Introduction

In the Module on Sustainable Natural Resource Use (Module 3) we examined the natural resources that are available in your area and how these resources can be used in a sustainable way according to low input principles. In this unit we revisit the concept of *sustainability* and build on it. Why is sustainability and low-input principles so important? The answer is simple. If we want to continue benefiting from what the Earth has to offer and have enough to eat, we need to work with nature and not against it. With this in mind you compiled a draft design plan for a food garden. You also made compost, which should be ready to use when you start planting your vegetables in Unit 3.

The unit consists of the following sections:
1.1 What is a sustainable system?
1.2 Three systems of farming
1.3 The homestead as a sustainable farming system
1.4 Farmer experimentation

Specific Outcome and learning outcomes

The specific outcome for this unit is to process and assess information about different farming systems in the community.

Learning outcomes	Assessment Activities	Actual time spent
	Workbook activities	
1.1 What is a sustainable system? 1.2 Three systems of farming 1.3 The homestead as a sustainable farming system 1.4 Experiment to find practices that work (Farmer experimentation)	Start-up activity (30 minutes) 1.2 The five categories of assets and the elements of sustainability 1.3. Flow diagrams of different farming systems (I hour) 1.4. Comparing farming systems (3 hours) 1.6. Assess a homestead farming system (4 hours) 1.7. Case study of a homestead farming systems (3 hours) **Assignments** Assignment 1: Information for this assignment is contained in Tutorial Letter 101. (3hrs)	

Key Concepts

Sustainability	Decomposing sub-system
Farming system	Indigenous knowledge
Homestead	Mimicry
Traditional Farming	Micro-organisms
High-External-Input farming	Cyclic flow patterns
Low-External-Input farming	SWOT analysis
Animal production sub-system	Furrows
Plant production sub-system	Mounds

Start-up activity

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

Aim: Revisit the concept of limited natural resources to link with work done in Module 3.

Time: 30 minutes

What you will need
A bowl, at least 50 nuts, sweets or small stones, a flip chart, marker pens

What you must do
Play the following game called the nuts game. Each player's goal is to get as many nuts as possible.

1. A small group of 4 to 5 players sits around an open bowl containing 25 nuts/sweets or stones.
2. The rest of the group watches (they are the spectators). Spectators may not interfere in the game or make comments while the game is being played.
3. Players should remain quiet during each round of the game.
4. The facilitator puts 25 nuts into the bowl.
5. When the facilitator gives a signal the players take nuts from the bowl – all at the same time, but using only one hand. This makes one "round".
6. After each round, the facilitator will double the number of nuts left in the bowl up to a maximum of 25 nuts.
7. The game is over when the bowl is empty, or after 10 rounds.
8. During the game the harvest (the number of nuts gained by each player in each round) is recorded. At the end of the game the total harvest per person and the group total is recorded.

Discuss the following questions:

1. How did the game make you feel?
2. What happened in the game?
3. What do you think the game represents?
4. What did you learn during the game?
5. How should we act towards the environment and other people when we use resources?

Comments on the start-up activity

Humans need to realize that the Earth has limited resources available because of over use and abuse. How should people respond to a situation where there are limited resources that should be shared? We need to do this in ways, which are humane, socially, economically and ecologically, just and financially sustainable. We can only address this issue when we understand how a system works, and this is the topic of our next section.

1.1 What is a sustainable system?

In Module 3, Unit 1 you discovered that nature functions as a system and that such a natural system is called an *ecosystem*. For an ecosystem to be successful it must be sustainable. This means the long term needs of all the organisms in the ecosystem must be met. This is possible because the organisms living in the ecosystem interact with each other and also with the physical environment (soil, air, water). Everything in an ecosystem is therefore connected to everything else. When one of the links in the system is damaged it has an impact on all the other parts. What happens to the one happens to the other. For example if we keep on dumping dangerous wastes into the river, the living things in the river will suffer and the people who depend directly or indirectly on the river will also suffer.

1.1.1 Systems thinking

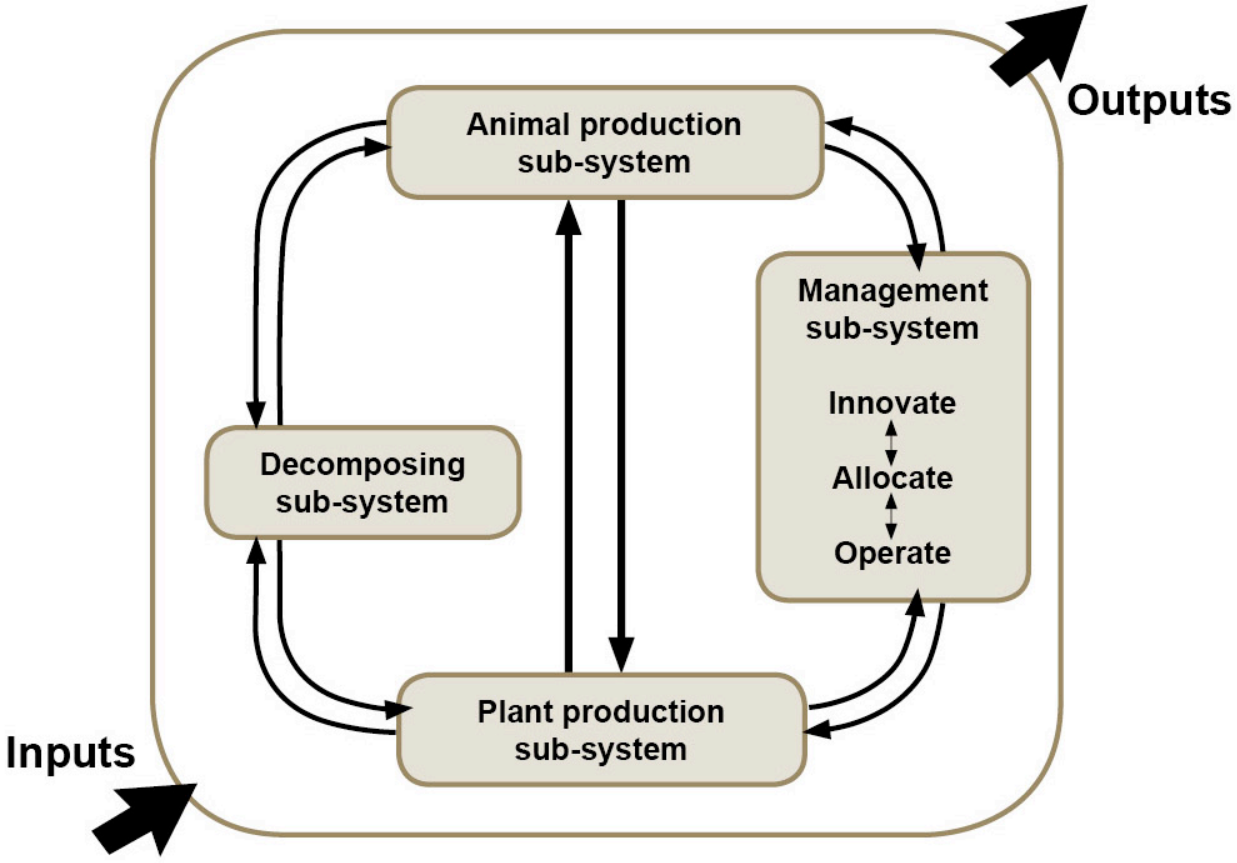
We do not only find systems in nature. Everything works as a system, because everything is inter-connected and every action has an effect on something or somebody else (every action has a reaction). A **homestead** (a home and its environment) is a very important system for humans. This is the place where we grow up, and are nourished. If the homestead is strong, nourishing and enabling, in other words sustainable, then our citizens are also strong, nourished and enabled. If the homesteads are weak, impoverished (poor) and disempowering (abusive) our citizens will be likewise.

A system, (also you homestead system) has certain characteristics. It has a boundary, inputs, outputs and sub-systems.
When we examine your homestead as a system we find that:

- **The boundary of the system** could be the 4 corners of your yard. It could also be an area that includes your homestead and field, or a number of homesteads relying on one water source, or a whole village. You define the boundaries of your homestead system yourself.

- **The inputs of the system** are the items or processes that feed into your system. The inputs may come from inside or outside the system. For example compost you make yourself and seeds you buy for your garden.
- **Outputs of the system** are what your system generates, for example produce (food), but also fodder, money, etc.
- **Sub-systems within the system** can turn your inputs into outputs. Notice that the sub-systems are linked by arrows.

Below is a diagram of a system with sub-systems. The relationships between the sub-systems are shown with arrows. Note that some of the arrows point in different directions.



(Adapted from: Wilson J. 1995)

Figure 1.1 A system has a boundary, inputs, outputs and sub-systems.

The animal production sub-system refers to all those elements required for producing animal products.
The plant production sub-system refers to all those elements required for producing plant products.
The decomposing sub-system refers to all those elements involved in plant and animal material breaking down over time to become compost.
The management sub-system refers to all the processes involved in managing the whole system.

What do the following words mean?
Innovate = try new things which will increase outputs and minimise inputs.
Allocate = ensure that inputs are effectively used where they have maximum benefit to the system, and that outputs are harvested, stored and used wisely.
Operate = perform tasks and manage processes to make sure that the system is working effectively.

The nuts game made us aware that for a system to function successfully, it has to be sustainable. This principle is also true when we plan a farming system. For a farming system to be sustainable and contribute to food security, it needs to be able to continue over a long period of time. It needs to be able to sustain itself. In other words, it needs to be able to keep going for many years without much external (outside) input. We can summarise by saying any sustainable system, including a farming system has to have a number of elements (factors) present.

1.1.2 Elements of sustainability

For farming to be sustainable it should be:

- **Economically viable**: Farmers produce at an adequate and stable level and at a risk level that is acceptable to them.
- **Ecologically sound**: The quality of the environment is maintained or enhanced and natural resources are conserved. Ecologically sound agricultural systems are healthy and highly resistant to stresses and shocks.
- **Socially just**: The agricultural system ensures equal access to land, capital, information and markets for all people involved, whatever their socio-economic position, gender, religion or ethnic group.
- **Humane**: All forms of life (plant, animal, human) are respected and treated with dignity.
- **Adaptable**: Sustainable rural communities are able to adjust to constantly changing conditions such as population growth, new government policies and market demand.

Elements of sustainability

These are practises, which can lead to sustainability. For example *Communal Grazing Management* is a set of rules that all cattle owners must respect and follow. The rules indicate how grazing of cattle should occur throughout the year which will ensures that the veld is not degraded.

(Adapted from Van Veldhuizen, *et. al,* date unknown.)

Activity 1.1 A homestead as a system

Complete this activity on your own in this study guide

1. Take your own homestead or one that you know well and draw a system diagram similar to the one shown above. Make sure you clearly indicate the boundaries of your system, inputs, outputs and relationships.

2. Think about the farming in this household (the garden or fields or grazing areas – choose one as your boundary). What potential do you see?

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3. What is required for this type of farming (inputs)?

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4. What is done and how is it done (process and relationships)?

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5. What is produced (outputs)?

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6. Comment on the present situation. How do the different elements of the system relate to one another? (Think about what each element has that another element needs).

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7. Make a comment about future possibilities for this system. What could be added (or changed) to make it more effective?

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Comments on Activity 1.1

One needs to be creative and innovative, and see the potential within the system. For instance, a person might only have a small area available for farming (restricted boundaries), but by using pots or hanging containers the outputs (vegetables) can be greatly increased. Also, if animals such as chickens or goats are kept (animal production sub-system) then the manure can be used to increase vegetable crops, by enriching the soil (inputs).

1.1.3 Assets and the elements of sustainability

As you are aware from work done in previous modules, livelihood assets can be divided into five different categories. These are: physical, social, human, financial and natural resources.

It can be difficult to find good examples of sustainable activities in our environments. To give you some ideas a small list of possible strategies is given below:

- Inter cropping of maize and legumes such as beans and cowpeas (*economically viable, ecologically sound, adaptable)*
- Organic homestead food production (*ecologically sound, socially just, adaptable)*
- Production of food crops and cash crops in the same field (*economically viable, adaptable)*
- Planting different varieties of the same crop to spread the risk of crop failure (*economically viable, adaptable, ecologically sound)*
- Working together in small savings and marketing groups *(socially just; economically viable)*
- Growing a crop such as cowpeas where the beans are sold and the crop remains are turned into silage or hay to feed dairy cows (*humane, ecologically sound, economically viable)*
- Storage of crops for sale or for later use (*economically viable, adaptable*)
- Using ploughing and fertilization practices that increase the fertility and life in the soil (*ecologically sound)*
- Ensuring that women have a right to cropping fields and to raising and keeping cattle (*socially just, humane)*
- Ensuring the health of your livestock through good feeding and timeous treatment of diseases and parasites (*humane, economically sound)*

You will notice that many activities fulfil more than one element of sustainability at the same time.

Activity 1.2 The five categories of assets and the elements of sustainability

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

Aim: Assess livelihood assets in terms of their sustainability.

Time: 2 hours

What you must do
Read through the descriptions in your text above on the elements of sustainability.

1. Write down one example of a sustainable activity for each element.
Ecologically sound; Economically viable; Adaptable; Socially just; Humane.

2. In your workbook, look at the figure for the five categories of livelihood assets. Take your 5 examples from question 1 and fit them into the livelihood category where you think they belong.

Comments on Activity 1.2

Examples will differ depending on your region and the culture of the people there. However, here are two examples to give you some guidelines on this activity:

Example 1: The Mtombeni household

Although the Mtombeni family has limited space, they plant vegetables in large pots, and they also keep chickens. They have decided to grow crops such as sweet potato, which is relatively drought tolerant.

Table 1.1 The Mtombeni household

Ecologically sound	The Mtombeni's make good use of limited space, and since they use crops that are drought tolerant, they do not misuse water which is a valuable resource.
Economically viable	The household gets protein from their chickens (both eggs and meat), and supplement this with essential carbohydrates and vitamins from the vegetables that they grow. They save a lot of money since these food sources provide most of their nutritional needs. They also sell surplus vegetables to their neighbours.
Adaptable	The household creatively addressed the problem of limited gardening space by growing their plants in large pots
Socially just	All members of the family, including the women and girls, help to maintain the garden and homestead and share in the profits.
Humane	The animals (chickens) are fed well and treated with respect.

Example 2: The Baadjies household

The Baadjies family lives on a farm near Calvinia in the Northern Cape. The farmer gave them sufficient space to maintain a relatively large garden. They cultivate different vegetables in the garden that they use themselves. They also cultivate a medicinal plant called *Sutherlandia frutescens* (known as the Cancer Bush), which they sell to a local pharmaceutical company.

Table 1.2 The Baadjies household

Ecologically sound	The family Baadjies plant different crops (no monoculture) for their food needs, and then cultivate a plant that naturally occurs in the region (*Sutherlandia*), which is well adapted to the dry area and fluctuations in temperature.
Economically viable	They provide to a large extent their own nutritional needs, and make a good income by selling medicinal plants to a local pharmaceutical company.
Adaptable	The household creatively uses local resources, and plants a medicinal plant for which there is a market.
Socially just	All members of the family, including the women and girls, help to maintain the garden and share in the profits.
Humane	The Cancer Bush is today used to treat people who suffer from HIV/AIDS and in their own small way, the Baadjies family help people who suffer from this pandemic to lead a higher quality of life.

1.2 Three systems of farming

In Module 3 we examined principles of Low Input gardening/farming, which is one type of farming system. In this section we will introduce other farming systems so that you can compare them. There may be different reasons, different practices and different outcomes for each farming system.

There are human **values** and principles that underlie each different farming system. We need an understanding of these values to understand the system.

What are the three farming systems and their major characteristics?

1.2.1 Traditional Farming (TF)

TF is based on **indigenous knowledge** and practices that have been developed over many generations.

What is indigenous knowledge?

The knowledge and practices that were tested over long periods of time in a particular community, and that have been passed on orally from one generation to the next.

Characteristics of TF

TF focuses on subsistence, uses resources that are locally available and makes little use of external inputs. It varies from one area to the next as the environmental conditions and the culture of the people differ.

Disadvantages of TF

Confronted with rapid changes such as increasing population pressure and greater needs for cash, farmers practicing traditional agriculture cannot always increase productivity sufficiently. They may therefore expand farming into **marginal** areas, which increases the risks of over-exploitation (of natural resources, for example, over-grazing of grasslands), erosion and other forms of environmental degradation.

An example of a TF system

Rain-fed maize, planted with seed kept by the family from year to year. Fields are ploughed with oxen and fertilized with cow manure. Planting and weeding is done by hand using the labour of family members. The harvest is used to feed the family and homestead chickens.

1.2.2 High-External-Input Farming (HEIF)

HEIF is the conventional, “modern” approach to agricultural development. It generally uses external inputs such as hybrid seed, fertilizer, biocides (herbicides and pesticides), mechanization (use of machinery, including tractors) and credit (borrowing of money from a financial institution) to increase productivity.

Characteristics of HEIF

- It uses high levels of external inputs
- It involves strong links between farmers and commercial (e.g. banks) and government services
- It is market oriented (cash crop)
- It specialises in monocultures (only one crop per field or only one animal kept in large numbers only for meat, or only for eggs)
- The biodiversity in the landscape is greatly reduced. This means there are fewer types of living organisms and plants and fewer numbers of those organisms and plants.

Advantages of HEIF

- short-term increases in production and cash income,
- uniform production processes, and
- lower labour costs.

Disadvantages of HEIF

- It is not suitable for dry farming areas that are vulnerable to shocks and stresses
- It has negative impacts (e.g. pollution) on water, air and human health
- It tends to erode soils, destroy **genetic resources** and ignore local or indigenous knowledge
- It cannot be applied by many poor farmers in poor areas
- It makes less use of available local resources and makes too much use of **non-renewable resources** such as fossil energy (petrol, gas, oil, etc.) and phosphorous
- It increases the dependency of farmers on non-renewable resources.
- It can lead to a situation where pests and epidemics can wipe out entire crops.

These and other disadvantages have stimulated interest in developing sustainable farming practices. New approaches have emerged such as organic farming, permaculture and ecological farming. These are described as being Low-external-input farming (LEIF) methods or approaches.

1.2.3 Low-External-Input Farming (LEIF)

LEIF depends primarily on resources from the farm, village and local area and is characterised as follows:

- It aims to integrate soil fertility management, cropping and livestock production into one system
- It makes efficient use of nutrients, water and energy and recycles them as much as possible, thus preventing depletion and pollution
- It uses external inputs only to compensate for local deficiencies
- It involves site-specific farming practices
- It aims at stable and long-lasting (sustainable) production levels
- And incorporates the best of all known farming practices in an area.

Traditional Farming (TF)

High-External-Input Farming (HEIF)

Low-External-Input Farming (LEIF)

Figure 1.2 Three types of farming systems using different land preparation methods

Below is a group activity that can help you work through the concepts presented above.

Activity 1.3 Flow diagrams of different farming systems

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

Aim: Draw flow diagrams of different farming systems

Time: 1 hour

What you must do:
Read the descriptions of HEIF, LEIF and TF in the section above. See also Portfolio activity 5.1

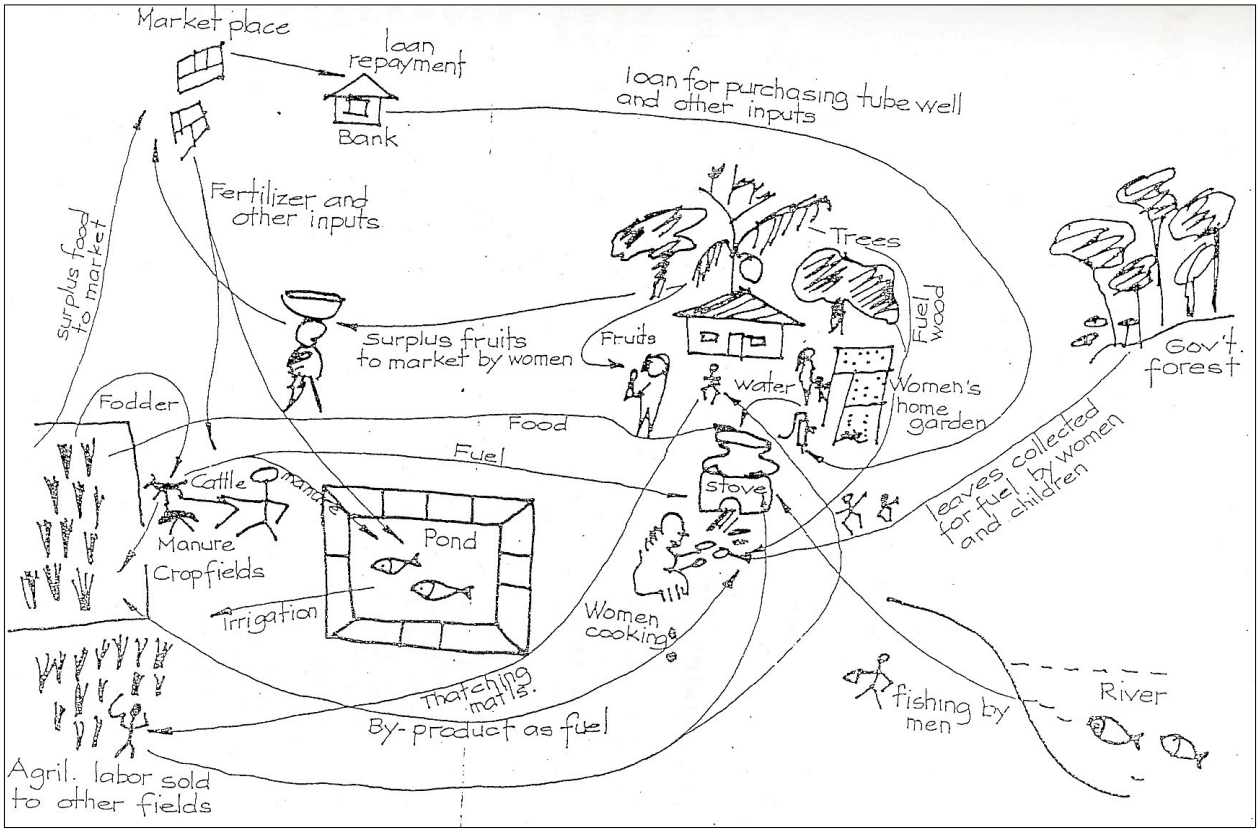
1. Choose a specific farming activity such as growing maize, vegetable production, livestock production etc. Discuss how t will happen in practice for each of the three different farming systems. Think how this farming activity will differ when using the HEIF system as compared to the LEIF and the TF systems. Make notes of your discussion or thoughts.

2. Familiarize yourselves with what a flow diagram is by looking at the examples given below and then take your notes and turn them into flow diagrams that represent the different farming approaches you discussed. You will thus draw three flow diagrams; one for HEIF, one for LEIF and one for TF.

Use the spaces provided in your workbook for your discussion notes and flow diagrams.

What are flow diagrams and how do they work?

Flow diagrams are a number of small diagrams connected by lines or arrows. They are useful for showing the positive or negative consequences of actions. The arrows at the end of lines indicate the direction of flow.



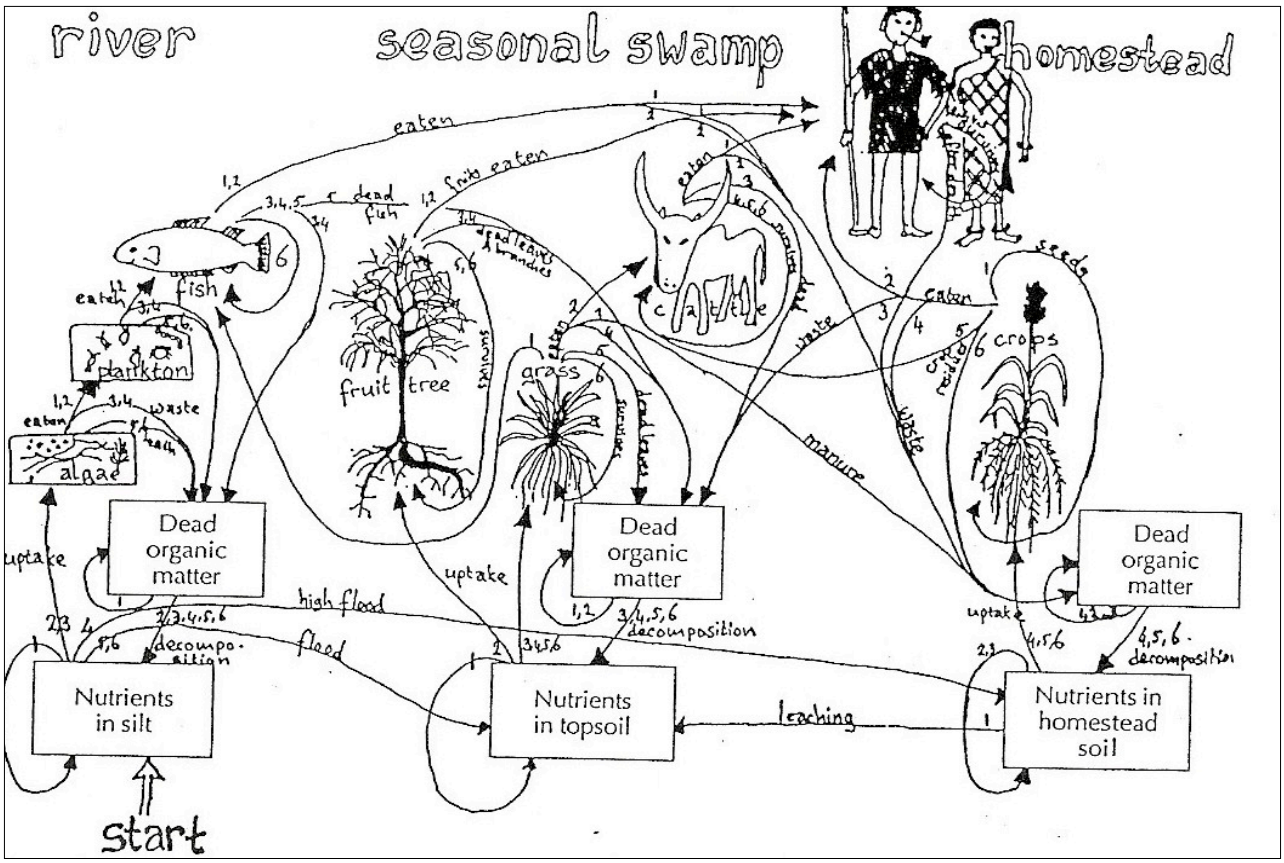


Figure 1.3 Two examples of resource flow in a homestead farming system
(Adapted from*: Developing technology with farmers. A trainer's guide for participatory learning.)*

Comments on Activity 1.3

There are many possibilities, but the following example might give you a better idea of what is expected. We'll use the same examples as in the previous activity (Mtombeni & Baadjies households).

Table 1.3 The Mtombeni and Baadjies households

	TF	**HEIF**	**LEIF**
Planting sweet potatoes	The Mtombeni's plant enough sweet potatoes for their own use, but also plant other vegetables. They use chicken manure to enrich the soil, and use little water. Unfortunately the goats they keep overgraze the land and this leads to soil erosion.	Here sweet potatoes will be planted as monoculture by a commercial farmer, who will get funding to do this from a bank. The farmer will hire labourers to work for him, and will also use irrigation and commercial fertilizers. Since monoculture crops are often very vulnerable to diseases and insects, he will also use pesticides to	Here the farmer will put resources like water and energy to good use, and will recycle effectively.

		protect the crop, which is harmful to the environment.	
Planting a medicinal plant such as *Sutherlandia frutescens*	Although the Baadjies family also use the plant for medicinal reasons (they make a health tea from the leaves), they mainly plant this crop to support their income. They harvest seeds from the plants every season to use again the next season.	Here a farmer grows *Sutherlandia* on a commercial scale, and hires workers, and uses fertilizer and pesticides which impact negatively on the environment.	Research has shown that *Sutherlandia* grows better if the soil is enriched with nitrogen (N), and therefore the farmer rotates crops so the farmer plants nitrogen fixing plants every third year.

Now that you have had some practise in how to construct flow diagrams and how to tell the different farming approaches apart, you are ready to analyse one of the farming approaches or systems in more detail.

Activity 1.4 Comparing farming systems

Complete this activity on your own or in your workbook

Aim: Analyse a known farming system in terms of the three approaches to farming discussed in this unit.

Time: 3 hrs

What you must do
Read through the descriptions in your text on TF, HEIF and LEIF.

1. Write down one example from your own experience of each farming system. (e.g. one example of TF, one example of HEIF, one example of LEIF).

Note: One example should be the farming system most commonly used in your area.

2. Use these examples to complete the table below. Clearly indicate which example represents the system used in your home environment. Your home environment may contain elements of more than one system.

Table 1.4 Three farming systems

Note: A variable is a factor that can change, e.g. water availability.

Variables	Traditional	HEIF	LEIF
Use of locally available inputs (e.g. manure, compost, seeds, oxen)			
Variety/specialisation (types of seed, e.g. hybrids, kept from last year)			
Use of external inputs (e.g. seeds, fertilizer, pesticide)			
Use of local knowledge (e.g. ways to plant, knowledge of seasons, rainfall, wind)			
Use of extension services (yes/no/sometimes?)			
Main production objectives (harvest is sold/feeds family/feeds livestock?)			
Cash income (yes/no/sometimes?)			
Labour requirements (how much labour? Family or hired?)			
Level of production (e.g. yield is high/low/vulnerable to risk?)			
Degree of recycling (are resources re-used? (e.g. cow manure used as fertilizer)			
Water use (how much? How often?)			
Sources of water (e.g. Rain Water Harvesting (RWH), rain, irrigation, hand-watering)			

Comments on Activity 1.4
Below is an example of how you could complete your table.

Table 1.5 Comparing farming systems

	TF	HEIF	LEIF
Local inputs	Use own seeds, harvested from previous year; use manure to enrich soils	Most often buy seeds and fertilizer	Use own seeds, compost, manure. Only buy what is not locally available.
Variety (e.g. seeds)	Use what is available. After a few years, seeds no longer give a good crop because there is little genetic variation.	Mostly purchase seeds - larger genetic variety. However, often practices monoculture.	Mostly use what is available in the community, so there is a bigger genetic variety.
External inputs	Little or none	High external inputs - need labourers, fertilizer, pesticides	Only use external inputs if local inputs are not available.
Local knowledge	Used	Often ignored	Most often used; tap into best practices
Extension services	Expert advice from outside people not always available	Always available	Use mostly indigenous knowledge
Production goals	Household food security	Commercial drive	Food security for the community
Cash income	Sometimes	Yes, always	Yes, sometimes
Labour requirements	Family members	Hire external labourers	Members of community
Level and risk	Risk can be reduced by having different crops and animals	High risk, because of monoculture (high risk of diseases)	Medium risk
Recycling	Yes	Most often not	Yes - striving for a balance
Water use	Little	High. Irrigation mostly always used	Water resources used wisely - e.g. ground covering to limit transpiration/ water loss
Water sources	Rain; hand watering	Irrigation from rivers and dams.	Recycling; e.g. would collect rain water. Grey water recycled (see next paragraph)

1.3 The homestead as a farming system

We will first look at the principles of low external input farming (LEIF) that can be applied to homestead food production. Then we will look at the homestead farming system within this context. We assume that a low external input approach is indeed the best option at a homestead level.

1.3.1 LEIF principles

There is no fixed set of LEIF practices. These need to be developed or adapted according to the specific situation and the needs of the farming household. To be able to do this, a good understanding of the basic principles of LEIF is necessary. You learned about these principles in Module 3, Unit 3 and you applied them when designing your draft homestead garden plan. However, the LEIF principles are important and the paragraphs below serve to remind you what they are.

Mimicking (imitating) nature: All natural ecosystems without human disturbance manage to accumulate (collect) nutrients. This means that they can sustain themselves over a long period of time. It would be good for us as farmers to look at how this happens and to copy or mimic these processes. The accumulation of nutrients happens in a number of ways:

- Living plants form a continuous soil cover
- A layer of decomposing plant material and leaves covers the soil
- Roots of different plants are distributed throughout the soil at different depths
- Most nutrients are retained in living plants or animals

Seeking diversity: Natural ecosystems consist of many different plant and animal species interacting with one another. These beneficial relationships develop over a long period. Farmers using LEIF methods try to develop similar processes by diversifying (ensuring there are many different kinds) the species of animals and plants that grow and interact with one another. This gives strength to the system enabling it to resist disturbances (stresses and shocks) such as erratic rainfall and attacks from pests and diseases:

- Many different types of plants grow together. They share space in the soil and above the soil.
- This creates an environment where many different organisms, creatures and animals can also survive.
- The plants and animals interact with each other in a beneficial way. An example is the Cape Parrot, which needs large decaying trees for its nests. They find these trees in natural forests. The parrots feed on fruit and seeds such as the seeds of the Yellow wood tree. This means that th parrots help to distribute these seeds throughout the forest enabling new Yellow wood trees to grow. Without the parrots, these trees do not propagate well and without these trees the parrots do not propagate well either. People have cut down most of the Yellow woods in natural forests for their beautiful wood, to make furniture and build houses. These trees are not re-growing well.
- In natural environments pest and disease **epidemics** hardly ever occur. There is a balance that ensures that beneficial and harmful organisms live in harmony.

Living soil: One of the most important components of soil is soil life, including bacteria, fungi, protozoa **(microorganisms)**, nematodes (**microscopic** worms), beetles, centipedes and earthworms. This plays a major role in nutrient availability and recycling and thus agricultural productivity. Farmers have to create favourable conditions for soil life and manage organic matter, so as to create a fertile soil in which healthy plants can develop. Vegetative (plant) cover protects the soil and decreases the impact of rain and heating by the sun. Mechanical measures can limit erosion by water and wind. Soil life also needs to be protected from harmful man-made substances such as pesticides and fungicides.

Cyclic flow patterns*:* In a natural ecosystem hardly any natural material is lost. LEIF aims at learning from these natural recycling processes to prevent depletion of natural resources.

Losses are minimised through:

- Cover crops
- Deep-rooting plant species that recycle nutrients
- Erosion control
- Improved collection, storage and application of wastes from crops (residues), livestock (manure and urine) and the kitchen (**grey water** and food wastes)
- Managing water flows so that optimum use is made of available water (rain water is harvested, grey water is recycled etc).

A few examples of the application of LEIF principles are given below:

Mimicking nature:

- Mulching
- Stacking
- Environmental awareness; promoting the presence of natural predators for pest control
- Natural pest and disease control mixtures such as chilli-soap mixtures for pest control
- Toilet paper rolls for cutworm control (mechanical barrier)

Seeking diversity:

- Mixed cropping of cereals and legumes
- Multiple sources of nutrients (manure, compost, mulch, trench beds)
- Planting herbs for diversification and pest control
- Mixtures of different varieties of plants
- Inter cropping and companion planting
- Napier fodder for windbreaks and animal fodder
- Planting garlic (pest control and for use as a condiment)

Living soil:

- Trench beds
- Mulching and cover crops
- Digging in manure into the top 10-15 cm of soil
- Contour bunds and wind breaks
- Organic matter to feed the soil
- Use of natural pest and disease control mixtures

Cyclic flow patterns:

- Rain water run-off ditches
- Liquid manure
- Seeds of various crops for diet diversification (including peanuts, jugo beans, mustard spinach, carrots, beetroot and others in smaller quantities – tree tomatoes, granadilla, fennel, parsley, coriander, garlic chives, spring onions)
- Use of crop residues as animal fodder
- Composting
- Deep-rooting crops (which pull up nutrients from deep in the soil)

How can the LEIF principles be applied to a homestead farming system?

Activity 1.5 LEIF principles and the homestead farming system

Complete this activity on your own in this study guide

1. Take your own homestead or one that you know well and construct a flow diagram of the farming system. Show how the four LEIF principles discussed above can be included into the farming system.

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2. Comment on the present situation. Are LEIF principles applied? If so,how? If not, how could the principles be applied to enhance the LEIF system?

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Comments on Activity 1.5

In your answers, you should consider the following:

Table 1.6 Applying LEIF principles to farming

Mimicking nature	Mulching; natural pest and disease control (e.g. using a light liquid soap spray (a tablespoon of liquid paraffin or canola oil and a few drops of Sunlight liquid in one litre of water)
Seeking diversity	Mixed cropping; e.g. planting different crops together
Living soil	Digging in manure; crop rotation; reducing the use of chemical fertilizers and pesticides; increasing the use of crops that cover the soil, and green manure.
Cyclic flow patterns	Make rain-water run-off ditches; composting.

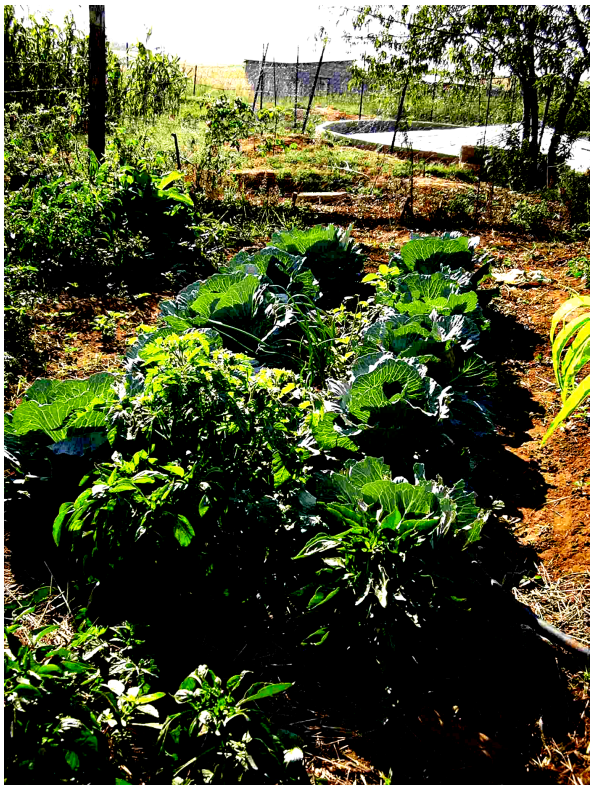

Figure 1.4 A homestead farming system based on LEIF

NOTE:
Mulching, mixed cropping(cabbage, chili and onion in one bed), use of trench beds and sunken paths for rainwater harvesting, underground rainwater storage tank in the background and planting of herbs (e.g. comfrey) and medicinal plants along the fence line in Mr Madondo's garden.

(Adapted from Kruger, 2010)

It is possible also to assess a homestead farming system in a different way. We can look at the strengths and weaknesses of the present system and assess the future opportunities and threats to the system. This is called a SWOT analysis

This method provides a quick summary to analyse a situation that can be used as a decision-making and planning tool. It highlights (shows or emphasises) the important issues in a short and accurate form.

SWOT stands for the following:

STRENGTHS (S): Make a list of the strengths of the situation – what is working well?

WEAKNESSES (W): Make a list of the weaknesses, problems, and difficulties – what is not working so well?

OPPORTUNITIES (O): Make a list of the possibilities, suggestions for action and change, new ideas that can be brought in – what could work well in the future?

THREATS (T): Make a list of the foreseeable dangers and problems related to the opportunities - what could not work well in the future?

Generally we present these lists in the form of a table. This becomes the basis of a discussion for the best possible interventions or actions for change in a particular situation. Below is an example of a SWOT analysis, using food security as a topic.

Table: 1.7 SWOT analysis of food security for a rural household

Strengths	Weaknesses	Opportunities	Threats
Access to land for farming and gardening	Little money to pay towards farming	Low external input farming	Limited knowledge of how to implement these systems
Natural resources for basic needs: water, fuel, grass, wild foods	Many people using limited resources	Uses resources that the household has control over; e.g. rain water falling within the boundaries of the homestead: cultivating your own resources e.g. firewood, medicinal plants.	Limited space, time and resources to initiate these activities. Immediate need may overshadow longer term production
Family can be involved in a range of livelihood activities	Lack of labour	Labour saving technologies and processes, such as planning a garden that can self-maintain, growing fruit and nut trees that need little attention but can still provide food. Using appropriate tools	Poor access to information and technologies
Safe, healthy environment for children	Lack of sanitation and diverse foods leads to diseases that are life-threatening for small children	Growing a diverse range of food crops that can supplement the diet of small children. Giving attention to sanitation	Motivation for change may be limiting for poor people that are struggling to survive

The table above shows that there are many opportunities for increasing food security at a homestead level. Most of the threats to implementing these ideas are related to lack of access to information and resources. Such a table helps give a clear idea of where to start with an intervention for change. This change may take the form of a project aimed at training people in

how to get access to the information needed, or a project that may help to bring in some resources to implement the new ideas.

As a facilitator you are expected to plan interventions to address the opportunities and threats. Here are a few examples, to help you.

Table 1.8 Interventions, to address the opportunities and threats.

Opportunities	Threats	Possible intervention
Cultivating medicinal plants	Little knowledge	A local medicinal plant that is well adapted to the environment and needs little external inputs. Plan an event, where a knowledgeable person explain to people how this plant can be cultivated, how its seeds should be collected and stored, and how it could be used for medicinal purposes.
Gardening land available, as well as family members who can work in the garden	Pests (e.g. insects) pose a threat	Have a workshop, where you assist people in gaining knowledge on household methods to control pests and diseases. For example insect-repellent plants such as mint, tomato, onion, chilli, garlic and marigolds can be cultivated, to repel insects. A liquid soap spray or wood ash could be used.

Activity 1.6 Assessing a homestead farming system

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

Aim: Analyse a homestead as a farming system in terms of strengths, weaknesses, opportunities and threats.

Time: 4 hrs

What you must do
This activity consists of two parts and you must do both of them.

Part A
Work with a gardener or farmer that you know in your area and draw a farming system flow diagram of his/her farming system. Make sure you clearly indicate the boundaries of your system, inputs, outputs and links between subsystems.

1. Make a comment about the present farming system. Can you identify any principles of LEIF applied here? If yes, what are they? How do they relate to each other? How do they increase the success of this farming system?

2. Make a comment about future possibilities for this system. In other words, how could application of LEIF principles help this farming system? Include the four LEIF principles that were discussed above.

Part B

1. Complete a table of strengths, weaknesses, opportunities and threats for the farming system in your workbook.

Strengths	Weaknesses	Opportunities	Threats

2. Suggest a potential intervention (project) that could change the situation for the better (based on your table).

1.3.2 Case study of a homestead farming system

Below is an example of a homestead farming system, as practiced by Mr Matlere in Lesotho. You will need to read through this case study carefully before you do the activity that follows.

The case study is one the next four pages.

Case study: A beautiful example of intensive food production and rainwater harvesting

Mr S. S. Matlere has been working with conservation/ ecological agriculture for many years. He noticed a number of problems in the cropping fields in his work as an agricultural extension officer. These included soil erosion through run-off, declining soil fertility, a lack of water, and low production. Through long and thoughtful observation he has now designed and implemented his own system of farming that solves these problems and has many other benefits as well. His design consists of making furrows on the contour in the fields, with a mound all along the down slope side of each furrow.

Figure. 1.5 Mr Matlere says "*Ask me about furrows*".

Organic matter (mulch) is continually added into the mounds. A range of crops are grown, including maize, wheat and vegetables such as beans, tomatoes, cabbages, potatoes, rape, mustard spinach and onions.

Figure 1.6 Furrows and mounds
Above left: *In a row of the field, cabbages were planted on the mound next to the maize. These cabbages are now being left to produce seed for the next season. Note the organic matter that is weeded out and placed as mulch in the furrow and on the mounds.*
Above right*: Mr Matlere is standing in one of his furrows. On the mound is a crop of maize, already harvested, with runner beans climbing up the stalks.*

Why does Mr Matlere use furrows and mounds?

- Furrows and mounds help regulate run-off water which would erode fertile topsoil.
- Furrows ensure that all the rain that falls on the field remains there. The rain is caught in the furrows and sinks into the soil.
- Furrows help distribute rainwater evenly throughout the entire field.
- Mounds help increase the depth of soil, which in turn helps the roots of the plants to go deeper in search of plant food and moisture. With strong, deep roots, the crops produce better yields.
- Furrows and mounds also increase the fertility of the soil through the organic matter that is added to the soil. The moisture in the soil and the heat of the sun striking the sides of the mounds help to speed up the breakdown of the organic matter to make compost. The plants can feed off this compost.

Figure 1.7 Planting on mounds

Right: Maize was planted and then inter-cropped with beans and tomatoes. The mound was formed during the summer season by heaping the soil and weeds together up around the row of maize planted. Thereafter, beans and tomatoes were planted on the mound with the maize. In autumn, after the maize was harvested, wheat was planted at the bottom of the mounds and kale was planted on top of the mound.

Left: The maize residues have been worked into the mounds once the crop was harvested. These mounds will be ready for planting again in spring.

In the way described above, the typical backbreaking land preparation in hard, dry soil is avoided. Crops can now be planted earlier – as soon as the first rains have come. In many areas, this means that the crop can mature during the peak rainy season, avoiding the major risk of crop failure through late season dry spells.

Cropping in furrows

In this system of furrow cropping, crops are grown over a longer period of time, so that more than one crop can be harvested in a season. Cattle are not allowed to enter into the field at any time, as they will trample the furrows and mounds, and will eat the residues that need to be incorporated into the soil.

Different crops can be grown in the same field in a relay fashion. As some crops are maturing, other crops are planted. The maize plants for example, become a support for the tomatoes and beans that are planted later. If a farmer wants to produce an early crop, seedlings can be raised in green houses, either in seedling trays, or in the case of larger seedlings like pumpkins and squashes, in old tin cans. The containers are filled with well-rotted manure or compost. The seedlings are transplanted onto the mounds and furrows as soon as the last threat of frost is over.

Figure 1.8 Materials for growing seedlings
A large pile of well rotted compost and a pile of tins for planting.

Figure 1.9 Inspecting mustard spinach seedlings
Mr Matlere (left) and Mr Thulo (right) (Care-Lesotho) inspecting mustard spinach seedlings planted in seedling trays. These seedlings are produced in the greenhouse towards the end of the hot period of summer, so that they can be planted in the field as soon as autumn comes. In this way, a good crop can be realised before the severe winter cold sets in.

Some interesting outcomes

- Continued absorption of rainwater into the furrows and mounds tends to influence the moisture in the area over time. Mr Matlere has experienced that two days after some days of soaking rain, the sun that strikes the sides of the mounds creates a mist that rises up from the beds. This happens due to the warmth generated in the mounds from the decomposing grasses, weeds and maize stalks. It provides a warm, moist micro-climate in an area that would otherwise be quite dry. This provides very favourable conditions for the growth of vegetables and pumpkins.
- The silt that collects in the furrows during heavy rains provides some more fertility, moisture and a better foothold to the crops planted there. Mr Matlere has noticed that the stand of maize is much better with this system. The maize does not fall over in heavy rains and winds, as they do under normal conditions.
- With the mounds, the organic matter that has been incorporated decomposes faster than it would without the mounds. The climate in Lesotho is mild and many months are quite cold and dry. The mounds provide a surface that is heated by the sun and the organic matter holds more moisture. Thus decomposition happens faster.
- Because there is more organic matter in the soil, it becomes fertile without the need even to add manure, if it is in short supply.
- Mr Matlere has noticed that with the increase in fertility and organic matter (humus) in the soil, there are fewer problems with pests and diseases.
- Because the spacing of the crops is quite wide with this system, the maize matures faster, there are more cobs per plant (4-5) and cobs are bigger. So, even though fewer plants are in the ground, a better harvest is achieved. This applies also to other crops like cabbage and wheat.
  - The wide spacing of the rows facilitates early weeding which is important.
  - Spacing is generally up to 2 m between the rows (on the mounds) and up to 60 cm between plants in the row (on the mounds).
  - This wide spacing can also facilitate the use of animal drawn implements (oxen or horses) for weeding.
  - For smaller crops like kale and tomatoes, the spacing between the plants in the row is 30 cm.
  - For row crops like wheat and onions, 2-3 rows are planted, with a spacing of 40-50 cm between rows and 30 cm between plants in the rows.

In this system seeds are planted by hand, rather than by animal drawn planters. Mr Matlere also only plants crops from which he can keep his own seed.

Activity 1.7 Case study of a homestead farming system

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

Aim: Analyse the case study given in terms of the farming system used (TF, HEIF, LEIF) and in terms of the elements of sustainability.

Time: 3 hrs

What you must do

Discuss and summarise the case study of a farming system that you have been given; using some of the processes and concepts discussed in this section (sustainability, 3 farming approaches, SWOT, and flow diagrams).

You will need to decide once you have read the case study which method you will use to present your summary. Use only ONE of the following methods:

- Elements of sustainability OR
- 3 Farming approaches OR
- System flow diagram OR
- SWOT analysis

1. Write a one-page summary of the case study and make your diagram using one of the above methods. Space has been provided in your workbook.

Comments on Activity 1.7

A SWOT analysis of this case study would look as follows:

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
* Mild climate in Lesotho * Many crops can be grown in the area- maize, wheat & vegetables	* Soil erosion * Declining soil fertility * Lack of water * Low production	* Making furrows on the contour of fields, with a mound all along the slope of the furrow, could address the weaknesses. * Organic matter (mulch) could continuously be added to the mounds. * These measures can increase production by regulating water and increasing soil fertility.	* Run-off water needs to be regulated. * Crop failure through late season dry spells.


You will recall that we used De Bono's thinking hats in Module 3. You will see that this method of analysing a problem is very closely related to the SWOT analysis:

The six hats are:

- **White hat.** This is a clinical or neutral colour and requires a person to discover the facts of the situation in an objective manner. It is the hat for data, detail, figures, information and the asking of useful questions.
- **Yellow hat** (= strengths). This is the bright and positive colour. It requires the person to look at the good points in a situation or proposal. Why should this proposal work?
- **Red hat.** This is a hot colour and encourages the person to allow his/ her emotions, intuition, and general feelings to hold court without any need for justice or substantiation. The thinker uses his/her emotions to lead the thinking.
- **Black hat** (= weaknesses). This is a serious colour that encourages the thinker to be cautious about an idea or the subject under review. It is possibly the most important hat in critical thinking and it prevents one's emotions from dominating a situation. The thinker plays devil's advocate and asks questions that are likely to expose weaknesses in a proposal.
- **Green hat** (= opportunities). This is the colour of new growth in plants, heralding new beginnings and creative ideas. This hat invites lateral solutions, creativity and innovative suggestions.
- **Blue hat** (= threats). This is the colour of the sky and suggests an overview of one's thinking. It challenges the thinker to be self-analytical, evaluative and to think holistically. Here one would consider factors that could influence the sustainability of a project.

Table 1.9: De Bono's six hat analysis of Mr. Matlere's homestead farming system

White hat (facts, questions) • Lesotho has a mild climate, suitable to grow many crops and vegetables. • However, there are certain issues like soil erosion, declining soil fertility, and lack of water that leads to low production.	**Red hat** (feelings, intuitions) • Mr. Matlere is a problem solver, and had a positive attitude and wanted to solve the problem.
Black hat (caution, weak points) • The area is faced with many problems: • Soil erosion • Declining soil fertility • Lack of water • Low plant (crop) production	**Green hat** (creative, alternatives) • Making furrows on the contour of fields, with a mound all along the slope of the furrow, could solve the weaknesses. • Organic matter (mulch) could continuously be added to the mounds.
Yellow hat (positive, why it will work) • Furrows and mounds can regulate run-off water, the rain will be utilized better (it will sink into the soil), and it will increase soil fertility.	**Blue hat** (overview, holistic) • The furrows and mounds should result in a higher crop production. • Crop failure through late season dry spells might be limited.

1.4 Farmer Experimentation

Small scale experimentation is a way for farmers to try out new ideas without risking their crops and livelihoods. They try out these new ideas in a small area of their garden, comparing it with their normal farming/ gardening practises and observing closely what the outcomes are. They are then well informed to make their own decisions about their preferred practices and how they would like to adapt them.

Farmer experimentation
This becomes the main technique used for interventions in the garden itself

Once an innovation has been tried and established that farmer may begin experimenting with other innovations. At the same time she/he may teach the innovations already implemented by others. When technology is introduced slowly by overcoming limiting factors one by one, farmers have a chance to test, implement and share the innovations. They also can build up strong circles of knowledge amongst themselves.

This means that as a facilitator your job is not to try and convince farmers to “adopt” specific technologies and innovations that you think are a good idea; your job is more to introduce new ideas/innovations that farmers can try out for themselves and make their own decisions.

In farming, we face new challenges all the time. We may also want to try out new ideas. We need to try these new ideas without taking risks and without making more problems/challenges for ourselves. An experiment is a test to see if an idea works. When we have worked out our problems and the causes for this problem, we can come up with suggestions for possible solutions to this problem. We can use these suggestions to plan an experiment.

As you work through this module you will find many examples of farmer experimentation which you may find useful for your own garden.

Here is an example of Mrs Ngobese from KwaHlongwa (Umzumbe, SA), who decided to experiment with methods of aphid control on her cabbage crop. She wanted to test the use of ash and chilli-soap solution for controlling aphids. These were solutions to aphid control that she could try by herself, without spending a lot of money.

She took a small piece of her garden (1/10th) as the experimental plot. This was divided into 3 sections:

1. For sprinkling ash
2. For a control (no test)
3. For spraying chilli-soap solution

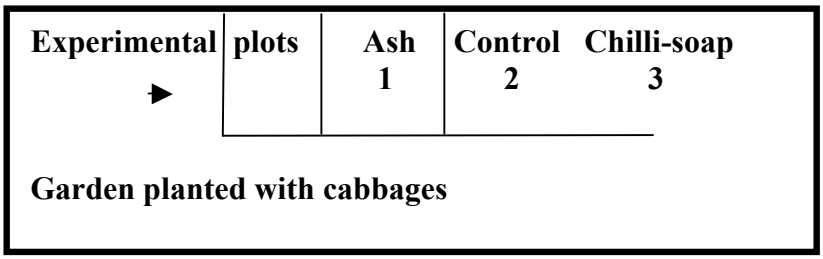

Figure1.10. A layout sketch and line drawing of Mrs Ngobese's experiments

Then she monitored, or looked at, her experiment. Every week she checked and wrote down which cabbages looked better. Here is an example of what her results could have been:

Table 1.10: Mrs Ngobese's experimentation results

Exp plot►	1	2	3
Date of monitoring ▼	**Ash**	**Control**	**Chili-soap**
Week 1	Good	Good	Good
Week 2	Good	Some aphids	Very few aphids
Week 3	Some aphids	Many aphids	Very few aphids
HARVEST (WEEK 12)	12kg weight of 10 cabbages	8kg weight of 10 cabbages	15kg weight of 10 cabbages

At the end of the experiment she weighed 10 cabbages from each experimental plot (1, 2 and 3) and she counted the number of aphids on each cabbage.

From this experiment the farmer will know which method of aphid control works the best for her. In future, she will use the most successful method. Can you work out which one that is?

You can use a table like the one below to plan your own small scale farmer experimentation.

SMALL SCALE EXPERIMENTAL PLAN

- What is the problem?
- What is a possible solution?
- Why will this solution solve the problem?
- How will I test this solution step by step?
- What will I look for and what will I measure?
- How will I measure the results or outcomes?
- How will I compare my experiment to my usual way of farming?

Concluding remarks

You now have a good understanding of three different farming systems- traditional farming, high external input farming (HEIF) and low-external input farming (LEIF). You analysed these farming systems according to their strengths, weaknesses, opportunities and threats, and identified LEIF as a very sustainable system, which is ideal to use for your homestead farming system. In the next unit we will examine aspects such as climate, selecting crop plants and others which we did not address in Module 3. These aspects need to be taken into consideration before your garden design plant can be finalized.