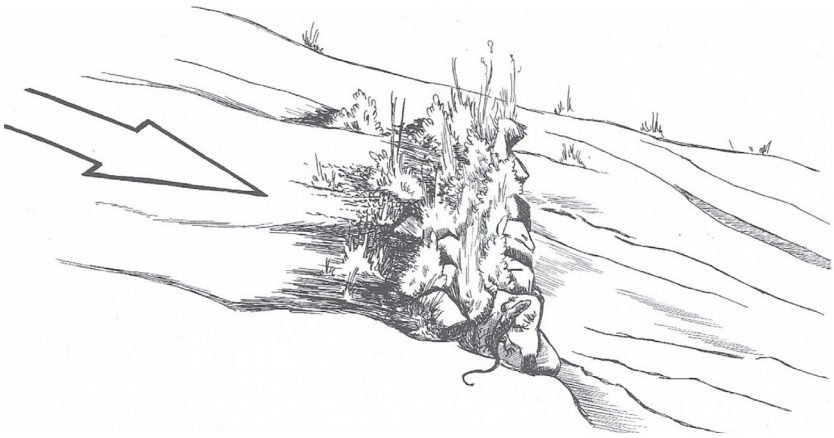


Figure 3.24 Water, soil, seeds and life gather where water flow slowly across the land.

When Mr Phiri began, it was very difficult to grow crops successfully, or make a profit. He had no money for deep wells, pumps, fuel and other equipment. Mr Phiri started his farming with long and careful observation. He noticed that where the run-off from rain went unchecked (not slowed down) very little infiltration took place. He then noticed that the soil remained moist for longer in small hollows/depressions. This also happened above rocks and plants on the slope (where the rainfall runoff is slowed down and can infiltrate between rocks and plants). He realised that he could copy this process and enhance areas of his land where soil was remaining moist for longer. Thus began his water farming.

Beginning at the top of his catchment, Mr Phiri built low stonewalls here and there on the contours. These 'check dam walls' slow down and spread the flow of storm run-off water. This controlled run-

off from the large rock (at the top of the hill) is then directed to two earth dams just below (one large and one somewhat smaller). These dams were dug out by hand.

The water in the larger dams seeps straight into the ground over a period of time. The overflow from the smaller dam is directed via a short pipe to an above ground ferrocement (steel reinforced concrete) tank that feeds the family's vegetable garden during dry times. Another tank, shaded and cooled by a granadilla vine, collects drinking water from the roof of the house. Besides these two tanks, all water harvesting structures on the farm directly infiltrate water into the soil.

Numerous water harvesting structures act as nets that collect the flow of the surface run-off and quickly infiltrate the water into the soil, before it can evaporate.

These include:

- Check dams (small stone walls placed within drainages across the waters' flow
- Vegetation planted on contours
- Terraces (built-up level fields or beds)
- **Berm-n**-basins (dug out basins with earth and plant banks, laid out on contour)
- Infiltration basins
- 'Fruition pits'. These are large basins dug out in the bottom of drainage lines (3 metres long, 2 metres wide and about 2 metres deep). When it rains, the pits fill up with water and the overflow fills one pit after another. Long after the rain stops, water remains in these pits, infiltrating into the soil. These fruition pits feed the **groundwater table** as well as the plants.

  Thatch grass, fruit trees and timber trees have been planted in and around the fruition pits. Mr Phiri explains with a smile: " I am digging fruition pits and **swales** to plant the water, so that it can germinate elsewhere."

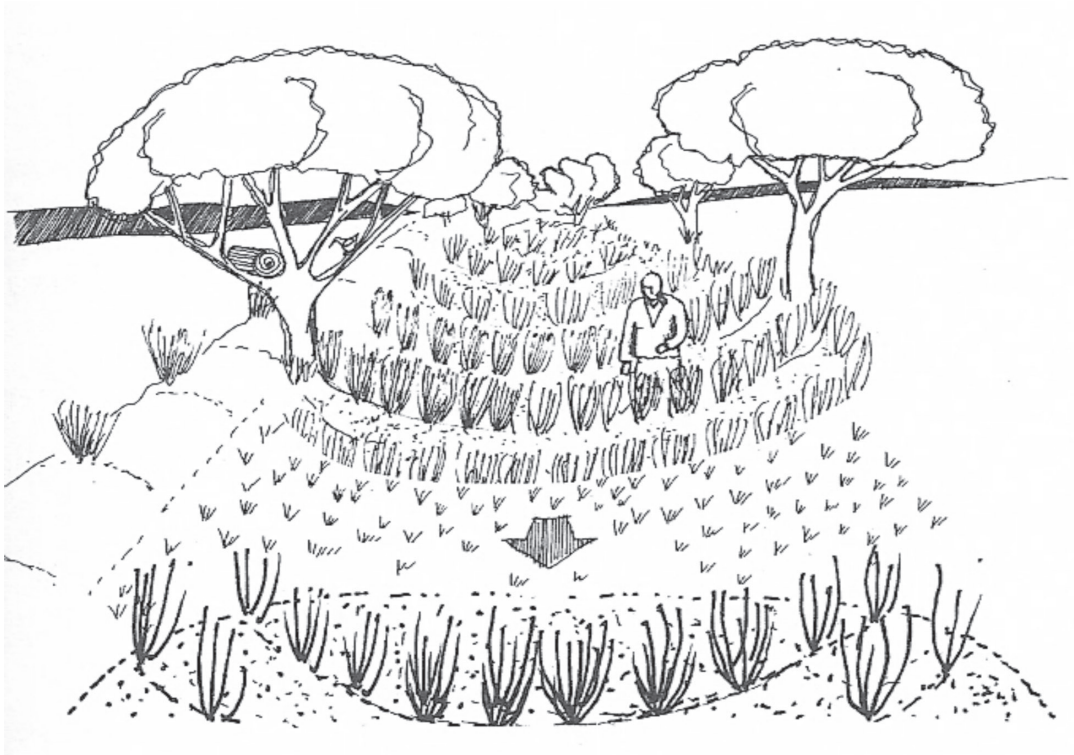
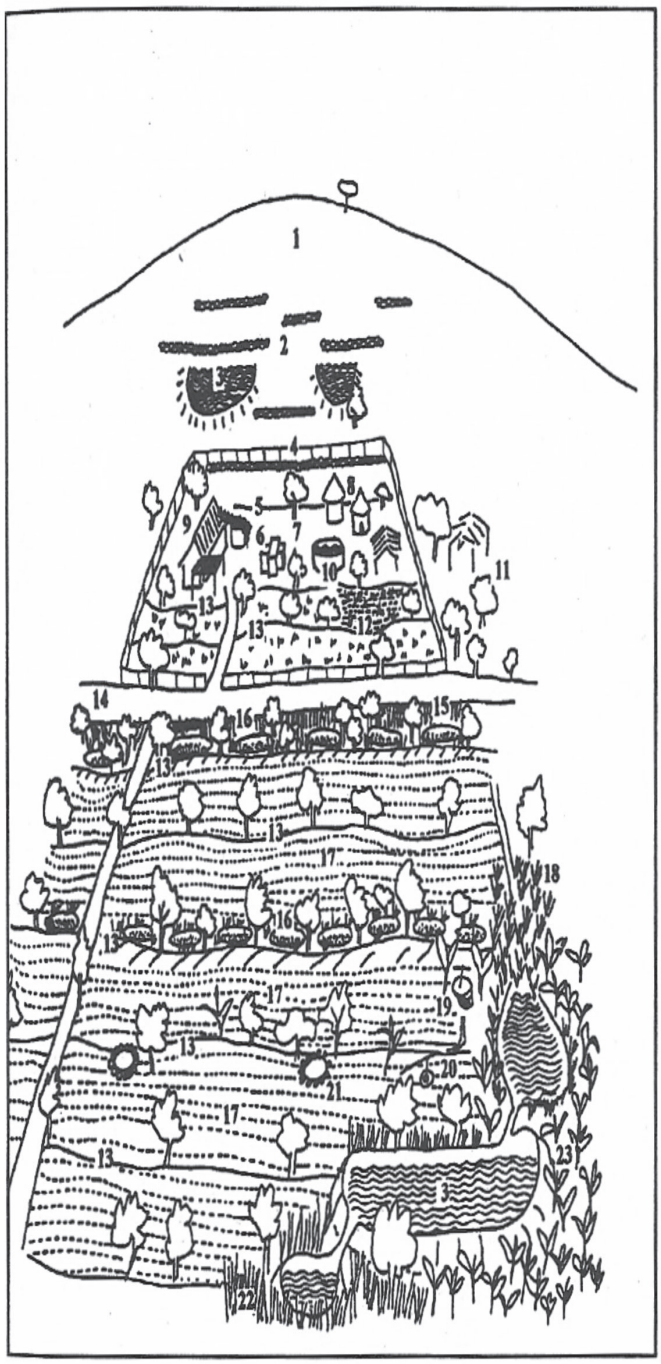


Figure 3.25 Sketch of Mr Phiri standing in a "fruition pit" full of thatch grass.



"As Mr. Phiri explains, 'I am digging fruition pits and swales to plant the water so that it can germinate elsewhere.'"

1. Granite dome
2. Unmortared stone walls
3. Reservoir
4. Fence with unmortared stone wall
5. Contour berm/terrace
6. Outdoor wash basin
7. Chickens and turkeys run freely in courtyard
8. Traditional round houses with thatched roofs
9. Main house with vine-covered cistern and rama
10. Open ferro-cement cistern
11. Kraal—cattle and goats
12. Courtyard garden
13. Contour berm
14. Dirt road
15. Thatch grass and thick vegetation
16. Fruition pit in large diversion swale
17. Crops
18. Dense grasses
19. Well and hand pump
20. Donkey pump
21. Open hand-dug well
22. Reeds and sugar cane
23. Dense banana grove

(illustration by Silvia Rayces from a drawing by Brad Lancaster)

Figure 3.26 Layout of Mr Phiri's farm.
(Adapted from Lancaster, 2008)

Mr Phiri plants a diverse range of crops on his farm: basket reeds, pumpkin (squash), maize, peppers, eggplant, lettuce, spinach, peas, garlic, onions, beans, granadilla, mangoes, guavas and paw-paws, as well as a number of different types of indigenous trees. Indigenous trees are those that occur naturally in the area. They are the best suited to dealing with the particular natural conditions. (Exotic trees come from other places and may not grow as well. Sometimes exotic trees grow too well and compete with indigenous trees. They are then called invasive. This can be a big problem). Mr Phiri's crops are planted on the terraces formed between the contour bunds and the swales. This diversity provides food security for his family: even if some crops fail, others will survive.

He only uses **open pollinated varieties** of crops and collects, keeps and plants his seed from one year to the next. Over time these crops become adapted to the drier conditions on the farm.

Mr Phiri has found that soils amended (improved) with local organic matter and **nitrogen fixing** plants (such as Pigeon Peas) infiltrate and hold water a lot better than those amended with **synthetic/ commercial** fertilizers. He says: "You apply fertilizer one year but not the next and the plants die. Apply manure once and plant nitrogen fixing plants and the plants continue to do well year after year". Note that another advantage of manure is that it is usually free manure compared to the costs of synthetic, commercial fertilizers.

Towards the bottom (the lower lying areas) of the farm are hand-dug, unlined wells (except for one, which is lined and has a small hand pump, for household use). These wells are situated in the wetland in the low-lying area. The wetland helps to filter and clean the water. That is why it is good for household use as well. There is almost always water in these wells and even during a drought it is possible to pump water up from the wells for irrigation. Mr Phiri uses a donkey-driven pump for his purpose. Below, in the box on the next page, is a further explanation of how management of your resources influences the groundwater table.

A **wetland** lies below the wells at the lowest point. Here three aquaculture (fish-farming) ponds/dams are surrounded by a soil-stabilising grove of bananas, sugar cane and reeds. The fish are harvested for food and their manure enriches the water used to irrigate the fields. The taller vegetation creates a windbreak around the ponds (reducing **evapotranspiration**). The shorter grasses filter incoming run-off water into the ponds and feed his cows when in calf.

For years, Mr Phiri found himself in opposition to the international aid and government programs that were pushing for ground water extraction and export crops as opposed to rainwater harvesting and local food production and distribution. As a response Mr Phiri formed a non-government organisation called the Zvishavane Water Resources Project that is spreading his techniques well beyond his area. He says: "It's a slow process. But that's life. Slowly implement these projects and as you begin to rhyme with nature, soon other lives will start to rhyme with yours".

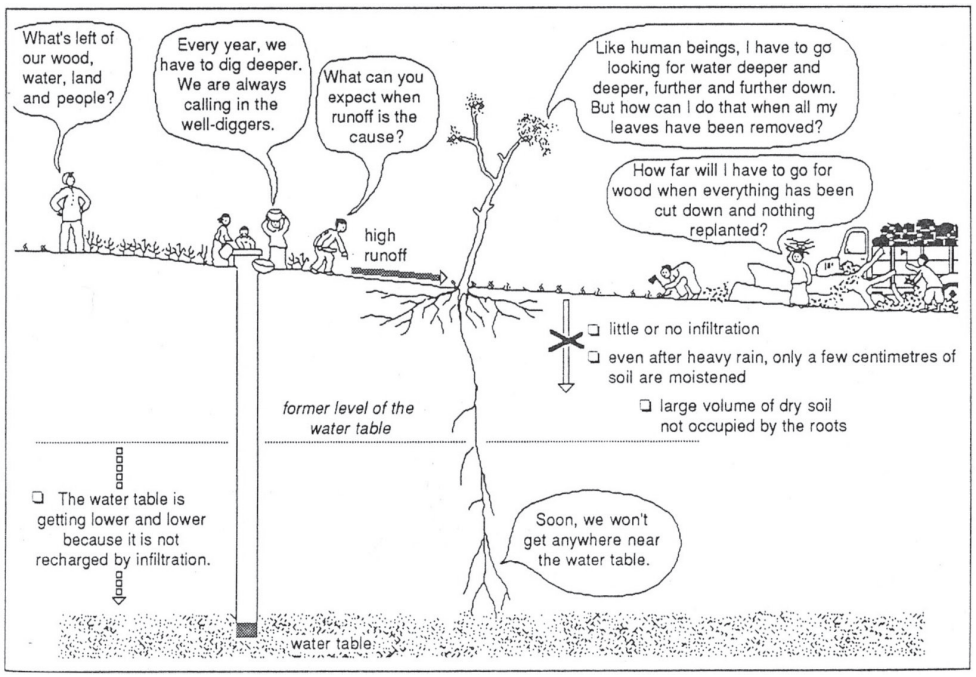


Figure 3.27 The water table and resource management.
A. The water table with deforestation and reduced groundcover.
(Dupreiz and De Leener, 1992)

Figure 3.27 A, illustrates what happens to the water table when resources in the environment are extracted or taken away without replenishing them. Because of the reduced groundcover the surface of the soil becomes hard and results in higher runoff rates and there is little or no infiltration of water. The area becomes drier all the time and it is difficult for plants and trees to survive, resulting in even less vegetation, again causing less infiltration. Boreholes and wells dry up. Other natural resource problems such as accelerated soil erosion, loss of fertile topsoil and the development of donga's are also results of this cyclical process – all initially caused by loss of vegetation.

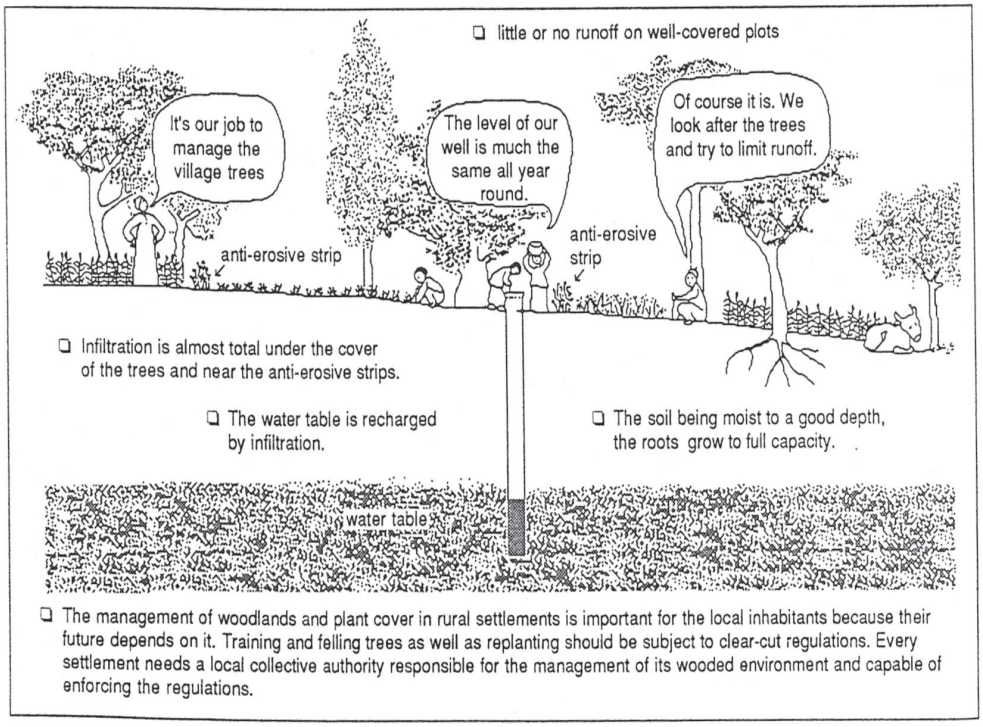


Figure 3.27 The water table and resource management.
B. The water table with improved plant growth and coverage.
(Dupreiz and De Leener, 1992)

Figure 3.27 B, illustrates the effects of plant cover on the water table: With good ground cover and management there is little or no run-off and good infiltration of water into the soil. The groundwater table is recharged and has enough water to support plant growth and provides a stable amount of water from wells and boreholes.

3.6.2 Water for Food Case Study: MmaTsepho Khumbane

MmaTshepo Khumbane has lived and worked in impoverished rural areas of South Africa for more than 30 years. These areas are mostly dry and prone to droughts. People suffer from hunger.

MmaTshepo realised through long and thoughtful observation, that run-off water is one of our most valuable resources and set out to harness (catch) run-off into run-on. Her method for designing her run-on system is described in detail in Module 6, Unit 2. A further explanation follows in the box entitled **Rainwater Harvesting**, below.

She also soon realised that people weakened by hunger and lack of success need to be motivated

to work and try out new things. Over the years, she developed her ”mind mobilization” process to celebrate the ability of people and the abundance they can create. (See Module 6, Unit 2 for a description of MmaTshepo’s mind mobilisation process) This concept has blossomed (grown quickly and beautifully) into the informal *Water for Food Movement* of women who share, celebrate and work together across deep rural areas of the country.

In her yard she slows down and spreads out water at the top of her catchment using a cut-off drain (trench). From there, overflow water from the trench is directed via sunken paths to her **fertility trenches** or **deep trenches** (see Module 6 Unit 3). Any further overflow is directed to the bottom corner of her homestead to be stored in an underground tank for later use.

She grows a diverse range of crops with the intention of always being able to provide a nutritious and balanced meal from the garden – right through the year.

Crops include:

- Annuals: onions, tomatoes, maize, sorghum, spinach, indigenous greens (imifino, morogo), peppers, eggplants, carrots, etc.
- Medicinal and multi-purpose plants: wormwood, garlic, chives, marigolds, bulbs, etc.
- Fruit: oranges, peaches, mangoes, bananas, paw-paws, etc.

All crops are **open-pollinated** and she selects, stores and replants her own seed. All the gardeners get together to share their different varieties of seeds among each other. In this way they ensure the survival of their crops. They also share recipes and have a celebration preparing food together and enjoying a meal.

The main aim of MmaTshepo’s gardening system is to have a diversity of food available in the homestead throughout the year.

Rainwater Harvesting: A system for classification

Water collection:

- Grey water collection (collecting used water from the house);
- *In-situ* rainwater collection (catching the rain where it falls and preventing it from flowing away/ running off);
- External storm water run-off collection (from neighbouring fields, roads or roofs);

Water storage: In the soil profile;

- In structures, like above- and below-ground water tanks;
- In groundwater, through recharge of groundwater;

Water use or application: Directly from the soil profile;

- Through irrigation, i.e., by applying water to the plants from storage.

MmaTshepo’s water harvesting system is probably unique, because it combines all the possibilities for collection, storage, and use, as follows:

- Collection: grey water and in-situ and external run-off collection;
- Storage: in the soil profile and in tanks and groundwater recharge

- Use: directly from the soil profile and through irrigation from storage tanks and groundwater pumped from a borehole.

MmaTshepo's rainwater harvesting system concentrates the runoff during a rainstorm directly into her vegetable beds, providing her crops with 'automatic irrigation'. Overflow runs into underground storage for use during the dry winter months. Her crops can survive longer periods between rainstorms than do crops planted conventionally (in the usual way), because the vegetable beds can hold more water, because of their high organic matter content.

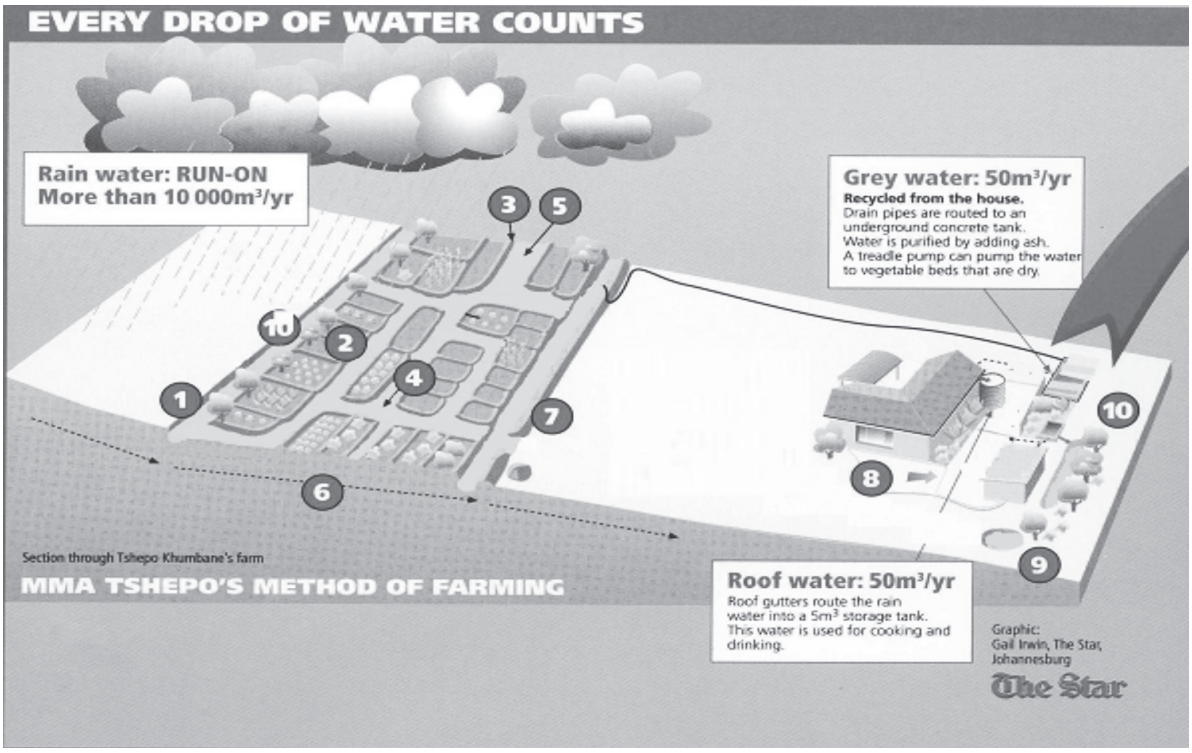


Figure 3.28 The multiple use of natural resources.

- A cut-off trench is dug across the runoff slope of the land to catch rainwater **(1)**.
- Beyond the trench, the vegetable beds **(2)** are dug 1m deep and filled with organic matter – grass, leaves, manure and ash – and mixed with soil. The beds are fertile and absorb and retain moisture.
- The beds are edged with ridges **(3)**. Some are reinforced with stones to stop the soil washing away.
- Between the beds, a network of depressions **(5)** connects the cut-off trench **(1)** to one lower down **(7)**. The water flows along these channels **(4)** during a rainstorm.
- These channels **(4/5)** are also the footpaths to access the beds without having to step into the vegetables.
- Between the trenches the gradient is shallower **(6)**, so that the water has more time to soak into the beds.
- If it rains too much, the second trench **(7)** is breached to prevent the beds from flooding.
- Catchment areas, concrete paving around the house is lipped and slopes to pipes **(8)** that lead to other deep trenches.
- Excess water flows into a water storage pit **(9)**.
- Fruit trees **(10)** are planted on the lower side of a trench so that their deep roots can benefit from the extra soaking

Similarities between the two case studies - Mr Phiri and MmaTshepo

Read through both of the case studies again carefully. Make notes of the main points of rainwater harvesting you can learn from each case.

The following questions will help to formulate your list of similarities.

- What was the first thing that both people did before they started harvesting rainwater? Where do they get their ideas?
- Where on the land did they start?
- What did they need to do to change the way that the water was flowing across the land?
- What was the aim of harvesting rainwater?
- Did they have lots of money to build their systems? How did money constraints affect the way they went about building their systems? (eg: where did they get labour?)
- What do they do with overflows?
- What kinds of plants/trees are used in the system? What purposes do the different plants serve (ie: only for food)?
- What varieties of crops are planted?

The 8 Rain Water Harvesting principles:

1. Start with long and thoughtful observation
2. Start at the top, or highest point of your watershed/catchment and work your way down.
3. Start small and simple.
4. Spread and infiltrate the flow of water.
5. Always plan for an overflow route and manage that overflow water as a resource.
6. Maximise organic and living ground cover.
7. Maximise beneficial relationships and efficiency by "stacking functions".
8. Continually reassess your system: the "feedback loop".

The above can be compared with the eight water harvesting principles given below:
In both cases:

- They decided to do the best they could within the limits of their available resources.
- They focused on a diverse and integrated land based livelihood strategy.
- They use plants with many different functions (such as nitrogen fixing shrubs/trees, that provide fodder and beans) along with their food crops.
- They decided on systems and methods that mimic natural processes that they have observed.
- They used practises that they could do themselves; they did the work themselves at a human scale – not waiting for larger interventions that they had no control over.
- They look after their environment, so that it can look after them. They do not extract or take resources out, but manage the resources sustainably.
- They produce foods first and then sell any surplus they have.
- They plant open pollinated varieties of crops adapted to local conditions.

The benefits of Communal Land and Restitution Act (CLaRA) will benefit households as they will have property rights. They can then invest in improvements to improve their livelihood on their 'four corners'.

3.6.3 Creating a design plan for your area

After reading and thinking about the ideas that we examined in this module and doing several relevant activities, you should be able to plan (design) a food or any other kind of garden around your **home, office, school or church** in a way that it will help you to grow more food and medicinal plants using fewer resources. *Design* means where you put things and how you arrange things. A good design will need careful planning.

The design plan is your vision of where the plants and animals (including you!) will live. It will show where the pathways, driveways, buildings, water tanks, solar panels, toilets, and other structures will be placed in your area. Everything that you've learned about low input must be considered in the design.

Some key questions to continually ask yourself are:

- Low Input – How can I make the best use of resources in the most efficient way?
- Diet Diversity – How can I get a diverse diet throughout the year?
- Soil Health – What do I need to include to make my soil healthy?
- Water Management – How can I make the best use of all my water?
- Permaculture principles - What does each plant, tree, or animal need to live healthily? Where is the best place to put it and what should it go with it?
- Considerations – I also need to consider resources, space, labour, lifestyle, availability and weather.

At first, as with any new skill or way of thinking, it will take some effort to remember all of these pointers. However, after a while it becomes your way of thinking with very little effort at all. In this next section you will have the opportunity to start thinking about a design for your area. Design plans may change as you put the plan into action and it may take years to complete the overall design plan.

3.6.4 Steps for your design plan

There are many ways to create a design plan. However it is important to work in a orderly and structured way. We therefore suggest six main steps to consider when you create a design plan. These steps form part of the next activity.

Note: In the next unit you will be following the six steps with your households, so make sure you understand and do every step as well as possible.

Activity 3.14 Creating a design plan for your area

Complete this activity on your own in your workbook

Aim: Create a design plan of a food or any other garden for your area taking low input principles into consideration.

Time: 4 hours

What you do

Follow the steps explained below, and use any relevant information in this module to design a plan of action to enhance food security in your area.

Step 1: Revisit your helicopter plan

In Unit 3 of Module 2 you had to draw a helicopter plan showing how you would like your area (yard) to look in five year's time. It is now time to revisit this helicopter plan to remind yourself of your expectations and to take them into consideration when you start your design plan.

Step 2: Revisit the map you compiled (Resources map and Transect walks)

In Unit 2 of this module, you used various tools to map your area. You will recall that we looked at resources mapping and transect walks. You now need to revisit this map to help you decide where you will make your garden.

Step 3: Decide where and how you will make your garden

Although you have a map of your community, and a list of your resources, you now need to decide on these important aspects:

1. Where will you make your garden?
2. How will you address the water needs?
3. How will you prepare your soil?
4. What plants you will you plant?

Where will you make your garden?

Walk around your own area, preferably with other people in your own household, You will want to do this several times at different times of the day to really understand the area. After ten years we still take what we call 'garden walks' to see how the designs are doing and to discuss what changes and additions we want to make.

You need to look at the following factors:

- The current layout of trees, the places where you keep your animals, and the buildings in your own area
- The life styles of your own household members
- The slope, aspect and ridges in your own area including where North, South, East and West are
- The direction of the usual winds and the position of trees throwing shade (which may change at different times of the year).

How will they address their water needs?

- Decide on how you will controll run-off
- How irrigation can be implemented in the most effective way
- How to address your water needs in the most sustainable way (capturing rainwater, dew and 'grey' water)

How will you prepare your soil?

- Establish the type of soil you have and how you can improve it (compostand/or manure)
- What will you use as mulch?
- What types of beds will you make; raised, sunken or level?
- How will you prevent soil erosion?

Which plants will you plant?

- Decide on the best plants and animals to use according to permaculture groups and to enhance food security directly or indirectly. For example, you will be directly enhancing food security by planting a variety of vegetables and fruits to eat. You will be indirectly enhancing food security by planting medicinal plants, food plants and flowers to sell.
- Consider using indigenous plants and seeds which you have harvested in a sustainable way from nature.

Step 4: Visualise or "draw" your plan:

There are several ways that you can visualize or "draw" your plan:

- in your head,
- on paper such as a notebook, flip chart, poster board, old cardboard or chalkboard,
- outside in the actual area with rocks, broken bricks, sticks, or other markings to help you see your ideas and make changes by moving them around as you think through your plan.
- by using all of these methods, which is the best way to do it.

A. The bare homestead plot

B. The garden design using bricks

Figure 3.29 An example of a design plan laid out with bricks

Step 5: Discuss your design plan with other people

You have worked hard and have designed a plan which you are very proud of**.** It is however very important to discuss your design plan with other people; not only with members of your group or household, but also with other knowlegeable people.There are numerous people with experience that will add value to your plan. After discussions, revisit your design and adapt it where necessary. Keep in mind that the success of your project depends on a good design which takes all low input principles into consideration.

Step 6: Action plan

After you have mapped your area and created your design plan, you have to write an action plan for your area. When you are working in a team or community situation, a written list helps to create clear communication. You can brainstorm all the activities that need to be done then put them in order into a plan. Remember, things may change when you get out there and start doing. This action plan will form the main topic of Module 5.

Questions

1. What were the major changes that you made to your original map for your area, after you had walked through the area a second time? What made you change your mind?
2. Was there agreement in your group, regarding the priorities that need to be addressed in the area? Is it important that every member should have a voice? Justify your answer.
3. What problems do you think you will encounter when you put your design into action? How can these be addressed?

Concluding remarks

In this unit we have explored how natural resources are abused and in danger of becoming so scarce that we will not have enough to satisfy our future needs. However, there is hope if we use our resources in a sustainable way. We have therefore looked at ways to manage our precious soil, water, biodiversity and energy resources efficiently without harming the natural environment, while still enhancing food security.

We also started planning a design for a homestead garden and other projects that will contribute to food security in our specific area.

In Unit 4 you will have an opportunity to apply what you have learned when you work with households.