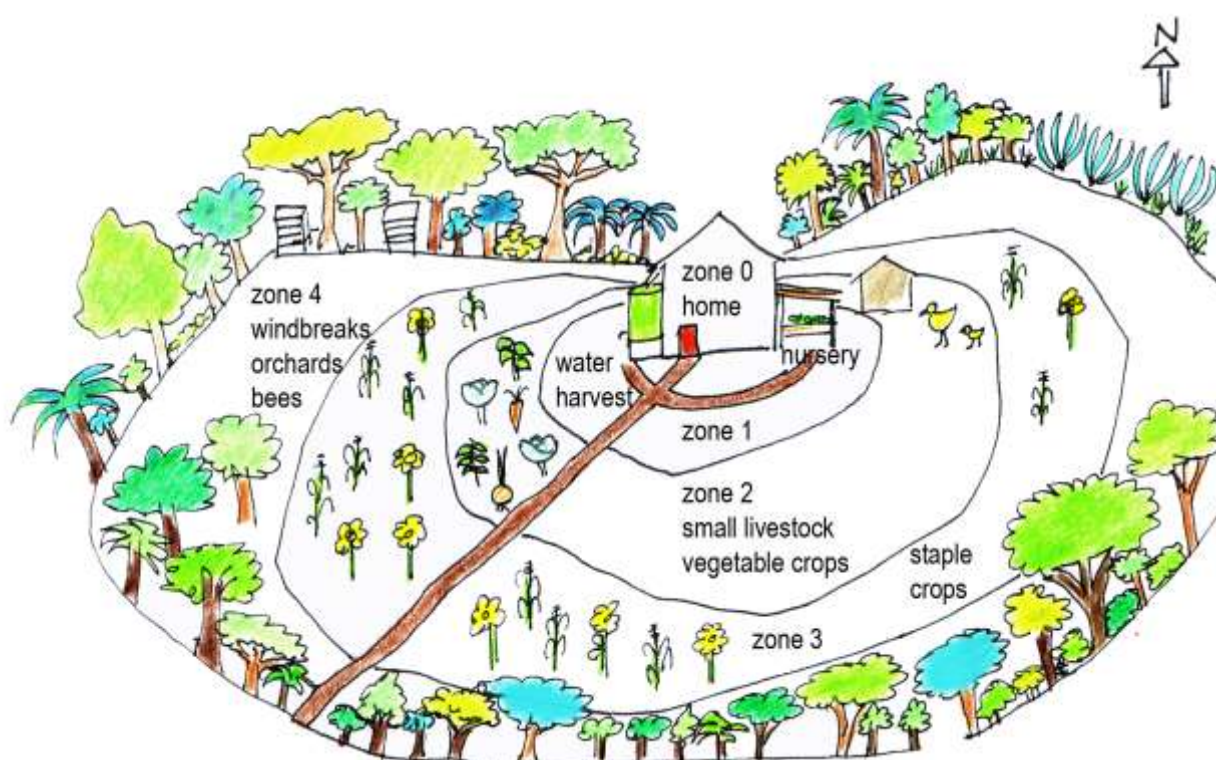


GardenAfrica

Growing Health

A guide to Establishing Sustainable Food & Medicinal Herb Gardens in Southern Africa



Permaculture Trainers Reference Manual

Compiled for GardenAfrica by John Nzira

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Urban Farming is registered in South Africa, and focuses on transferring practical skills, for nutritional development using Permaculture and low external input agricultural methods for the development of sustainable livelihoods in urban, peri-urban and rural areas. Its work is made possible by many institutions and individuals who support it through various ways. We gratefully acknowledge their contributions. We also wish to specifically thank all those who supported the production of this manual.

We welcome the reproduction and use of this manual in order to extend skills and knowledge to whomever may benefit, either for their own use or that of the communities with whom they work.

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Urban Farming and GardenAfrica would welcome the use of this manual for the benefit of others. If the reader requires a bound hard copy, then they can **contact Urban Farming** at the below address for information and assistance. Please note that there may be a charge to cover costs (print, binding, postage).

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LIST OF ACRONYMS

AI	Artificial Insemination
AIDS	Acquired Immune Deficiency Syndrome
ARVs	Anti Retro Virals
ART	Anti-Retroviral Treatment
BMP	Best Management Practices
CITES	Convention on International Trade in Endangered Species (of Wild Fauna and Flora)
CSA	Community Supported Agriculture
CSOs	Civil Society Organisations
GEOs	Genetically Engineered Organisms
GG	Grower Group
GMOs	Genetically Modified Organisms
HIV	Human Immuno-deficiency Virus
ISO	International Organisation for Standardization
IPM	Integrated Pest Management
MDGs	Millennium Development Goals
NGO	Non Governmental Organization
NQF	National Qualifications Framework
NPK	Nitrogen, Phosphorus, and Potassium
OM	Organic Matter
OVC	Orphans and Vulnerable Children
PAETA	Primary Agriculture Education and Training Authority
PLWHA	Person Living With HIV and AIDS
QA	Quality Assurance
TB	Tuberculosis
TQM	Total Quality Management
SABIO	South Africa Bee Industry Organization

UN	United Nations
UNAIDS	United Nations Global Programme on HIV and AIDS
UNGASS	United Nations General Assembly Special Session
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organisation
WTO	World Trade Organisation

Unit 1: Permaculture principles and design

LEARNING OUTCOMES

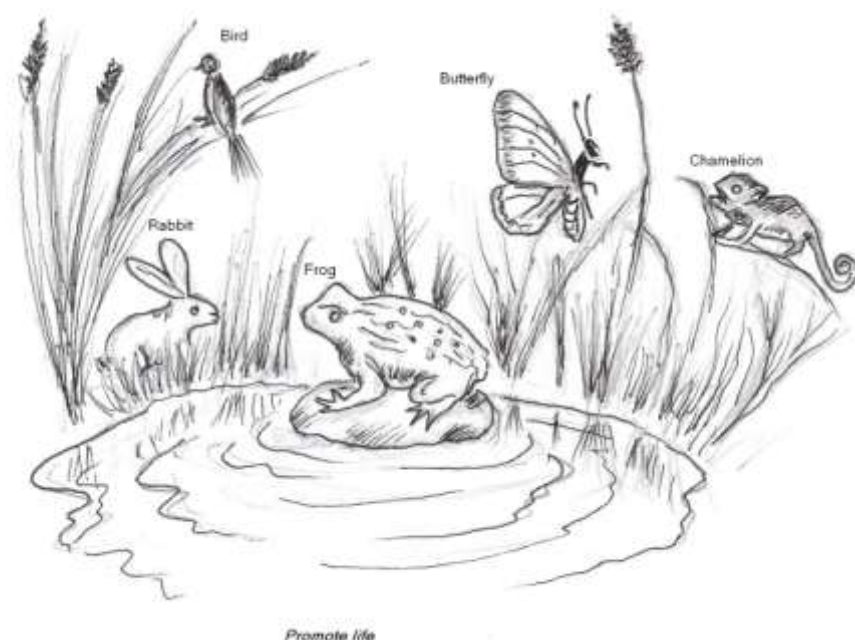
By the end of this Unit the reader will have learned about:

- Concepts and principles of Permaculture
- Permaculture food gardens and medicinal plants
- Permaculture techniques
- Ways of implementing sustainable gardening ethics in our lives
- Garden design

What is Permaculture?

‘PERMACULTURE’ is a tool for sustainable living. The word was originally coined in the mid-seventies by two Australians, David Holmgren and Bill Mollison, to describe the design system pioneered as a response to what they, and many others globally, saw as serious challenges to the survival of us all. Originally derived from the words ‘**P**ermanent **a**griculture’, Permaculture has gone beyond its roots in looking at strategies to create sustainable food growing methods to become a worldwide movement encompassing all aspects of how we as human beings can live harmoniously in relation to Earth and its finite resources: a **permanent culture**. Permaculture now probably has as many definitions as there are practitioners, but one that is particularly useful is: “creating sustainable human habitats by following nature’s patterns.”

Permaculture offers an approach to food production, urban renewal, water, soil, energy and waste management which is more appropriate for the southern hemisphere than other comparative systems applied elsewhere. It integrates ecology, landscaping, organic gardening, architecture and agro-forestry in creating a rich and sustainable way of living. It uses appropriate technology giving high yields from low energy inputs, achieving a resource of great diversity and stability. The design principles are equally applicable to both urban and rural dwellers.



Permaculture is a form of landscaping that strives to create a naturally balanced ecosystem that meets the gardener's food needs as well as providing fuel, materials for shelter and home, and habitat for livestock. Indigenous species are utilized whenever possible and when they are not, species are chosen for their compatibility with the local environment.

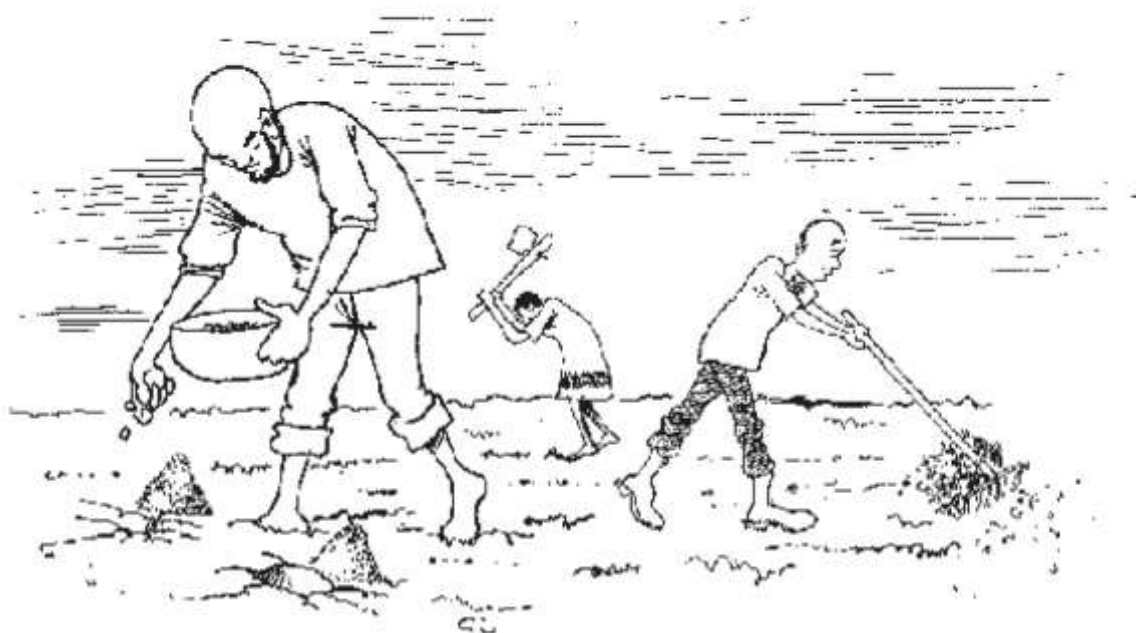
Permaculture is the thoughtful design of a system of farming and gardening that uses and combines all available resources, including plants, animals, soil resources, water resources, landscape, climate, human resources, buildings, technology, waste materials and local knowledge. It regards the relationships among different resources in a given area as the relationships of one whole or integrated community and tries to encourage the most productive relationships, especially ones that produce more energy than they use.

In Permaculture, we try to recycle all waste products because most of them carry nutrients that can still be used in the garden, energy that can still be used by humans, or physical materials that can be used to make a new product. Permaculture encourages us to think more holistically by considering all the participants and resources in an environment and the way they relate to each other, and learning to spend time imagining the consequences of our actions on the future of a particular environment or community.

Permaculture does all this without the use of too many external resources. Instead, it tries to use affordable technology and seed, organic fertilizers and natural pesticides. It also promotes food consumption close to the source to cut on energy costs associated with storage and long distance transport and the loss of nutritional quality.

Permaculture focuses on designs that:

- Spend as little energy as possible
- Look as far into the future as possible and think of the consequence of every action
- Use all available resources in the most productive relationships possible
- Use as many different plant and animal species as possible
- Grow food close to where the people are
- Recognise the environment as a complex set of living relationships; and
- Copy the processes of nature to allow an environment to sustain itself naturally.

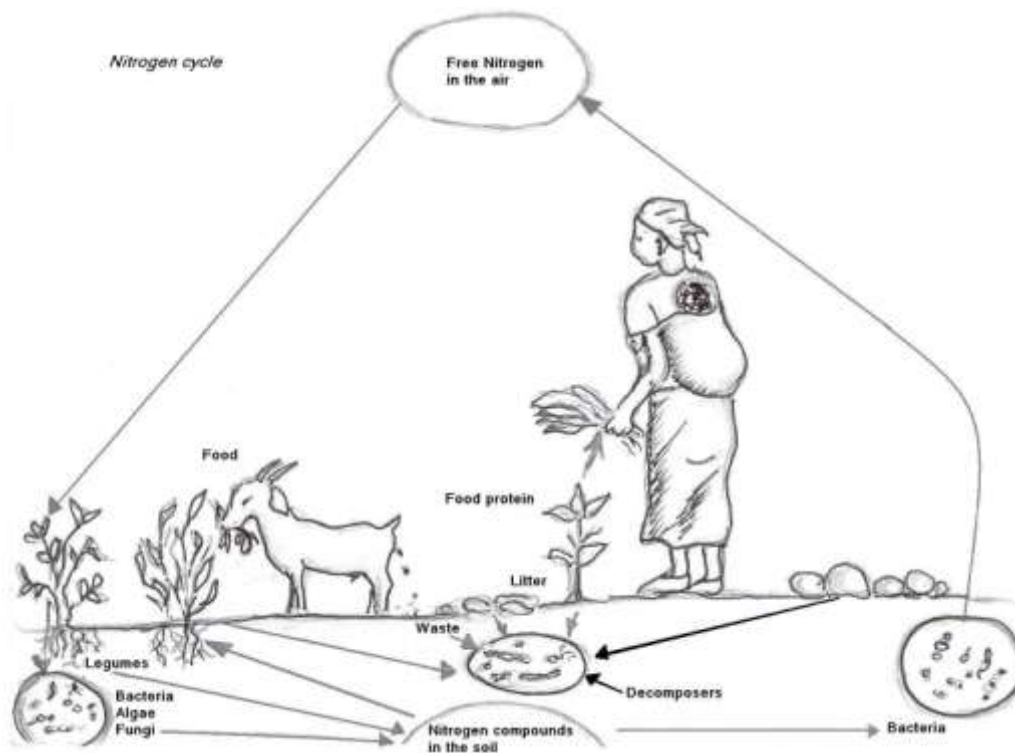


Value of Permaculture gardens

Permaculture gardens help to:

1. Empower people by promoting household food security and allowing people to take control of as much food production as possible
2. Provide nutritious food, like the fresh fruit and vegetables that build healthy immune systems, prevent disease and improve the health of those already living with diseases such as TB and HIV/AIDS
3. Empower people to grow their own medicine
4. Facilitate community pride and give communities a sense of control and the capacity to take positive action
5. Affirm traditional eating habits and indigenous knowledge systems about plants, and
6. Challenge the notion of health as something that always costs you money and facilitate people to take control of their own health so that they rely less on expensive pharmaceuticals which are inaccessible to the majority.

Creating a garden can be done in a way that is inexpensive and does not rely on outsiders to bring in extra resources. It can be done by using the everyday resources we already have around us, by learning to conserve the natural resources we have and by recycling and reusing waste materials.



Permaculture principles for sustainable garden design

- Everything in relationship: The needs of one element are easily met by the products of another element. For example, onions planted with cabbages will repel pests that eat cabbages. Beans planted with maize will help to restore nitrogen to the soil when maize takes it out.
- Diversity rules: Ecosystems or gardens that survive are usually the ones that contain a lot of diversity. Plant as many diverse species as possible. Use as many diverse production processes as possible. Also, choose and use plants for as many diverse uses such as nutrition, medicine, beauty, as well as their spiritual/cultural and economic value.
- Work with nature: After you harvest plants put back all the parts you do not use into the soil. These parts are converted into compost that plants will need for growth and production.

- Cooperation not competition: Design must go beyond the boundaries of your beds and the fences that surround your garden. At the same time make use of the natural characteristics of plants and animals and the site, rather than imposing changes.
- Design for the people: People are the users of gardens. Design must be all about what people need as well as their beliefs, tastes and feelings.

Chiefs, councillors, educators, etc. must be involved



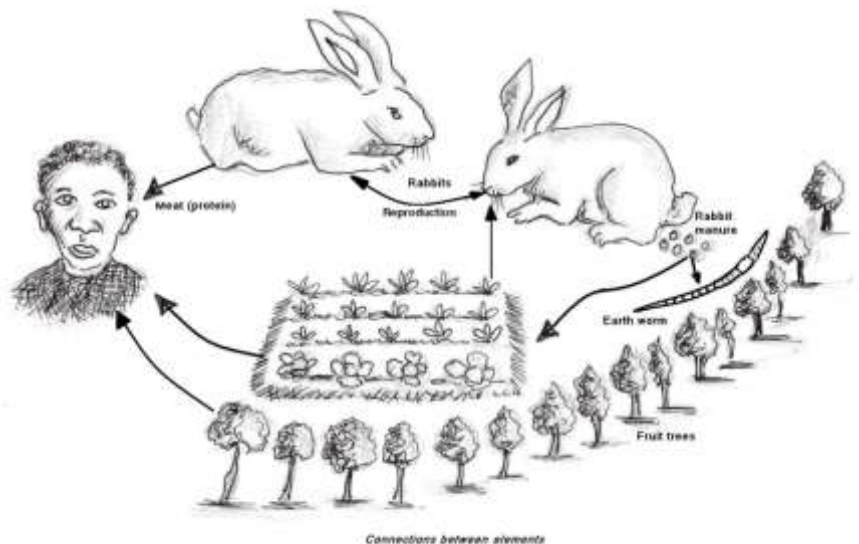
Participatory designing



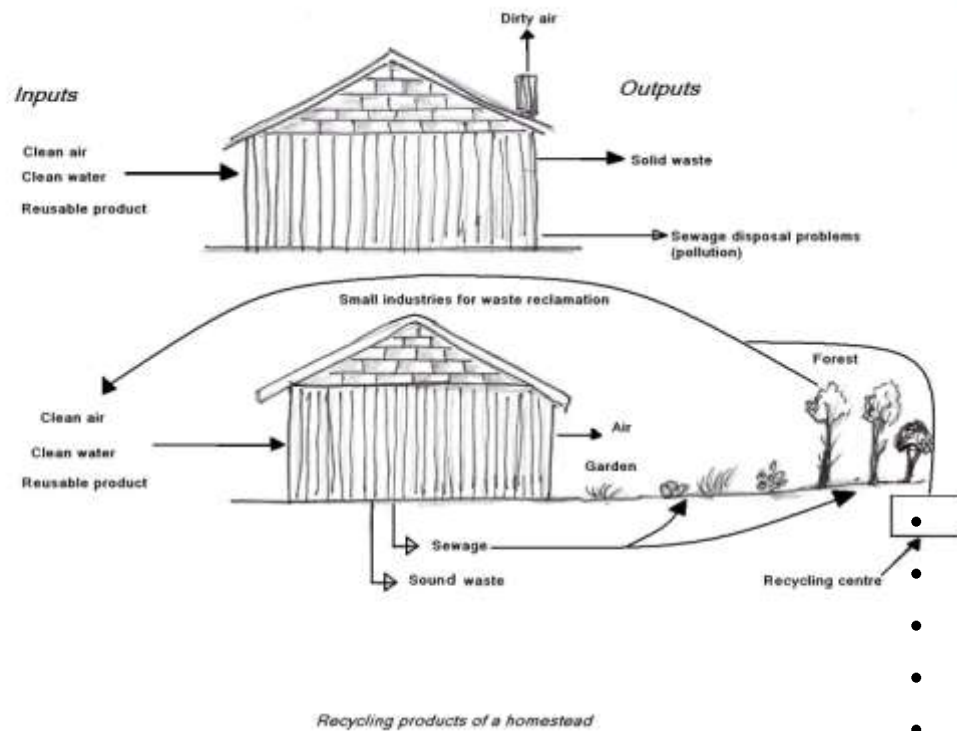
- Work with those who want to work: Gardens provide opportunities for many people. One of these is the opportunity for meaningful work.
- Work where it counts: Make a list of priorities and spend your time working where it is most important.
- It is better to first spend a lot of time thinking than a lot of time working, and then reworking.
- Take the long view: Plan for long-term sustainability.
- Recycle, reuse and reduce: Use everything at your disposal and recycle all waste. It is very important to plan your garden before you begin planting or keeping livestock to ensure the efficient use of waste.
- Place elements in the right place and at the right time: The needs of one element are easily met by the by-products of another element. (Elements are objects or things that are connected or linked to each other to form a garden or homestead).

- Everything must have a purpose: Design focus must go beyond the limits of physical boundaries. You must establish whether the surroundings will have a good or bad influence on your homestead or site. This will influence your final design. Land must not be wasted and every corner of the site must be used.

- Mistakes are opportunities for learning what to do next: Never give up, for mistakes can be the building blocks of prosperity.



- Use on-site resources: Recycle, utilize existing land and hire unemployed people. Nature is also a “client” of all living and non- living organisms and should be cared for.
- Principles of stress and harmony: Gardens or homesteads should be designed to suppress or relieve stress. Planting flowers around your homestead and in between vegetable beds helps to relieve stress to the gardener. Harmony is about the good relationship or connections between objects or things in the same design. These beneficial relationships create many useful products for both the people and the environment.



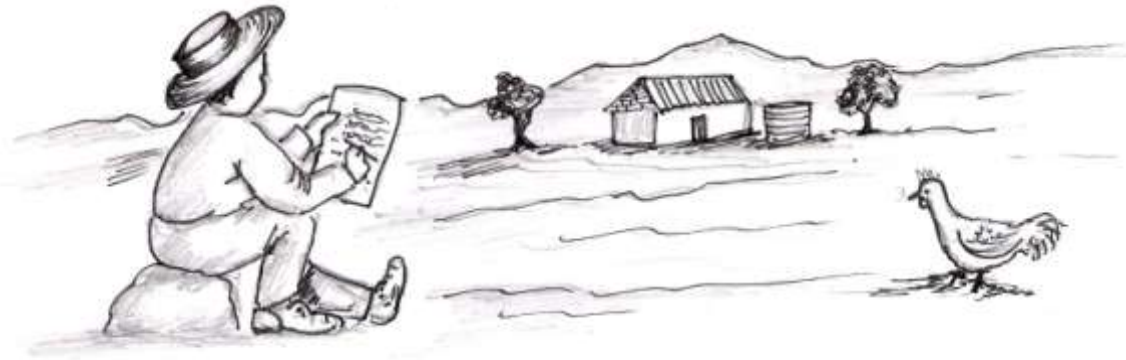
- Principles of stability: It is not the number of diverse things in a design that lead to stability, but the number of beneficial relationships in that system.
- Sharing: Information, skills, know-how and resources with others to create a broader system of cultural & biological diversity. You and your garden will be the ultimate beneficiaries.

Permaculture techniques

Permaculture techniques include, but are not limited to:

- Learning to observe and take advantage of natural processes like water flow, wind direction, sunlight distribution
- Learning to observe the impact of humans on the environment
- Learning to identify and utilize useful resources (especially those that most people regard as waste)
- Making an accurate list (audit) of all available resources
- Carefully designing gardens to make the best use of the landscape
- Finding clever ways to catch and “harvest” rain water and waste water
- Planting vegetation that keeps away unwanted pests

- Using mulch (layers of dead plant material) to keep moisture in the ground
- Maintaining levels of useful nitrogen in the soil by planting nitrogen-fixing plants
- Using leftovers of uncooked vegetables and fruit to create compost
- Collecting seed for future planting (propagation)
- Using waste products, such as plastic containers, to create useful gardening tools



Observation

Twenty Ways of practicing sustainable gardening ethics in our lives:

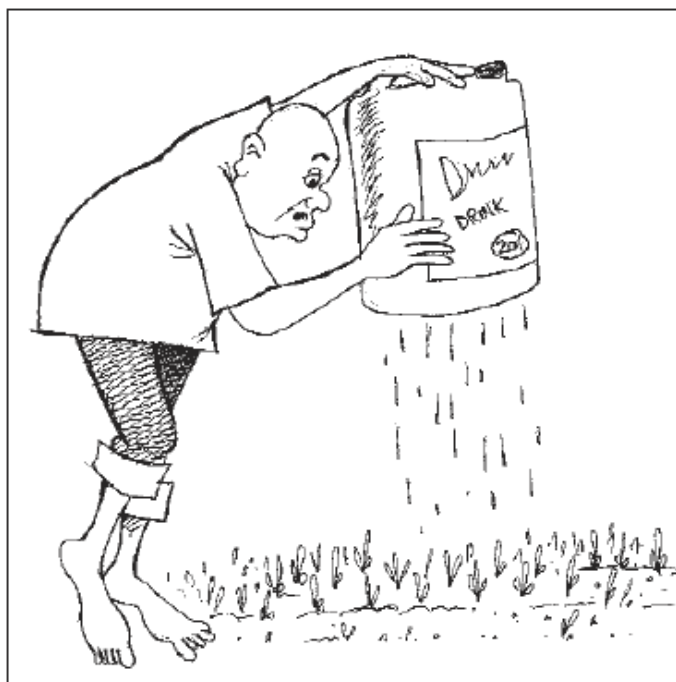
- Plan to generate income and enough food for your family and the community.
- Grow what your family and local people need.
- Focus more on indigenous plants than exotic species.
- Plan for sustainability in the long-term.
- Grow traditional food plants.
- Cultivate even the smallest possible land area.
- Use different plants to suit different weather conditions.
- Save seeds and grow your own seedlings as far as possible.
- Use low-energy environmental and biological systems to conserve and generate energy.
- Bring food growing back into the cities and towns, where it has always traditionally been in sustainable societies.
- Assist people to become self-reliant, and promote community responsibility.
- Plant forests and restore soil fertility.
- Use everything at your disposal and recycle all waste.
- Control pests and diseases naturally.
- See solutions, not problems.
- Diversify your production.
- Grow plants for beauty as well.
- Work where it counts (assist people who want to learn).
- Network with other in the same, or complementary businesses.
- Train others, especially your own children.

Conclusion

This unit has introduced you to the concept of Permaculture, the principles behind it, and their application. It is important to understanding what Permaculture is about before moving to the next units of the manual. The following unit discusses how to plan a garden.

Reflection points

- Define Permaculture and sustainable livelihoods.
- Why is food security important at household level?
- List any Permaculture principles that you know.
- What do you see as the advantages of Permaculture?



Unit 2: Planning

LEARNING OUTCOMES

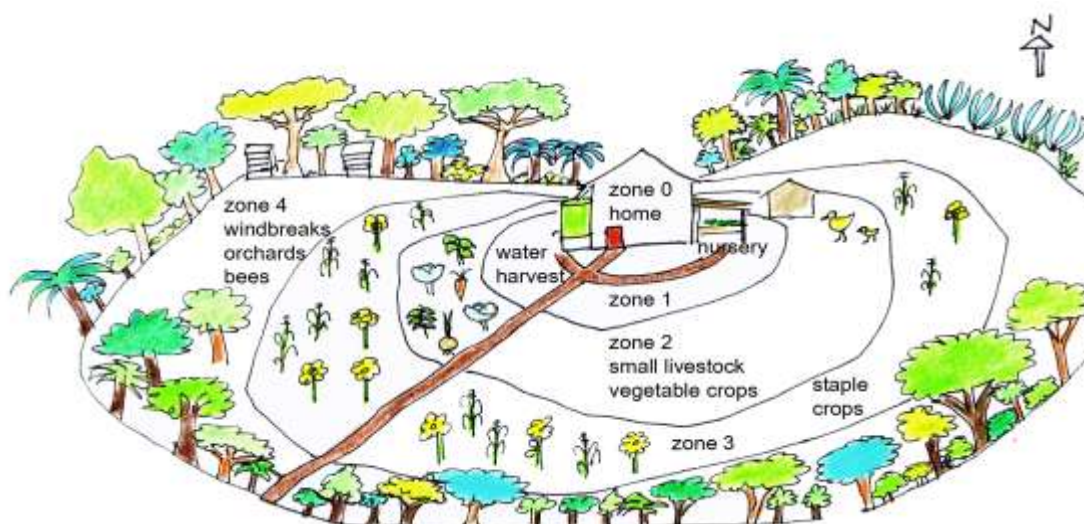
By the end of this Unit the reader will have learned about:

- How to plan a sustainable Permaculture garden
- The key aspects of sustainable Permaculture gardening
- Determining the tools and materials they need
- Information gathering techniques
- Considerations when starting a garden
- Basic tools for recording progress
- Budgeting for gardens

Introduction

Good builders construct a house with guidance from a plan. Building a house is a process with several inter-related activities, one leading to the other, until the house is completed.

What would happen if the builder did not use a plan? What would happen if managers did not plan? What happens if garden designers do not plan? It is really worthwhile for farmers and gardeners to spend enough time on planning their gardens, fields and pastures before digging, planting or stocking in order to make the most of the piece of land while retaining its ability to support life systems.



It is always important to consider the interests and needs of neighbours and other stakeholders. One way to ensure this is to involve them in your planning and designing. In the case of schools, the key stakeholders would be the parents, teachers, pupils or students, the municipality officials and relevant ministries.

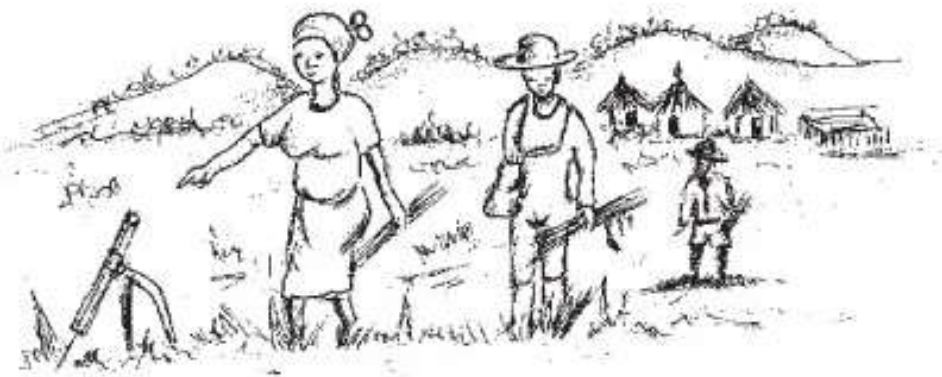
Considerations when planning for a garden

Before starting a garden project, one should be clear about the goal. In many cases the purpose should be defined together with other people such as family members, project members and other stakeholders. Goals unpack the

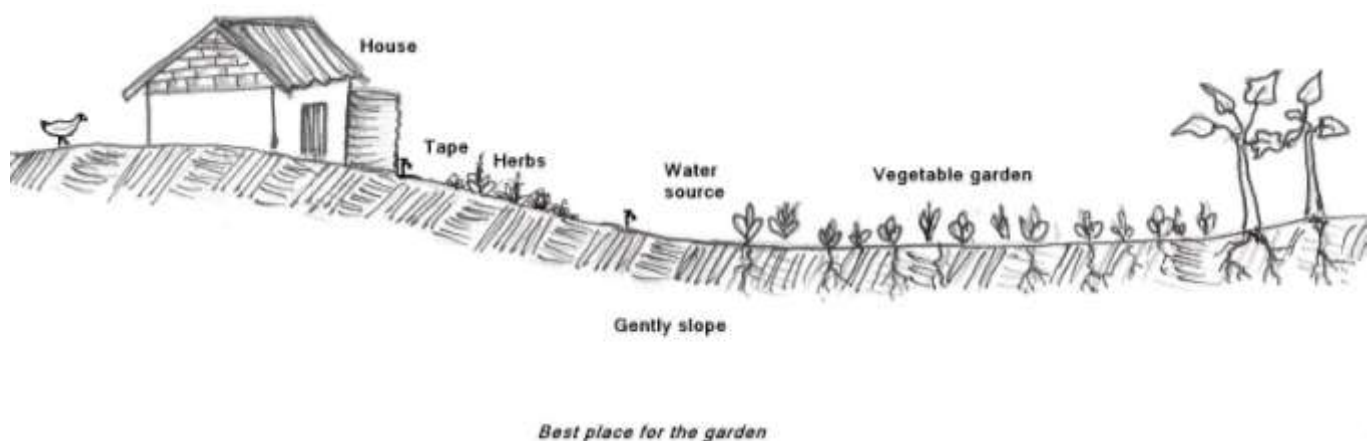
future plans; they tell us what we want to achieve in the medium and long term. A goal can be broken down into smaller, more achievable steps. This may entail listing what needs to be achieved in six months, one year, five years or ten years. Goals may be set for specific outcomes such as a goal for quality of life, a goal for means of production, goal for landscape design, etc.

Assess the site of your garden

- After you have developed your goals assess the site on which you wish to grow vegetables, fruits, and other related activities that support a sustainable Permaculture garden.
- Walk across the garden and observe the patterns of the environment. Consider the vegetation, the soil, the animals, the wind direction and the direction of the sun. If these components are assessed well it will be easier to identify the opportunities and challenges they represent, and will help you to integrate this information into your final design plan.



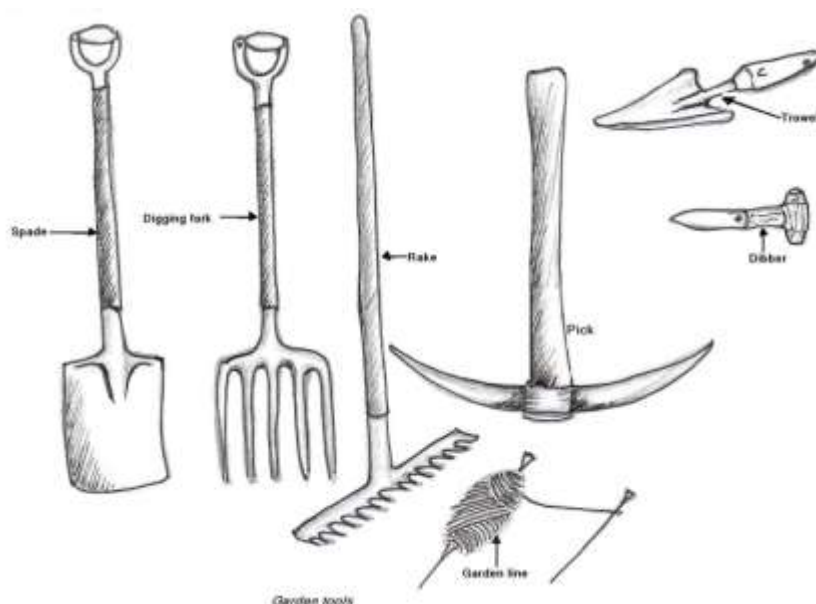
- Consider that vegetables grow best in a sunny place, where there is lots of water. It is then better to plan your garden near a tap or close to where you can get water. Not all vegetables need sun, such as lettuces, brassicas, etc.
- Create your garden near a place that will be visible so that you can watch and care for your vegetables easily.
- In choosing a site, look for a well-drained area. Few plants grow in poorly drained soil. In such areas, roots will rot because of inadequate air pockets in the soil.
- Choose a site which is level or gently sloping. A steep slope is difficult to plant and care for. In addition, water running down the slope may carry away topsoil and seeds. Therefore appropriate designs such as terracing and pit beds are encouraged where steep slopes cannot be avoided.



Determine the tools and materials you need

Make a checklist of the tools you need for a sustainable food garden. The following are some of the tools you *may* need:

- Tools and materials for preparing the site: Forks, rakes, wheel barrow, shovels, watering cans, buckets, hosepipe, mulch, manure, gloves, hoes, pegs, sticks and hammers.
- Tools for garden maintaining: Garden shears, hand forks, hand shovels, trowels, picks, a dibber and garden line, secateurs, long handle secateurs and straight-bladed saw.
- Other tools: Large tape measure (100m), small tape measure (5m to 30m), strides, thermometer, and a rain gauge.



Understanding your resources and needs

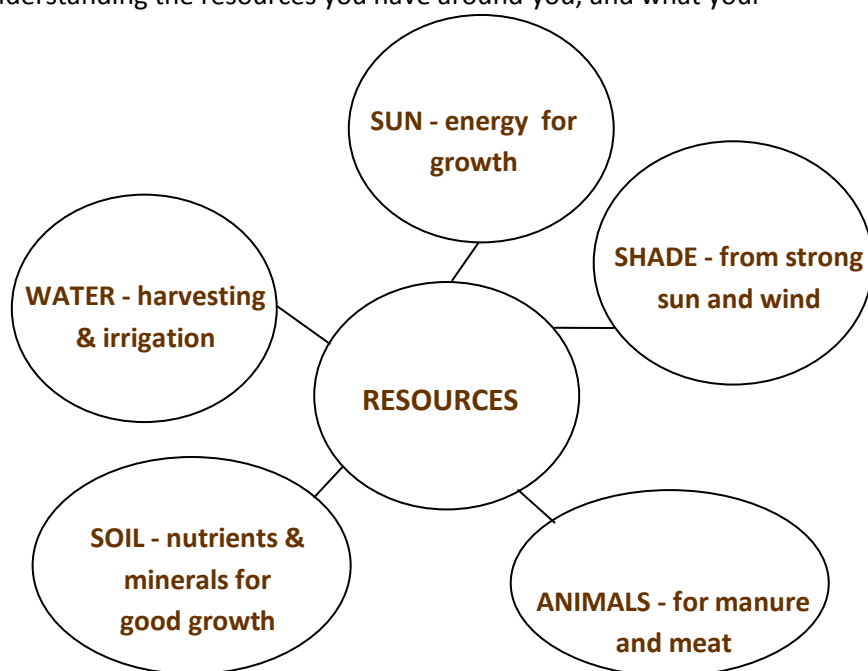
A successful and fruitful garden can be made by understanding the resources you have around you, and what your needs are.

Protect your plants from the elements including:

Wind (burning plants)
 Sun (burning tender plants)
 Water (rapid run-off from roofs)
 Animals (grazing)
 People (theft)
 Fire

Needs: What do you want from your garden?

Food
 Medicinal herbs
 Fruits
 Security
 A play area
 Or all of the above.



Understanding your needs helps you to plan your homestead. Divide your homestead into 4 ZONES – Zone planning helps to give the best solutions for your home design.

Determine the size of the garden you need

You will also need to know how much space each crop requires. How many varieties of plants do you want to grow on your land? It is important to know the distance apart of all the plants and crops you wish to grow. Check the table at the end of this unit. In Permaculture, you should make an effort to use both the vertical and horizontal space.

Weight	Length	Area
1 gram = 1000 milligrams	1 centimetre = 10 millimetres	1 hectare = 10000 square meters
1 kilogram = 1000 grams	1 metre = 100 centimetres	100 square metres = 10 metres x 10 metres
1 tonne = 1000 kilograms	1 kilometre = 1000 metres	

Above is some basic information about measurements that might be useful.

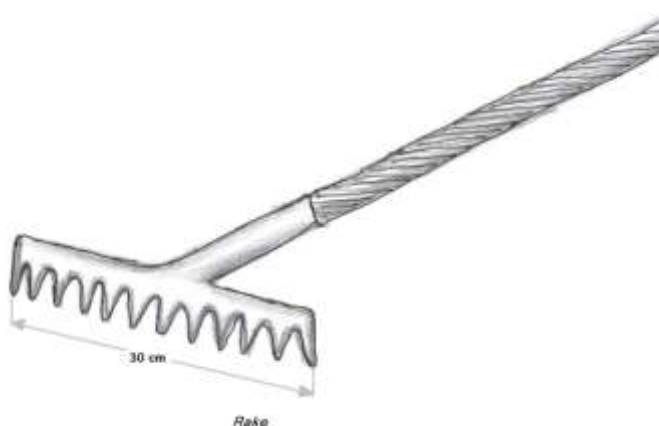
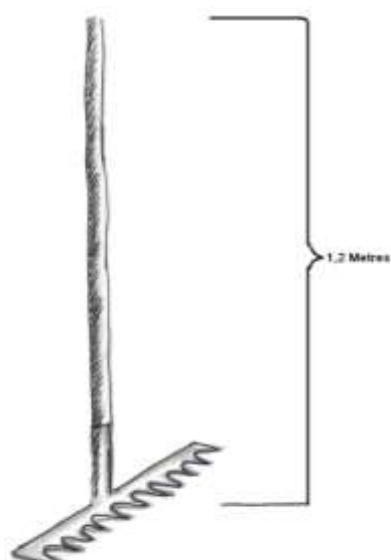
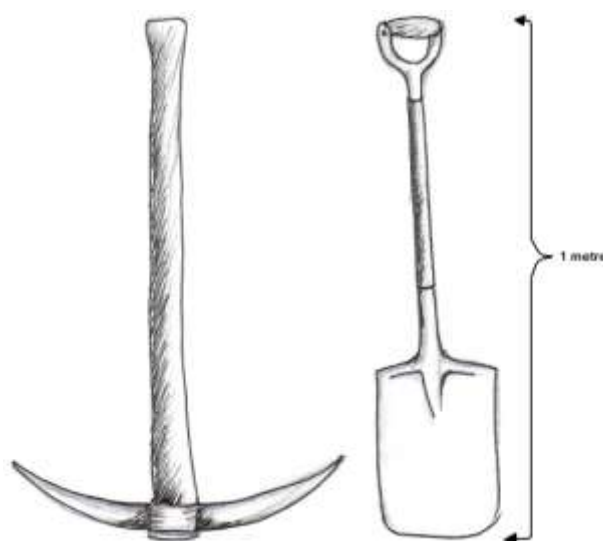
In order to get the area of a rectangular shape: multiply the length by the breadth or width to give you the area. A garden that is 10m in length and 5m in breadth is 50 square metres. The area of a circle is $\pi \times \text{radius squared}$, with π being 3.14. A 3m diameter (diameter is radius x 2) circle, the area is $3.14 \times 1.5 \text{ m squared}$, meaning $3.14 \times 2.25 = 7\text{sqm}$. For irregular shapes draw a square grid over the shape. Find the area of a single square. Gauge how many whole squares you have and multiply them by the area of the single square.

- Volume - The area of the base multiplied by the height, for example, a tank of water measuring 100 x 100 x 100 cm has a volume is 1,000,000 cubic cms.

Tips for using garden tools for measurement

There are suggested measurements that can be used in preparing for your garden. You may, however, use your own experience on how to do these.

- 15cm is the same as half the length of the blade of a garden spade, and it is also about the length of your hand.
- 30cm is the same as the length of the blade of a garden fork or a hand fork.
- 1 m is the same as the length of the spade or fork or the handle of a pick.
- 1.2m is the same as the length of a steel rake.



Important factors in selecting plants for your garden

Temperature and rainfall

Certain plants grow well in certain climatic conditions. For example mango trees grow well in low rainfall and hot climates. It is a poor design if you plant a mango tree in a frost prone area. At the same time, crops such as sugar cane require good amounts of water and high temperatures. Plant selection should therefore consider temperature and rainfall or availability of water.

Compatibility of plants

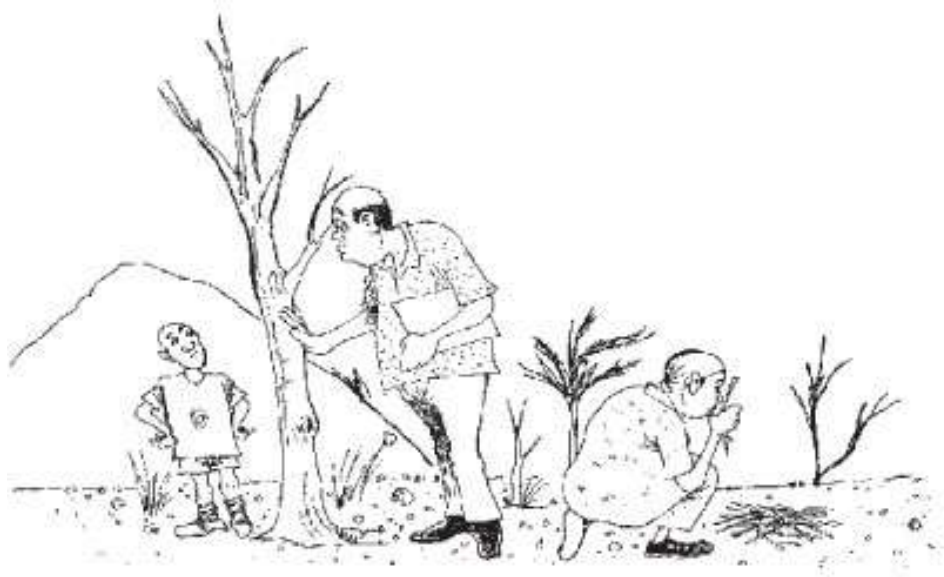
Some plants grow well when they are planted alongside certain other plants. When plants are compatible, we call them 'companions'. Some plants host insects that eat bugs on other plants. These create beneficial relationships. However, if certain plants are grown together one or both may suffer. For example, brassicas (such as cabbage or broccoli) planted next to tomatoes do not do well. Such plants are incompatible. Plants, animals and structures that work together in harmony form 'a guild'.

It is important to know in detail what plants and elements can be put together in order to multiply functions. In a Permaculture system, each element performs many functions in relation to other elements in the same unit.

In Permaculture, an 'element' is a design component. This can be a tank, a fowl run, a pond or a compost pile. Each element has needs; and outputs of one element feed into another element, preferably with minimum energy use – saving you time and energy. For example, a dam wall can be used as a boundary, as can a road. Both a road or a dam can provide a firebreak for crop protection.

How to gather information about the garden site

The following methods can be used in collecting data (a series of information relating to your site):



Transect walk (checking state of the land)

This is a participatory method of walking across the land as a group or a family, especially from highest to lowest points to observe and record or map all the landscape features around you such as the presence of wildlife, the condition of the soil, types of plants around. All are indicators of ecological disturbance or interaction. In the case of a school, selected students, teachers and representatives from the surrounding community can participate.

Observation

You can also spend time wandering around, getting a feel for the land, looking at it from as many angles as possible, listening to the sounds flowing through and from it, smelling its scents and feeling the various temperature changes over the days, weeks and months on the site.

Watch the way the sun moves through your homestead. The sun rises in the East and sets in the West. Moss and lichen only grows on the south side of tree bark – facing away from the sun. This helps you work out where due North is, which helps to plan your garden and homestead.

Assessment of natural resources, plant and animal species

Assess all the natural resources present on the site and in the surrounding environment, such as rivers, sources of composting materials, wood, and the presence of productive plant species and infrastructure. This information gives you an idea of what building blocks you have at your disposal to begin with. You will also have to research local weather patterns, history of land-use and relationships to markets. Assess the nature and condition of the plant and animal species present in the garden and surrounding area, to give you an indication of the site's history and previous land-use patterns. Use a thermometer and a rain gauge to tell you accurately what to expect in terms of temperature, light range and rainfall patterns.



Interviews

Carry out interviews and assessments of all the groups and individuals involved in the area to be designed and record the information. Assess the nature of their relationship to the proposed Permaculture site; especially the key role-players, such as chiefs, councillors, learners, educators, the surrounding community, landowners, neighbours and business clients. This information will allow you to integrate the stakeholders into your Permaculture system harmoniously. Stakeholders include people who contribute to the project positively as well as those who are negative.

Tips on building your knowledge of Permaculture

Sometimes it is difficult to start a garden on your own. Your best starting point is to draw inspiration from the things that you admire. The following points are areas that you may consider experimenting with:

- Carry a camera and notebook to record ideas that occur to you.
- Collect and read books, magazines and watch TV programmes that have related topics to your goals.
- Visit friends, projects, garden centres, and nurseries.
- List plants you like and assess their sustainability for your scheme .
- Think about what is happening in your community: What issues and nutritional needs are on the agenda in your community or in the country, and can your project assist in addressing these issues?
- List all plants and other elements you need to see in your garden. These include: Vegetables, Fruits, Medicinal Plants, Flowers, Animals, water and wind breaks.

Garden Design

A well-designed garden or homestead addresses the needs of the people and the environment. The elements should work in harmony with one another and this means that the garden has excellent forms, colour, and textures that support each other and look “happy” together. A garden should be designed to provide you with all you need by placing plants and animals in the right places. The plants or animals that need to be visited most frequently are placed near the home, while areas with plants or objects that are visited less often are placed further away. Good design is about placing the right element at the right place at the right time.

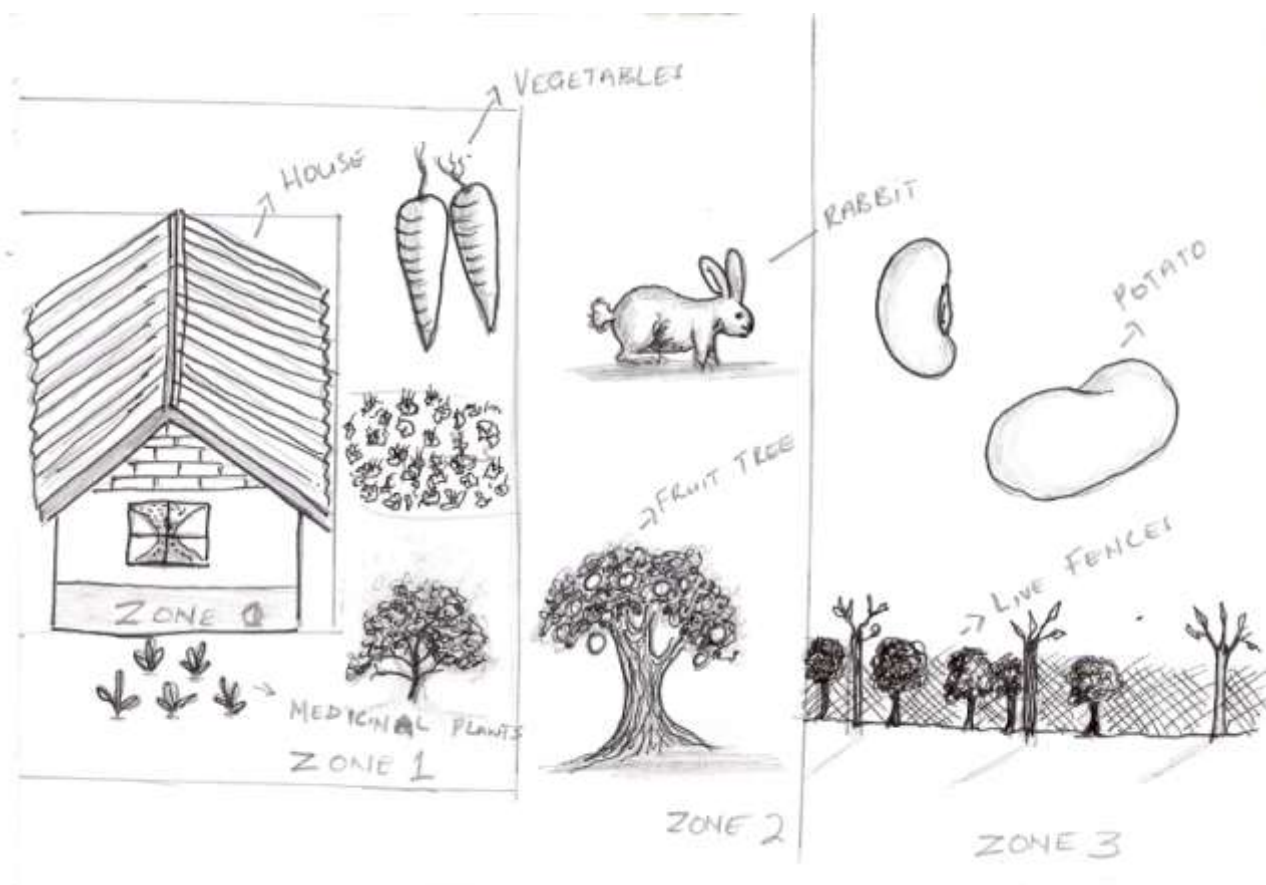


Applying the concept of zones

Zones and sectors are part of designing. Elements are placed according to how many times you need to use and visit them. Plants and animals that need frequent visiting for harvesting and maintenance include annual vegetable gardens, the nursery and chickens. Gardens can be organized into zones, which are determined by their distance from the centre that is often the home. The number of zones is usually determined by the size of land and the goals of the land user. In order to illustrate the concept of zones, we will assume we have a piece of land big enough to accommodate four zones.

Zone	What to place in the zone
0	Energy efficient home, school or other building
1	Nursery, rainwater storage, seedlings, herbs
2	Vegetable crops, small livestock
3	Staple alley crops (maize, pumpkins)
4	Trees (fire & wind breaks), shrubs, bees

Orchards, woodlots and animal systems, can be placed in zone 3, because they require less attention and are harvested less often. It is important to consider that some of the plants such as the Aloe forex can be planted in zone 1 or zone 2, for medicinal purposes and also in zone 3 to function as a natural 'live' fenceline and firebreak.



Slopes and aspects

Slope planning is where you look at your site in side profile, bearing in mind slope angles and elevation so that you develop swales, terraces, dams, water storage tanks and pathways. (Covered in more detail later.)

- North Slope: in the Southern hemisphere, the north facing slope or wall is very hot in summer and good for plants and animals that can withstand heat.
- East Slope: Gets morning sun and warms up quickly in the morning, very good for the placement of nurseries, vegetables, herbs and medicinal plants.
- South Slope: Cool and moist, ideal for moisture loving plants. Good for water storage.
- West Slope: Gets sun late in the morning so can be cold in the mornings. West slopes get very hot in the afternoons especially in summer. Herbs and indigenous plants tend to do well here.

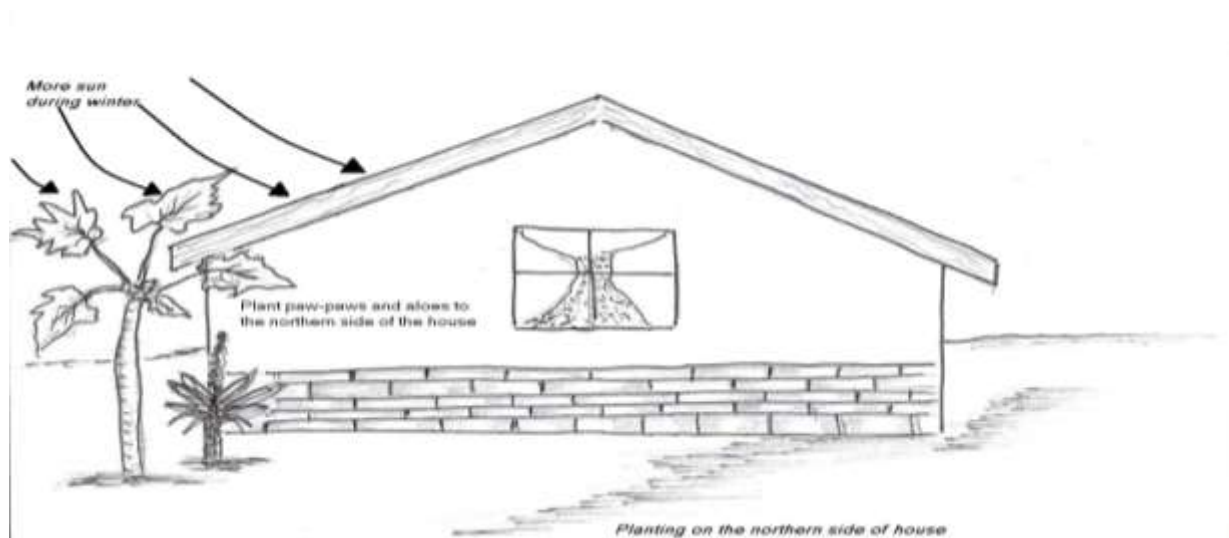
Wind

Wind can damage your plants, and your property.

Erect a wind-sock or piece of material on a pole to form a simple flag. Watch & record where the hot/dry winds come from in summer, and where the chilled winds come from in winter. This is a very important part of your planning process.

Trees and shrubs can provide protection from harsh winter winds, and a cooling updraft in summer.

Depending on the size of your plot, trees and shrubs planted in ZONE 3 can provide both shade from the sun and

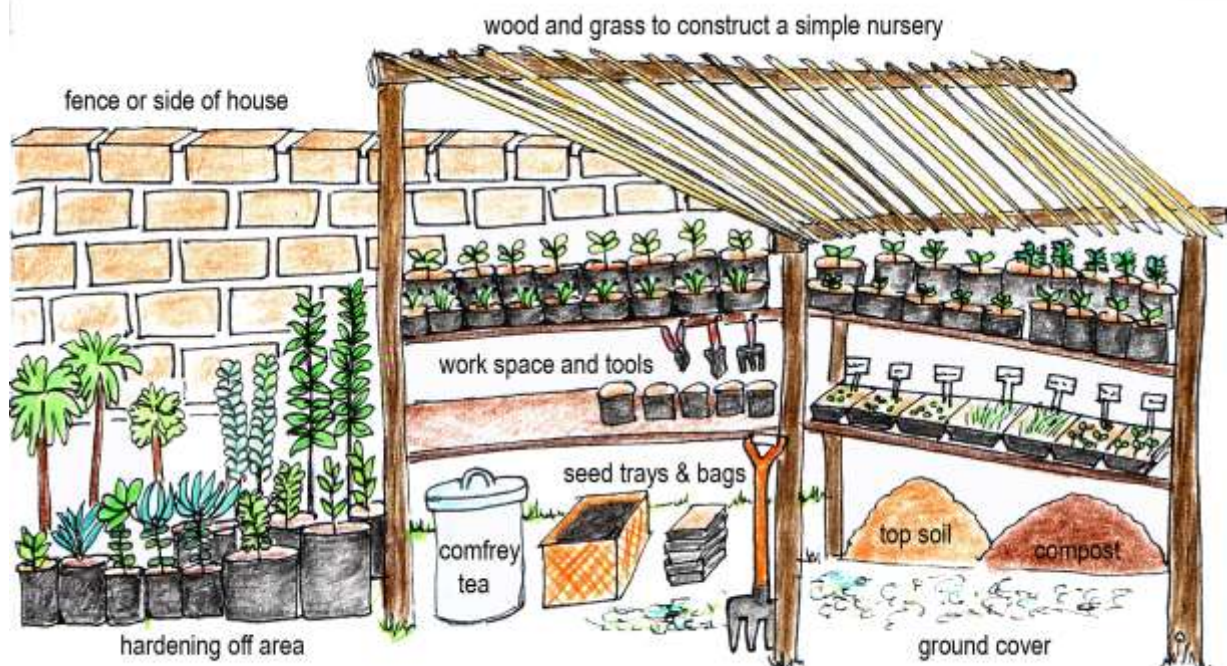


protection from wind.

Nursery

A nursery will do well placed along a warm north-facing boundary wall, or next to the house. You can make a small nursery area out of poles and grass. You can grow many kinds of fruiting trees that will give long-term nutrition.

A good nursery is a well organized work-space, with clean tools, compost and soil. Grow ground covers to keep from slipping around inside the nursery. Have a space for storing containers and bags. All seed trays should be marked with the date and variety planted. Remember to water seedlings often so they grow well. A hardening-off area is needed to help plants get ready for outside conditions.



Securing you plot

Fencing can be made from recycled wood or metal found lying around. To create a hard boundary fence the materials must be securely tied together.

Next to your hard fence, plant 'live fencing' that will add to your garden and meet your needs. Low-lying thick and impassable trees and shrubs will keep out foraging animals. Plants are the best form of natural fence against fire, wind, sun and unwelcome visitors.



Acacia Karoo or Nigrescens have medicinal properties and are nitrogen fixers, so add vital ingredients to your oil. Their flowers attract birds & bees for garden fertility, and have long thorns that act as a fence.





Aloe ferox – This medicinal plant soothes digestion & skin, is impassable, and provides wonderful flowering spikes to add variety to your garden

Doviyalis Caffra Kei apple (Umkolo) is a drought resistant tree, producing flowers (to encourage birds and bees) & has long thorns, if kept pruned. Its fruit is used for jam.



Basic tips on design and budgeting

- Design your homestead garden for nutrition and waste reduction.
- Using the completed zone, slope and the sector information as a guideline. Fill in the zoned map with the interconnecting components and systems like pathways, roads, irrigation and water supply systems, and enclosed, where necessary, with fencing etc, placed appropriately, for maximum benefit and productivity.
- Budgeting is the process of relating money, materials and human resources required to start a project as well as those needed throughout the duration of the project.
- The first step in budgeting is to identify the items that have a cost. These may be the land itself, seed, garden equipment, water and labour.
- The next step is to quantify the items needed as well as how often they will be needed. For example, you may need two packets of tomato seed once at the beginning of the project but you might need onion seed once every three months because you cannot harvest its seed.
- When you have calculated the quantities, check the prices of each item and multiply by the quantities in order to come up with a budget. Your budget can be annual, seasonal, monthly or even weekly.

Factors to consider when costing materials include: description of item, quantity required or frequency of use, total quantity needed per month, unit cost and the total cost.

Tools for tracking your progress

The following documents should be developed:

- Planning sheet, where you write your plans over a given period of time
- Daily record sheet, where you record your observations, inputs (what you do) and outputs (what you get)
- Monthly record sheet, where you summarise your monthly garden records for monitoring
- Production record sheet, where you record what you have produced from the garden
- Tools record sheet, where you keep a record of the tools you have for monitoring and possible replacement
- Details of plant spacing for crops, vegetables fruits and herbs for your observation and personal learning.
- Plant placement: To assist with seasonal rotation of crops to prevent pests and nutrient loss to the soil.

Top Tips:

- Find natural, multi-use solutions: those which serve two or more purposes, & save you money.
- Talk to other gardeners in your area about the local conditions, and how they manage. Most importantly:
- Plan & experiment. Don't be disheartened.
- Plan, observe & share. It takes time.

Conclusion

In this module you have learned about planning the establishment of a garden. Now that you know what to do when you want to establish a garden it is important to go further and learn about nutrition and dietary needs.

Reflection points

- What do you want to produce in the short term and in the long term?
- What key factors should you consider when planning a garden?
- Develop a realistic budget for a garden measuring 10 m by 10 m in an urban set up. Or a budget for a rural setting measuring 40 m by 40 m.
- List the kind of indigenous edible plants that grow well in your area.
- What are the average monthly temperatures in your area?
- What is the average annual rainfall in your area?

Unit 3: Dietary needs & nutrition

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:

- The principles of nutrition
- The importance of nutrition in our systems
- Sources of nutrition
- Getting a balanced diet
- Managing HIV and AIDS with good nutrition
- The problems that arise from under-nutrition

What is nutrition?

Nutrition is about eating the right food at the right time. Good nutrition requires a balanced diet which comes from eating the right quantities of the food types. In Permaculture, knowledge of the nutritional value of plants and animals is important because it allows for better planning of future food production. The food we eat can be classified into a number of broad categories, namely: fruit and vegetables; grains and cereals; milk and dairy; meat, fish and eggs; and fats and oils. But how much of these different foods should you include in your diet every day? And under which circumstances should you increase your intake of certain foods? These are some of the questions that this unit will try to answer.

There is a general lack of balanced eating in South African households because families do not produce enough variety of foods. This is partly caused by families not knowing which crops to grow in order to provide a balanced diet or sustainable, efficient ways to produce vegetables. Some families lack water, good soil and the necessary agricultural inputs and cannot buy enough food because their incomes are too low.



What is Diet?

To establish a sustainable and health-supporting garden one need to understand what Diet and Nutrition are all about.

What is the difference between Nutrition and Diet?

Nutrition is a three-part process. First, food or drink is consumed. Second, the body breaks down the food or drink into nutrients. Third, the nutrients travel through the bloodstream to different parts of the body where they are used as “fuel” and for many other purposes. To give the body proper nutrition, a person has to eat and drink enough of the foods that contain key nutrients through a healthy diet (variety of food per day, especially vegetables).

Diet is about eating the food with the right nutrients for your body to function and resist diseases. Having a healthy diet is one of the most important things you can do to help your overall health. Along with physical activity, your diet is the key factor that affects your weight and well-being.

Poor diet increases your risk of heart disease, diabetes, high blood pressure, stroke, breathing problems, arthritis, gallbladder disease, sleep apnea (breathing problems while sleeping) and cancers.

The basic steps to good nutrition come from a diet that:

- Helps you to maintain your body weight and is balanced overall, with foods from all food groups, including lots of delicious fruits, vegetables, whole-grains, and fat-free or low-fat milk
- Is low in saturated fat, trans-fat, and cholesterol, includes a variety of grains daily, especially whole-grains, a good source of fibre
- Has foods prepared with less sodium or salt
- Has less alcohol or acidic drinks.

A low-protein diet may reduce the stress on the kidney. Avoiding salt can help maintain normal blood pressure and drinking lots of water can help reduce the risk of kidney stones.”

Food provides us with energy and nutrients that our bodies need to:

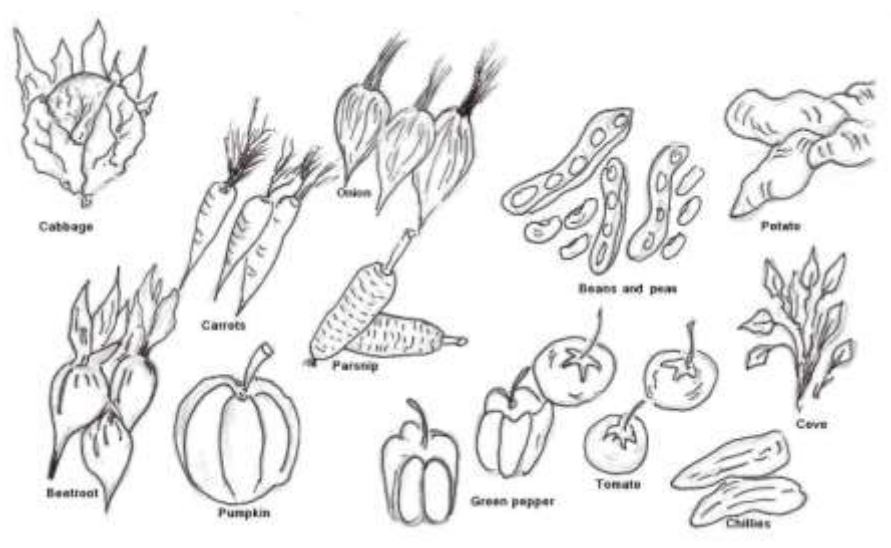
- Stay alive, move and work
- Build new cells and tissues for growth, maintenance and repair
- Resist and fight infections
- Perform daily activities
- Maintain and replenish the body’s cells
- Reinforce the immune system
- Prevent chronic diseases
- Maintain good mental health
- Ensure healthy teeth and bones

When the body does not get enough food, it becomes weak and cannot develop or function properly. Healthy and balanced nutrition means eating the right quantities of each food group to keep healthy, keep fit and enjoy ourselves.

What are nutrients?

Nutrients are substances in the food we eat, which our bodies use to produce energy for growth and repair. The following groups are required by your body:

- Fruit and vegetables:** These are rich in health-promoting nutrients such as beta-carotene, vitamins A and C (powerful antioxidants), minerals, dietary fibre (wonderful for regularity, promoting growth of naturally occurring helpful gut bacteria), and flavonoids (protective against many diseases). Noting that fruits and vegetables contain so many protective nutrients, and improve the immune system, they should be eaten in large quantities and everyone should try and eat five or more portions a day. Try to eat more dark green vegetables such as covo, chomolia, rape, broccoli, kale and other dark leaf greens, orange vegetables such as carrots, sweet potatoes, pumpkin and winter squash; and beans and peas including pinto beans, kidney beans, black beans, garbanzo beans, split peas and lentils. In a day, eat a variety of fruits, whether fresh, frozen, canned or dried, rather than fruit juice for most of your fruit choices. It is important to grow a variety of vegetables and fruits in your own garden.



- Protein:** Protein provides the building blocks of lean body mass. When a protein-rich food is consumed, it is broken down into amino acids, that are reassembled to create enzymes, hormones, and body tissues. Good protein sources include meat, poultry, fish, eggs, dairy products, tofu, nuts, and legumes (e.g., dried beans, lentils). Meat might be difficult to get therefore vegetables such as Moringa Olifera, spinach, amaranths and traditional vegetables are excellent as a supplement to provide calcium and protein.
- Carbohydrates:** Carbohydrates, which are converted to glucose in the body, are a primary source of energy. Simple carbohydrates are found in processed sugar, honey, fruit, fruit juice and lactose (milk sugar). Complex carbohydrates are found in grain products such as bread, pasta, and rice; and starchy foods such as corn, potatoes, winter squash and root vegetables. There is a lot of evidence that people who eat mainly unprocessed starches and carbohydrates such as cereals and grains, are very healthy and do not suffer from the diseases associated with our western lifestyle. Traditionally people in South Africa had diets based on unprocessed grain (millet, sorghum, maize). These unprocessed grains help to reduce risks of heart diseases, stroke and cancer. These people do not tend to be obese. The ideal is to make the bulk of each meal a carbohydrate-rich food, e.g. eat a bowl of unsifted maize meal, Millet (Mabele) or oats porridge, or high-fibre cereal, plus whole-wheat toast for breakfast. Or have whole-wheat sandwiches for lunch if you are at work and base your evening meal on jacket potatoes, brown rice, pasta, samp or boiled crushed wheat.
- Cereals and grains** group is our best source of B vitamins, vitamin E, essential minerals and trace elements (zinc, copper, selenium, magnesium, potassium), dietary fibre and polyphenols. These nutrients protect us against heart disease, many different kinds of cancer, diabetes and obesity. Eat two or more portions of the cereal and grain group at each meal and you will be healthier, live longer and gain less weight.

- **Fats:** Fat in food is a source of energy and has a high concentration of calories. Excess energy from any source not just fatty food is converted to fat in the body and stored for later use. Everyone needs some dietary fat, but getting too little is rarely a problem. Saturated fat is found in meat, butter, tropical oils (e.g., coconut, palm), Polyunsaturated fats (found in sunflower, corn, and soybean oils) and monounsaturated fats (found in olive and canola oils, nuts, seeds, and avocados).
- **Fibre:** Also known as roughage, fibre is indigestible plant matter such as cellulose. Insoluble fibre plays an important role in digestion, helping food move smoothly through the colon (large intestine). This type of fibre is found in the skin and pulp of many fruits and vegetables, whole grains, popcorn and seeds.
- **Vitamins and minerals:** Most vitamins must be obtained from food, except for vitamin D, which the body manufactures when skin is exposed to sunlight, and others that are produced by bacteria in the gut. Vitamins are useful for balancing hormones, producing energy and boosting immunity. They make the skin healthy and support the nervous system. The body needs several trace elements in tiny amounts, including boron, iron, chromium, cobalt, copper, iodine, manganese, molybdenum, selenium and zinc. Minerals are important for making blood cells, bones and teeth, body renewal and building the immune systems. Cooking and processing can destroy some vitamins and minerals.
- **Antioxidants** include vitamins C and E, and beta-carotene. They slow down a person's ageing process and fight against cancer, pollution and heart disease.

Water and your body

Clean water is the body's first requirement after oxygen. Always check that water is safe for drinking, otherwise boil. Water purges toxins and wastes from your body and keeps the mind clear.

- Provides a full feeling, assists in the regulation of bowels and aids in relieving such disorders as constipation
- Helps transport waste to the kidneys and lungs for excretion
- Helps carry hormones and disease fighting cells through the bloodstream
- Is a necessary element for the many chemical reactions involved in the process of digestion and metabolism
- Assists in regulating body temperature
- Helps protect and cushion tissues and lubricate the joints

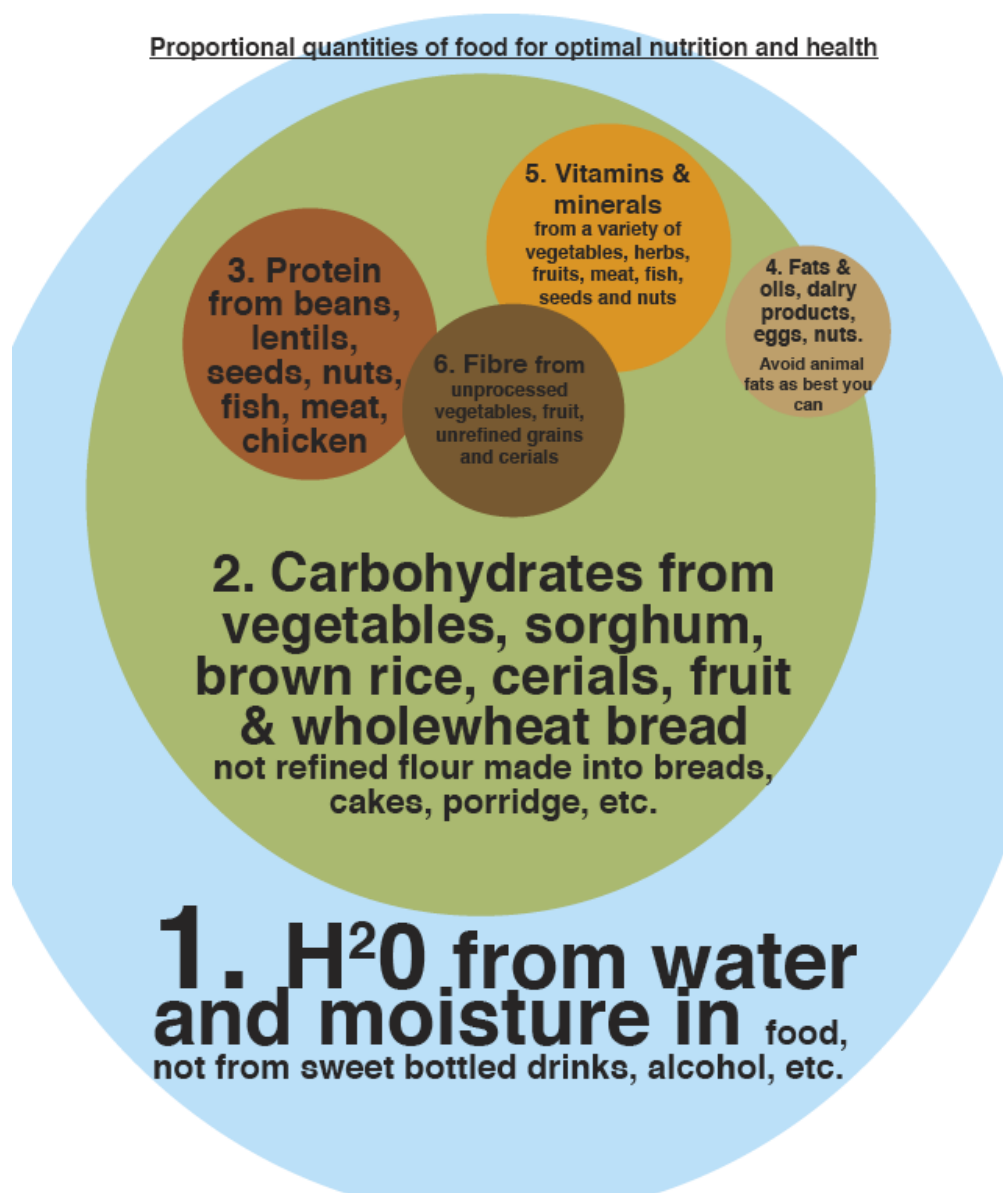
Alcoholic drinks, tea and coffee, cola and all canned and bottled soft drinks, remove water from the body and therefore should be avoided or taken in moderation. Alcohol can also interfere with the action of medicines. (And remember that alcohol is the number one reason why women and children are abused.)

A balanced diet

A balanced diet includes different types of food and adequate water intake. Examples of foods under each category are given below. You need to take more carbohydrates, fruits and vegetables than proteins, fats, oils and sweets. Every day, foods should be selected from the following food groups:

- Mabele, bread, cereal, rice and pasta: 6-11 servings per day
- Vegetables: 3-5 servings per day
- Fruit: 2-4 servings per day
- Milk, yoghurt and cheese: 2-3 servings per day

- Meat, poultry, fish, dry beans, eggs and nuts: 2-3 servings per day
- Fats, oils and sweets: use sparingly



What the body gets from different types of food

Nutrient

Main function

Nutrient	Main function
Sugars and starches	Fuel for energy, movement, brain function they give us to walk, talk, run etc
Fibre	Keeps the heart healthy, removes cholesterol from the body
Fat	Fuel for energy. Essential acids are used for body building especially the brain, nervous system and immune system
Protein	Building the body and immune system
Water	Part of all cells and body fluids, e.g. urine, blood and sweat

Iron	Building red blood cells and muscle
Iodine	Ingredient of thyroid hormones
Zinc	Helps normal growth and development, wound healing and fighting infections
Vitamin A	Helps to keep the surfaces of the eyes, gut, etc healthy and to preserve the immune system
Folate	Makes red blood cells
Vitamin C	Helps the body to use calcium to build and repair bones and other tissues. Increases absorption of non-haem iron from food.

Preventing nutrient loss

Most plant and animal food has the most nutritional value when it is fresh. However, sometimes you have to keep food to last over periods of time for various reasons: sometimes because the food is seasonal, and at other times because you have produced plenty of it. The following strategies are useful for preserving the nutritional value of food:

Ways to retain food nutrients

Storing and buying - Do not keep foods for a long time after harvesting or buying them because some vitamins may be lost. Also take care not to damage foods when harvesting or storing them as this exposes them to disease.

Drying foods - Dry fruits and vegetables by exposing them only briefly to heat to preserve vitamin C. Dry vitamin A-rich foods by putting them in boiling water for two or three minutes, to destroy enzymes which make foods go bad, and dry in the shade.

Preparing foods - Wash fresh foods thoroughly to clean them. Do not soak as this will result in loss of vitamin C. Do not soak sliced vegetables for the same reason.

Cooking foods - Cook vegetables by putting them into just enough boiling water to cover or into a stew or soup. Cover and cook until the vegetables are just ready. This preserves the vitamins that are destroyed by over-boiling. Use the cooking water from vegetables for stews, so you do not waste vitamin C in cooking water.

Supporting your immune system

Under-nutrition or malnutrition happens when the diet of a child or adult does not provide enough energy, protein and other nutrients to meet nutrient needs. It is also important to note that HIV infection causes specific deficiencies of minerals and vitamins in your body through malabsorption.

The immune system of the body is responsible for keeping diseases away or for resisting those that attack it. It is important to maintain a healthy and properly functioning immune system. Apart from eating the right food, the immune system can be improved by an appropriate lifestyle, stress management, exercise, diet, nutritional supplements, glandular therapy, and the use of plant-based medicines. Mood and attitude have a tremendous bearing on the immune system. Positive emotional states such as laughter, smiling, and meditation have been shown to enhance the immune system. Stress, refined sugar, excess alcohol, smoking and poor eating habits increase vulnerability of the body to diseases.

Optimal immune function requires a healthy diet that is rich in whole, natural or organic foods. Take eight cups of potable water per day, stay active and sleep for at least eight hours every day.

Detoxifying your body

Detoxification is the process of clearing unwanted elements (toxins) from the body or neutralizing or transforming them. Fats (especially oxidized fats and cholesterol), free radicals, and other irritating molecules act as toxins in the

body. These toxins may result from poor digestion, colon sluggishness and dysfunction, reduced liver function, and poor elimination through kidneys, respiratory tract or the skin. They may result in excess acid in the body, high levels of blood sugars and cholesterol.

Acid

Acids are reduced by taking enough calcium into your body. Calcium is commonly found in vegetables, such as celery, broccoli, kale, carrots, beetroot, parsley; fruits, such as grapes, citrus, peach, banana and pears, and also in nuts, oats and seeds. Regular exercise every day helps in the reduction of acids in your body.

High levels of blood sugar

These are caused by over-consumption of refined food and soft drinks. To control high levels of blood sugar, reduce sugar, jam, cakes, sweets and honey in the diet. Eat sweet potatoes, wholegrain bread and pasta, millet, sorghum and brown rice instead to naturally bring down sugar.

High Cholesterol

Cholesterol is caused by over-consumption of animal fats, and a lack of enough fish, vegetables and fibre-rich food. The fats used in prepared meals you buy in supermarkets and fast food outlets are particularly bad for you. Control of cholesterol can be achieved by reducing consumption of heated oils, animal fats, margarine and processed foods, and eating more beans, lentils, sorghum, fruits and vegetables every day.

Obesity

We get fat when we eat poor nutrition. Refined maize and flour products eaten with sugar, jam and margarine are full of empty calories. Meat products that come out of factories are full of trans-fats and chemicals that interfere with the body's digestive processes. Chips, sweets, chocolates, ice-cream, beer and wine contain ingredients that are closer to plastic than to food. The brightly coloured foods that are made to taste so wonderful don't feed us properly and make us fat and unhealthy. The only cure is to take charge of your nutrition. Remember that you are a natural being and you need to feed on natural foods. Have beans, peas and lentils in stews and soups for long-lasting protein. Eat sweet potato, sorghum, mabumbe, and root vegetables to fill you up, because it takes your body a while to break up all the different nutrients. If you can grow and cook the food yourself, that's even better.

Nutrition and HIV/AIDS

Good nutrition is the key to a healthy lifestyle, regardless of whether one is living with HIV/AIDS. For those who are HIV positive, optimal nutrition can help boost immune function, maximize the effectiveness of antiretroviral therapy and reduce the risk of chronic illnesses.

What is HIV and how does it affect the body?

It is important to discuss HIV in Africa because there are many people infected with the virus. HIV stands for "human immunodeficiency virus". It is a retrovirus. This means that the virus uses the body's own cells to reproduce itself or to multiply. HIV attacks the immune system, thereby weakening it and making it vulnerable to infections.

The immune system consists of T-helper cells that contain a protein called CD4. The virus enters the blood and gains access to the T-helper cells by attaching itself to the CD4. The normal range for CD4+T cells in a healthy person is 800 to 1 200 cells per cubic millilitre of blood. An HIV-infected person's CD4 count falls over time. It can take up to 10 years for the CD4 count to fall below 200 per cubic millimetre of blood. When this happens, the body becomes increasingly vulnerable to opportunistic infections such as tuberculosis.

The virus is transmitted through having unprotected sex with an infected person; through infected blood; by sharing needles with an infected person; and through blood transfusions (where the blood has not been screened for the virus). Infected pregnant women can also pass the virus to their babies during pregnancy, delivery or through breast-feeding.

What is AIDS?

AIDS stands for “acquired immune deficiency syndrome”. A syndrome is a collection of symptoms and illnesses. When a person is infected with the virus, he or she is said to be HIV-positive. This means that the person is carrying the HI virus and the process of immune-system deterioration has begun. It often takes many years for the immune system to decline to the point where an HIV positive person is said to have AIDS.

How are HIV and AIDS treated?

There is no cure for HIV and AIDS. However, the disease can be managed by living a healthy lifestyle, eating the right food at the right time, e.g. fruits and vegetables, proteins, carbohydrates, vitamins and minerals and using anti-HIV drugs. An HIV-positive person may live with the disease for a long time even more than 20 years. The primary method of treating HIV and AIDS is the use of drugs called Antiretrovirals (ARVs) which are sometimes referred to as antiretroviral treatment (ART). These should be sought from clinics and hospitals.

Voluntary Testing & Counselling

The HIV antibody test is available free of charge at certain clinics. After infection, it may take up to three months for the HIV antibodies to be produced. These are the ones that are used for telling the HIV status of a person. So, it is possible to get a negative result when someone has been recently infected. This period is called the “window period”. Know your status, get tested.

Prevention of HIV and AIDS

Preventative measures can be taken to ensure that one is not infected with HIV, such as safe sex:

- Using a condom during sexual intercourse
- Abstinence
- Being faithful to one partner

It is thought that a strong immune system - assisted by good nutrition - can make people less susceptible to HIV infection.

Research on male circumcision has been found to lower HIV infection rates. Circumcised males are two to eight times less likely to become infected with HIV. Furthermore, circumcision also protects against other sexually transmitted infections, such as syphilis and gonorrhoea, and since people who have a sexually transmitted infection are two to five times more likely to become infected with HIV, circumcision provide added protection. The above measures should be used in combination. Above all, be sensible and act responsibly.

Managing HIV and AIDS

Good nutrition is also vital to help maintain the health and quality of life of the person living with AIDS. Infection with HIV damages the immune system, which leads to other infections of opportunistic disease such as fever and diarrhoea. These infections result in lower food intake because they reduce appetite and interfere with the body’s ability to absorb food. As a result, the person becomes malnourished, loses weight and is weakened. However, the following actions should be taken to reduce the burden of HIV infection:

- Public awareness campaigns on a safe and healthy lifestyle
- Effective management of sexually transmitted diseases

- Reducing mother-to-child transmission
- Providing adequate access to voluntary testing and counselling
- Providing post-exposure services
- Treatment, care and support
- Work to lower the cost of ARVs and make them accessible
- Improving the programme of home-based care
- Research and monitoring of the disease and the treatments
- Conducting regular surveillance of the epidemic

When the nutritional needs are not met, recovery from an illness will take longer. If the person is sick, the family will have the burden of caring, paying health bills and absorbing the loss of earnings as the person is unable to work. Good nutrition can help to extend the period when the person with HIV/AIDS remains well and productive. The main principles of a healthy diet for a person living with HIV are:

- Maintain a healthy weight
- Eat regularly, three or four times a day
- Exercise to make sure your body has enough muscle tissue
- Eat a variety of foods
- Protein foods, fruits and vegetables everyday
- Plenty of foods providing energy
- Maintain good standards of food hygiene
- Drink clean water
- Cook food properly
- Store food properly
- Keep yourself and your kitchen clean

Growing food for a balanced diet

Growing fruit and vegetables for eating at home can improve a family's diet, adding vital nutrients at low cost. If crops are carefully chosen for their nutritional value, this can have a particularly positive impact on the health of adults and children. It is not necessary to have a large piece of land to grow nutritious vegetables even small pieces of land (door size) can be used productively.

Vegetables and fruits you can eat in a particular season

January – March	April – June	July – September	Oct - December
Apricot	Artichoke	Apricot	Apricot
Artichoke	Avocadoes	Artichoke	Artichoke
Beans	Beans	Beans	Beans
Berries		Berries	Berries

Brinjals		Brinjals	Brinjals
Cabbage	Cabbages	Cabbage	Cabbage
Carrot	Carrots	Carrot	Carrot
Cauliflower	Cauliflower	Cauliflower	Cauliflower
Cherries		Cherries	Cherries
Chillies		Chillies	Chillies
Cow Peas		Cow Peas	Cow Peas
Cow Pea leaves		Cow Pea leaves	Cow Pea leaves
Cucumber		Cucumber	Cucumber
Grapes		Grapes	Grapes
Ground nuts	Green Pepper	Ground nuts	Ground nuts
Indigenous veg	Indigenous veg	Indigenous veg	Indigenous veg
Mango	Mango	Mango	Mango
Mealies		Mealies	Mealies
Melon	Melon	Melon	Melon
Nectarines	Nectarines	Nectarines	Nectarines
Okra		Okra	Okra
Onions	Onions	Onions	Onions
	Oranges	Oranges	Oranges
Peach		Peach	Peach
Pears	Pears	Pears	Pears
Pigeon Pea	Pigeon Pea	Pigeon Pea	Pigeon Pea
Pigweed	Pigweed	Pigweed	Pigweed
Pineapples	Pineapples	Pineapples	Pineapples
Pomegranates		Pomegranates	Pomegranates
Potatoes	Potatoes	Potatoes	Potatoes
Pumpkins		Pumpkin	Pumpkin

Spinach	Spinach	Spinach	Spinach
Strawberries		Strawberries	Strawberries
Sweet Potato	Sweet potatoes	Sweet potato	Sweet potato
Tomatoes	Tomatoes	Tomatoes	Tomatoes
Wild Fruits		Wild Fruits	Wild Fruits
Wild Mushrooms	Wild Mushroom	Wild Mushrooms	Wild Mushrooms

Conclusion

This chapter covered several aspects of nutrition, which include the sources of a balanced diet, under-nutrition and ways of addressing problems associated with malnutrition. Deliberate effort was also made to demonstrate the clear relationship between nutrition, HIV and AIDS.

Reflection points

- What plants grow in your garden and what are their nutritional values?
- How can you preserve the nutritional value of food when you have no refrigerator?
- How can your family ensure that you eat a balanced diet?
- Why is water important to your body?
- Why is a good diet important for people living with HIV/AIDS?

Unit 4: Soil in your garden and steps for improvement

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:

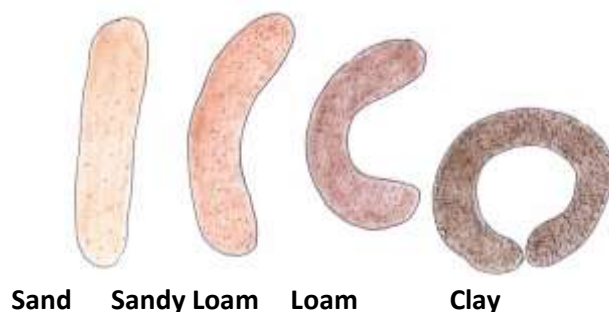
- Soil management
- Soil types
- How to prepare soil for cropping
- Mulching
- How to make compost
- Using and managing earthworms in the garden
- Crop rotation
- The different types of manure

What is soil?

Soils are alive in that they are inhabited by billions of micro-organisms, fungi, bacteria, small insects and worms. Then there are thousands of larger organisms, like rats, mice, rabbits, snakes and moles, all contributing towards the health and vitality of the soil. Permaculture does not concentrate on feeding the plant as is the case with conventional agriculture but rather focuses on building a healthy soil. A healthy soil gives rise to healthy plants and animals and, ultimately, healthy people.

What type of soil do you have?

It is very important to know the type of soil you have before you start growing vegetables and other crops. The soil is the source of everything the plant needs to grow, except sunlight. There are different types of soil. Always remember to test the soil before use to find out whether the soil is clay, sand or loamy. After identifying the soil type, it is then easier to know what methods to use for improving it.



Enhancing soil fertility

Organic fertilizers are made up of naturally occurring organic materials. These include fish, bone meal, blood, hoof and horn, and sea weed meal. They have no modifications and they are natural products; they are safe to use as organic fertilizers. Inorganic fertilizers are those that have been made artificially, are concentrated; and are usually soluble in water and hence they are easily washed from soil.

Minerals found in the soil

Major Elements

- Nitrogen - Essential for the growth of leaf and stems
- Potassium - Increases disease resistance and quality of fruits and grain
- Phosphorus - Promotes early maturity
- Calcium - Essential for cell division
- Sulphur - A constituent of amino acids, proteins, vitamins and enzymes

Minor Elements

- Iron - Helps in chlorophyll formation
- Magnesium - Has a major role in phosphorus transport
- Molybdenum - Essential for nitrogen fixation
- Manganese - Assists in chlorophyll production and metabolism depends on it
- Boron - Important in calcium uptake and quality of fruit and vegetables
- Copper - Most functions are indirect and complex
- Zinc - Helps in uptake and use of water in plants
- Chlorine - Contributes to water holding capacity of plants

Soil pH

Plants have problems absorbing nutrients from the soil unless the soil has the right Acid and Alkaline balance, or pH. The best pH for garden soils is about 6.5. Soil pH is determined by rainfall, parent rock and plant vegetation. Acidic soils are generally found in areas of high rainfall because the water leaches the soil of minerals. Low rainfall areas can have very alkaline soils because the minerals concentrate in the soils.

Soil testing

Garden soils need to be tested before you cultivate them so you know what type of soil you have and thus know which soil conditioning and pioneer approach to take.

Plant Growth

- Growth phase- Nitrogen
- Changeover phase- Reduce Nitrogen and increase Phosphorus, Potassium and Calcium
- Reproductive phase- Remove Nitrogen and use only Phosphorus, Potassium and Calcium based teas

Soil analysis

On any site identified for gardening a basic soil survey is necessary to find out the pH throughout the entire property and examine drainage capacity and the types of vegetation already growing. From this survey, one can decide which species to plant where and which improvements should be made. Bare soil is soil damaged by people, animals, water, sun, or wind. The good news is that this soil can be rehabilitated.

Components of a soil test

A soil test may include analysis of the following components:

(a) Ph

- Acidity/alkalinity of soil
- Influences of the availability of all essential plant nutrients
- Affects activity of soil microorganisms

(b) Organic Matter (OM)

- Moisture holding capacity of the soil
- Serves as supply of nutrients to plants, microorganisms, earthworms
- Tilth, friability

(c) Cation Exchange Capacity (CEC)

- Indication of potential soil fertility
- Measures the soil's ability to store cations (calcium, magnesium, and potassium)

(d) Nitrogen

- Essential for above ground vegetative growth
- Development of chlorophyll

(e) Phosphorus

- Influences energy transfer reactions in plant cells
- Stimulates root development
- Stimulates flowering

(f) Potassium

- Activates plant enzyme systems
- Promotes carbohydrate and protein formation and movement
- Improves winter hardiness, stalk strength

(f) Calcium

- Low test indicates very acid soil
- Promotes overall plant health

(g) Magnesium, Zinc, Iron, Manganese

- Components of chlorophyll
- Important for protein and enzyme functions
- Excess of magnesium may make other nutrients less available

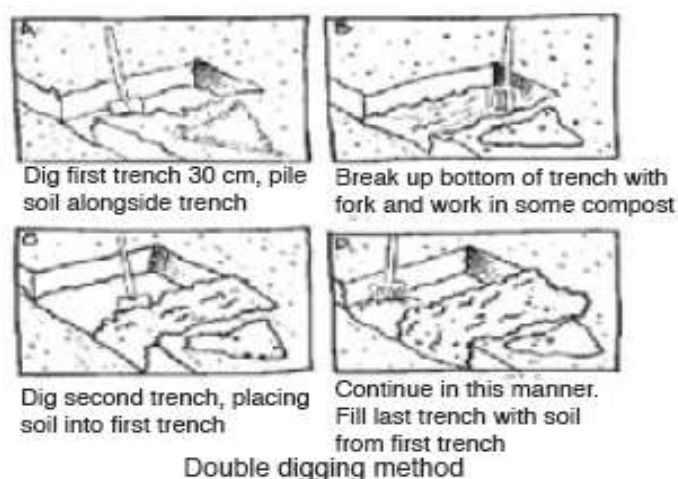
(h) Sulphur

- Component in three plant amino acids
- Plant vigour
- Boron
- Plant vigour

Preparing the land and the soil for planting

Clear the land first by removing weeds, large stones and other items from the soil. Preparing the soil means breaking it up, adding organic matter or other materials to improve it and make it more friable. If possible, the soil should be prepared several months before planting is to begin. The added material will then be thoroughly blended with the soil by planting time. If the soil is clay, the crumb structure will be loosened whilst sandy soil will form a structure that holds water. The secret of a rich and healthy vegetable garden is to feed soil regularly.

A healthy soil has the nutrients and natural systems which provide a good environment for growing nutritious crops. Permaculture aims to work with nature to prevent problems, rather than to treat them when they have arisen.



Raised beds

Raised beds are areas in the garden which are prepared for planting the crops. Measure out a bed which is approximately 1.2m wide and as long as you need. Spread manure or compost over the surface. Dig the soil to a depth of 30cm. As you dig you will notice that the soil changes colour and texture at a certain depth. Digging is the best way to break up any hard layers in the soil and to allow air to enter the soil. The use of a bed system with areas of deep soil with pathways between them is a good way to get good and high yields; and grow more crops in a small space.

Ridging the soil

Another method of preparing the soil for planting is ridging. This is particularly useful if the soil is likely to become waterlogged or if drainage is poor. The ridges should be spaced at the normal row spacing for the crop and should be as high as you can easily build. If they are built higher the soil is likely to be washed away from the roots of the crop during heavy rain.

Maize, sweet potatoes and Irish potatoes are better grown on ridges.

Groups of crops that can be used in rotation

- **CUCURBITS:** Pumpkins, squash, marrow, calabash, cucumber and melons.
- **ROOTS:** Carrots, onions, leeks, parsnip, radish, celeriac, turnip, beet, root parsley, shallot, garlic, indigenous garlic, potatoes, sweet potatoes and Jerusalem artichoke.
- **FRUIT CROPS:** Tomato, sweet peppers, hot peppers, brinjal, gooseberries, tomatillo, honey pear, okra and strawberries.
- **SALADS (leaf vegetables):** Lettuce, spinach, chard, endive, rocket, salad burnet, New Zealand spinach, summer savoury, winter savoury, sorrel, coriander, cress, water cress, parsley and celery.

- **LEGUMES:** Runner bean, bush bean, peas, cow peas, lentils, chick peas, soya beans, broad beans, pigeon peas and ground nuts.
- **BRASSICAS:** Cabbage, cauliflower, broccoli, brussels sprouts, covo, rape, kale, mustard, Chinese cabbage, Chinese broccoli, swede and collard.
- **GRAINS:** Maize, rye, wheat, barley, sorghum, millet and rice.

Trench Bed

You can also dig a trench bed and fill it with grass cuttings, vegetable peels, crushed egg shells and other leftover foods that will rot. Do not use left over meat since it attracts dogs and disease.

Pit Beds

A pit bed is a circular raised bed around a central hollow, which is ideal in dry areas for disposing of daily kitchen waste and grey water as the hollow is used for dumping any available scraps and wastes. It is normally 75cm deep and 50 to 75cm in diameter. The soil that is removed is heaped around the pit to make a growing bed.

Horseshoe beds

These are very good for water catchment and companion planting. They are easy to maintain as everything is close at hand and have a very balanced appearance. They can be effectively used on slopes as well as on flat ground.

How to build soil fertility for sustainable production

There are different ways of adding nutrients to the soil so that it can support a better and more balanced production system and sustain good levels of production. The different strategies that enhance soil fertility.

Green Manure

Green manure comes from green plants, which are grown to benefit the soil in a number of ways. These plants may be returned into the soil as mulch or by digging them into the beds to provide organic matter in the soil. Most of the plants used for green manure are legumes such as beans, lucerne, cow peas, chick peas, etc. These plants fix nitrogen into the soil and other plants use the nitrogen as their food. You can use green manure in rotation farming. Plant the nitrogen fixing plants (heavy givers) in a plot or bed and, when established, harvest them, or cut them back just before they flower and mulch the bed. Plant heavy feeders on the bed so that they will benefit from the nutrients left on the bed by a heavy giver. Lucerne is a perennial nitrogen fixing plant. It is used as fodder and for green manure. Because it is perennial, it is wasteful to plough back, but you cut the leaves and dig them into the soil. After two weeks, plant crops like cabbages and spinach. Planting lucerne on the edge of the bed helps in soil improvement because it fixes nitrogen in the soil.

Mulch

When the soil is covered with a layer of dried leaves, grass cuttings or straw, it is called mulch. Mulch, cover crops and green manure crops prevent soil erosion, they add organic matter and nutrients to the soil, buffer the soil from extremes of heat and cold, and protect soil water from evaporation.

There are two categories of mulch, dead and living:

- **Dead.** This is dried out, decayed, or dying straw, dried leaves, recently cut vegetable matter. It should be collected from various locations and placed on top of the soil and around plants. You can use inorganic mulch such as stones and newspaper, but this has fewer advantages.
- **Living.** Living mulch grows underneath trees and shrubs.

How to get the most out of mulch:

- Mulch the bed immediately after planting.
- Spread the mulch around the plants.
- The mulch should be 8cm thick.
- As mulch decomposes or is washed away, it must be replaced on a regular basis.

Compost

Compost is organic matter that is put in a heap or a pit to break down into humus. A well-developed compost will contain several minerals that plants need, but does not have as much nitrogen as animal manure. Below are some guidelines for making compost. It is important to get appropriate training in compost making.

- Composting is a process of making food for plants and small animals, like earthworms.. It is essential in the long run to grow all your composting materials on the farm and produce your own animal manure. This is if you want to produce organic food, because imported animal and plant materials are likely to contain agricultural chemicals. Because we are feeding the soil with compost we must ensure that we have all the major and minor elements found in soil (see Minerals in Soil chart) present in the compost so that it is effective.
- Where to make compost? Compost should be made near to where it is going to be used and within easy access to the composting material. Try to make the heap or the pit in a shady place to prevent high evaporation. Kraal compost can be made near the animal (goats, sheep, horse, donkey or cattle) kraal.
- Construction of a compost heap : The process for making compost is much the same regardless of the materials used. There are two types of compost heap: aerobic and anaerobic. Aerobic compost is where the compost is created by micro-organisms that use oxygen in the process of decomposition. Aerobic compost is quick to decompose and destroys most of the weed seeds and plant diseases in the process if it is made correctly. Anaerobic compost on the other hand does not use oxygen.

Guidelines for making aerobic compost:

- Lay down a 20cm layer of coarse materials (straw or twigs) at the base of the heap to allow for aeration and drainage. If possible the compost heap should always be made on the ground so that micro-organisms and worms can move up and into it
- Lay down a 5cm layer of animal manure for green grass or leaves
- Lay down 5cm of composting plants and kitchen scraps if possible or old compost
- Lay down a 5cm layer of activating material (grass cuttings, weeds)
- Lay down 20cm of straw/mulch (carboniferous material)
- Repeat steps 2-5 until the heap is at the desired height spraying water over each layer as you go until it is damp. Do not saturate the compost heap as this will prevent it from heating and cause depletion of oxygen
- Plugs of red wrigglers and earthworms can be added to the heap when it starts cooling down. Earthworms will speed up decomposition and their eggs will mix into the soil when the compost is spread.
- Once the compost heap is completed it must be covered with a layer of straw to act as a mulch and then covered with black plastic to keep existing moisture and gasses in and further moisture out so as not to over saturate the heap
- The heap will heat rapidly over the first 3 days, insert a metal pole into the heap and when you pull it out the pole should be hot indicating that the heap is doing its thing
- The heap will continue to get really hot for the first 6 days (you can bake food in a pot if you insert the pot into the outer third of the heap). After the 6th day it will start cooling and by the 10th day it should be ready for turning
- When turning the heap use a fork and mix all the layers together (except the bottom materials placed for drainage purposes) and add more water if it is needed. Repeat this process until the heap is ready

Application of compost

As the compost heap decomposes it will get smaller and eventually loses about 25% of its volume. The finished product should be dark, crumbly, sweet smelling and teeming with micro-organisms. It should be impossible to identify any of the raw materials used. Compost should be used immediately when it is ready. If it is left standing for too long, the fertility of the heap often gets lost through leaching and drying and dying of micro organisms.

Use a wheel barrow for 1 square metre, spread the compost on the soil surface about 10cm deep and use a garden fork to mix it with the soil. If the compost is not yet well-decomposed it should be treated as mulch. The nutrients will move from the surface of the soil into the soil through watering.

Tips on materials for compost making

Many disease-causing microorganisms are killed by high heat. For example, if the whole compost heap heats up to 80 Degrees Celsius, it is likely that the majority of diseases will be eradicated. However, be aware of diseases such as white rot, grey mould, mildews, wilts and tobacco mosaic virus that can survive such temperatures. Plants with such diseases should not be added to the compost heap. It is advisable to burn all diseased materials and use the ash for controlling termites and other insects.

The use of dog and cat droppings is not recommended because some of the diseases that attack these animals can be passed to humans. Wood shavings and saw dust take many years to decompose so it is unwise to use them. They also contain high levels of Carbon and low levels of Nitrogen, that if added to the soil before decomposition, the bacteria rob the plants of Nitrogen in order to work on the wood.

Add soft hedge cuttings to compost. Hard cuttings take longer to decompose and some of them could develop roots.

Animal manures and how to apply them

Make sure you compost all animal manure before use. Animal manure carries seeds and they easily germinate if the manure isn't composted first. Before planting, spread animal manure and plough into the soil, and cover the ground with mulch. Leave for 3 to 5 days before planting.

Earthworms

Earthworms are nature's ploughs that move, aerate and drain the soil. Less commonly known is that their excreta and secretions are high in organic matter and soil bacteria, which make nutrients and growth stimulants available to plants. Earthworm castings are produced when organic matter passes through the gut of the worm. The worm's digestive processes grind and uniformly mix the nutrients and trace elements into simple forms. These become readily available to the plant. pH is neutralised and microbial action is increased, which rejuvenates and nourishes the soil. Castings are rich in soluble Nitrogen, Potassium, Phosphates, Calcium, Magnesium, Enzymes and Auxins (growth hormones). These are accessible to the plant in a slow-release formula. Castings have a unique shape that builds soil structure and improves aeration.

Castings have a high concentration of beneficial bacteria and micro organisms that suppress pathogens and toxins. This results in a fertile and living soil. Plants show vigorous growth and are more able to resist pests and diseases naturally. When fruit and vegetables are grown organically, they are richer in vitamins and minerals, which, in turn, boost and strengthen our own bodies and immune systems.

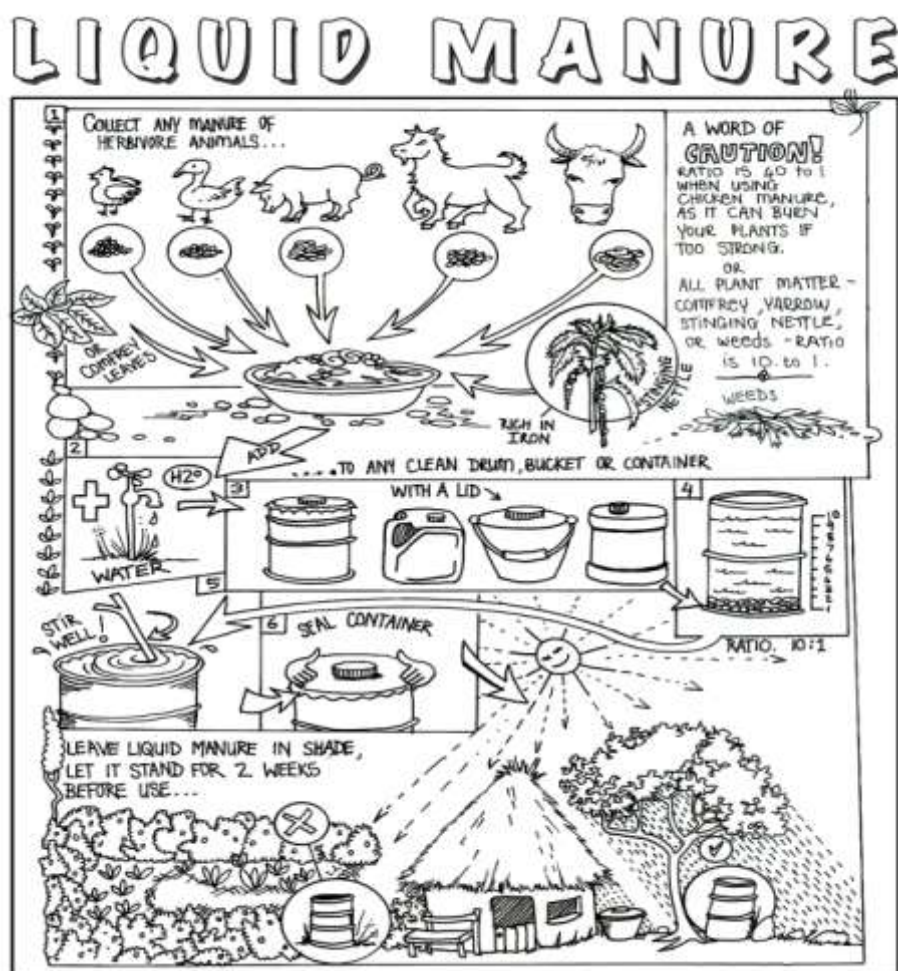
When earthworms are present in the soil we have all the above benefits PLUS the fact that the worms are continually taking down organic matter into the soil and mixing it up. Experiments have also shown that the presence of earthworms in the soil reduces the numbers of harmful eelworms or nematodes. The main way of attracting earthworms into our gardens is to use a no-till system of cultivation and to apply liberal amounts of mulch. Also, never

use insecticides or any poisons in the garden.

To take advantage of their natural abilities earthworms can be sprinkled in the garden at the rate of 10 earthworms per square meter.

Increasing earthworms in the garden

- Maintain soil moisture
- Always cover the ground
- Make pit beds in the garden to attract earthworm breeding.
- Keep earthworms in boxes and feed with animal manure, kitchen waste and vegetables



How to look after earthworms

There are many different ways to keep earthworms. You can keep them indoors or outdoors, on a concrete floor or on compacted ground. They are happy in wooden boxes, metal drums, trenches or windrows (long rows on the ground). And these are just some of the ways in which people keep these most useful of 'pets'. Caring for your earthworms carefully will reward you greatly in the garden.

Cover the bed of the container with black plastic or shade cloth. Put a layer of grass on top. This keeps the bed moist and dark, which earthworms need to function. The layer of grass protects the bed from extreme heat and cold. If the bed is outdoors it must be in the shade or the layer of grass on top needs to be 20-30cm thick.

Worm beds must be kept moist but not waterlogged. Although the worms can survive waterlogged conditions, they will come up to the surface. Moist conditions also deter ants, who prefer dry conditions. Make sure there is adequate drainage if the worms are contained in drums or trenches, and kept outdoors, where rain can fall into their habitat. A bad odour indicates too much water, in which case you should uncover the container, check the drainage and turn the bed lightly with a fork.

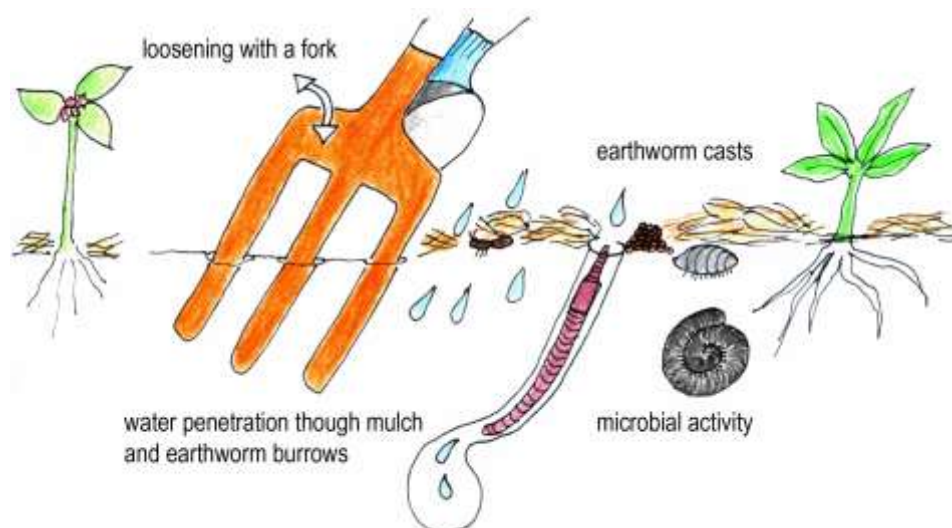
Earthworms eat all kitchen scraps, except citrus and onion family. They eat decomposing organic matter, like leaves, straw, grass clippings and crop residues and manure from rabbits, cows and horses; the fresher the better. If the manure is mixed with urine, it needs to be watered, mixed and aerated until the smell of ammonia can no longer be detected. The feed should be decomposing, but not rotten or smelly. It should also be coarsely chopped and thoroughly wet. Feed the worms by placing a 10cm layer of feed on top of the bed. This should be repeated when the feed has been consumed and a layer of castings is now visible where the feed was.

After a few months, it is possible to harvest earthworm castings. Place feed on just one side of the bed. The worms will move to the fresh food. After several feedings, castings can be harvested from the left free of food. Be careful not to remove the fresh cocoons, which are about the size of a match head and bright yellow or orange. It takes about 21 days for a cocoon to hatch and another 2-3 weeks for the babies to migrate to the feeding side.

A worm bed is a living and diverse ecosystem. The presence of the odd spider, beetle, millipede, black ant or bug is nothing to worry about. They have their role to play in keeping the bed clean, aerated and odourless. However, if these become plentiful, the balance has been upset and needs to be restored. The pests listed below eat large quantities of worms and must be dealt with. Never use poison.

Earthworm pests and associated control measure

- Rodents - Live traps and cats or spring-loaded traps
- Red ants - Remove by hand
- Centipedes - Remove by hand and feed to chickens
- Frogs - Remove by hand



Making liquid manures

Liquid manures are another way of feeding the soil. Below are guidelines on how to make liquid manure:

- Use a 210 litre drum with the lid removed is ideal
- First fill the drum with rainwater to 75%
- Add a 50kg grain bag full of animal manure or mixed composting plants depending on the type of liquid manure you are wanting to make, to the water and stir it in well

- Cover the barrel with a lid or stretch plastic over the top to prevent fumes escaping - any smell from the drum is a loss of Nitrogen in the form of Ammonia
 - Stir the contents every 2 days for 8 days
 - After 8 days the liquid manure will be ready for application. There should be no solid materials left in the brew but just a sludge on the bottom that can be poured around tree stems or spread onto the garden or compost heap
 - The raw liquid manure can then be diluted 1/3 for field crops and 1/5 for the nursery
- One should not apply the liquid manure more than once a week in small quantities or once every 2 weeks in larger amounts.

Crop rotation

Crop rotation means growing different types of crops on the same piece of land one after the other. It helps to maintain soil fertility, controls weeds, pests and diseases and helps a good variety of natural predators to survive on the farm. Beans and other legume plants, for example groundnuts, are particularly valuable for including in a rotation. They provide very nutritious food crops and also improve the fertility of the soil by “fixing” Nitrogen from the air into a form that plants can use. Normally, if the same type of crop is planted in the same plot year after year, the yields will decrease and the plants will become unhealthy.

Each type of crop uses particular nutrients and minerals, which are present in the soil. Sometimes large amounts of one particular mineral are used. These minerals will be used up until the soil has very little of them left. Plants that are grown in soil without enough of a particular essential nutrient will grow poorly and may show signs of weak leaves. Crops, which use few soil nutrients should follow a season of crops that use large quantities of soil nutrients. Deep-rooted crops should follow a season of shallow-rooted ones.

Conclusion

Having understood soil classification, nutrients for the soil and plants, how to prepare the soil, mulching, development of compost and about manure (green manure and liquid manure), we trust you are now able to manage soil fertility and plant nutrients. This module has helped you to be knowledgeable about soil management, which is essential when practising gardening.

Reflection points

- Explain how feeding the soil can result in a nation with healthy people.
- What are the advantages of using organic manure?
- Describe the ways in which earthworms contribute to the ecology of the garden as well as to its productivity.
- Why should a farmer rotate crops?
- What principles should be used in crop rotation?

Unit 5: Water Management, Conservation & Irrigation

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:

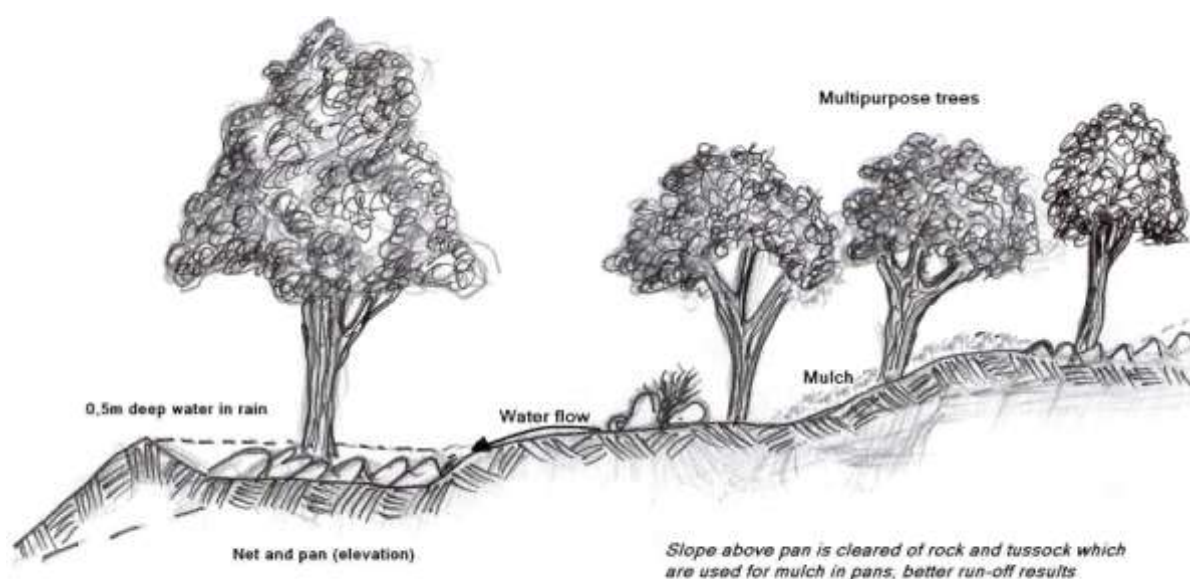
- Water harvesting techniques
- Water management techniques
- Water conservation
- Grey water management
- Irrigation techniques and technologies

Introduction

Now that you know how to manage your soil it is important to know about water. Water is one of the most important elements needed by plants. This module will take you through various topics regarding water use and management.

Water Management

The starting point is to observe the water cycle in your area. What happens to the rain that falls on your doorstep? Does it get into the soil? Do you collect it in a tank? Does it run into a storm drain? It is important to use as much rain water as possible for household use and watering plants. Rain water is the best for farming because it is less polluted than borehole or river water and has less chemicals than municipality water. Harvesting and storage is the basis for starting permaculture food production.



Principles for day to day water management (PSSS):

- **Protect:** Protect your sources and storage points from pollution.
- **Store:** Catch and store all the run-off water you can in barrels, tanks and reservoirs.
- **Sink:** Put the water into the ground to build the ground water table using pits and swales and mulch.
- **Spread:** Direct the water to vegetated land put in swales connected to small earth dams and make use of appropriate irrigation technology, such as drip irrigation.
- **Save:** It is important to put strategies in place for saving water as a household. For example, the water used for washing dishes and clothes, and for bathing, can be directed into the toilet system, rather than flushing away clean water.

Water use in the garden

It cannot be stressed enough that watering, if done incorrectly, is almost as bad as having too little water. There are some principles to bear in mind when watering gardens.

- Only irrigate at night in summer to avoid excessive evaporation that happens on hot days. This gives the water time to sink in before the sun rises. Also water on the surface of plants and on mulch. Watering directly on bare ground during hot days results in quick evaporation leaving crystallised salts behind. Long-term irrigation in this manner leads to salting of soils.
- Only irrigate in the morning on a mild day in winter to avoid freezing the plants on cold nights in winter. Watering in the afternoon in winter is unwise as it leaves the plants and ground too wet when the sun sets and the evening chill sets in.
- Do not waterlog the soil because this kills micro-life and plants die from lack of oxygen.

Some guidelines on watering plants

Most garden plants (hardy species are an exception) must be watered regularly. This is especially important for all seedlings. Lack of water will stunt them and make them flower and set seed too soon. Plants must be given enough water to see them adequately through their growth to maturity. You will notice when a plant is not getting enough water or is in dry ground, it will start wilting and its growth will slow down. Another way to test when garden plants need water is to stick a finger in the ground, if you can push it about 3cm into the ground without finding water, then it is time to water.

Water until the area is soaked once in a while, rather than frequent short watering. A good watering for garden plants in loamy soils is about 25mm, but you will have to work it out for yourself by irrigating each area and checking on it until you find the soil around the plants is well soaked. The water must seep through the mulch and seep right into the soil, the soil should be moist. Allow the top 2 cm of top soil to dry out before watering again. This will ensure the water goes deep into the soil encouraging the plant roots to grow deep and access sub soil water, making them resistant to dry spells. Frequent shallow watering cause the plant roots to grow upwards looking for water, which makes them weak and susceptible to drought and pest attack.

The watering needs of Permaculture systems are not as high as conventional agricultural systems and vary according to Zone placement of species and age of species. Irrigation systems must be specific and well focused to deliver water exactly where you want it so none is wasted on watering areas that do not need watering.

Irrigation Systems

For efficient delivery of water to different elements in the Permaculture structure, the simplest systems are the most elegant and effective.

Micro-jet spray irrigation

Micro-jet spray irrigation systems are ideal for watering Zone 1 and 2 gardens. These consist of micro sprinkler nozzles set on a one metre aluminium rod, which is inserted into the ground, with a connection to an appropriate length of 15 mm irrigation piping. They generally spray in a 3-metre arc around them and the fineness of the spray is usually determined by the resolution of the spray nozzle and the water pressure. Fine nozzles and spray are only suitable for nurseries.

Small sprinklers

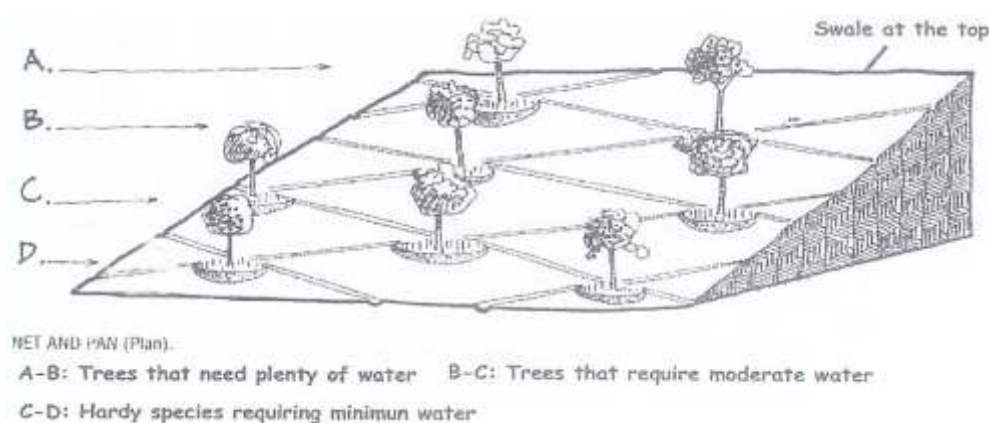
Independent small sprinklers that spray uniformly in a 6-meter arc are ideal for spot watering. The best ones are those that spray a consistent, dense, yet not heavy spray outwards, from the central hole. This type of sprinklers are cheap and found at most garden shops, nurseries and co-ops. They saturate an area very swiftly and can be moved anywhere, provided you have enough hose to supply the sprinkler with pressurised water.

Drip irrigation

Drip irrigation is the most efficient irrigation system because it has the highest amount of water seeping into the soil to feed the plants. As much as 90% of the irrigation seeps into the soil. Drip irrigation works by inserting drip nozzles into 20mm piping that is laid down along the beds under the mulch in parallel lines. The drip nozzles are placed 30cm apart and the pipe spacing is 50cm. In this way you cover all of your bed through the drippers. In a bed 1.5m wide, you will run 2 lines of piping 50cm apart.

Net and pan

Net and pan irrigation systems for trees are useful in two situations: as a water catchment and in directing infrastructure that relies on rainfall to fill the cross channels and pans with sheet run-off. Secondly it works as an irrigation system whereby water is directed into the net and pan system from a swale or pipeline situated above the trees on a slope. Net and pan will only work on a slope. With gentle vegetated slopes, water will have to be piped in, as infiltration rates between the nets will be high other than in big storms. On steep or bare slopes, however, they work well by collecting run-off and directing it into the pans.



Water harvesting and conservation

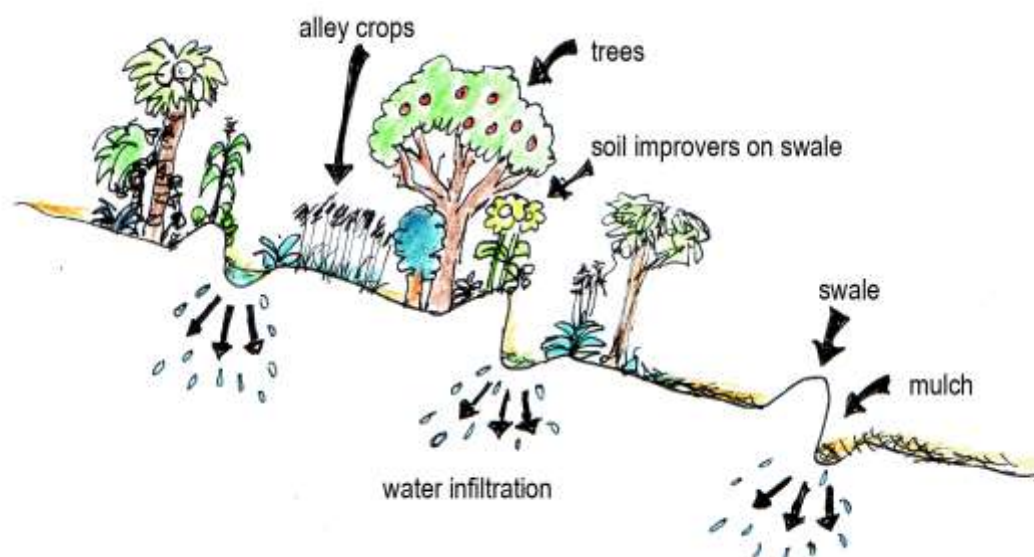
Swales

When marking the swales, put the peg at the starting point. When the string meets the midpoint, mark on the cross bar, it indicates that the two points where the legs touch the ground are on the same level.

If the string is not on the mark, the legs are not on the same level. Move one leg up or down until the string is at the midpoint of the cross-bar.

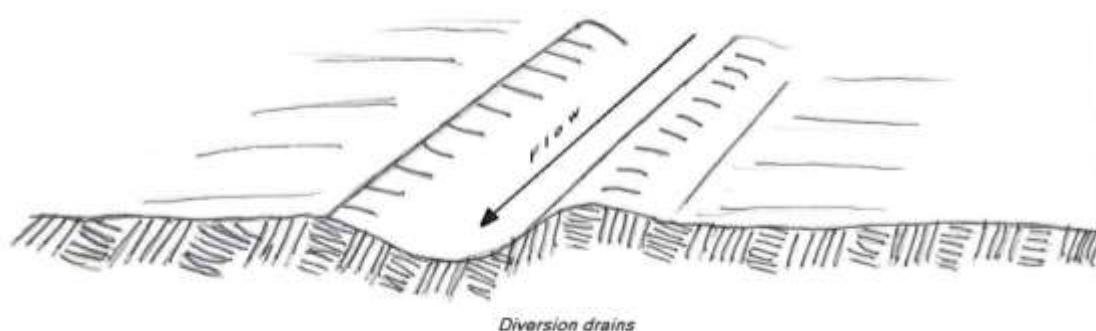
To establish a level contour line from left to right across the face of a slope, use the A-frame to find two level points on the left side of the area where you are trying to establish the contour. Mark the two points with stakes. Pivot the A-frame on the right leg. Swing the left leg around to the other side. Continue until you reach the end of the row. The pegs or stones you marked at each point will indicate the level of the contour.

This is the easiest way of marking contours and is much cheaper than scientific technologies. Anybody can afford to make an A-Frame.



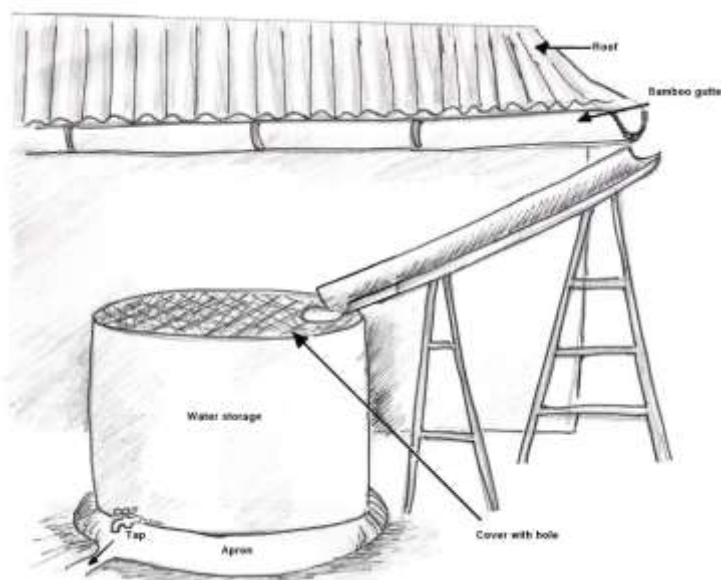
Diversion drains

These are similar to swales but they run at a slight angle across the contours with the specific intention of transferring water from one area to the next. They are particularly useful in transferring water overflow from road surfaces and rooftops to suitable storage points.



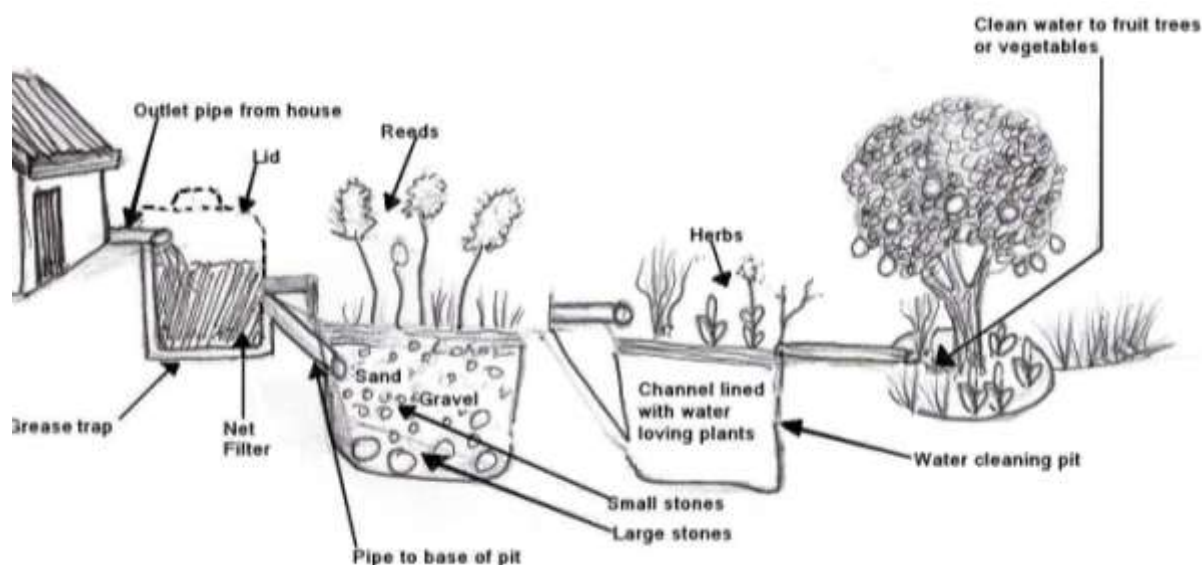
Water spreading

This method can be used in conjunction with swales and diversion drains, where overland water flow is infiltrated into the ground, and the excess is channelled to use points where it is allowed to seep. These use points can include earth-bermed fields, tree pans and pit beds, where all excess water is sent, nothing is wasted and allowed to flow away.



Rainwater storage in tanks

Water can be caught off roof areas, roads, and other paved areas, and used for both drinking water and shower, washing or garden water, provided it can be stored. Roof water is the least polluted, or most easily treated for drinking and cooking in the house. Plastic tanks can be purchased in sizes ranging from 1000 l to 20 000 l. Homemade concrete tanks are the cheapest form of domestic rain water catchment available. Galvanised rain tanks can rust away very quickly. However, they can be rehabilitated by sinking their base into a foundation of concrete and covered with chicken wire. An appropriate mixture of sand, cement and salt is plastered over the wire and left to dry. This type of tank will last a while and is cheaper than buying a new tank. If the roof area is corrugated iron, make sure the paint is not peeling off, because if it is, it will contaminate the water with mercury and lead. Asbestos roofing should not be source of drinking water. The illustration at the end of this unit demonstrates how to purify rainwater coming off the roof.



Recycling water

In Permaculture, we do all we can to recycle water from the bathroom and kitchen. This kind of water is called grey water.

When using wastewater from the kitchen, bathroom, and laundry, it is wise to establish just what chemicals, and at what concentration, are being released into grey water systems. Grey water systems are systems that collect this dirty water, purify most of the waste from it and then lead it to an appropriate place for use in the gardens. Soil organisms can deal with most contaminants in grey water, but the really heavy stuff (pharmaceutical chemicals, medicines and heavy metals) should not be poured down the drain. Try and use environmentally friendly soaps and shampoos. Woody perennials can cope better with pollutants than other garden plants

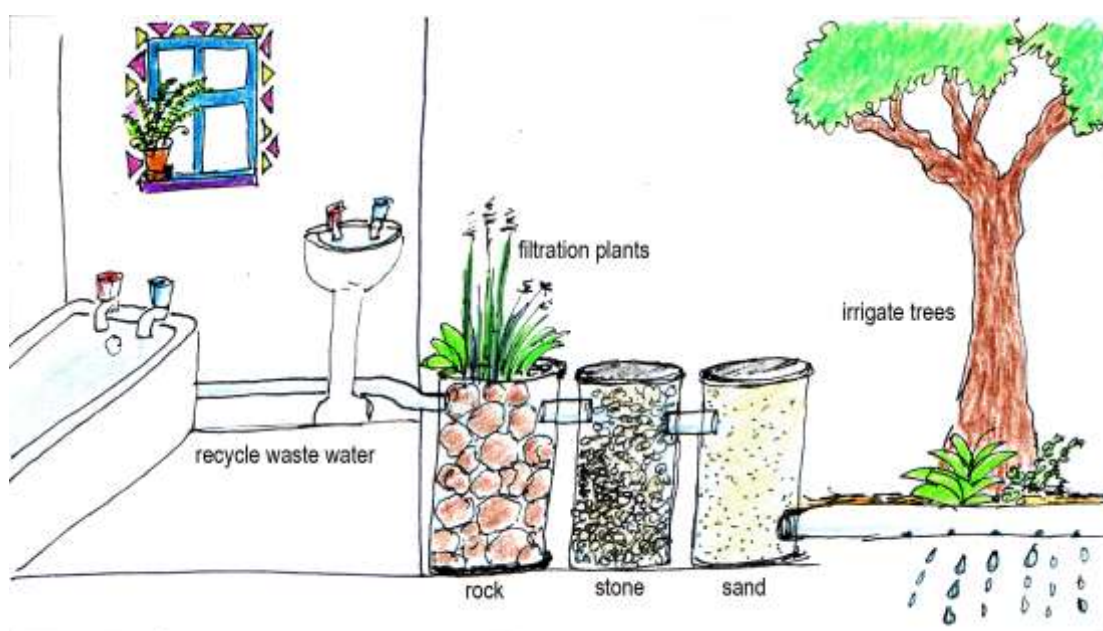
Cleaning grey water

Grey water systems can be productive, if properly made, they clean the initial discharge through a grease trap, and then the water flows through a sand/rock filter, where it percolates to a surface wetland. From that point onwards any overflow drifts gently through a meandering channel lined with water cleaning plants into either a purification wetland or off to trees. This system can contain plant species that grow well in water purification wetland, that have high Nitrogen content, and make excellent mulch and liquid manure. Edible plants other than woody herbs and trees should not be consumed if the plants use grey water.

Plant species for grey water systems

There are many other trees that can grow in grey water systems, as long as they are not planted in the wetlands but rather on the edges of the channels, where they will not block the progress of the water with their roots. Examples include:

- Channel plants: Comfrey, madumbe, red-hot poker, watercress and mints.
- Wetland plants: Papyrus, bulrush, common reed (*Phragmites australis*), comfrey, watercress, madumbe, jungle rice and Chinese water chestnuts.
- Trees: Tree tomato, *Haleria lucida*, *Rhus montana*, *Rhus viminalis*, *Acacia robusta* and Waterberry.



Conclusion

Having understood water harvesting, conservation, irrigation and other water management systems, we hope you are now able to manage water and practise irrigation. This module has helped you to be knowledgeable about water management and the different types of irrigation that can be practised when gardening.

Reflection points

- Why is harvesting important?
- Suggest a process that you would engage in so that you can recharge a spring that has run dry in a given rural community.
- What are the sources of grey water in your school and how is it being used?
- How would you calculate the amount of water that would be collected from a roof?

Unit 6: Trees & Shrubs

LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- The role of plants in agriculture
- How to plant trees and shrubs
- Development of windbreaks
- Development of live fence
- Alley cropping
- How to grow and manage specific tree species
- Development of Agro-forestry
- Establishment and management of orchards

Introduction

You should now understand more about Permaculture principles and have learnt how to implement Permaculture, in the way you plan your garden and required nutritional needs. It is now time to get to know about the plants that can help you to achieve the goals you set. This module will enable you to learn about the role of trees and shrubs, how to plant them, how to develop wind breaks and live fences, how to practice alley cropping, how to develop agro-forestry and orchards. The knowledge you will acquire will enable you to practice in real life, putting the right tree in the right place at the right time.

The role of trees and shrubs in the landscape

Trees are vital in a Permaculture design. They provide shelter for other organisms and a wide range of useful yields (fuel, food, fodder, nitrogen fixing, medicine and they can be used for construction). In order to choose the right species of trees to perform the right function, we must understand the local climate and which species can flourish in a particular area. We should know about indigenous trees in our area to be able to select appropriate species. Consider which species are wind, drought and animal resistant. Some tree species can create problems in the local environment. For example, the alien eucalyptus species remove vast amounts of ground water.

Besides the vital service of providing the planet with oxygen, trees also perform a number of other important functions:

- Provide detritus and humus, such as dead plants and animals that decompose and become soil nutrients
- Provide shelter for living organisms, such as birds, spiders, and lizards
- If its' seeds are legumes, it fixes Nitrogen in the soil, which becomes available for the plants growing in the same area
- Cool the air in the surrounding area through evapo-transpiration, which enables other plants to grow there
- "Mines" bedrock minerals, which then become available over time to surrounding plants as the leaves die, fall off and decompose in the soil
- Can intercept heavy downpours and protect the plants growing under them
- Slow down or deflect (change the direction of) wind
- Prevents soil erosion and land slides

The difference between a tree and shrub

- A shrub grows less than 5 metres
- A tree can grow at least 5 metres

Classification of trees

Plants can be classified in a number of ways depending on the subject or specific interest of an individual. One way of classifying plants is to look at their origin, thus we have indigenous and exotic (alien) plants.

Indigenous plants

Indigenous plants are those that originate or are native in a particular country. They grow well naturally in the different climatic conditions found in the different parts of a particular country. Some of them are of high economic value if they have medicinal properties or deliver high value timber. Some trees provide good shade while others have colourful and attractive flowers that encourage birds, bees and butterflies.

Exotic plants

Exotic plants, on the other hand, are those that are known as 'aliens'. In other words, they do not originate in that particular country. They have their own characteristics, which may include fast growth rate. Some of them are invasive and dominate indigenous plants.

Endangered and Extinct Plants

Endangered plants are those in danger of extinction. Extinct plants are those that do not exist any more, usually because they were over-exploited or their habitat was destroyed.

Examples of Endangered and Extinct plants in South Africa:

ENDANGERED

Serruria aemula
 Leucadendron levisanus
 Kniphofia leucocephala
 Erica jasminiflora
 Frithia humilis
 Leucadendron macowanii
 Encephalartos lebomboensis
 Lachenalia viridiflora
 Serruria trilopha
 Gerbera aurantiaca
 Serruria furcellata
 Lachenalia liliflora
 Mraea gigandra
 Widdringtonia cedarbergensis

EXTINCT

Orchids in southern Africa:
 Encephalartos woodii (cycad)
 Erica verticillata
 Erica turgida
 Euphorbia obesa
 Freylinia visseri
 Jordaaniella dubia and
 Jordaanie la anemoniflora

Invasive plants

Invasive alien plants are plants from other countries which thrive in our conditions, and take over the habitat of native species. In South Africa, these include Lantana Camara and water hyacinth.

Invasive alien plants may:

- Reduce our ability to farm
- Intensify flooding and fires
- Destroy of rivers through excessive use of the ground water
- Pollution of dams and estuaries in the case of plants such as the water hyacinth
- Displace indigenous vegetation
- Upset natural ecosystems

Tree Planting

The history of Arbour Day

Arbour Day originated in 1872 in the United States territory of Nebraska. Mr. J. Sterling Morton, a newcomer to the treeless plains of Nebraska, was a keen proponent of the beauty and benefit of trees. He persuaded the local agricultural board to set aside a day for planting trees and through his position as editor of Nebraska's first newspaper, encouraged participation in the event by publishing articles on the value of trees for soil protection, fruit, shade and building. Mr. Morton's home, known as Arbour Lodge, was a testament to his love for trees and so inspired the name of the holiday: Arbour Day. Within two decades Arbour Day was celebrated in every US State and territory, and eventually spread around the world. The tradition continues annually in the second week of August, in global acknowledgment of Mr. Morton's slogan, "other holidays repose upon the past; Arbour Day proposes for the future."

In South Africa, Arbour Day was first celebrated in 1983. The event captured the imagination of people who recognized the need for raising awareness of the value of trees in our society. As sources of building material, food, medicine, and simple scenic beauty, trees play a vital role in the health and well-being of our communities. Collective enthusiasm for the importance of this issue in South Africa inspired the national government, in 1999, to extend the celebration of Arbour Day to National Arbour Week. From 1 to 7 September every year, schools, businesses and organizations are encouraged to participate in community "greening" events to improve the health and beauty of the local environment and propose a green future for South Africa.

South Africa's Trees of the Year (2007- 2015)

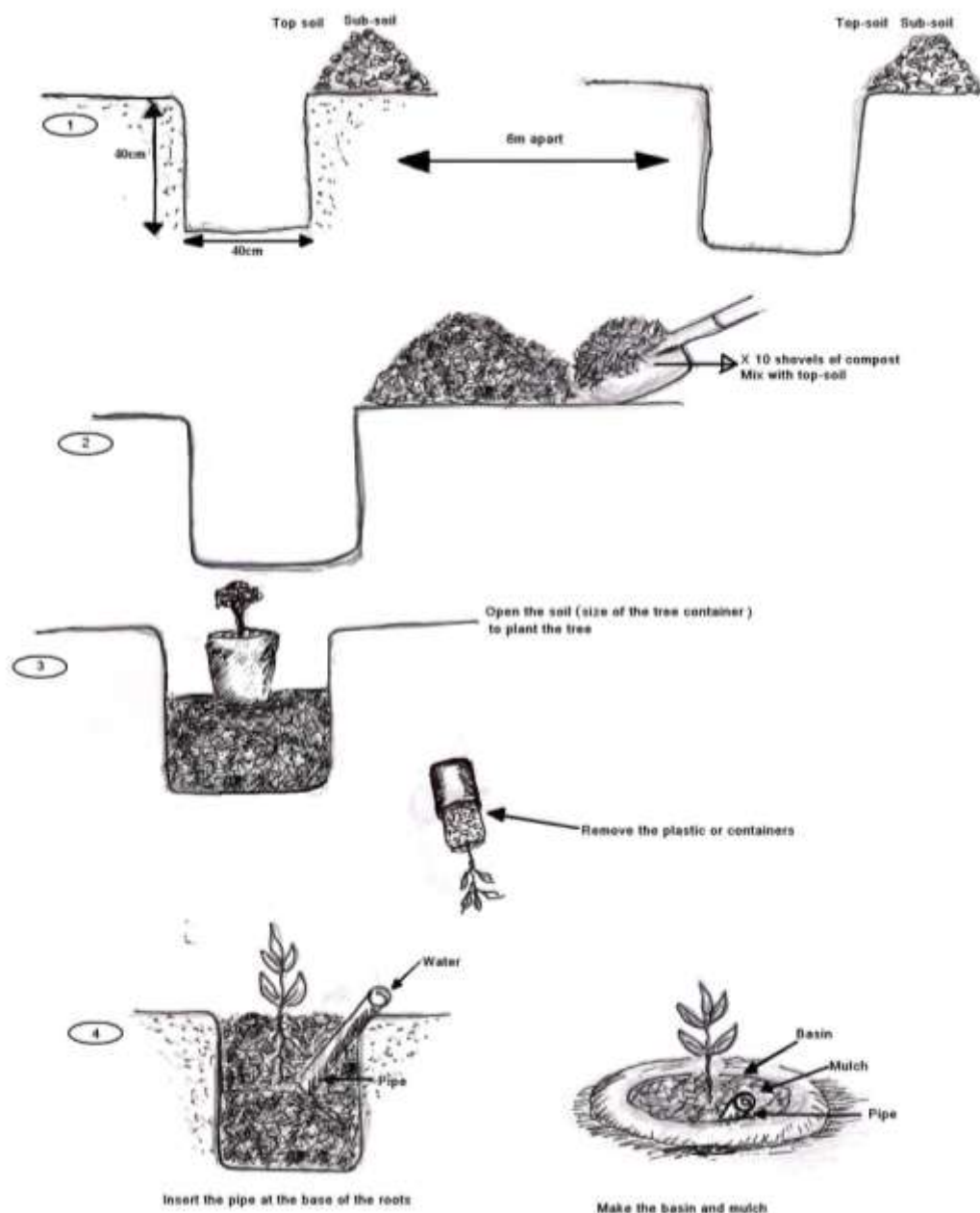
These are indigenous species selected by the South African Government for every Arbour Week celebration and this highlights two specific trees; one common and one rare species.

How to plant trees

Here is a step-by-step process of planting trees:

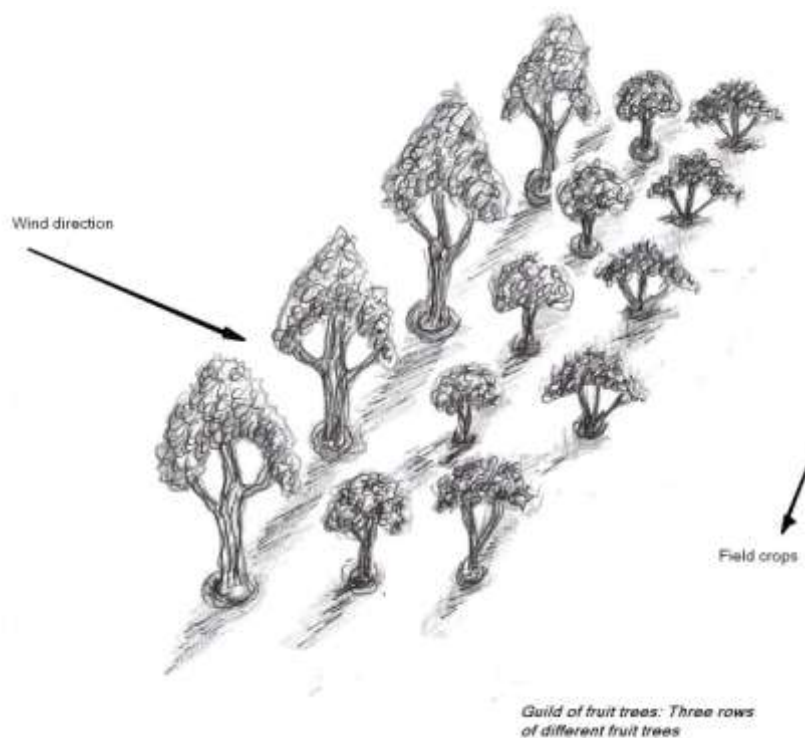
- Select a suitable site
- Water the trees to be planted one hour before they are due to go into the ground
- Mark points 6m apart for planting trees
- Dig a hole of about 50cm deep x 50cm wide and 50cm length on each marked point
- Pile together topsoil and subsoil
- Mix the soil with 10 full shovels of compost or well-rotted manure and fill the pit
- Open a hole in the filled pit, the size of the container of the tree you're planting
- Remove the plastic covering or container carrying the plant
- Insert a 50cm x 50mm old pipe at the base of the roots of the trees

- Plant the tree and make a basin around it
- Water the tree by pouring water in the basin
- Make sure the pipe is free of soil, to that water goes directly to the roots, whilst the basin will hold water that will slowly percolate into the soil
- Mulch the basin
- Make a “C” bed around the tree for planting vegetables and herbs
- When you water the tree other plants also get water
- Water three times a week for the first four months



Planting trees together (Guild)

In the natural environment plants grow and develop in communities, within an eco-system in which species interact with each other in beneficial ways. There are fewer antagonistic and more beneficial interactions among plant species. In planning gardens and choosing trees to plant, you should try to maximize the beneficial relationships plants have with each other. You can do this by forming guilds which are beneficial assemblies of species around a central element.



Beneficial relationships or interactions among plants include:

- Preventing pest problems by providing anti-feed ants, e.g. nasturtium roots provide chemicals to some Solanum species like tomatoes and gooseberries that deter whitefly
- Killing root parasites: marigolds deter nematodes
- Hosting predator species: umbelliferous plants host predator wasps
- Reducing root competition such as keeping grasses away from fruit trees
- Providing food or mulch: legumes are an excellent plant to feed the soil
- Providing specific nutrients: Nitrogen fixing plants around a fruit tree, such as Lucerne or clover
- Providing physical shelter: this could be a windbreak or frost protection
- Saving human energy by planting clusters that are likely to be harvested together. For example, tomatoes, basil and lettuce grown together as salad plants.

In addition to this, we can take into consideration the actions of animals and other living organisms. Chickens and geese, for example, can perform a pest control function if allowed to forage in a controlled way within the orchard. Specific species of plants can be planted to attract insectivorous birds to an orchard.

Developing Orchards

Fruit and nut trees can provide both nutrition and an income (fresh or processed). When planting orchards, consider the following:

- Are these the fruit trees appropriate for this climate?
- Will the family and community eat or buy these fruits?
- Is there enough water available for these fruit trees?
- Where is the best place on the site to plant them? Will they have enough light, wind and protection?
- Do any specific pests threaten these trees? If so, what can be done to reduce this threat (companion planting, guilds and organic remedies)?
- Can different varieties of the same tree be planted to increase the yield over time?
- Are there different fruit trees that produce fruit all year round so that the family has a supply of fruit throughout the year?
- How do these trees produce fruit? Pollination, or are both male and female plants are needed?
- The structure of the mature tree: Is it umbrella shaped, or open. Generally, umbrella shaped trees cast a dense shade, preventing many crops growing below them. Open trees allow light through to allow ground crops to grow.
- Some trees such as most citrus can grow beneath tall trees and may not require full sun to produce fruits.
- Tree height at maturity: This is useful to know when deciding a tree's location and space requirements so it does not out-compete the other trees for sunlight.
- Moisture needs: Place drought resistant trees (carob) and moisture needy plants (stone fruits) in separate groupings to aid watering.

Agro-forestry

Value of agro-forestry

Agro-forestry is the integration of trees and shrubs into the farming system so that they are managed, protected and harvested for the benefit of people and livestock. Agro-forestry brings benefits which include:

- Food for people in the form of fruit, leaves or seed
- Food for livestock in the form of leaves of pods
- Firewood for fuel
- Poles for fencing and in some instances, live fences
- Stabilization of soil on steep slopes, which may increase water infiltration and build the water table
- Recycle nutrients that cannot be reached by short-rooted plants such as vegetables
- Trees can also be used as windbreaks.

Mixing trees and crops can help in creating more integrated, diverse, productive, profitable, healthy and sustainable land-use systems. Agro-forestry practices focus on meeting the economic, environmental and social needs of people on their private lands. At the farm level, agro-forestry is a set of practices that provide strong economic and conservation incentives for landowner adoption. Incorporated into watersheds and landscapes, agro-forestry practices help to attain community goals for more diverse, healthy and sustainable land-use systems.

Where does Agro-forestry apply?

Agro-forestry can be applied to private, public and communal agricultural and forest lands. Targeted areas include highly disturbed, human-dominated land-use systems as well as highly-erodible, flood-prone, economically marginal and environmentally sensitive lands. The goal is to restore essential processes needed for ecosystem health and sustainability, rather than to restore natural ecosystems. Agro-forestry provides strong incentives for adoption of

conservation practices and alternative land uses, and can support a collaborative watershed analysis approach to management of landscapes containing mixed ownerships, vegetation types and land uses.

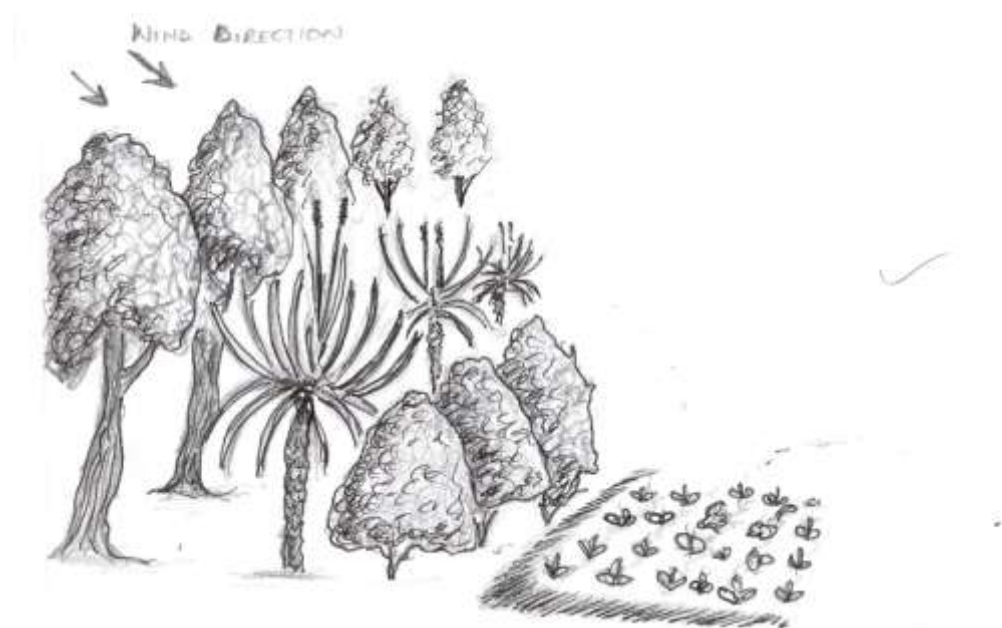
Using plants as wind breaks

Value of windbreaks or a live fence

Windbreaks or live fences have been used for years to shelter houses, animals and crops from wind, and are the most effective in micro-climate control. The benefits of windbreaks include:

- Reducing wind pressure and soil erosion caused by wind
- Reducing crop losses caused by the shaking out of seed or grains
- Modifying air and soil temperatures
- Prevents animals and people from entering the property

Well-designed windbreaks modify climate, reduce erosion, hold the water on the land, provide refuge for wildlife, and produce many resources. Wind is fluid like water; and it can be deflected sideways or upwards. It naturally forms into layers with hot air rising and cooler air flowing underneath. Every windbreak should be designed to work many ways, and to yield a variety of products such as mulch, bee fodder, animal browse, firewood and building timber.



Windbreak and live fence design guidelines

The windbreak should always face across the prevailing wind direction. Leave no gaps in the windbreak as this will funnel the wind and increase its velocity, damaging everything in its path. There are two types of windbreak: large windbreaks that are planted in areas where winds are strong and prevailing, and are the first wind buffer as it enters the property. The other type of break is smaller and is planted within the gardens to keep wind velocity down after it has been dampened by the first big break.

- A windbreak or live fence should have at least three layers to its structure; an herbaceous layer made up of tall hardy herbs that can handle wind abrasion, like aloes, wild dagga and vertiver grass, in front of the break. This layer later serves to stop wind funnelling under the main windbreak trees between the ground and the first branches.
- The second layer is made up of shrubs and small dense trees that are hardy such as Buddleja, Rhus and Elderberry. Mix Pigeon peas, and other shrub legumes into this layer. This layer deadens the blast of the wind, allowing it to rustle

through the next layer and into the garden at a greatly reduced velocity. This layer also allows you to plant a few productive species in the main windbreak, and place beehives and geese hocks behind the shrubs.

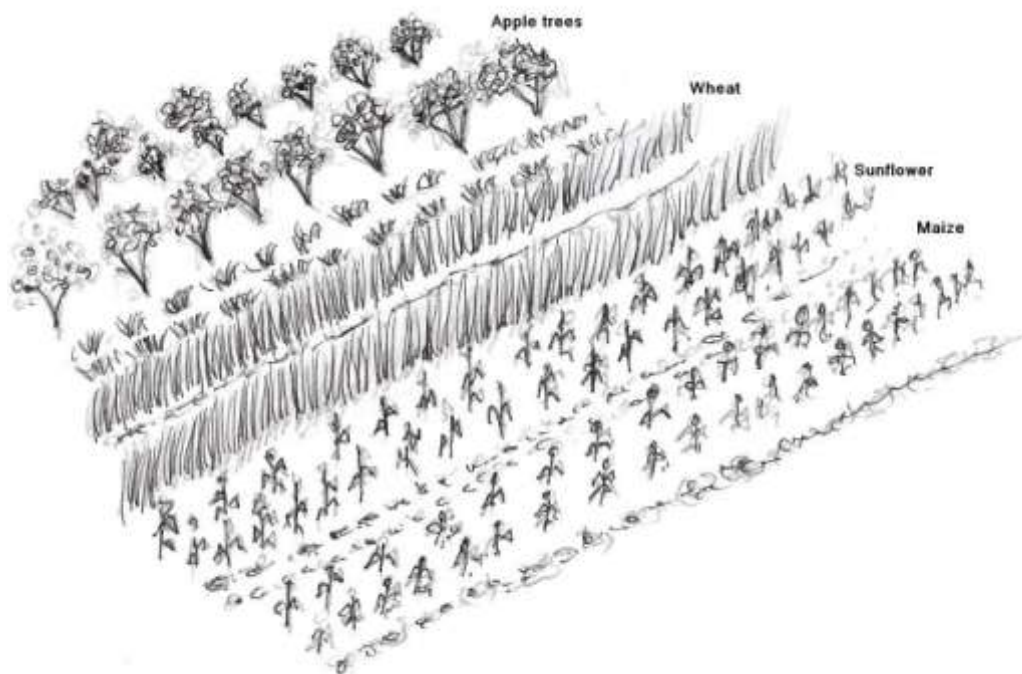
- The third and final layer is made up of large trees that are wind resistant in the sense that their leaves are hairy or leathery. They have dense canopies and are relatively tall, so they push the blast up and over the garden, allowing a gentle wind through to swirl harmlessly through the gardens below. These trees, which include stinkwood, chestnut, figs, and yellow wood, are valuable timber trees. Fruit species can be placed in the breaks as well. Ideally, every fifth tree should be a legume for Nitrogen fixing.



Alley cropping

Definition of alley cropping

Alley cropping is an agro-forestry practice in which perennial, preferably leguminous trees or shrubs, such as Pigeon Peas, *Moringa Olifera*, are grown simultaneously with crops. The trees, managed as hedgerows, are grown in wide rows and crop is planted in the interspaces or 'alley' between the tree rows. During the cropping phase the trees are pruned and the prunings used as green manure or mulch on the crop to improve the organic matter status of the soil and to provide nutrients, particularly nitrogen, to the crop. Alley cropping retains the basic restorative attributes of the bush fallow system, allowing the farmer to crop the land for an extended period.



Benefits of Alley Cropping

- Improved crop performance due to the addition of nutrients and organic matter to the soil/plant system
- A reduction of the use of chemical fertilisers
- Improved soil structure resulting in better infiltration
- Reduced runoff
- Soil erosion control
- The provision of additional products such as forage, firewood or stakes when a multipurpose tree legume is used as the hedgerow
- An improvement in weed control

Some useful trees for agro-forestry

In this part of the unit, you will learn about several trees and shrubs that you can find in South Africa and that are useful in agro-forestry. For each tree or shrub selected, you will learn about its appearance, where it naturally occurs, where you can grow it successfully, its value in agro-forestry as well as how you can propagate it. The names are given in English (E), Tswana (T), Zulu (Z), Venda (V), Sotho (So) and Xhosa (X) to assist different people to know that plant under discussion.

Acacia Karoo

Sweet thorn, karoo thorn (E), Mooka, Kalagadi (Tsw), Mookana (N. So), umuNga (Z), Muunga, Muswu (V), UmNga? (X)

Description: A deciduous tree which grows up to 8m tall, with rough grey-black bark, peeling to show red rust below, straight sharp spines up to 7cm long, feathery leaves made up of 8-20 pairs of glossy green leaflets, golden yellow flower balls.

Habitat: Black clay soils in open grassland and along river courses.

Where to plant: Plant it in zone 1 for shade. In zone 2 or 3 plant it in rows with orange or banana or avocado plants as a nematodes repellent. Plant it on the edges of your fields, or create a buffer zone with other species in Zone 3. Planting it with Carrissa and Dovyalis helps to build a strong live fence.

Uses: Shade, live fence, wind break and medicinal. It can be used as a soothing agent as well as for treatment of colds, conjunctivitis and haemorrhage.

How to multiply: Seed

Aloe Ferox

Bitter Aloe (E), UmHlaba, iNhlaba (Z) Kgopa (So), Sokgopha (So), UmHlaba, iKhala (X) Thikhopha (V)

Description: Robust single stemmed succulent to 2 m high, rarely to 5 m, with the old leaves remaining on the trunk. Evergreen. Leaves tapering with sharp brown teeth on the margins and sometimes the leaf surfaces. Flowers nodding in dense, branched candelabras, usually orange to red, about 30mm long. Habitat: Widely distributed on stony soils, on flat and steep slopes.

Where to plant: Live fence, Zone 3.

Uses: It has medicinal uses. The leaf gel is used for hair and skin products to treat sunburn, scalp and scalds, open wounds, sores, itchy insect bites and ulcers. How to multiply: Seed.

Aloe Tenuior

Basuto Kraal Aloe (E), Inhlaba empofu (Z) Kgopa (So) Tshikhopha (V)

Description: The fast growing free-flowering aloe forms a dense rounded shrub with succulent green leaves. Stem: Many branched aloe with no main stem, up to 1m. Leaves: single shaped, long, narrow and soft with tiny spikes on the leaf margin. Flowers: red and yellow flowers appearing in spring and autumn.

Habitat: Rocky areas in cold environments.

Where to plant: An excellent plant in zone 1 for developing boundaries and screening or focal point. Plant it in rockeries for beauty and attracting birds. Use in zone 3 as live fence. Use for rehabilitating eroded areas.

Uses: Roots and leaves are used for pest control, and is a good firebreak. Cultural - leaves are used as protective charms. Medicinal - hair and skin care; as a stimulant and to boost the immune system; to cool sunburn, and treat cancer, scalds, open wounds, high blood pressure, sores, bites and ulcers.

How to multiply: Seed or cuttings.

Artemisia Afra

African Worm Wood (English) Umhlonyane (Z, X); lengana (S, T).

Description: Multi-stemmed perennial shrub 2 metres high. It has feathery leaves with a strong smell.

Habitat: Dry and wet areas. Cold and warm areas, in well-drained soil.

Where to plant: Plant it in rows as a windbreak for small plants or vegetables. Plant it in cluster to form a focal point or as a screen in the garden or at homesteads.

Uses: Relieves mild pain and acts as an anti-microbial, anti-worm, anti-oxidant and narcotic. It has been used for treating respiratory infections and problems (influenza, coughs, pneumonia, TB, colds and chest complaints). It is also used for treating fever, stimulating the appetite, constipation, indigestion, intestinal worms, malaria, and gastritis. Used as a wash for haemorrhoids, measles rash, wounds, sores, rashes, bites, stings and eyes. Leaves may also be boiled in water as a steam bath and the fumes inhaled for treating blocked noses and cold and flu states. Artemisia afra can also be mixed with African potatoes and Leonotis leonorus for energy (Do not use it if on anti-retroviral therapy (ART) as it can interfere with the medication.)

How to multiply: Cuttings and seed (grow them in river sand beds).

Cajanus Cajan

Pigeon pea (E) Ndonji (T, S) Nyandoro (S)

Description: Perennial woody shrub, mostly grown as an annual for the legume; stems strong, woody, to 4 m tall, freely branching; root system deep and extensive, to about 2 m, with a taproot. Leaves alternate, pinnately trifoliate 15 cm long and 6 cm wide. Flowers multi-coloured with yellow, red, purple, orange. Fruit is a pod which produces seeds like peas, but slightly smaller.

Habitat: Pigeon pea is drought resistant, tolerating dry areas and it can also grow in high altitudes if protected from frost. The plant is sensitive to water logging and frost. It grows in all types of soils, varying from sand to heavy clay loams and well-drained medium-heavy loams.

Where to plant: Plant pigeon pea in zone 1-2 as a windbreak for small plants or a screen. Plant it as fodder or bee forage in zone 3.

Uses: Seeds and leaves provide firewood and food. It can also be used as fodder, bee forage, windbreak, Nitrogen fixing and soil conservation. Pigeon peas are a nutritious, protein-rich food popular in central Africa. Ripe seeds are a source of flour and can be used in soups or eaten with rice. Ripe seeds may be germinated and eaten as sprouts. The plant produces forage quickly and can be used as a perennial forage crop or used for green manure. Dried stalks can be used for fuel, thatching and basket making.

Medicinally the leaves are applied to sores. Powdered leaves help expel bladder (kidney) stones. The leaf decoction is prized for healing genital and other skin irritations, especially in women. Floral decoctions are used for bronchitis, coughs, and pneumonia. Leaves are also used for toothache, mouthwash, sore gums and dysentery. Scorched seed, added to coffee can alleviate headache. Fresh seeds are said to help incontinence of urine in men, while immature fruits are believed to be of use in liver and kidney ailments.

How to multiply: Seed and cuttings

Carica Papaya

Paw paw (E), Papawe (TS, V) Popo (S)

Description: A single-stemmed small tree with a thick, somewhat fleshy trunk and very large palmate-lobed leaves clustered at the top. Male and female flowers are borne on separate trees. The fruits are large and fleshy, initially green but bright orange upon ripening. It grows up to 3 m high.

Habitat: Hot areas, and well drained soils.

Where to plant: Plant paw paw in zone 1-2, grow it against walls facing North to take advantage of the heat and sunlight. Plant paw paw in rows with pigeon pea or lucerne or cow peas, at 1 metre apart.

Uses: Paw paw can be used as a digestive aid and for the treatment of malaria, intestinal disorder, roundworms, skin disorders and menstrual irregularities. Eat fresh seeds for stomach cramps and diarrhoea

How to multiply: Seed.

Carrissa Macrocarpa

Big Num-num (E), Tlaba dilebanye (So), Amathungulu (Z, X) Murungulu (V)

Description: Evergreen large shrub or small tree (2-5m), found on margins of coastal forest, in coastal bush. It is multi-stemmed and branched and has a rough, light brown bark. Leaves occur as opposite pairs, leathery, shiny dark green above, paler beneath. The margins are entire, tapering to bristle tip. The base is square to round. The flowers are large, white, with tinges of pink and occur in clusters at the base of the thorns. It is fast growing and wind resistant.

Habitat: Coastal bush, coastal forest and sand dunes.

Where to plant: Zone 3, plant at about a metre apart to form a hedge. Plant it as a live fence.

Uses: Big num-num can be used as an ornament, or as a focal point, or as a firebreak and also as a live fence because of its thorns. It can also be used for hair and skin care and to treat sunburn, scalds, open wounds, sores, bites and ulcers.

How to multiply: Seed

Carya Illinoensis

Pecan nut (E)

Description: Pecan nut trees are deciduous, fast growing and grow up to 40 m high. Pecan trees may live and bear nuts for more than three hundred years. The leaves are alternate and pinnate. The flowers are wind pollinated. The fruit is an oval to oblong, nut dark brown with a rough husk which splits off at maturity to release the thin-shelled nut. The nuts can be stored at room temperature for as long as 6 months before they are marketed. Pecan nuts ripen from April to July. As soon as the nut is ripe, the green husk becomes dry, cracks open and the nut drops out. The nuts are mainly collected manually from under the trees.

Habitat: The pecan nut tree is well-adapted to subtropical areas. It also grows well in areas with short, cold winters and long, hot summers. Low temperatures and even frost during June to August are required for successful budding and flower formation. During the summer months (October to April) the tree requires high temperatures for fruit growth. Trees are successfully established in valleys and along rivers where the winter temperature is low and frosts occur, and temperatures are high in summer.

Where to plant: Plant pecan nut trees in zone 3 in orchard. Newly planted trees must be irrigated immediately. Thereafter, irrigation should be applied carefully, because too much water given before the tree starts growing, may cause the roots to rot. Planting it with Acacias will help to reduce termite attacks. The trees should be white-washed to prevent sunburn damage. It is advisable to put a straw mulch around the base of the young tree for better moisture conservation and to protect the roots against high temperatures. After planting, the trees must be topped to encourage branching when it reaches the height of one metre. Pruning is important to pecan nuts. Summer pruning dwarfs a tree and will increase production considerably during the first 10 years.

Uses: The nuts of the pecan are edible and have a rich, buttery flavour. They can be eaten fresh or used in cooking, particularly in sweet desserts. The nut is rich in protein, vitamins, carbohydrates and oil. The wood of the pecan tree is used in making furniture, hardwood flooring and fire wood.

How to multiply: Seeds and grafting.

Citrus

Lemon, oranges, naartjies

Description: Citrus includes lemon, orange, grapefruit and naartjies. They are small evergreen trees, 3-6m high, with an erect grey-green stem and branches armed with strong straight thorns. The leaves are oval. The fruit resembles a tennis ball. While the orange and naartjies are sweet, the lemon is sour and grapefruits slightly bitter. The lemon is generally smaller, dryer and rougher, with a thick wrinkled yellow skin.

Habitat: Forest margins, kloofs in low rainfall areas.

Where to plant: Plant along the fence and in orchards.

Uses: Used in the treatment of asthma, liver complaints, TB, gout, rheumatism, nausea, indigestion, influenza, dry coughs and sore throats. Lemon juice has a high Vitamin C content, which helps slow down insulin reactions making it beneficial for diabetics and HIV positive people.

Lemon juice is used to treat excessive menstruation, hot flushes and uterine fibroids and as a douche for vaginal discharges. Excessive sexual drive is said to be reduced by taking lemon juice. The juice is used undiluted as an antiseptic for wounds, acne and fungal infections.

How to multiply: The plant is cultivated from root stock, seeds and grafts.

Dodonaea Angustifolia

Sand Olive (E) Fence (N/S)

Description: Shrub or small tree usually multi-stemmed, occurring in open areas associated with forest, bush, wooded grassland. Leaves are narrow and shiny and are a green above, paler green below. The sand olive's small greenish-yellow flowers occur in auxiliary or terminal groups.

Habitat: Dodonaea grows throughout South Africa especially in dry areas.

Where to plant: Plant it in zone 1 or zone 3. It is an excellent plant in the buffer zones.

Uses: Sand olive is used as a live fence and also medicinally for sore throats .

How to multiply: Seeds and young cuttings

Dovyalis Caffra

Kei apple (E) Motlhono (So) Umqokolo(X), Mutunu (V)

Description: The kei apple is a drought-resistant, spiny shrub. It has oval waxy light-green leaves and small cream-green flowers that are followed by a large rounded apricot-coloured fruit, rich in Vitamin C.

Habit: hot dry country, open bush and wooded grassland, rocky kopjes and the edges of dune forests.

Where to plant: Zone 3 in the buffer zones. It is a good plant for security fencing.

Uses: It can be used to attract bees, relieve nausea in pregnancy, and treat stomach problems and ulcers. The fruit can turn yellow when ripe and can be eaten raw or made into jam and juice.

How to multiply: Seed.

Leonotis Leonurus

Wild dagga (E); UmCwili? (Z) imVovo (X) Lebake (S)

Description: Wild dagga is an evergreen fast-growing shrub, which grows up to 2.5 m high. Its leaves are ovate and toothed. Its flowers occur in well-spaced spherical clusters. They are velvety, orange, 40-55mm long. The calyx is unevenly toothed, with the upper tooth larger.

Habitat: Rocky slopes and forest margins.

Where to plant: Good as a windbreak for small plants or vegetables. Grow in zone 1-3

Uses: Leonotis is drought-resistant and attracts bees. It has medicinal properties that help in the treatment of colds, flu, coughs, bronchitis, headaches, asthma, high blood pressure and snake bites. The leaf and stem make a strong tea to fight the diseases mentioned. Leaf teas can also be used to treat viral hepatitis, dysentery, and for removing tapeworm. Use a strong tea made from the leaf and stem and apply to skin to treat insect bites, stings, boils, eczema, itching and various other skin diseases.

Warning: Do not use it while on anti-retroviral therapy (ART) as it can interfere with the medication. Do not use during pregnancy since it can cause birth defects.

How to multiply: Seed and cuttings

Lessertia Microphylla, previously Sutherlandia Frutescens

Cancer bush (E), musapelo (S), unwele (Z)

Description: It is a perennial shrub that is either erect or sprawling and grows up to 1 m. The leaves are divided into many small oblong leaflets that are rounded at the tips. They are greyish green and usually thinly hairy above. Flowers occur in short racemes, bright red, and 20-40mm long. The pods are large and balloon-like with smooth papery walls.

Habitat: Widespread on a variety of soils but usually along roads and disturbed soils and in warm parts of the country.

Where to plant: Needs very little attention and grows in zone 1 or 2. Plant on swales or in a rockery.

Uses: Young stems are used for stomach problems, internal cancers (prevention and treatment), fever, poor appetite, indigestion, diabetes, colds, flu, cough, asthma, chronic bronchitis, kidney and liver conditions, rheumatism, heart failure, urinary tract infections, stress and anxiety. It is considered as an adaptogen (tonic plant) that has shown to be very good in improving the weight, appetite and well-being of HIV and AIDS patients. The plant leaves are excellent to make a tea for spraying pests such as aphids and caterpillars in the garden.

Warning: Do not use if on anti-retroviral therapy (ART) as it can interfere with the medication. Do not use during pregnancy since it can cause birth defects.

How to multiply: Sow seed in spring in well-drained soil. Can be grown from hardwood cuttings. It is frost tolerant.

Lippia Javanica

Fever tea (E) Umsuzwane (Z) Musukudu (Ts) Musuzugwane (V)

Description: A much-branched shrub with an erect stem, 1-2m high, with hairy leaves, strongly aromatic when crushed. The whole plant is roughly hairy, including the bracts from which short stalked spikes of small cream or white flowers emerge.

Habitat: Dry and wet areas, cold and hot areas, disturbed and virgin lands.

Where to plant: Grow it in zone 1-3 as a windbreak for small plants, excellent for stabilizing soil on contour ridges and swales. Plant it around chicken runs to repel pests like fleas.

Uses: It can be used as live fence, as well as for treating colds, headache, fever, bronchitis, chest complaints, rashes, malaria, digestive disorders and diarrhoea. The plant leaves are traditionally used to control livestock and crop pests such as fleas and aphids. Branches and leaves are crushed and sprinkled in chicken runs to repel fleas. Infused or brewed leaves make an excellent aromatic herbal tea.

How to multiply: Seeds and cuttings.

Macadamia Integrifolia

Macadamia, Queensland Nut (E).

Description: Macadamias are large, spreading evergreen trees reaching 15m high and almost as wide. More upright types are known and being selected because of their suitability for closer planting. The bark is rough but unfurrowed, brown and dark red when cut. The macadamia has proteoid roots and dense clusters of short lateral rootlets.

The adult leaves are long and thick with a single central spine. New leaves are pale green. In young trees four flushes may occur. Flowers are borne on long narrow racemes arising from the axils of leaves or the scars of fallen leaves. They may be borne on the new growth if it is mature, but more often on the two or three season's growth preceding the most recently matured flushes. Wind pollination may play some role, but bees are the major agent in pollination. Cross-pollination by hand has been shown to increase nut set and quality. Macadamia nuts have a very hard seed coat enclosed in a green husk that splits open as the nut matures. There are several Macadamia cultivars which include Beaumont, Cate, Elimah, Keaau and Vista.

Habitat: Macadamias will perform on a wide range of soil types from open sand soil to heavy clay soil, as long as the soil is well drained. They do best, however, in deep, rich soil. It is important to water macadamias regularly during dry periods. Pruning is recommended in autumn. Mature macadamia nuts will fall to the ground from late autumn to spring. It is best to harvest fallen nuts, since shaking the trees to dislodge the nuts may also bring down immature nuts. A long pole can be used to carefully knock down mature nuts that are out of reach.

Where to plant: Macadamias do best in full sun, although in hot climates partial shade can be beneficial. Windy locations should also be avoided. The brittle branches can be damaged by wind, especially when laden with a heavy crop of nuts. Protect macadamia from frost especially the young trees.

How to multiply: Seed and cuttings. However, seedlings may take 8 to 12 years to bear a crop and the quality of the nuts is unpredictable. Grafting is the most common method of producing nursery trees and is best done in spring or autumn.

Mangifera Indica

Mango (E) Manngo (V)

Description: It is an evergreen sub-tropical tree, with a spreading habit of growth, with fruits that vary in size and shape. Mangoes have many varieties which include but are not limited to the following:

Haden. Large yellow crimson fruit, oval in shape, fibreless, ripens in December and January.

Kent. Oval greenish-red fruits, fibreless, ripens in February and March.

Kidney. Large trees bear fibrous fruits, good for achar and chutney, ripens in January and February

Peach. Medium-sized fruits that ripen in November and December

Zill. Large dark crimson fruit, yellow-orange in colour, ripens in January and February

Habitat: They grow in light soils and in dry warm areas

Where to plant: The fruits are sweet and enjoyed fresh. Excellent tree in large gardens. It should be planted in zone 1 for beauty as well as for their fruit and shade. It is a good windbreaker for crops if planted in zone 3. In large gardens it can be planted with Acacia trees which repel nematodes. Other crops and vegetables cannot grow well underneath a fully grown mango tree.

Uses: Excellent shade tree when planted away from other trees. Ripe and unripe fruit can be used. The seed is used for treating heat stroke, gastro-intestinal complaints, blood, eye and women's disorders, to promote weight-loss, calm diarrhoea and treat diabetes and scorpion bites.

How to multiply: Seed and grafting.

Moringa Oleifera

Drum stick, Horseradish tree (E)

Description: A succulent small to middle-sized shrubby tree, growing up to 6m. Its leaves are alternate and compound.

The flowers are white. Fruit is pod-like with three sides, yellowish green, splitting into three valves. The seeds are winged. Grow it in marginal soil in full sun. It requires little water and is sensitive to frost. Established trees will die back in winter to grow up to 4 m in a year.

Habitat: Grows in dry areas in sandy soils. In South Africa it is commonly found in Mpumalanga Province.

Where to plant: Good alley plant, plant as a windbreaker in zone 3. Plant it in fodder strips, as it's good as animal feed, especially the leaves.

Uses: Excellent nutritious and medicinal plant. The leaf powder is used to stabilize blood pressure and blood sugar, increase urine flow, and as a remedy for diarrhoea, dysentery, colitis and gonorrhoea. It also increases milk production in women who are breast-feeding.

Flower powder is used to promote urination and bile flow and as a tonic. It is also used for treating chest and throat problems as well as for deworming.

Pods and seeds are excellent for liver and spleen and treating pain in the joints. Seed oil is taken for gout and rheumatism. Crushed seeds are used for de-worming.

Roots and bark are good for detoxification. The bulbous root can be grated and fried or pickled in vinegar. Gum infusions are used in treating fevers, dysentery, asthma, syphilis, rheumatism and for dental care.

Nutrition:

- Moringa leaf contains 7 times the vitamin C of oranges
- 4 times the calcium of milk
- 4 times vitamin A of carrots
- 3 times the potassium of bananas and 2 times the protein of yoghurt Moringa is a legume, it improves soil structure, provides animal fodder and bee forage

Warning: An overdose of moringa can cause abortion. Pregnant women should only eat the fresh or dried leaf in small quantities.

Propagation: Seeds or cuttings.

Musa Species

Banana (E) uBanana (Z), keBanana (So)

Description: It is a tropical herbaceous perennial plant which grows up to 2.5m. The trunk of a banana is called a pseudo stem. When it has borne a bunch of fruit and you have harvested the fruit, cut it down to just above ground level to allow the next sucker to grow and take its place

Habitat: Needs heat, moisture and humidity, temperatures above 20 degrees Celsius. Needs water throughout the year and grows well in loam soil.

Where to plant: Plant bananas in zone 1-3 at a distance of 4m apart. In zone 1, plant them closer to your house where they are fed by run-off water from the roof. It is ideal to make a pit-bed to catch run-off water from the buildings and plant bananas around it. Plant bananas in rows as a windbreak to protect smaller plants. Plant bananas with legumes

such as pigeon pea, Acacia trees and Tephrosia to control nematodes. You can also plant them with coffee trees, should you experience inadequate rainfall. Bananas need protection from strong winds and frost.

Uses: The banana fruit is high in Calcium, vitamin C and Phosphorus. It promotes healthy digestion and can be used to fight anaemia, arthritis, gout, allergies, kidney disorder, tuberculosis, overweight, burns, menstrual disorder and wounds. Juice from the banana stem and roots is used for urinary disorders. Banana leaves are excellent for compost and mulch as well as making fodder for rabbits and larger livestock.

How to multiply: Seed or suckers.

Olea Europea Subs Africana

Wild olive (E) Mohlware (So) umNqumo (Z) Motlware (Tsw) Mutwari (V) umNquma (X)

Description: Wild olive is a small to medium-sized evergreen tree with a dense rounded crown and greyish-green foliage. It grows up to 9m and has leaves that are narrow, opposite, oblong, green with whitish scales above, greyish below. The flowers are sweetly scented white or cream and the fruit purplish black. It is easily recognized by its irregular trunk.

Habitat: It occurs in a wide range of habitats usually in rocky hillsides or stream banks.

Where to plant: The tree can be planted as shade 4m away from the building in zone 1. Plant it as a windbreak or screen in zone 2-3. You can also plant it with Acacias, Carrissas and Dovyalis. In schools and other public places, you can plant it in parking lots to provide shade for cars. Plant with mangoes in an orchard at 4-6 m apart.

Uses: Historically the plant has been mentioned in the Bible for its miraculous uses. In the African culture, the plant is used for communicating with ancestors. In most cases, it is used as a shade, fence or windbreak. The durable wood can be used for making fence poles and spoons. Medicinally the leaf is used as eye lotion, lowers the blood pressure, improves kidney functioning and treats sore throats. Infusions of leaves produces a natural antibiotic, effective in lowering blood pressure, kidney performance and improving blood circulation to the hands and feet. The bark is used as a tonic, the infusion of the fresh bark is taken to relieve colic.

How to multiply: Seed or wood cuttings.

Persea Americana

Avocado (E), Afulchada (V)

Description: Avocado is a large evergreen tree up 10m tall. It is shallow-rooted and has spirally arranged leaves variable in shape and size. Flowers are yellowish. The fruits vary in shape from large and round to long and pear-shaped and in colour from light to dark green, reddish brown and almost black.

Some of the avocado varieties are:

Carton, which ripens in February and March
 Edrano, which ripens in August and September
 Fuerte, which ripens from April to August
 Hass, which ripens from September to November
 Itzamma, which ripens from October to December
 Nabal, which ripens from September to November
 Ryan, which ripens from November to January
 Shapless, which ripens in September and October

Habitat: They grow well in frost free areas.

Where to plant: Plant avocados in zone 1 for both shade and fruit. Plant it at least 6m away from the buildings. They can also be planted in the orchard and mixed with Acacia which is effective against nematodes.

Uses: High in fat, phosphorus, vitamin A and Calcium. Helps the digestive system, bad breath and for skin care.

How to multiply: Seed or grafting.

Portulacaria Afra

Elephant's foot (E), isiDandwane, isAmbilane, iNdibili, isiCococo (Z) iGqwanitsha (X) Tshitopitopi (V)

Description: Succulent shrub or small tree to 3m high. Leaves are opposite, fleshy, obviate. They are alternate, succulent and smooth with the midrib prominent beneath. Flowers in clusters at the branch tips, pink, 250mm diameter. The flowers are greenish and occur in dense, hanging sprays. The fruit ripens from August to September.

Habitat: It grows in bushveld, on rocky hillsides and hot dry valleys.

Where to plant: Plant it in zone 2 as a border plant and in dry areas of your garden.

Uses: Dry powdered leaves used traditionally as a snuff. A valuable fodder plant in dry areas,.

How to multiply: Seed, cuttings and truncheons.

Punica Granatum

Pomegranate (E)

Description: Pomegranate is a spiny, deciduous shrub or small tree of about 5m in height. It has small leaves clustered at the branch tips, attractive red flowers, fleshy fruit crowned with a persistent calyx and numerous seeds, each with a bright red, fleshy, edible layer.

Habitat: It grows in dry areas and in moderate cold areas.

Where to plant: Plant as a live fence in zone 3. If the plant is trimmed well, it creates a very aesthetic garden.

Uses: Root bark is traditionally used as a vermifuge to treat intestinal parasites, mainly tape worm. The dried fruit rind or the fruit pulp is a common remedy for upset stomachs and diarrhoea. Fruits are used to produce grenadine, a cordial, and the rind to tan leather. In traditional medicine, infusions or tinctures of the fresh or dried fruit rind are taken, usually with honey added to counter the bitter taste. Decoctions of the root bark with stem bark, (leaves or young fruit added) were widely used as a tapeworm remedy up to the first half of the twentieth century.

How to multiply: Cuttings.

Syzygium Cordatum

Water Berry (E) Montlho (N,S) Mutu (V) umDoni (Z) umJoni, umSwi (X) mmako (Tsw) Mukute (S) umDoni (Nd) Muthwa (Tso) Mutu (V)

Description: Medium-size evergreen tree that grows up to 15m to 20m. The stem is often crooked with dense, spreading rounded crown. Bark rough, pale to dark grey in mature trees, smooth and grey in young trees. Leaves occur opposite and in pairs at right angle. They are thick, leathery, smooth bluish green above and pale beneath. Masses of

showy creamy white to pink flowers appear before the rains. They are bisexual, cup-shaped with numerous stamens, giving a powder puff effect and they are very sweetly scented with plentiful nectar. The fruit is pear-shaped or oval growing in bunches and changing in colour from shining green to red, to deep purple when ripe. The fruit ripens in November to March.

Habitat: Near rivers, swamp areas or watercourses at medium to higher altitudes. It grows fast in sandy soils.

Where to plant: Do not plant the water berry tree close to a building and drive ways, as its aggressive root system may cause damage. In larger gardens plant in zone 1 for shade and shelter. Plant on contour ridges in zone 3. Also plant water berry in zone 3 to control erosion on stream banks.

Uses: The fruits are sweet and are enjoyed fresh. The fruit can be made into a fruit drink. The drink becomes alcoholic if the fruit is allowed to ferment for 3 to 4 days. With modern methods, a very good jam or jelly is made, adding equal quantities of brown sugar to the cooked fruit pulp or strained juice. An extract of the leaves is used to treat diarrhoea and general stomach complaints. An infusion of the burning branches is pleasantly aromatic and is sometimes used to season gourds. The flowers attract bees and other insects. The wood is durable for poles and furniture.

How to multiply: Seed.

Tephrosia Grandiflora

Puk bush pea (E), Hlozane (Z), Chitupa-tupa (Sh) THIS STANDS FOR SHONA

Description: Tephrosia is shrubby and hairy. Leaves up to 4cm long, stalks short, stipules very small, leaflets (3 to 5 pairs), distinctly stalked, up to 1,5cm long by 6mm wide, tip blunt, square or slightly notched, with small backward-turned point. Inflorescence lateral, short, with one or few rather large flowers. The pod is flat, usually carries five seeds and grows up to 3cm long by 8mm wide.

Habitat: Likes growing in well-drained soil with a fairly neutral pH between, 6 and 8 normally. Most soils and garden plants species fit this condition.

Where to plant: Beautiful plant for the focal point in zone1. Plant it as a hedge row or as windbreak for small plants. Rockery spaces have become very popular, especially around water gardening areas. Gardens with rocks aplenty will benefit from being planted with this shrub.

Uses: The flowers are beautiful. Plant it to prevent pests in the garden. Used as a spray to control a wide variety of pests in the garden. Windbreak for small plants or vegetables.

How to multiply. Seeds and cuttings

Warburgia Salutaris

Manaka, Mulanga (V) Shibaha (Tso) isiBaha (Z) Pepper bark (E)

Description: It is an evergreen tree which grows up to 20m in height. It has small greenish-yellow flowers that are produced between the shiny leaves which have a strong peppery smell.

Habitat: It grows in dry areas as well as in cold environments. It does not withstand frost and drought very well.

Where to plant: It can be grown as live fence for the shade or for beauty. This means it can be found in zones 1, 2 or 3. It likes plenty of water and could be planted in a swale or next to a mulch pit. It prefers well-drained soils.

Uses: The plant has numerous medicinal uses: The bark or roots treat coughs, flu, malaria, venereal diseases, headache

and toothache. The powder from the roots or bark is taken in cold water. It has also been used for the treatment of cancer, rheumatism and low libido. A weak tea is also useful in controlling oral candidiasis (thrush), though causes some short-lived irritation. The leaves can be used to make a spray for pests.

Warning: Warburgia should never be taken during pregnancy because it can result in an abortion. It has toxic properties and should be used carefully in small doses.

How to multiply: Seed or cuttings. It can be grown from seeds at the end of summer but good seed is hard to find as it is usually damaged by wasps.

Ziziphus Jujuba

Buffalo-thorn (E), Umphafa (X) umlahlankosi (Z) Mokgalo (S) Mukhalu (V)

Description: The tree grows up to 6m high, has sharp thorns mostly found on twigs. The flowers are green and the fruit is reddish.

Habitat: Grows well and fast in dry areas. This tree is rare and needs to be conserved.

Where to plant: Good for live fence and wind-break. Plant in zone 3.

Uses: Edible fruits. Parts of the plant are used for treating chest problems, boils, diarrhoea, dysentery, swellings and pain.

How to multiply: Seed.

Conclusion

This unit has helped you to learn about different types of trees, both indigenous and exotic, their value in agriculture, where you can grow them in your garden and the benefits you can derive from each tree or shrub. You should by now be in a position to develop wind breaks, live fence, alley cropping, agro-forestry and orchards.

Reflection points

- List five reasons for growing trees.
- What indigenous tree species grow on your land or in your environment?
- Find out from elderly people in your area what kind of trees they grew and what they were used for.
- Find out why some of them are no longer common or available.
- In your opinion what are the advantages of growing indigenous trees and shrubs in your garden?

Unit 7: Vegetables & edible crops

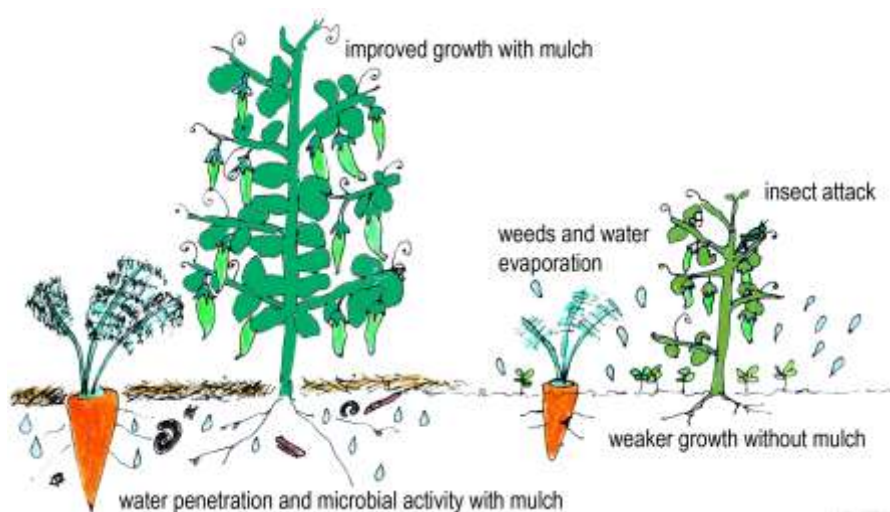
LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- Types of vegetables and crops
- How to grow vegetables and crops
- How to save the seed for multiplication
- The nutritional value of different types of vegetables

Introduction

This section gives general information on the types of vegetables and crops. It also describes how to grow vegetables and benefit from their many health-giving qualities. Vegetables form an important part of people's diets. They provide much-needed vitamins and minerals as well as roughage. Most of the vegetables that people rely on are annuals and must be grown on an on-going basis. This unit will discuss both indigenous and exotic vegetables. It will focus on those that have a high nutritional value and can be easily grown in South Africa. Root crops such as beetroot and carrot are also discussed. Legumes, whose seed are an important source of protein, are covered in this unit too.



Guidelines for growing selected crops

Amaranth

Cockscomb (E), poor man's Spinach, Prince's feather, Thepe (Z), Theepe (So), Teke, Guxe (Ts), Vowa (V), Mowa (Sh)

Description: Amaranth is a very nutritious leaf vegetable and is an annual plant, which grows up to 1m high. Some species of amaranth are tolerant of a wide range of soil conditions although light soil with organic matter is best. It is normally grown below an altitude of 800m. Rainfall requirements vary according to species and varieties. Other edible species of amaranth are: A graecizans with narrow leaves, A thun bergizil (S) bonongwe, which has tiny flowers and is common in deserted cattle pans in the rainy season and A Spinosa (E) spiny amaranth.

Cultivation: Dig the soil and add animal manure or compost. Leave the soil surface smooth and fine. Raised beds are useful for amaranth as they can be grown close together and are easier to reach for weeding.

Sow the seeds thinly and try to sow them approximately 15cm apart. Thin the seedlings to 20cm to 30cm apart. The seedlings can also be grown on nursery beds and transplanted when they are large enough to handle without damaging them. If you sow during a time of heavy rain, cover the beds with a grass mulch until the seeds germinate. You will need to water if amaranth is grown during the dry season.

Saving seed: Amaranth will cross-pollinate with other related species. You should isolate plants wherever possible. The seed matures 4 to 5 months after planting. In order to test if the seed is ready for harvesting, press the seed between your fingers and if it resists being crushed, it is ready. Cut or pull the plants and pile stalks (pyramid-shaped heaps) in the field to dry. Beat the heap with sticks and remove the chaff by winnowing in the wind. Store the seed in a dry place.

Nutritional value: Amaranth leaves are used as a relish and in stews, soups and salads. They are a good source of Vitamin A and C, protein, iron, fibre and foliate. Some varieties are grown for their grain which is very high in digestible protein with a good balance of amino acids, particularly when eaten with other cereals. The grain is also a useful source of amino acids, protein, iron, zinc and other minerals.

Beetroots (Beets)

Description: Beetroot has distinctive bright red coloured leaves, stem and root. When they are cut or bruised, they exude a deep red juice. Unlike parsnip and carrots, the bulk of the vegetable's swollen root sits on top of the ground so that you can watch its progress and easily determine when it is ready to harvest. Most of the seeds are made up of cluster seeds, which means that when they germinate they produce several seedlings close together.



Cultivation: Beetroot (beets) needs an open and sunny position. It will grow in heavy soils, but do best in light ones. The soil should be fertile but not freshly manured. Use a plot that was manured for the previous crop or one into which manure was dug during the previous autumn. Sow directly onto the open soil into shallow holes 1cm deep and set 20cm apart.

Storage: Beetroot (beets) can be left in the ground until they are required. In cold areas they can be lifted, cleaned and placed in trays of just-moist sand or peat moss. Store these trays in a cool, frost-free shed or garage.

Nutritional value: Beetroot promotes the production of white blood cells and helps to replace the foliates which are removed by some HIV medicines. The leaves are used as a relish and in stews, soups and salads. They are a good source of vitamin A and C, protein, iron, fibre and foliate.

Cabbage

Description: Cabbage comes in various forms harvested at different times of the year. Most cabbages have white leaves forming the bud of the head. There are also red cabbages.



Cultivation: Cabbages need an open and sunny position. They will grow in heavy soils, well fertilized with organic matter. Transplant the seedlings when they reach 8cm to 10cm high. Plant the seedlings in rows 40cm apart with plants 60cm apart within the rows. Make sure the bed is mulched with organic matter to keep the root temperatures as constant as possible. Rotation with other crop types is necessary to avoid the build-up of diseases in the soil.

Storage: Most cabbages are winter hardy and can be left in the beds until required. Those with solid heads can be cut and stored in a cool place, where they will keep for a couple of months. Some varieties of red cabbages may not be as

hardy and can be harvested in early winter and stored.

Nutritional value: Cabbage is used in stews and soups as a salad. Cabbage is a good source of vitamin A and C.

Carrots

Description: The edible part of the carrot is the root, below ground. You may wonder if it is worth growing carrots when they are so cheap to buy. The answer must be an emphatic yes. Fresh carrots, whether old or young, that are taken straight from the ground and eaten raw taste better than shop-bought ones. There is no comparison.

Cultivation: Choose an open and sunny position. Carrots will grow in heavier soils, but they do best in light, sandy soil. The soil should be free from stones and fresh manure, because both will cause the carrots to fork. If the soil is stony, make individual holes with a crowbar, fill them with compost and sow into these. Sow very thinly in drills 1cm deep and set 15 to 20cm apart. When the seedlings appear, thin the earliest to 8cm apart and the main crop to 5-8cm apart, depending on the size of the carrot required. Mulch the bed with organic matter and make sure you do not cover the seedlings in the process. Plant carrots and onions in same bed to repel the carrot-fly.

Storage: Carrots are usually left in the ground until they are required. They can be left in the ground over winter unless there are a lot of slugs or the winter is very harsh. Alternatively, they can be lifted, cleaned and placed in a tray of just-moist sand or peat.

Nutritional value: Use carrots as vegetables in stews, soups as well as eating them raw. They are a good source of vitamin A.



Eggplant (aubergines)

Description: The eggplant is also known as garden egg. The plant height ranges between 30cm to 1.5m. The fruits vary in colour and size and can be up to 15cm long and are often egg-shaped. Aubergines are grown as annuals. They grow best with high temperature. They prefer well-drained soils with reasonable organic matter content. They need to be watered during the dry periods. Too much rainfall will negatively affect flower formation.

Cultivation: Dig the soil to at least 25cm and add organic matter in the form of animal manure or compost before planting. Prepare a good fine seed bed. Raised beds are ideal for the final planting position.

Soak the seeds in water for 24 hours and sow the seeds just below the soil surface (in containers or nursery beds), 4cm to 10cm apart. Transplant the seedlings when they reach 8cm to 10cm high. Plant the seedlings in rows 80cm apart with plants 60cm apart within the rows. Aubergines can be grown in wet or dry climates and should be watered during dry periods. Make sure the bed is mulched with organic matter to keep the root temperatures as constant as possible. Aubergines do not store for long periods and are best eaten within 1 or 2 weeks from harvest.

Saving seed: Choose plants which crop well and appear resistant to disease. Allow the fruit to mature beyond the edible stage. Cut the fruit and crush the flesh to a pulp. Put the pulp into water and mix. Select only the heavy seeds, which are the ones which sink to the bottom. Wash these seeds and spread in a thin layer on paper to dry thoroughly in the breeze. Store the seed in an airtight container and cool place.

Nutritional value: Aubergine fruits are tasty and are widely used for stews and relishes. The leaves of some species are also eaten in this way or boiled on their own. The leaves supply some vitamin C and A. The fruits are rich in vitamin A.



Lettuce

Description: Lettuce is used for decorative purpose as well as for taste and nutrition. They grow relatively quickly and will be ready from 3 to 12 weeks after sowing. This means that they can be grown among slower growing crops or used to replace another crop that has already been harvested. You can mix lettuce with other crops because it is a light feeder.



Cultivation: Lettuces need an open and sunny position although light, partial shade during the heat of the day can be an advantage in hot areas or during hot summers. The soil needs to be fertile and retain water well, which can be achieved by incorporating plenty of compost during land preparation. Lettuces can be sown directly in to the ground or grown in trays and transplanted. Sow in shallow holes 1cm deep in rows which are 30cm apart. Thin the lettuces to 15 to 30cm apart depending on the variety. Transplanted lettuces should be planted at the same distances.

Storage: Whole lettuces can be kept in a refrigerator for a short time but they are best used straight from the garden.

Nutritional value: Leaves are used as salads. They are a good source of vitamin A and C, protein, iron and fibre.

Onion

Description: A bulbous perennial with hollow green leaves arising from a bulb formed by dense layers of fleshy leaf base. The hollow flowering stem bears a rounded cluster of white or purple flowers. It is widely cultivated as an important culinary herb and vegetable.

Cultivation: Onions grow well in winter in sandy or loamy soils. Plant the onion seeds in beds and thin them as they grow. Plant onions 7 to 10cm apart in a raised bed. Reduce watering when bulbs are produced. Mix onions with brassicas and salad crops, since they help to repel pests.



Nutritional value and uses: Onion helps improve appetite loss, assists in blood formation and boosts the immune system. Traditionally it is used for the treatment of dysentery, wounds, scars, asthma, and diabetes, amongst many other traditional uses. The juice of onion, extracted with sugar, is a very soothing cough remedy.

Peas

Description: Peas grow to 60cm or more and have to be supported with pea-sticks. Modern varieties are generally quite short and can be easily supported with low wire netting or even a couple of strings stretching horizontally. Some varieties need no support at all. Intercrop peas with maize, which benefits from the nitrogen, and provides a natural support for taller varieties.

Cultivation: Peas like an open and sunny site. The soil should be fertile, with manure or compost incorporated during the previous autumn. The best way to sow peas is to pull out a flat-bottomed trench with a hoe, with roughly the following measurements: 15cm wide, 20cm long and 5cm deep. The peas are then sown in pairs.

Storage: Peas are best picked straight from the plant, although they can be frozen, so that they are available throughout the year. They can also be preserved by drying.

Nutritional value: Mangetout (snow) peas, and sugar snaps, can be eaten whole when the peas are still immature. Snap peas also have edible pods but can be eaten when they are more mature. Peas are a good source of protein and calories and B-vitamins, including foliate. Dried peas provide an excellent source of protein.

Potatoes or Irish Potatoes

Description: They are grown as an annual crop. They have underground tubers which are eaten as a staple food in many areas. Potatoes need a well-drained, fertile, deep soil that is slightly acidic. High temperatures may slow the growth of tubers. You will need to water the plants if there is no rain while the tubers are swelling.

Cultivation: Dig the soil deep, up to 25cm and add animal manure or compost. Dig trenches 15cm, 60cm apart. Tubers, known as seed potatoes, are used as the planting material. Use the whole tuber or part of a tuber which has at least two or more buds or eyes. Place seed tubers in a box, with most eyes pointing upwards, 2 weeks before planting. The shoots will begin to grow from the eyes. Plant the sprouted tubers, with the shoots pointing upwards, 25cm apart in the trenches and lightly cover with soil. Water if there is no rain. It is best to plant the sprouted tubers at the beginning of the rains. Frost will kill the sprouting shoots, so you should be sure to wait until frosts are over before planting your potatoes.

When the shoots are 15cm to 20cm high, fill the trenches, but do not compact the soil. You can earth up the plants by pushing soil upwards to the stems with a hoe. This will keep the tubers covered and also support the plant's water during dry periods. Tyre potato production is the easiest method. By adding a tyre and soil when a shoot appears, you will soon have a tower of tyres, full of potatoes.

Nutritional value: Potatoes are a staple which are usually used fresh and boiled, baked, roasted or fried. They are sometimes added to soup and stew. They are a good source of calories and starch, contain some protein (which is of better quality than the protein of cassava and yams) and B-vitamins. They are a useful source of vitamin C if large amounts are eaten, but this vitamin can be lost during storage or overcooking.

Pumpkin

Description: Also known as squash-gourd, the pumpkin produces a large fruit on a vine which grows along the ground. They are grown as annual crops. They tolerate a wide range of well-drained soils with high organic matter content and pH of 5.5 to 7.5, but need daytime temperatures over 25 degrees Celsius. They grow better in low rainfall areas or during the dry season when crops are watered by hand.

Squash plants are bushes. Generally, male flowers appear first, but in a few hybrids, female flowers appear first and will fail to set fruit if a source of pollen is absent. Fruits are harvested immature and have a short storage life.

Gourds are grown for their outer shell or fibre rather than for food. Although there are a number of different species referred to as gourds, they are easily distinguished from each other, unlike pumpkins and squashes. Most of these are currently grown as ornamentals or novelties.

Cultivation: Prepare soil by adding manure or compost. The seeds can be sown directly or raised in containers and transplanted. Prepare ridges or raised beds and sow the seeds directly in rows 20cm apart with 60cm to 100cm between the plants. It is best to sow in the dry season, before the beginning of the rain season. Sow 2 seeds per planting hole, 2cm deep. Germination usually takes 5 to 6 days. Remove the weaker seedling, leaving one strong seedling per planting hole. Seeds sown in containers should be transplanted when they reach 8cm to 10cm. Water regularly if it is hot and dry. Mulch the soil so that it can hold water. While the fruit is developing, raise the pumpkin off the ground on a bed of grass or straw to protect it from soil insects.

Storage: It will store for a short time if kept cool and well aerated.

Saving seed: Pumpkins produce flowers which are very attractive to bees and other insects. Pollination is carried out by bees. If you want the pumpkin to produce seeds of the same variety as the one you are growing, then it is important that there are no other gourd or squash plants of another variety close by. If there are other gourd or squash plants close by, then the pumpkin will still be pollinated but it may produce a fruit with different characteristics. Harvest the fruits once they are mature. The fruit stalk will begin to shrivel and the skin of the fruit will

be hard. After you have opened the fruit, remove the seeds and clean them in a bowl of water. Dry the seeds on a flat surface. Store the seed in a cool, dry place.

Nutritional value: Mature pumpkin fruit is boiled or baked and used in relishes. Leaves and immature fruits are used as a vegetable in stews. The seeds are eaten as snacks or made into flour and added to relishes, soups and stews. The seeds are rich in protein and oil and are high in zinc, which boosts the immune system, and are extremely high in magnesium for the joints and nerve endings. Eating pumpkin seeds helps to get rid of intestinal worms. The fruit is a useful source of Vitamin A. The more dark yellow the flesh, the more vitamin A it contains. The leaves are rich in vitamin A and usually contain more protein than the fruit.

Soya bean

Description: They are a widely grown crop and the beans are often processed into more digestible foods such as bean curd. There are many different varieties of soya bean. It is therefore best to find a variety that is most suited to local cultural and ecological conditions. The soil should be deep, well-drained and fertile and have a high water retention capacity.

Cultivation: Dig the soil thoroughly only if it was not well-prepared for the previous crop. A dressing of manure or compost will help the early crop growth. Dry the seed in shade before sowing. You can also apply soil from a field, which has recently grown soya bean at a rate of one handful of soil per square metre in order to encourage the early establishment of beneficial relationships.

Sow the seeds at a rate of 40g to 60g per 10 square metre, just when the rains have become well established. Soya beans should be sown in rows that are 60cm to 90cm apart with seeds about 5cm apart within rows. The seeds should be sown between 3cm and 4cm deep.

Saving seed: Soya beans, like other bean crops, will readily cross with other related plants if they are grown in closely together. It is best to select plants where no risk of crossing will occur in order to obtain good seed. Identify good plants which are resistant to disease and produce a heavy crop at the right time. Select pods and save them separately from the rest of the crop. Remove the seeds from the pods and dry and clean them thoroughly.

Nutritional Value: Soya beans must be thoroughly cooked or processed to remove the bitter taste and anti-nutrients which reduce digestibility. It can be cooked or roasted and ground to flour and used for porridge and in relishes and stews. Soya bean products can also be fermented to make a variety of products such as sauces and pastes. Immature bean pods and germinated beans are used as a vegetable for salads and cooked dishes.

Whole soya beans are a good source of protein and foliate. The bean shoots provide vitamin C. The oil from soya bean is rich in calories and help guard against muscle wasting.

Spinach and Swiss Chard

Description: Spinach and chard are related to the beetroot and not to the cabbages and lettuces, to which they bear a superficial resemblance. They are plants for a cool climate. The plants look rather like a loose lettuce, with stalked leaves rising from a central stem.

Cultivation: Grow spinach in an open, sunny position but where it does not get very hot. The soil should be fertile and contain as much organic material as possible for moisture retention. Water-logged soils should be avoided. Sow the seed thinly in early spring, with succession sowing at two-week intervals through to late spring. Sow in shallow holes, about 1cm deep and 30cm apart. As soon as the seedlings are big enough to handle, thin them out to 15cm apart. Keep them well-watered and remove weeds. If well-fed and watered you can harvest spinach leaves through out the year.

Storage: Spinach should be picked and used as fresh as possible because it does not store easily. The leaves can,

however, be frozen.

Nutritional value: Leaves are used as a relish and in stews, soups and salads. They are a good source of vitamin A and C, protein, iron, fibre and foliate. High levels of calcium in spinach and other dark green, leafy vegetables act as a natural anti-depressant.

Sweet and hot pepper (capsicums)

Description: Also known as bell pepper, capsicums grow as an annual plant to between 30cm and 1.5m tall. They are related to chillies and the many other types of peppers, all with similar planting and growing needs. Capsicums need well-drained, fertile soil with a little organic matter. They can be grown as a rain-fed crop as long as there is no water logging. Hot pepper will tolerate higher temperatures than sweet pepper.

Cultivation: Dig the soil and add organic matter in the form of animal manure or compost to the soil before planting. Sow the seeds just below the soil surface, in containers or nursery beds, 4cm to 10cm apart. Plant the seedlings to a spacing of 50cm apart when they reach 8cm to 10cm high, preferably at the end of the dry season or the beginning of the wet season. Water during dry periods. Rotation with other crop types is necessary to avoid the build-up of diseases such as bacterial wilt and viruses in the soil. Control weeds at all times.

Storage: Sweet peppers can be eaten fresh or sun-dried. To dry, cut the larger fleshy peppers down one side and remove the seeds. Lay them out or string them up in a clean, dry, sunny spot.

Seed saving: Capsicums are pollinated easily with pollen from other capsicum varieties. If you want to collect seed of the same variety as the one you are growing, you will need to plant the seed plants some distance away from capsicums of another variety. Allow the fruit to ripen fully and remove the seeds.

Nutritional value: Sweet pepper fruit is used in relish, soup and stews and for salads. Chilli pepper is used for flavouring. They are a good source of vitamins A and C.

Tomatoes

Description: Tomatoes are probably the most widely grown vegetable. Even people without a garden often manage to grow a plant or two on a balcony. One reason for this is that tomatoes are relatively easy to grow.

Tomatoes can either be grown on cordons (upright plant) or as bushes. It is well worth not only growing your own particular favourite varieties each year, but also experimenting with at least one new one. Tomatoes are used widely both in raw and cooked dishes. They can even be used in their unripened state. Tomatoes are half-hardy and can be grown under glass or outside. Earlier and later crops, as well as heavier ones, are obtained under glass, but outside crops often taste better, particularly if the summer has been hot and the fruit has ripened well.

Cultivation: Grow tomatoes in an open, sunny position and a fertile soil, with good compost. Create ridges and plant tomatoes on the ridges and mulch with half composted organic matter. Do not use mulch from old tomato stalks for they may bring diseases and pests into the field. Sow in mid-spring, plant out in early summer. Plant about 45cm apart, in 75cm rows. In frost free areas grow tomatoes throughout the year. You can also grow tomatoes throughout the year if you have a greenhouse. Cherry tomatoes are easy to grow along the boundaries of your garden or within hedge rows. Water tomatoes at the roots and avoid putting water on the leaves. All tomatoes will need staking. Support the plant with sticks and strings so that the ripening tomatoes don't rest on the soil. Remove the side shoots of the tomato plant (those which form in the 'V' between two branches). Bush forms are treated in the same way, except that there is no need to remove the side shoots.

Storage: Tomatoes are best eaten straight from the plants, although they will keep for a few days. They can be dried or frozen, but then used only in cooked dishes as they lose their firmness. Tomatoes can be made into relishes, sauces and jams.

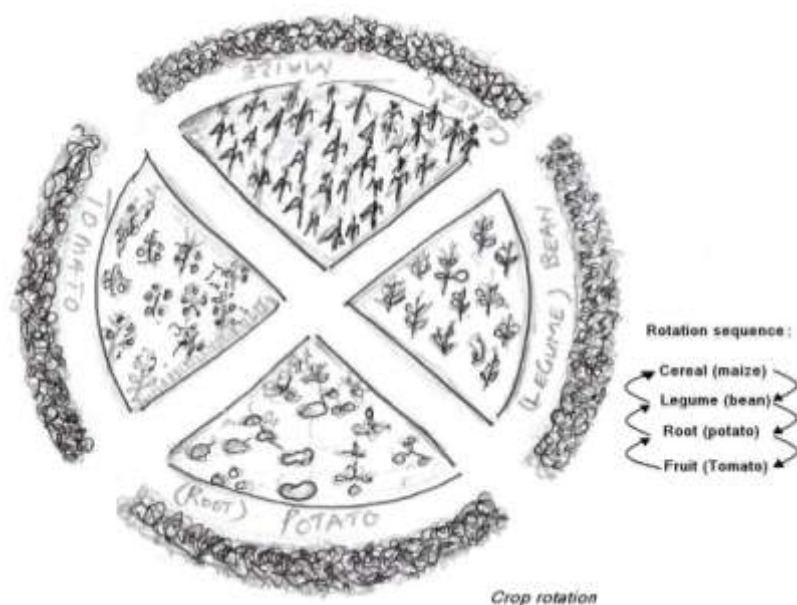
Nutritional value: Tomatoes are used widely both in raw and cooked dishes. They can even be used in their unripe state. Tomatoes are more nutritious if they are eaten fresh (uncooked), although when reduced by cooking slowly for a long time, tomato sauce provides lycopene, which is a powerful anti-cancer agent. Tomatoes are used in relishes, soups, stews, salads, on sandwiches and is high in vitamin C and A.

Growing root crops in general

Root vegetables can be planted directly into your garden beds.

The process:

- When your beds are ready, make small furrows or grooves in the soil using a stick
- Construct the furrows about 15cm apart and 2cm deep
- Plant the seeds about 1cm apart in each furrow and then cover them with about 1cm of soil
- Water the seeds gently once or twice a day
- After about four weeks you will need to thin the seedlings out to 2cm apart, so that the plants have enough space to grow. If the plants are too close together, they compete for nutrients, which results in weak, unhealthy plants
- You can replant the beetroot and turnip seedlings from the thinnings that you take out. Carrots are generally not transplanted.



Conclusion

In this chapter we have learned about the different types of vegetables. We discussed how to grow and manage these vegetables. Suffice to say that vegetables are an integral part of Permaculture. By now, you should be able to describe the conditions that are ideal for growing the vegetables discussed.

Reflection points

- Why would you grow vegetables in your garden?
- What indigenous vegetable varieties grow on your land or in your environment?
- How have other producers in your area managed and saved seed from leafy vegetables and root crops?

Unit 8: Herbs & medicinal plants

LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- Types of herbs
- Gardening with herbs
- Using herbs for nutrition and for medicinal purposes
- Different ways of preparing and storing herbs for various uses
- Growing healthy herbs

Introduction

The word herb means green plant. Herbs are essential plants with a specific use and have been cultivated since we ceased to be nomadic people.

Herbs require different types of places to grow. Some prefer to be in full sun, others in semi-shade, while others will prefer complete shade. Similarly, different herbs grow in an array of different soils: rich compost, moist and organic, well drained, acid and alkaline. You will need to know every herb's special preferences if you want to harvest their priceless health and beauty ingredients.



Main Uses for Herbs

- Culinary or kitchen herbs
- Nutritional
- Medicinal herbs
- Scented herbs
- Herbal teas
- Insect repelling

Types of herbs

Annual herbs

Those plants that will complete their growth cycle within one season or year. These are usually seed sown plants. Basil is an example.

Perennial Herbs

These are usually herbs that will grow for a few seasons. They are often ground covers and small bushes. They can be grown by seeds or cuttings. Examples include: lavender, rosemary, cleveland sage, dianthus, mint, peppermint, rose, wild rose, citronella, camphor, fennel and evening primrose.

Shrub and tree herbs

These are longer lasting plants that can grow for many years. They are grown from either cuttings or seed. Examples include: lemon verbena, roses, scented geraniums and bay tree. It is very important to know what each herb plant and its expected life span is if you are to consider planting it in the landscape.

Considerations for Herb Garden site

Like with all gardens, you will be rewarded later if you first consider climatic factors carefully when choosing a site and design for your new herb garden.

Climatic and Microclimatic Factors

- Rainfall patterns
- Temperature ranges
- Humidity levels
- Wind speed and direction
- The impact the sun will have on the site
- Is the site subject to severe frost?
- Are there any large trees or buildings that will create a shadow?
- Is the site subjected to strong winds?

Topographical Factors

- Is the site level or on a slope?
- Will you need to “cut and fill” or terrace the slope?
- Will run-off water create problems?
- Aspect: the direction in which the slope is facing in relation to the sun.
- What views to design with or against?

Existing Vegetation

- Are there any trees, shrubs or other plants that can be used as part of the design?
- What types of plants are on the site?

Use of the Herb Garden

- Is the herb for decorative value only?
- Is it to have a specific function, for example, is it culinary or medicinal?

The use factor will determine what kind of design to follow, as it should be comfortable to harvest the herbs.

Some guidelines for design with herbs

The herb garden should be in harmony with the site and could be either a formal layout or a more natural, informal design that includes the elements of good landscape design.

Growing and Landscaping with Herbs:

Gardeners the world over have taken pride in their gardens for many centuries, taking care to balance form, colour and fragrance. In addition to the many health benefits, the psychological impact of gardening has been found to be beneficial for those recovering from trauma or illness – providing a calm space in which to commune with nature, and to nurture that which is within our control.

While herbs may be grown for specific uses in terms of herbal application, they are also decorative. With a bit of imagination one can also improve the overall look of the garden by ensuring good colour distribution. In a formal herb garden, repeating strong, primary in the same section of each part of the design will create visual balance and rhythm. Secondary colours and softer herbs can be used to link up the brighter colours and provide unity. In a more natural garden the bright primary colours can be used to create a focal point.

Designing gardens with herbs for colour harmony

Colour	Herb
Grey	Lavender, Cleveland Sage, Cotton Lavender, Lambs Ear, Wormwood and Mugwort.
Pink	Perennial basil, woolly sage, bressingham thyme, wild rose geraniums, roses and bergamot.
Yellow	Tansy, rue, Jerusalem artichoke, golden creeping oreganum, golden feverfew and golden celery.

Purple	Lavender flowers, Chives, Wild Garlic, Forget-Me-Not and Violas.
Blue	Rosemary, Comfrey, Catnip, Borage, Canary Lavender flowers and Ajuga.
White	Yarrow, Garlic Chives, Chamomile, White Thyme, Pyrethrum, Chervil, Angelica and Elderberry.
Green	Pineapple Sage, Roses, Bergamot, Poppies and Nasturtiums.
Red	Mints and Thymes.

Types of herbs

Basil

This is a small group of famous herbs of the mint family, Labiatae, that not only originate in Mediterranean Europe, but to a great extent in Africa and Asia. They are mostly very aromatic, used for flavouring and scent, and are often used as mosquito repellents.

All plants from the Labiatae family have anti-bacterial properties, and can be used effectively as antiseptics. These are effective anti-bacterials, and when boiled with water can be used to wash surfaces to improve food and home hygiene.

The most widely grown in South Africa is sweet basil. Pot basil, a smaller plant, and lemon basil are less common. There is a medicinally invaluable species of basil from the East called 'sacred' or 'holy' basil which is also not yet common in South Africa.

Sweet basil has many branches, is shiny and has a pungent smell. It is an annual (occasionally perennial), with green or purple leaves and small white to purplish flowers in rings. It is used as a culinary herb and combines well with tomato dishes. It is also used as a sedative tea for headaches or tension. In India, the leaf juice is used for treating ringworm, earache and deafness. An infusion treats gonorrhoea, diarrhoea and dysentery. It is reputed to be an aphrodisiac.

Borage

Borage is a robust annual plant which grows up to 1m high with thick prickly stems. It has big, broad and rough hairy leaves. Starry flowers are, at first, pinkish, then turn true blue, with shiny black anthers at their hearts. The leaves and flowers are edible with excellent health benefits. The flowers are used in salads and fruit cups. The leaves can be added to a steam bath for inhalation. Lightly boiled leaves can be used as a soothing poultice that helps with sunburn and insect bites. Made into a tea, borage has, for many years, been used as an anti-depressant and to treat fevers, chest colds and stomach upsets. For hay fever, put flowers in hot water, then hold to the face, inhaling the favours. Cultivation is done from the seed.

Castor oil plant

The castor oil plant originated in India and other tropical countries. It is now common in South Africa and has become a weed. The shrub is upright and grows up to 4m high with handsome lobed leaves and spiny capsules holding large spotted poisonous seeds. The leaves are used as dressings for wounds and sores, to draw boils and relieve headaches and rheumatism. They are used externally.

Chives

Chives originated in Europe. They are perennial and make dense tufts of grassy, delicately onion-flavoured, tubular leaves, usually up to 25cm high. The flowers are purplish and occur in closely packed heads. Chives are used for

flavouring dishes and for salads. Cultivation is achieved through both seed and bulb. The plant dies down in winter.

Note: Leaves should be cut as needed at about 5cm from the ground. Chives are often confused with onions, as they are part of the same family, and can look similar yet are smaller. If in doubt as to the identity of one of these plants, look at the bulb to see if it is single or makes a clump. If it is a single bulb, it is an onion.

Coriander

Coriander originated in Southern Europe. It is a smallish delicate annual which grows up to 60cm high. The lower leaves have broad jagged segments, the upper are threadlike. It bears small flowers in white or pinkish umbels. The fruits are roundish and unpleasantly scented when fresh. Both the fresh leaves and the seeds of coriander are widely used flavouring. It is cultivated from seed.

Fennel

Fennel originated in Southern Europe. It is a tall perennial with a hearty taproot and much divided, blue-green leaves with threadlike segments. It has a sweet penetrating aniseed scent and flavour. The small flowers grow in flat golden umbels, and the seeds are oval and ribbed. It is used in salads and can be taken as a tea to treat asthma. The seeds are used for flavouring and for treating diarrhoea, stomach-ache and flatulence (once much used at the Cape). It is said to reduce appetite and aid slimming. Florence fennel has swollen and edible stalk bases and edible foliage. It grows from seed.

Lavender

Most lavender plants are native to Southern Europe. They have narrow smooth-edged leaves with small, fragrant flowers growing in rings about the stalks. As well as being an anti-bacterial, they have a delicious scent which is calming and soothing. Lavender oil is used for minor burns and skin complaints. Outwardly applied, it relieves toothache, neuralgia, sprains, and rheumatism. And has a calming affect is rubbed on the temples. A tea brewed from lavender tops, made in moderate strength, is excellent to relieve headache, fatigue and exhaustion. They are propagated from cuttings.

Marjoram

Marjoram is considered to be the romantic plant of the Labiatae family, native to the hills of Mediterranean countries. Several varieties are common in herb gardens. Sweet marjoram is a small shrubby plant, perennial in warm climates, with smallish, very fragrant, grey or green leaves and round clusters or knots of white or purple flowers. The herb is used for flavouring as well as for treating stomach troubles, colds and coughs. Make tea, add to salads, make spice, or cook with majoram leaves. It is grown from the seed, cuttings or root divisions.

Nasturtium

Nasturtium is native to South America. It is somewhat succulent and usually a trailing plant with long-stalked, roundish, flat leaves and fairly big yellow, orange or red spurred flowers. All parts are spicy-tasting. The leaves, buds and flowers are used in salads and to flavour vinegar. It is eaten for its antiseptic effect, and is very high in vitamin C. It is cultivated from seed.

Parsley

Parsley may have originally been found in Southern Europe. It is usually a biennial with many divided curly leaves. The leaves and stalks are strongly and pleasantly flavoured, making it one of the most popular of all kitchen herbs. The leaves as used to flavour cooked and raw foods. The roots are eaten as vegetables, raw or cooked. All parts are rich in vitamins A, B and C, iron and other minerals. It is chewed to destroy a strong garlic breath. It is cultivated from seed.

Rosemary

Rosemary occurs naturally in Mediterranean countries. It is an evergreen perennial shrub up to 1.8 m tall, with small simple, narrow opposite leaves that are leathery and very aromatic. They are smooth and dark green above, hairy white below. It has blue flowers in the axils of the leaves. It is used in cooked foods, salads, in cosmetics and medicines. It is an extremely effective anti-bacterial, and when boiled with water can be used to wash surfaces to improve food and home hygiene. Rosemary tea is a general tonic and pick-me-up and stimulates body and skin. Crushed up, the fragrance is said to wake you up and aid concentration and memory, and “comforts the brain”. If eyes are dim from overwork or strain, eat the flowers. It is cultivated from cuttings.

Rue

Rue is indigenous to Southern Europe. It is a small, strong-smelling, blue-green shrub with deeply divided leaves and yellow flowers. It is now so common in South Africa that it is treated as a weed. The leaf is used for the treatment of scarlet and typhoid fever and the juice for convulsions and fits, toothache and earache. It is sometimes used as an infusion for the heart, but this can be dangerous and is therefore not recommended. Cultivation is from seed and cuttings.

Sage or salvia

The sage group of plants also belong to the Labiatae family and occurs in many different parts of the world. In South Africa, there are 22 native species. Sages are used for flavouring, perfume and medicine. It is taken as a health-giving tea, for ailments of the liver, coughs, fever and also as an antiseptic. It is a powerful immune stimulant and a study in Germany showed that drinking sage infusion on an empty stomach reduced blood sugar levels in diabetic patients. They are grown from seed and cuttings.

Thyme

There are a number of species in Europe and Asia, of which the common and wild thymes are best known. There are also a number of hybrids and forms which are sometimes flavoured like lemon and sometimes variegated. None are indigenous to South Africa, although they have been cultivated here for a long time. The common or garden thyme originated from Western Mediterranean countries and is now widely cultivated. It is a small upright, woody plant with tiny grey-green leaves and small white to lilac flowers. It is used for flavouring, in salads and as a tea. It has a high thymol content and is used as an antiseptic, for respiratory, stomach and digestive ailments and also and also helps prevent parasitic worms. Cultivation is from seed or cuttings, by layering or by root division.

Preparing and using herbs and medicinal plants

Medicinal plants and herbs are prepared using different methods.

Harvesting and storing herbs

- Select the variety of herbs you like for use
- Harvest with scissors or secateurs
- Dry leaves and flowers thoroughly in brown paper bags
- When sufficiently dried, grind and mix together and store in dark, airtight bottles

Herbal Bath

The fragrance of herbs in warm water is relaxing and soothing. Add a few springs of lavender or chamomile flowers to a bath to soothe a variety of skin irritations. When treating hives, a rash, or sunburn, make the infusion a stronger.

Get to know your herbs and their effects on the human body before following these methods. Always take care during pregnancy, as some herbs are very potent.

Preparing medicinal plants for a bath: (Get to know your herbs and their effects on the human body before following these methods. To make a medicinal bath tea, bring water to a boil. Turn the heat down to the lowest setting. Add the herbs (fresh or dried) and let it steep for 30 to 45 minutes. Strain the bath tea into your bath water through a piece of thin, soft, clean cloth. Bundle up the cloth so that you can use it as a herbal scrub while you bath, or hold it on a troubled area as a poultice.

Make a vinegar infusion for a bath that will soothe itchy skin, relax aching muscles and soften skin: Bring 570ml apple cider vinegar and a handful of fresh bath herbs slowly to the boil, then infuse overnight. Strain and store in a bottle for future use. Add a cupful (225ml) of the mixture to the bath.

Facial steams

To perform a facial steam, bring water to a boil in a large pot. Toss in a handful of herbs, cover and let simmer for a couple of minutes. Remove the pot from the heat and place it on a heat-proof surface at a level that will enable you to comfortably sit and place your face over the pot. Leaning over the pot, drape a large, thick towel over your head and the pot, capturing the steaming herb water. It will get very hot under the towel. To regulate the heat, raise or lower your head or lift a corner of the towel to let in some cool air. Steam for 5 to 8 minutes.

Steam for dry to normal skin:

- 3 parts comfrey leaf
- 2 parts calendula
- 2 parts chamomile
- 1 part lavender
- 1 part aloe ferox

Combine the herbs, adjusting the amounts to suit your skin type. Store the mixture in an airtight glass bottle.



Fennel face cleaner

This fresh mixture made from fennel seed, buttermilk and honey is a lovely way to cleanse the face naturally.

Crush or chop 1 tablespoon of fennel seed and then pour 1 cup of boiling water over it. Let it stand for about half an hour and then strain into a small bowl. Add 2 tablespoons of buttermilk and 1 teaspoon of honey to the fennel seed water and mix it all together. Pour the resulting mixture into a clean container and refrigerate. The cleanser can be taken from the fridge as needed. Fresh fennel leaves and other herbs can be added to make the infused water.

Herbs for the skin

- Borage: It is good for dry skin and for sensitive skin.
- Aloe Vera: The jelly-like juice from the leaf is excellent for sunburn relief and minor burns. It can be applied for a wide range of skin conditions such as eczema, rashes and wounds.



- **Calendula:** An infusion of calendula flower added to a salve heals chapped, burned, irritated or wounded skin. It is good for all skin types, including baby skin. The flowers also makes a wonderful infused oil. Calendula helps grow new healthy cells at the site of a wound and increases the number of microscopic blood vessels.
- **Chamomile:** Anti-inflammatory compounds make this herb useful for sensitive or thin, dry skin. Use it for rashes, spider bites or scrapes.
- **Dandelion:** Contains a rich emollient useful in cleansing lotions for dry, mature and sallow skin.
- **Elderflower:** A good tonic for all skin types, especially mature or sallow skins. Reputed to soften skin and smooth wrinkles and soothe sunburn.
- **Fennel:** It is used for cleansing and soothing.
- **Lavender:** It is used for treating acne, skin problems or insect bites as well as for the treatment of burns and sunburns. It helps to balance the skin's oil production, correcting problems of over-production or underproduction of oils. Lavender in the bath has actually been clinically proven to enhance relaxation.
- **Lemon:** A frequent complement to herbs, lemon juice is a tonic that restores the skin's natural acid balance.
- **Parsley:** It is a conditioner for dry, sensitive and trouble skins.
- **Peppermint:** A stimulating astringent, which clears the complexion.
- **Rose:** A soothing and gentle cleanser, which has a refining and softening effect on the skin.
- **Rosemary:** This beloved culinary herb also stimulates and regenerates sluggish, devitalised, or sallow skin. It is a good ingredient in bath products designed to stimulate and energize, rather than to relax. The leaf has been used to treat eczema and wounds.
- **Sage:** It is a cleansing, stimulating astringent, which also tightens pores.
- **Thyme:** Anti-microbial action makes it a good wound cleaner with its astringent effect. It is effective in a footbath against fungal infection like athlete's foot. Thyme is a good immune booster.

Traditional preparations using Medicinal plants

In South Africa, bark, leaves, rhizomes (roots), bulbs, tubers, fruits and seeds are all used as medicine. Each part of a plant, leaf, root, bark, fruit or flower, carries different chemicals, or active ingredients. Plants are potent and should always be treated with the greatest respect and willingness to learn. A mistake could bring harm instead of healing. It is essential to use the right part of the plant and ensure that you have identified the plant correctly.

Plants are either used fresh or they are dried for storage. Once medicinal plants have been dried they should not be exposed to light or heat as this will degrade them. They should be stored in a cool dark place. They are then measured into correct dosages for further processing. These are the most common ways in which medicines are prepared from plants.

Infusions (teas)

Two types of infusion teas exist; hot and cold. A hot infusion is made when wet or dry plant material is placed in boiling water that is removed from the heat source and allowed to stand for 10 minutes. The water soluble elements are dissolved into the water and a hot infusion results, like a cup of tea. Some active ingredients are easily destroyed by heat. For plants containing these ingredients, cold water would be used and the plants left in the water, usually overnight, to create a cold water infusion. These medicines should be used the same day as they soon start to ferment.

Decoctions (boiled)

A decoction is made when plant material is boiled to extract the active ingredients. The boiling time differs according to the plant and may be anywhere from 10 minutes to 8 hours. Usually, if the plant part is very hard, as with bark, the

cooking time is longer. Sometimes milk is used instead of water as it absorbs some of the oils and fats which do not dissolve easily in water. Medicines should not be cooked in aluminium pots, as aluminium can change the chemistry of a medicine. Aluminium is also toxic to the body in high amounts and is believed to be a cause in a number of diseases affecting the nervous system.

Mixtures

These are liquid or powder preparations where more than one plant is used. In traditional medicine these are often complex mixtures of many plants that have properties or contain chemicals that work well together. Thorough study is required.

Tinctures

A tincture is made when plant material is placed in alcohol like cane spirits (42% alcohol) or grain alcohol (up to 80% alcohol) and left to stand for up to three weeks in a dark warm place. Tinctures have an advantage as they extract the active ingredients, like fats and oils, that are difficult to extract with water. Tinctures also extract the active ingredients that can be dissolved by water. In addition, alcohol is a preservative. This method is of great benefit in rural areas where people do not have access to refrigeration. Tinctures can be stored for a long time and kept till they are needed. This saves a lot of time as they do not need to be prepared on a daily basis. This adds real value as the medicines may be stored safely until they are used or sold.

Syrups

Syrups are tinctures to which sugar or honey has been added. Sugar and honey have a preserving action and increase the shelf life of the medicine. They also improve the flavour of otherwise bitter or bad tasting medicines, just like the cough syrups one buys in the pharmacy.

Ointments and Salves

These are prepared by placing usually dry plant material into heated oil or fat. Once the active ingredients have been extracted and soaked into the fat, the plant material is separated by pouring the liquid through a sieve or a cloth. Traditionally fats from snakes, sheep, and other animals are used. These days many healers prepare their ointments in Vaseline. Bees wax is also a common addition to ointments.

Powders

After drying, most medicines are ground down into a powder. These are then used in other preparations or can be taken directly, normally licked from the hand or sometimes sniffed into the sinuses as is the case with snuffs. They are also applied directly to open wounds, sometimes to control bleeding and to kill germs that might cause infection.

Juice

The juice of certain plants is sometimes squeezed and applied directly to wounds or is taken orally. A commonly used juice in South Africa is the juice of the pig's ear, *Cotyledon orbiculata*, squeezed into the ears to control earache and infection. Sour fig juice is taken for sore throats and Bulbanella and Aloe vera or Aloe Ferox juice soothe skin ailments.

Conservation of Medicinal Plants

Many medicinal plants in general are extinct or endangered, rare or vulnerable. Some only grow in a specific area and cannot be found anywhere else. The bark is often harvested only in strips from the east side of a tree, so the gentle morning sun will help the tree to recover.

Strategies for the conservation of medicinal plants

- Harvest seed from a population of plants in a specific area, grow in a nursery, replant with their parent plants.
- Encourage plant part substitution, as when the leaves would be a more sustainable option than the using the roots. A good candidate for this approach is the indigenous ginger, *Isiphepheto* (Z), *Siphonochilus aethiopica*, which is extinct in Natal. It is not always necessary to harvest the bark, which can kill the tree. Often twigs, which contain the same chemical compounds, can be harvested and used.
- Specialist medicinal plant nurseries could contribute to the awareness of threatened species, and could even become community-based businesses, which supply the healers and community members with plants to grow on their own land. With a great number of species, seed could be harvested by the community from designated areas without destroying the plants to supply such nurseries. This model could be used for job creation, economic development and as a conservation tool. It could be seen as a way of saving lives by saving plants. If considering harvesting for commercial purposes, you will need to apply for a permit from SANBI (contact details are provided at the rear of this manual)
- Diverse ecosystems, like forests, often hold more economic value in the form of sustainable harvests of diverse products than agricultural land. This is a key insight for conservation. Our forests, containing many of our medicinal plant resources, are literally being chopped down and burnt for firewood or developed into agricultural land for crops or livestock. We must think of creative ways of dealing with this crisis. For example, sustainable technologies like solar cookers, that reflect and direct sunlight off their polished metal surfaces, could help reduce reliance on fire wood. Our forests and wild areas still hold medicinal secrets that remain undiscovered and are worth conserving for that reason alone.

Conclusion

Herbs are useful species. It is therefore important to conserve them. Apart from outlining the different types of herbs, this Unit provided information on how to grow, use and conserve these important plants.

There are a number of important traditional herbs in South Africa. It is essential to know what they are and what they are used for in order to select which ones to cultivate, conserve and use. Some of these, such as African potato (*Hypoxis*) and wild garlic should be used with caution if being taken alongside anti-retrovirals. It is always important to research any possible plant-drug interactions when considering the use of any medicinal plants.

Reflection points

- Give at least five good reasons for growing herbs in your garden.
- List four different types of herbs that you know which have not been discussed in the manual and for each explain the appearance of the plant, its origins, why it is grown and where one can buy it.
- Identify the companies and NGOs that grow herbs in your area and select from them the kind of herbs that would be useful for your family and for the school.
- Which herbs are good for immune boosting?

Unit 9: Integrating livestock

LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- Types of livestock
- How small livestock can be integrated into crop farming

Introduction

Small livestock can play a vital role in sustainable development if they are integrated carefully into the farming systems. Livestock provide meat, eggs, feathers, skin, honey, medicine and manure. They can generate income and can influence the creation of a more complete ecosystem. Some even control pests.

A few examples can show how animals balance the ecosystem. Spreading wood ash on the floor of the chicken run under the roosts is a good way of dealing with the droppings by neutralising the acidity. Chicken manure and the wood ash react, driving off the nitrogen and drying out the manure, producing an easily handled, easy-to-store, organic fertilizer rich in potassium and phosphorus.

Spread the type of “browns” you use for composting in the chicken run — dead leaves, spoiled hay, straw, sawdust, shredded newspaper, cardboard and wood chips. Throw edible scraps from the vegetable garden and the kitchen on top. The chickens will scratch it up, manure it, and mix it thoroughly for you — when it’s ready, put it straight in the compost bin.



Apiculture

Apiculture is concerned with keeping bees. Bees are one of the most productive elements for a farm. If you are in an urban areas, you will need a permit to keep bees. Bees play a very important function in a Permaculture system. They produce a wide range of products that can generate a good small business and increase the pollination of crops and thus production of food. They do not require much space and maintenance is low.

Why Keep Bees?

Conservation: Bees need forage, which is food and other resources from plants that bees need to make honey, propolis and wax. Plant species that contribute to the bees' needs should be protected and more planted to provide bee food. The best place for these plants are on contour ridges or at the boundary of your farm. The selection of the plants should be based on whether the plants can also be used as windbreaks or as live fence.

Honey: Honey is a most delicious and nutritious food. It is also the bees' food. Bees work hard to store this food and people "rob" the honey for their own use. The interesting part is that the more we take honey from bees the stronger a hive is, but never take all honey from the hive. Honey can generate income for the family. In South Africa, a jar (500g) cost R40. A hive can produce over 30 jars per crop. A good hive of bees, with good forage, can produce over 120 jars per year. With good management of forage and bees, it is possible to generate R4 800 net profit. If you have 10 hives you can generate R48 000. Honey is good business in Africa and in other continents.

Propolis: Propolis is the glue that bees use to close open spaces in the hive. It is dark grey in colour. Propolis has medicinal properties. It is anti-viral and anti-bacterial. Propolis helps to treat TB, flue, colds, headaches and other viral and bacterial infections.

Wax: The wax is the yellow whitish matter that builds the combs. The wax is used for making candles, soap and polish. It can be sold to generate income. As a base for creams, wax is an excellent anti-bacterial medium to which other components can be safely added.

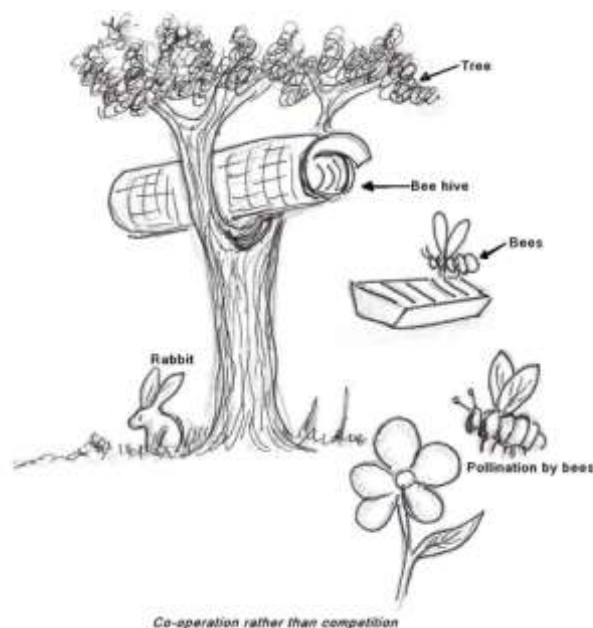
Pollination: Most plants cannot produce fruit and seeds if the flowers are not visited by pollinating insects and the honey bee is one of the best pollinators. Avocados, most fruit trees, crops and vegetables can not produce fruits without the bees' involvement. Commercial fruit farmers hire in bee hives for large scale pollination. The farmers pay bee keepers for the work done by bees on a daily basis.

Note the following:

Security: Place your bee hives on the boundary of the farm as people are often afraid of bees.

Stings: Bee stings are used medicinally by doctors to relieve rheumatism. A bee sting can be painful and should be treated immediately by putting on some honey or vinegar. Too many stings are dangerous. Before you keep bees find out if you or anybody else who will be working with the bees are allergic to bee venom.

Warning: Bees can kill. Register your bee project with the local association. Also find out what the by-laws of your local government say about keeping bees. If you go into large-scale honey production, follow all safety precautions recommended by local government and your local association. Inform everybody in the immediate vicinity of safety precautions to be followed around your hives. You may also want to take out liability insurance in case a trespasser is attacked on your property.



Bees Family

The Queen: Female, mother bee is the largest, and the leader of the colony: She controls all the relationships of the bees, so that all live in harmony. The colony keeps only one queen per hive. She controls the colony by producing a distinctive scent that is different from that of other queens, and from other hives. If her family members get lost and end up at another hive, they will not be accepted, because their scent is different. The Queen's sting is used only on rival queens. The Queen mates with at least 10 drones in one session. She flies high up and the stronger drones mate with her. She will never fly again and all the drones will die, but their sperm is kept alive in a sperm sac and used to fertilize female eggs when more worker bees are required. The Queen can lay eggs after 3 days of the mating day. She lays more than 3000 eggs per day. The Queen can live for at least 3 years.



The Drone: The drone is the male bee that is developed from unfertilised eggs. His role is to mate with the queen and once this task is complete, he dies. When food becomes scarce in the hive, most of the drones are expelled and will eventually die. The drone cannot sting and has a maximum life span of 2 months.

The Workers: The female bee is the smallest in the hive. She is responsible for security, building cells, cleaning the hive, making decisions, scouting, foraging, changing nectar into honey, house-keeping, covering and warming the brood, producing wax, guarding the entrance and nursing the queen. The workers sting and defend the colony. Once a worker stings, she dies. Workers communicate with the rest of the hive through pheromones (chemical scent signals produced by the queen and workers) as they dance and vibrate.

Brood: This is made up of the eggs, larvae and the pupae. The brood are protected by the workers and are held at a constant temperature of about 35 degrees Celsius. When it is cold, the bees eat more honey and cluster together, so that they can generate more heat.

If it is too warm, the colony disperses and a lot of water is collected for both drinking and cooling purposes.

What equipment do you need to work with bees?

A Smoker is a tool for smoking the bees so that they do not start a mass attack. Bees are smoked so that they sense that a bush fire is coming and then rush to the honey cells, filling their stomach with honey, ready for an emergency escape. These bees will not be keen to fly and attack.

Aquaculture

Aquaculture is concerned with the keeping of water animals, which includes fish, ducks and geese. Fish farming depends greatly on the climate, the environment and local law. The accidental introduction of foreign species of fish into rivers, wetlands and lakes can be disastrous. If you want to farm fish, be guided by the best local advisors you can find.

Poultry

Ducks and Geese: Duck and geese are good sources of protein. Fat from the skin can be rendered and used in cooking. The flesh itself has very little fat and has a unique



and delicious flavour. Each ducks and goose lays about 25 eggs in a season.

Muscovies, a certain kind of duck, are cheap to keep. They are self-reliant and better foragers than other ducks. They grow fast and seldom get sick. They clean up after your other livestock and eat spillage and leftovers from the other animals. Muscovies come in black and white and various shades of grey and brown, with a bright red crest around their eyes and above the beak, like a cockscomb. Muscovies have never been industrialised or “developed” on a large scale, probably because they do not come in standard sizes.

They usually start laying eggs in August. Generally it is advisable to start with a drake and three hens. Muscovy hens can set three or four times a year, with clutches of eight to 21 eggs. The eggs hatch after 35 days. The birds are ready to eat 70 days later.

Ducks and geese are highly productive if they are free ranged. They require a pond to swim in and can therefore be integrated with fish farming. They fertilise the water and clean water ways. Keep the little ones in a closed house until the age of 2 months. They can swim soon after birth but it is better to let them swim only after 2 weeks.

Feed ducks and geese with a variety of vegetables, weeds and mixed grains. Protect them from diseases and fleas by feeding them wild garlic, comfrey and aloe. Ducks and geese are great for cleaning housefly larvae, especially in cattle kraals, and for controlling snails and slugs in the garden. Ducks and geese do not scratch mulches in the garden.

African chickens: African chickens are the best for free ranging. They are very productive if they are housed at night. Chickens are great for homesteads and it is almost a must to have them, no matter how big or small your homestead is. They scratch and eat little bugs and tiny weed seeds. They provide compost and control pests. Ensure that there are chickens to work over your whole place every season, along with the ducks and geese. Chickens provide meat and eggs. You do not need a rooster to have eggs, but you do need one if you want to breed them. Chickens cluck away busily and shriek if they are frightened and can therefore serve to warn you of any intruders. A traditional hen can produce more than 60 eggs or 40 chicks per year.

Tips for increasing the survival rate of chickens

- Keep chicks away from the mother a day after hatching. Put them into a warm cage and feed them with starter meal for 3 weeks and then with growers’ meal for 4 weeks. During this period, feed them with greens and earth worms. In the 5th week feed them with mixed grains and greens.
- Separate the hens and the cocks in the 10th week, and feed the hens with a mixture of mixed grains and layers meal at the ration of 1:1. Feed the cocks with mixed grains. Remember to give the chickens enough space for free ranging and use rotational systems to improve their food variety, to control pests, and plough and fertilise the soil.
- Chickens can be linked with fruit trees of the garden. In the garden, it is better to keep them in a chicken tractor. In orchards apply rotational systems and methods. Feed chickens with vegetables, weeds, earth worms and mixed grains.

Rabbitry

Rabbits breed very fast because they can bear young ones throughout the year and have a gestation period of about one month.

Key considerations

- Keep bucks (male rabbits) apart because they fight. They burrow under fences. If you have children they will do the work for you as they tend to love rabbits. Rabbits are grass cutters and they can keep the lawn short.
- Rabbits burrow and like to eat juicy green leaves! If rabbits are free ranged, make sure the fence is in a concrete foundation or lay down a 30cm wall of rubble stone. This will prevent rabbits from burrowing through the fence.

- For breeding, take the doe (female) to the buck to avoid fighting. Leave them together for two days, then take her back again 12 days later. If she refuses to mate, it means mating was successful on the first occasion. When she finally produces young, leave her with them for six weeks, then mate her again two weeks later. In other words, she will breed four times a year and has potential to wean over 50 offspring a year.
- Rabbit manure is of high-quality and easy to handle.

Guinea fowl

Guinea fowl are an all-round asset at any homestead. Guinea fowl need very little care — just leave them alone. They do what they like, feed themselves, look after themselves, and lay about the best eggs. They are smallish but rich and delicious as they should be nurtured on a rich and varied diet of insects and weed seeds. They effectively keep the pests down. Guinea fowl are the best control for ticks and house flies from cattle and goat pens.

Vermicomposting

Vermicomposting means making compost with the assistance of worms. Red worms are better if you have poultry. Worms are high in protein (better than beef) and make excellent live (or dried) poultry feed. Worm populations double in at least six weeks and they eat their weight of compost material a day.



Conclusion

In this unit we have discussed how to integrate animals in the garden in a way that enhances synergy and productivity. We have concentrated on the small livestock, which can co-exist with plants in the garden. You have also learnt how to tap into the ability of bees to produce honey, to pollinate and increase production.

Reflection points

- What factors would you consider when choosing a bird to keep in your garden?
- Describe the ways in which geese and ducks contribute to the ecology of the garden as well as its productivity.
- Why would a farmer keep worms?

Unit 10: Mixing plants in your garden

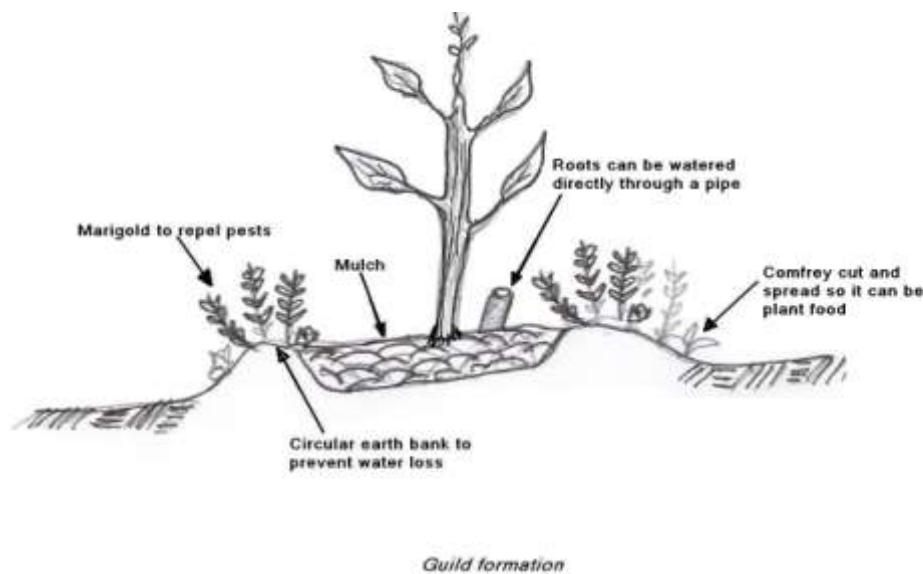
LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- Essence of planting crops together
- How you can plant certain crops together
- Identifying plants that can grow well together and those that may not do well planted together

Introduction

Planting many crops together (Polyculture) reflects the essence of the Permaculture approach. This is a major step towards diversity in production, which enhances the availability of nutritional requirements. Growing plants together with useful connections is called a guild.



Guilds

A guild is a harmonious assembly of species clustered around a central element (plant or animal). This assembly acts in relation to the element to assist its health, aid our work in management, or buffer adverse environmental effects. Here are some reasons to place species in association:

- Reduces root competition
- Assists pest control in various ways
- Provides mulch
- Provides free nutrients
- Provides physical shelter from frost, sunburn, or wind
- Assists us in gathering by creating culinary guilds
- Reduces competition for light

In the interactions between plant species the following realities prevail:

- Most species get along fine; perhaps 80% of all plant species co-mingle without ill effect.
- Some species greatly assist one or other many ways.
- A minority of species show antagonistic behaviour towards one or more other species.

Some guidelines for choosing plants to grow together

Some species are planted together because they help each other. If plants compete for the same resources, separate them and replant their own beneficial guilds.

It has also been observed that plant families often exhibit the same tendencies regarding their interactions with the environment, so that when guilds are created, family members can be placed in similar circumstance. Also, depending on the nature of the climate, you will find that summer plants generally grow well together and winter plants grow well together, but summer and winter plants conflict if placed in the same area. Thus by planting plants during the appropriate season; conflicts over resources among elements can be avoided.

A simple way of looking at companion planting is that some plants are light feeders (onion), others are heavy feeders (maize, pumpkin), while others are heavy givers (legumes i.e. beans). Always put heavy givers with heavy feeders such as planting beans with maize.

Crop	Companions
Melon	Corn, peanut and sunflower
Plum	Horseradish
Raspberry	Tansy
Strawberry	Beans, spinach, borage and lettuce
Asparagus	Tomato, parsley, basil, nasturtium and marigold
Beans	Carrot, cauliflower, savory, cabbage, beet, borage, maize, marigold, squash, strawberry, tomato, nasturtium, potato, cucumber, collards and sunflowers
Beet	Onion and kohlrabi
Broccoli	Beans, nasturtium, oregano, potato, celery, dill, chamomile, sage, mints, rosemary and onion
Brussels	Beans, nasturtium, potato, celery, dill, sage, mints, rosemary and hyssop
Cabbage	Beans, nasturtium, oregano, celery, dill, chamomile, sage, mints, rosemary, lavender, beet, onion, tansy, tomato, chickweed and morog.

Carrot	Peas, onion, leek, rosemary, sage, tomato, lettuce, chive, beans, radish and wormwood. Cauliflower - Beans, nasturtium, oregano, celery, dill, chamomile, mints, lavender, beet, onion, hyssop and radish
Cauliflower	Beans, leek, tomato, cabbage, cauliflower and onion
Celery	Beans, leek, tomato, cabbage, cauliflower and onion
Cucumber	Beans, peas, radish, corn, sunflower, broccoli, celery, lettuce, tomato, marigold
Eggplant	Beans, peas, clover, tarragon and thyme
Onion	Beet, strawberry, tomato, lettuce, clover, cabbage, carrot, potato, savory, beans and sow thistle
Flax	Carrot and potato
Leek	Celery, carrot and onion
Lovage	Beans
Peas	Carrot, maize, cucumber, eggplant, lettuce, radish, spinach, tomato and turnip
Peppers	Basil, carrot, lovage, marjoram, onion and oregano
Potato	Beans, corn, cabbage, marigold, lettuce, onion, petunia, radish, flax, lima, horseradish and dead nettle
Pumpkin	Maize, cowpeas and clover
Radish	Peas, nasturtium, lettuce and cucumber
Soybean	Grows with anything and helps everything
Spinach	Strawberry, cabbage, celery, eggplant, onion and peas
Squash	Nasturtium, corn, beans, mints and radish
Tomato	Onion, parsley, asparagus, carrot, basil, cabbage, peas, sage, chive, marigold, nasturtium, lima and sow thistle
Turnip	Peas

Herbs and Flowers	Companions
Anise	Beans and corriander
Basil	Tomato, beans and cabbage
Bee Balm	Tomato
Borage	Tomato, strawberry and squash
Caraway	Peas
Camomile	Onion, cabbage, mints and cucumber
Chive	Carrot, grape, parlsey, tomato and fruit trees
Coriander	Peas
Dill	Cabbage, carrot, lettuce and onion
Garlic	Rose, carrot, tomato and raspberry
Mints	Cabbage family and tomato
Nasturtium	Tomato, radish, cabbage, cucumber and fruit trees
Oragano	Cucumber
Parsley	Tomato, asparagus, carrot, onion
Petunia	Beans
Rosemary	Carrot, beans, cabbage and sage
Rue	Rose and raspberry
Sage	Carrot, cabbage, rosemary, peas, beans, marjoram, strawberry and tomato
Savory	Beans and onions
Southernwood	Cabbage
Sunflower	Cucumber
Tansy	Fruit trees, rose, raspberry, peppers and potato
Yarrow and Garlic	Enhance essential oil production in herbs

Vegetables	Competitors
Asparagus	Onions
Beans	Chive, fennel, garlic, leek and marigold
Beet	Beans
Broccoli	Lettuce, strawberry, tomato and rue
Cabbage	Grape, strawberry, tomato and rue
Carrot	Dill and anise
Cauliflower	Strawberry and tomato
Cucumber	Rue, sage and potatoes
Kohlrabi	Beans, peppers and tomato
Leek	Beans and broccoli
Onion	Beans and peas
Peppers	Fennel and kohlrabi
Potato	Apple, pumpkin, tomato, raspberry and rosemary
Pumpkin	Potato
Radish	Grape and hyssop
Squash	Potato
Tomato	Fennel, potato, dill, cabbages and kohlrabi

Fruits	Competitors
Apple, apricot, peach, plum and pear	Potato, lucerne, clover and cowpeas, nasturtium, wild garlic, stinging nettle, comfrey
Fig	Rue, lucerne, clover
Grape	Cabbage, lucerne, clover and radish
Raspberry	Potato, lucerne, clover
Strawberry	Cabbage, cauliflower, broccoli, lucerne, clover and Brussels sprout

Herbs	Competitors
Anise	Carrot
Basil	Rue
Caraway	Fennel
Chive	Beans and peas
Coriander	Fennel
Dill	Carrot and tomato
Fennel	Beans, caraway, coriander, dill and tomato
Garlic	Beans, peas and strawberry
Hyssop	Radish
Mint	Parsley
Parsley	Mint
Rosemary	Potato, basil, cabbage and sage
Sage	Cucumber and rue

Conclusion

In this unit you will have learned about the reasons for, and the best ways of, combining different types of plants in order to get the most out of them and to minimize negative effects that they might have on each other. This should enable you to plan and manage your garden effectively.

Reflection points

- What are the advantages of growing plants in guilds?
- What kind of plants should not be grown in the same guild and why?
- Find out the kind of plants that tend to grow together in nature and share this information with others. Suggest reasons why they grow well together.
- Design three guilds and name at least four plants for each

Unit 11: Propagation of plants

LEARNING OUTCOMES

By the end of this Unit the reader will have learned about:

- How to raise plants using sexual and asexual methods
- Growing fruit crops
- Strategies to improve seed germination
- Nursery establishment and management

Introduction

This is a very important module. It will take you through various processes in plant propagation. You will be introduced to processes which will enrich your understanding about Permaculture practices. The module will empower you with tools of how to raise plants from sexual and asexual methods for own use and for sale.

Propagation is the planting and caring of plants. Plant propagation begins with seed or vegetative reproduction (cuttings) and it ends with harvesting. There are many steps in between. The most suitable place for plants to be propagated is in the nursery where there is a safe sheltered space for young plants to grow. Seedlings need shelter and protection, food and water, time, a safe space and careful and gentle attention. A nursery is a place that can fulfil some of these needs. The gardener needs to fulfil the rest.



Establishing a nursery

A nursery should be established by considering the potential market, so that the plants grown are relevant and useful to the gardener and the other farmers around. This also means that factors such as soil type, water availability and peoples' needs should be taken into account.

Guidelines on establishing a nursery

A nursery does not necessarily need to be a large expensive structure. Seedlings do not take up much space therefore the plot needed is relatively small. A tree can provide a suitable area for a nursery, as long as the seedlings are provided with all their basic needs.

- The nursery must be established near a water source, with easy access. The ground should be level to prevent runoff. Cover the ground with mulch, especially where it is exposed. The mulch will protect the soil surface from rain splash and from crusting over, and it will keep the weeds at bay.
- A nursery needs different degrees of shade. Some plants prefer heavier shade than others and some plants need different degrees of shade during different stages of their development. A tree can provide suitable shade, or you can easily build an inexpensive shade house from a framework of poles and a grass roof. Long veld grass or palm fronds can be laid in varying thickness.
- The soil in a seedling bed should be free of anything that may hinder growth, such as stones, sticks, hard clods of clay, etc. A germination bed should have loosely tilled, aerated, fertile soil for at least 10 to 15cm. Nursery soil should have a good mix equal proportions of river sand, clay and decayed organic matter. It is important that the soil has good drainage.
- Prepared soil can be put between small stone walls, in wooden boxes or car tyres as special beds. When using car tyres, it is very important to make sure that the tyre is either covered, painted with a light colour or in the shade, as if exposed to direct sunlight, the tyre will get very hot and cook the soil. The tyres are best placed on plastic to prevent the seedling roots from growing into the ground. For a bed on a raised wooden table, sieve the soil and mix it with straw. Make a layer of soil mix about 15 to 20cm thick on top of the soil and straw mix. This system has good drainage and avoids many pests from ground level. Water twice a day.
- Trees and cuttings prefer to be in their own individual containers. Several types of containers can be used, from plastic bags to tins and clay pots. When preparing a container, it is very important to make sure that there is adequate drainage. Once the seedlings in the seedling bed are well developed, select the hardier plants. It is wise to transplant the young plants into individual containers. The plant's roots can now be protected in their own ball of soil.
- Hygiene in the nursery is important to prevent disease and weeds. If there is a disease problem in the soil, it may be necessary to sterilize the soil. The easiest way to sterilize the soil is to pour boiling water over the soil to a depth of no more than 50cm. For large quantities of soil, you can steam the soil. Place soil in a drum with holes, over a fire.
- It is important to protect the nursery from animals and children. Thorny branches can be used to keep small animals such as rodents away from the seedlings. Strong smelling herbs can be planted around the nursery to ward off pests. A mulch of small thorny branches will ward off some pests such as snails.

The value of a nursery

- When seedlings are raised in rich soil and carefully tended, they will be stronger throughout their life cycle, even if they are transplanted into less fertile soil.
- Young plants need close and careful attention, which is difficult to do in the field.
- In the nursery, the first sign of pests or disease attack can be dealt with more easily.
- Watering is controlled in the nursery, so the seedlings are never stressed with too much or too little water.
- The strongest plants can be selected and the weakest can be removed and composted.

- Nursery production can save time during the growing season. New seedlings can be sown in the nursery before the harvest of plants in the field.

How to plan and establish a nursery

- Plan where to put everything you need to start a nursery
- Choose a suitable site
- Terrace and protect the site
- Protect it from strong winds
- Establish it near your water source
- Collect containers for planting seedlings
- Collect your soil and materials from a growing medium
- Make compost
- Collect or buy your seeds
- Plant and look after the seeds and seedlings

Nursery Management

Day to day running of a nursery involves the following:

- | | |
|---|---|
| <ul style="list-style-type: none"> • Obtaining necessary materials (soil, water, compost, mulch, tools, • Preparing the growing medium, seed-beds • Seed treatment • Sowing the seeds customers, selling, and giving • Plant cuttings, watering away plants • Caring for seedlings and removing weeds; • Transplanting; and research; and • Caring for tools and equipment; | <ul style="list-style-type: none"> • Using compost when necessary equipment, and seeds • Keeping a nursery clean • Controlling pests and diseases and nursery beds and potting bags • Making compost • Marketing, advertising, serving • Keeping records, experimenting, • Dispatching plants. |
|---|---|

Qualities of a good nursery manager

- Understand people and their needs
- Build up confidence
- Know how to plan and make decisions
- Be able to follow up and act on a decision made without delay
- Be a good learner and listener
- Be a good teacher and be open to suggestions
- Be a good salesperson
- Be able to organize, keep and file records
- Be able to communicate well with customers
- Be responsible, reliable and effective

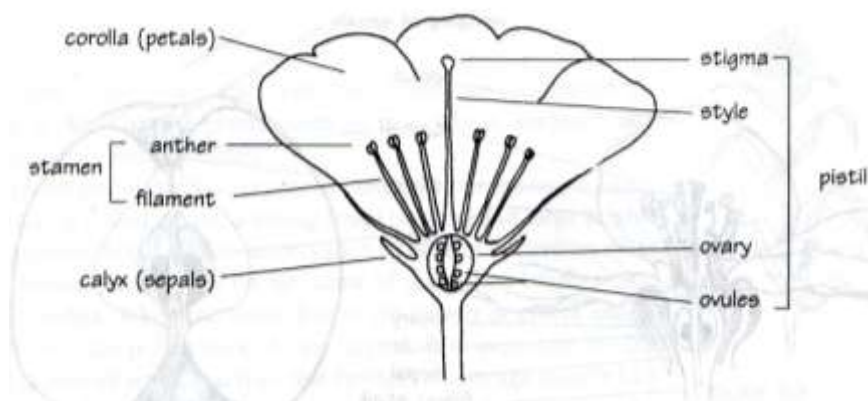
- Have a positive attitude towards the environment, business and people
- Be able to network with different organizations

Ways of propagating plants

There are two main ways by which plants can be propagated. One is called sexual reproduction while the other is called asexual reproduction. Sexual reproduction occurs when germination is from a seed and asexual reproduction takes place when a plant grows from a vegetative part such as the stem or the root. Examples of sexually reproduced plants include tomatoes, maize, millet and soya beans. Plants such as garlic, potatoes, sugarcane and figs reproduce asexually.

Sexual reproduction

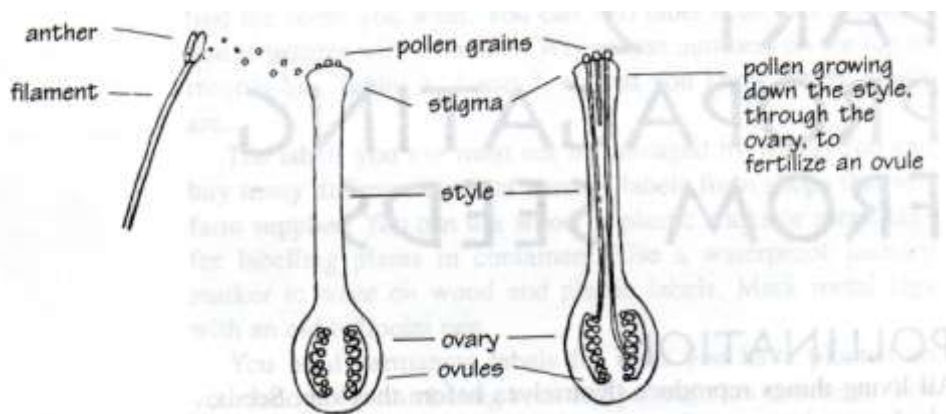
Sexual reproduction takes place through pollination. Plants, like animals, have reproductive organs, which are found in the flower. The male organ is called the stamen, and the female organ is called the pistil.



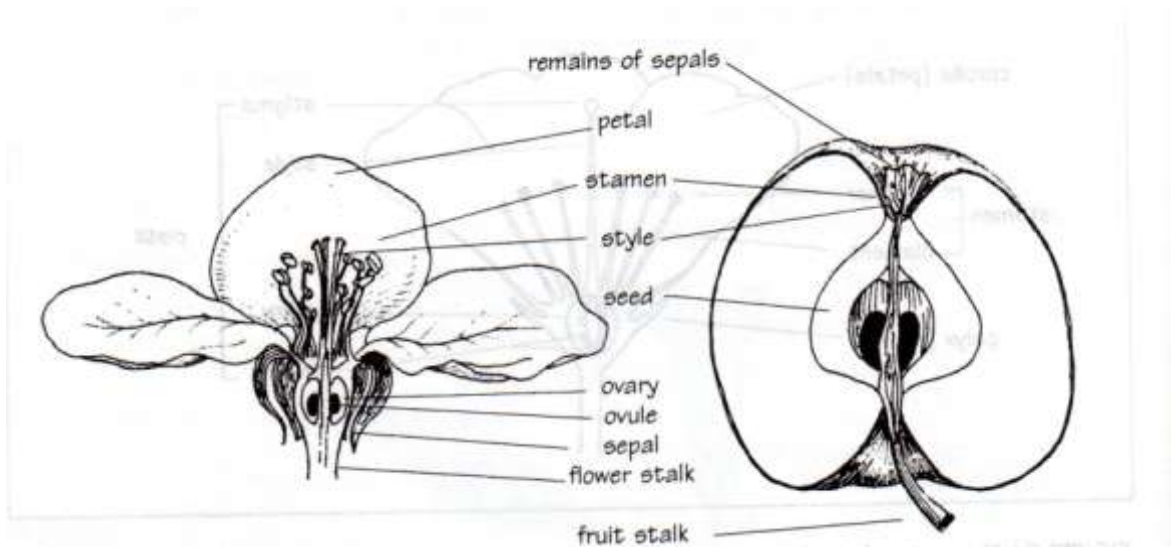
The stamen consists of the filaments and anthers. These anthers produce tiny pollen grains. These are the male reproduction cells, similar to sperm in animals. The pistil, on the other hand, consists of the stigma, the style and the ovary. This is where the ovules (or eggs) are lodged.

Pollen is carried from the stigma to the anther by wind or insects, which is why we call them pollinators.

Plants that rely on insects for pollination tend to produce brightly coloured and/or scented flowers to attract their insect of choice. Whereas wind pollinated plants, such as grains and grasses, tend to produce anthers which hang from the flower, with feathery stigma to collect the pollen carried by the wind. When pollen is deposited on the stigma, it grows down to style to the ovary, which is then fertilised.



After fertilisation, the ovary changes in shape to form the fruit, and the ovules develop into seeds. All seeds have an embryo, which is the young plant inside the seed.

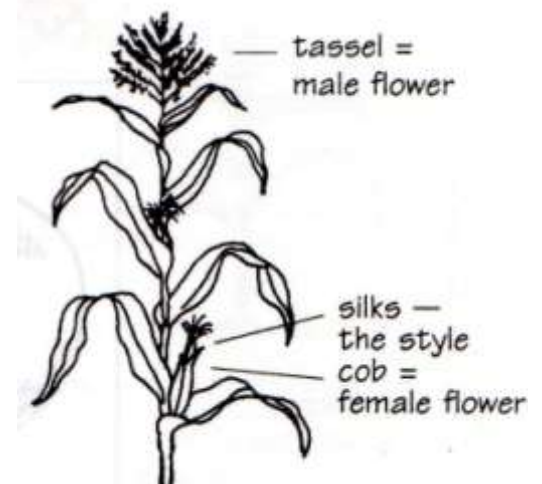


As the above illustration shows, most plants have the male and female organs in the *same flower*.

Some plants however, like pumpkin and maize, contain both male and female flowers separately, but on the *same plant*. If there are not enough pollinators in your garden, sometimes you will need to pollinate by hand, ensuring that the pollen is transferred to the female. The female can be identified by a bulb at the base of the flower which males do not have. Pollination of maize is more easily achieved by planting in blocks to ensure that the pollen is transferred by the wind from one part of the plant to the other.

A few plants, such as paw-paw, oyster nut and kiwi fruit have the male and female parts on completely *separate plants*. In other words, only the female plants produce fruit, while the male trees are needed to provide the pollen.

How to obtain



seeds

There are 4 ways to get seed. You can buy them, grow plants for their seed, or collect them from the wild or from bought fruit.

If buying seed to propagate for the future, then look for open pollinated seed varieties (OPVs). If you buy hybrid seed then these will not produce well during the following season, so will need to be purchased each year. Check the date on the packets, as these only have a limited shelf-life.

Great care must be taken when growing plants for their seed, whether you plan to sell them, or use them for yourself. The quality of the seed will have a great impact on the quality of the plant it produces, and the resulting harvest. Good seeds are therefore:

- Clean
- Free of pests and diseases
- Well developed
- Viable (will germinate)
- From healthy, productive parent plants

Selecting the right seed

In order to select excellent quality seed, identify a strong, healthy plant and leave it to go to seed. When a plant is stressed, it sets seed by 'bolting'. This is a mechanism which triggers reproduction when the plant thinks that it is dying. Do not select from these plants, as they may be stressed as a result of genetic weaknesses, so may not be a good choice.

Once you have selected your plant, and it begins to produce flowers, if you want to produce a pure cultivar from that plant, then as soon as pollination has occurred and seed begins to form, cover the seed head with a paper.



FIGURE 66
Prevent cross-pollination by placing paper bags over the flowers as soon as the flower buds form

Harvesting & Processing Seed

Seeds are ripe when they no longer increase in size. If seeds are harvested before they are fully formed, few of them will be viable and most will not germinate. However, if you wait too long, the fruit may split and drop onto the ground where it will be eaten by insects and birds. So check your seed plants often.

It is important to harvest seed when plants are dry. If it has been raining, then wait. Seed needs to be kept dry and cool at all times. Store your dried seeds in a paper bag (not plastic as this will make them sweat and grow mould), preferably in a cool, dark place. Always label your seed bags with the name of the species, and date of harvest.

Plants that drop their seeds:

For collection of seed such as legumes (peas and beans) onion, brassicas, okra and many flower varieties you will need to avoid the loss of seed. To achieve this, harvest just before their fruits have completely dried. Tie a paper bag over the head of the fruit, and cut off at the stem. Hang upside down to up to 3 weeks to allow to dry completely. You can then shake the bag to release the seeds.

Once your seeds are collected, you will need to clean them to remove any dirt, soil, or husks. You can do this by using a screen or threshing basket - pouring your seed from one container to another. The wind should carry the lighter materials away, leaving you with clean seed.

Plants that do not drop their seeds:

This generally relates to grains such as maize, sorghum, millet, rice and wheat. These can be harvested directly from your chosen, healthy plants. But you will be competing with the birds, so may need to place a paper bag over the seed head, or remove them altogether once the seed is set. Remove seed by hand, and thresh to remove any waste (as above).

Harvesting from fruits:

These include tomatoes, cucumber, pumpkin, peppers, peach, mango, apple, paw-paw. Harvest from your chosen plant when the fruits are plump and fully ripened. Cut open the fruit, and scoop out the seed. To separate the pulp from the seed, place in a container of water and leave them to soak overnight. The next morning, gently rub the seed between your fingers to remove any remaining pulp. Drain them, and rinse them again in fresh water. Place them on paper in a shady place to dry.

Collection from the wild:

If collecting from the wild, you may need a permit. Check before you plan to collect, as some species are endangered, and you are therefore responsible for their conservation. Collect seed from healthy plants. Select plants which have adapted to the conditions in which you want to cultivate. Some plants need lots of water, and will therefore compete with your other plants for water. In the same way, select from plants growing in similar soil to your own. This way you know that the plant will flourish in your garden. Never collect seed from plants which are invasive. They may look pretty, but will soon take over your garden, and affect others.

Testing for viable seed

This can be achieved simply, by adding hard coated seed to water. Those that float are not viable (will not germinate) and can be discarded.

Storing seed

Different seeds will only stored for different lengths of time. See the tables below for guidance. Short-lived seed can be stored in clean, damp sand in a sealed container (jam jar) and stored in a cool place. Other, longer-lived seed should be stored in clearly marked and sealed paper bags.



Techniques for improving seed germination

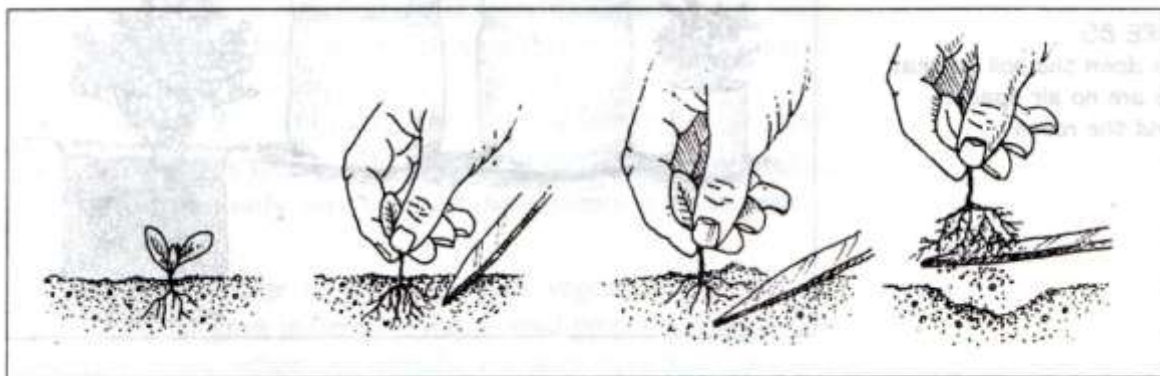
Scarify: Some seeds have a very hard outer coating that protects the seed and prevents it from germinating unless the conditions are suitable. We can scarify (scar or damage) the hard outer coating to weaken it and allow water to penetrate and trigger germination. First soak the seed in hot water for 24 hours, and then scarify the outer layer by simply chipping the surface with a blade or rubbing it with sandpaper. Take care to damage only the outer layer of the seed. It is very important that you do not damage the inside part which germinates.

Soak: Many seeds will germinate quickly after they have been soaked, for example beans. Pour hot water (not boiling but hotter than lukewarm) over the seeds so that they are well covered. Leave them to soak for about 24 hours, or until they have swelled. Some seed will swell quicker than others. Now they are ready to be planted.

Create a suitable micro-climate: Seeds basically need moisture, warmth and darkness to germinate. They should not be sown too early in spring in open ground, as it may be too cold. The plant is at a very vulnerable stage in its life when it first begins to grow. It is thus very important that the tiny little root feeling its way into the soil has the right conditions. Once the seed is planted it is essential that the soil is kept moist constantly. On a hot day, it may be necessary to water them twice a day.

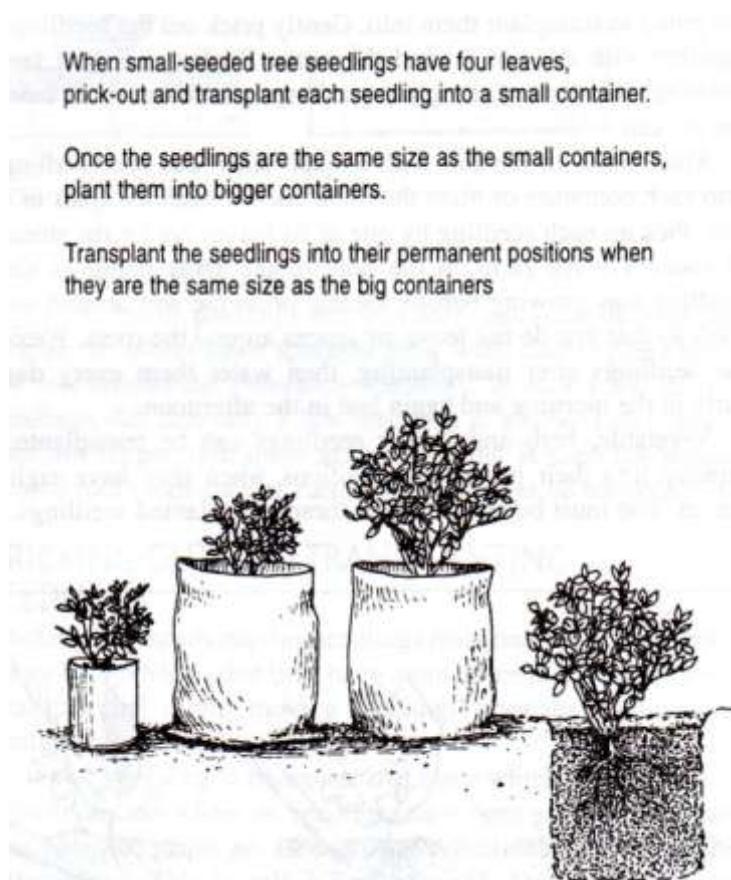
Transplanting

Here we are going to discuss the removal of plants from the seedbed or nursery to a permanent place. Plants raised on a seedbed or in nurseries must not be kept there too long. Transplanting is always done at the end of the day when it is cool and moist. The plant has time to recover during the cool night hours.



Seedlings transplanted from a bed - The time to transplant seedlings is when they have 2 to 6 true leaves and several well-developed roots. The stem should be strong, sturdy and erect. When seedlings are transplanted from a bed, their roots are exposed, as most of the soil is removed. Using a hand shovel will help to crumble the soil and lift the plant out without damaging the roots. Once the seedling has been removed from the bed, it must be replanted immediately and not left exposed so that the roots dry out. Wrap a wet cloth or newspaper around the roots if planting is delayed. The seedlings should be transplanted in well-loosened soil so that they can easily spread their roots. The depth of the hole should be larger than the length of the roots, and must be positioned carefully.

- **Seedlings planted from bags or pots** - Plants that have grown in small containers have a root ball protecting their roots with soil. Therefore transplanting is not as risky. The bag or pot must be carefully removed from around the roots so that they can easily grow. When transplanting, it is very important that you do not remove the plant out of the soil by pulling it by its stem, this could damage the roots and the stem. The plant is placed in loose, moist and fertile soil. The collar is easily positioned level with the ground. These transplants need less shade but should be pressed firmly into the ground and mulched and watered straight after planting.
- **Transplanting trees** - Trees should be planted early in the rainy season. Depending on the type of tree, they may need to be watered during dry periods.



Seed sowing guide for vegetables in Southern Africa

Summer (Protect seedlings from pests, sunlight and rain)

December: Amaranth, bush and climbing beans, beetroot, broccoli, cabbage, carrot, cauliflower, cucumber and radish.

January: Amaranth, marog, bush bean, beetroot, broccoli, cabbage, carrot, cauliflower, kohlrabi, kale, leek, lettuce, radish, Swiss chard and turnip.

February: Beetroot, broccoli, cabbage, carrot, cauliflower, kale, kohlrabi, leek, lettuce, onion, parsley, radish, Swiss chard and turnip.

Autumn (Protect seedlings from pests and early frost)

March: Broad beans, beetroot, cabbage, Chinese cabbage, carrot, kohlrabi, CM kale, leek, lettuce, onion, parsley, radish, Swiss chard and turnip.

April: Broad beans, cabbage, Chinese cabbage, carrot, lettuce, garlic, parsley, sugar snap peas and turnip.

May: Broad beans, cabbage, Chinese cabbage and sugar snap peas.

Winter (Protect baby plants from frost)

June: Cabbage, Chinese cabbage and sugar snap peas.

July: Cabbage, chillies, green pepper and sugar snap peas.

August: Bush beans, beetroot, urinal, cabbage, chillies, carrot, green pepper, leek, lettuce, sugar snap peas, Swiss chard and tomato.

Spring

(Best time for planting a variety of plants in Free State, Eastern Cape, Western Cape and Gauteng, be aware of frost in September)

September: Amaranth, bush beans, eggplant, cabbage, carrot, chillies, cucumber, kohlrabi, parsley, pepper, radish and New Zealand spinach.

October: Amaranth, chillies, pepper, radish and New Zealand spinach.

November: Amaranth, radish and New Zealand spinach.

Asexual reproduction

So far we have looked at the ways to grow plants from seeds. Another way to grow plants is either to take a cutting from a plant's new growth, or to take part of one plant and join it with another. This is sometimes known as the *vegetative* propagation.

Advantages of vegetative propagation

There are four main advantages of using vegetative methods to grow plants:

- Plants that *grow* from seeds are not exactly the same as the plant that *produced* the seeds, in the same way as a child is not exactly the same as either of its parents. This method allows you to duplicate your chosen plant, ensuring that its qualities and properties are exactly the same.
- Plants grown by vegetative methods usually grow faster than plants that are grown from seeds.
- Fruit trees and vines, which are grown from seeds, may take many years to produce fruit. But fruit trees grown by vegetative methods bear fruit in the first year that they are planted.
- Some plants such as pineapples and bananas do not produce seeds at all. The only way to grow these plants is by vegetative methods.

We will now look at three important vegetative methods: stem cutting, parts of stems or roots and grafting.

Plant parts used for asexual reproduction

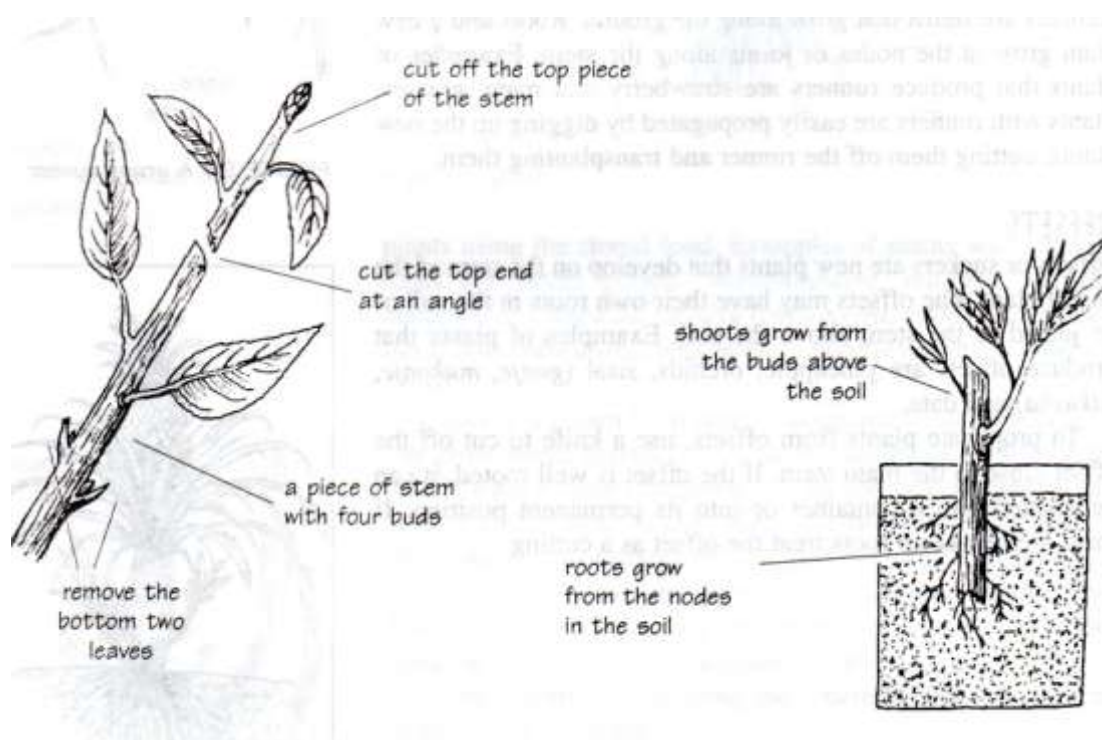
- **Stem cutting** - Stem cuttings are pieces of stems from which new plants grow. When they are planted into the soil, stem cuttings develop roots and new shoots of leaves. When you take cuttings, choose a healthy and productive plant. Do not take cuttings from plants that have pests or diseases.
- **Parts of stems or roots** - Some plants have special types of stems or roots from which new plants grow. In this unit you will learn about these different types of stems and roots and you will see how you can use them to grow new plants.
- **Bulbs** - Bulbs grow leaves and then produce flowers during the growing season. The leaves die at the end of the growing season and the bulb remains in the soil until the next growing season. Bulbs also produce new bulbs around or inside the older bulb. To grow new plants from bulbs, dig up the plants when they have died down at the end of the growing season. Separate or split the bulb, or store them in a cool, dark and dry place and replant them before the beginning of the next growing season. Examples of bulbs are plants such as African potatoes, lily, iris, onion, garlic, chives and shallots. Farmers grow onion from seeds. To produce onion seeds, they plant onion bulbs.

Growing plants from cuttings

Taking cuttings are a fast and effective method for propagating perennial plants. A healthy plant should be selected, as the plant propagated from a cutting, results in an identical offspring and preserves the same qualities. A cutting taken from an unhealthy plant will result in an unhealthy offspring.

Depending with the plant species, cuttings will generally take 3 to 9 months to develop sufficient roots before they can be transplanted.

How to take cuttings



Step 1: Use a sharp knife, razor blade or secateurs to cut off stem as thick as a pencil. Choose stems that have buds. The new shoots will grow from these buds.

Step 2: Cut the top pieces of the stems off, so that you are left with pieces that have at least four nodes. A node is a join in the stem. Buds form at nodes.

Step 3: Cut the top ends of the stem at an angle to make them look different from the bottom ends. This will help later to know which end of the stem goes into the soil. This is important, because if you plant the cuttings upside down, then they will not grow.

Step 4: Cut off the bottom two leaves. Then cut off some of the top leaves to stop the cutting from losing too much water. Cut off all flowers from the cutting.

Step 5: Prepare a place to plant the cuttings. It is best to plant the cuttings in containers in the shade until the plants are growing strongly.

Step 6: Place the cuttings into the soil so that two nodes are above the soil and two nodes are in the soil. Roots will grow from the part of the cuttings that are in the soil. The buds above the soil will grow into new stems. Keep the soil wet until the shoots are growing well.

Rooting plants and bulbs

Some plants can be propagated from pieces of root, for example comfrey. Potatoes are grown from small baby tubers. When growing potato 'seed' stock, choose the best potatoes. They can be stored in a pit and buried in dry sand to protect them from rats and other pests.

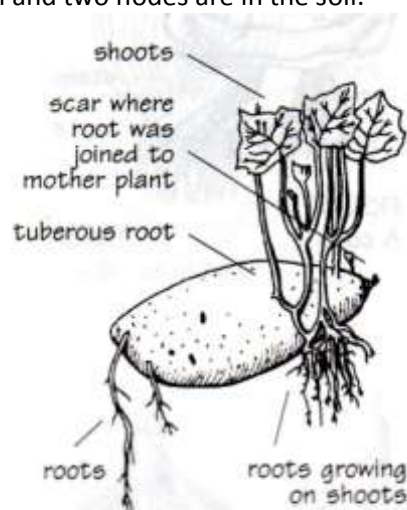
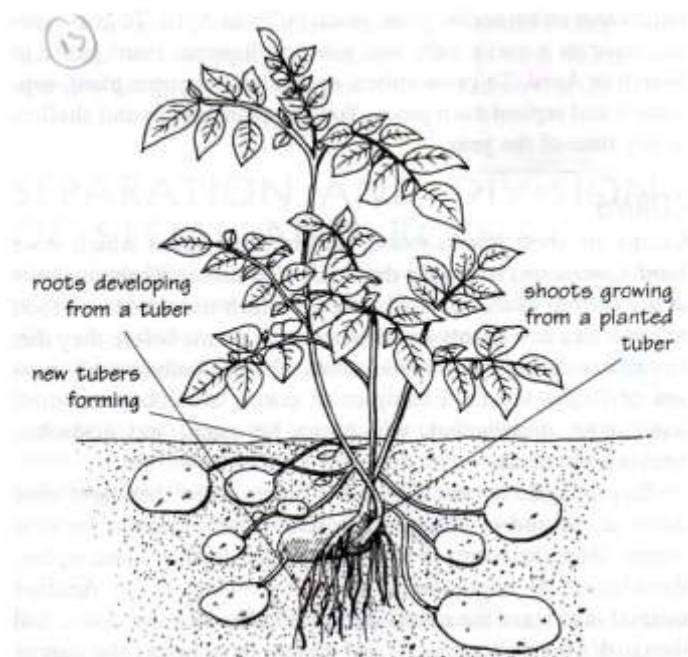


FIGURE 94
Tuberous root of sweet potato



Bulbs are small underground stem covered in fleshy leaves, such as garlic, onion and many flowering plants. For garlic, once the plants have died back, dig up and separate for replanting. Onions can be grown from seed (in April) but can also be bought in 'sets' which are small onions grown from seed in free draining soil, which are then planted directly in the ground.

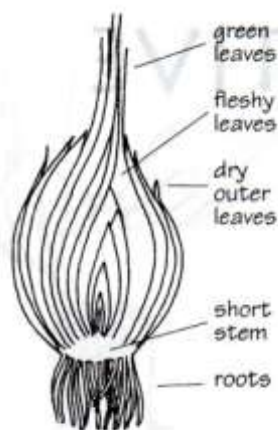


FIGURE 87
A bulb cut in half

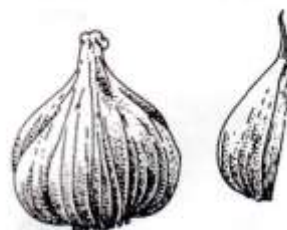


FIGURE 88
A garlic bulb before separating and a separated clove

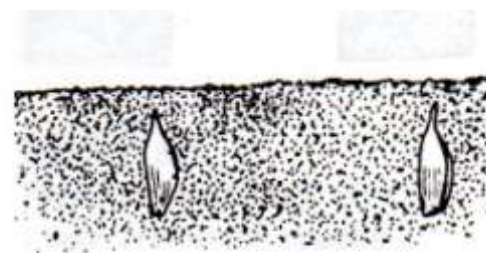


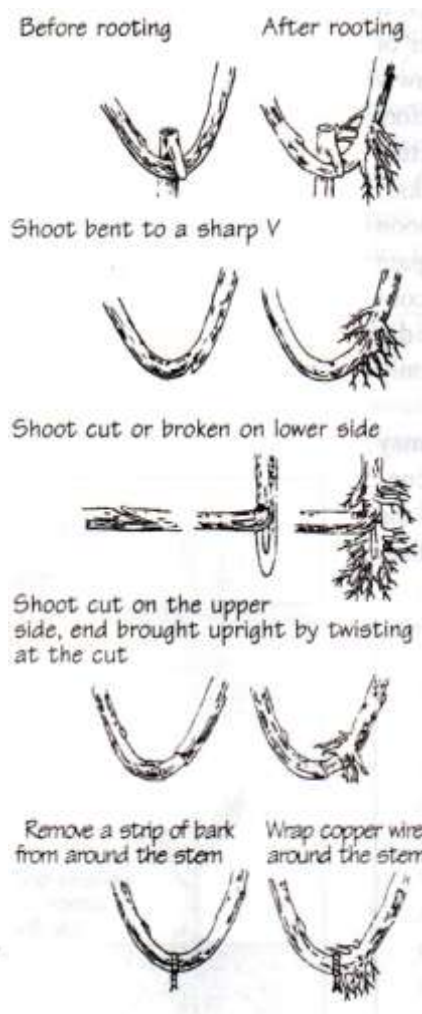
FIGURE 89
Planted garlic cloves

Layering

This can be done in 3 different ways.

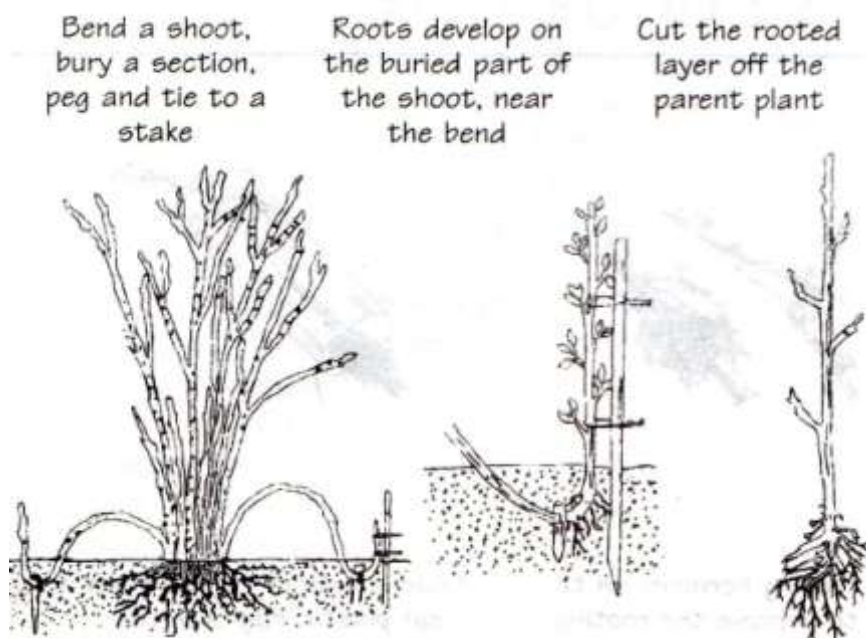
Layering for vegetables and other soft stemmed plants (right):

The simplest method of layering used for vegetables like tomato and cucumber is to bend the stem of a plant to encourage roots to form on the stem (right) while it is still attached to the plant. You can then cut the stem away from the plant, and plant it separately.



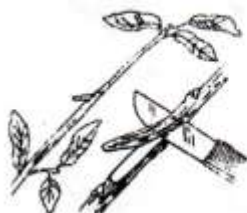
Ground layering for perennial plants (below):

Make small incisions in the growth nodes about 20cm from the growth tips, and bend the plant slowly over until it is lying on the ground. Peg it down with a wire or wooden peg. Over time roots will form where the nodes touch the ground and new shoots will grow up into the light. Once these shoots are established you can separate them from each other and the mother plant with a sharp knife and gently remove each plant from the ground taking care not to let the soil drop away from the roots, and transplant them. Water the ground well before removing the new plants from the ground.

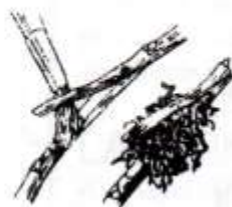


Air layering for fruit trees:

This is a method used to encourage root growth on woody stems by tying rooting material or growth hormone around the stem, and then tying it with plastic to retain the moisture in order to encourage root growth. For this reason, it is best to air layer in damp weather, checking regularly. If it looks as though it's drying out, then squirt some water under the plastic. Use clear plastic so that you can check on its progress. Once roots have formed, you can remove the stem from the parent plant in winter when growth slows, and transplant into a container. Place in a cool dry position until it is more established. Keep it well watered.



Choose a tip of a branch where the stem is less than one year old and has good buds. Cut a strip of bark on the stem about one hand (20 cm) from the tip of the stem and just below a leaf stalk or joint. Cut the strip of bark about as wide as your thumbnail (2 cm).



Put rooting hormone on the cut to improve the rooting. Put some rooting material under the strip of bark.



Slide a tube of plastic from a clear plastic bag over the branch. Use thin plastic bags that you can see through because this type of plastic allows air in.



Bind the lower end of the plastic tube with electrical tape or narrow strips of plastic.



Fill the tube with rooting material and bind the top end. The binding must start before the end of the plastic, especially on the upper end, so that water cannot move into the wrapping.



Support the layered branch by tying it to another branch or to a stick tied to the parent plant.

Grafting

Grafting is about joining two pieces of living parts of the plants (branch, stem, etc) from the same family to form a good variety of plant. Rootstock and *scion* must come from plants that can be grafted together. For example you can take a scion or top branch of a peach tree and join it with the same, or another rootstock. Some trees suffer from problems because their root stock is weak. For this reason, it is sometimes desirable to join one tree with a stronger root stock.

Plums and nectarines grow well on peach, and you can graft naartjies onto an orange tree's rootstock. This gives you variety in a small garden, where growing many different species of trees is not possible.

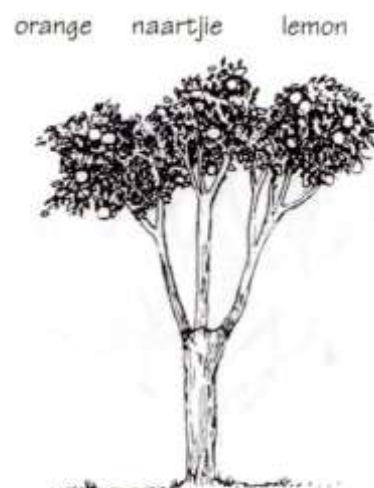
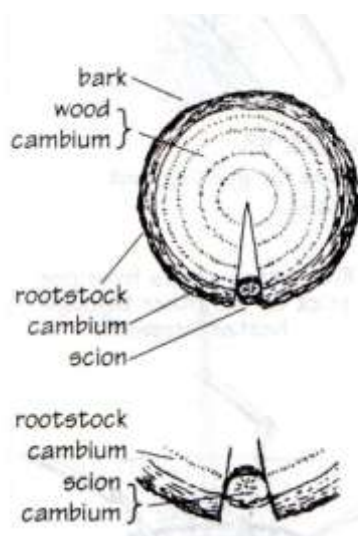
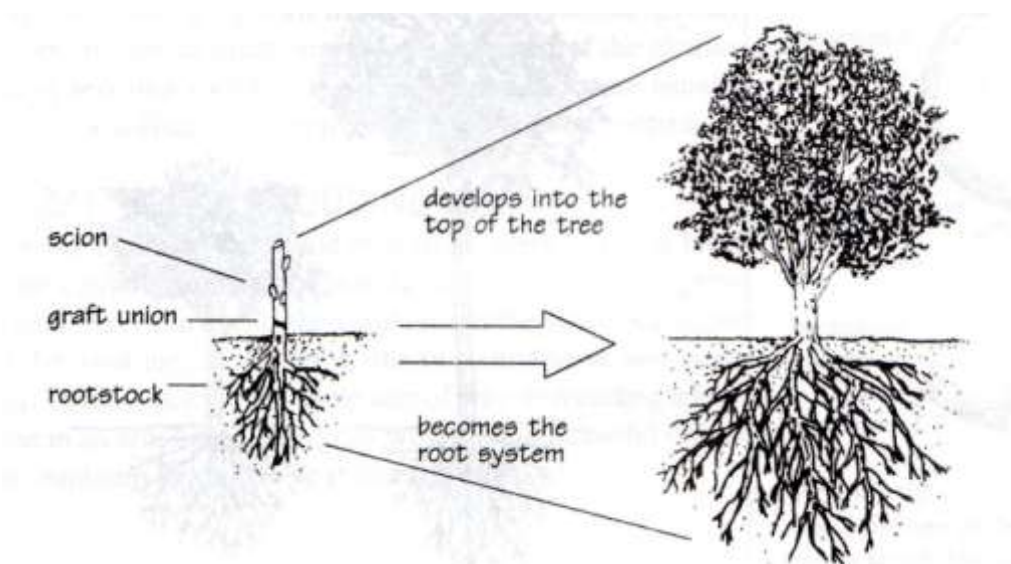


FIGURE 111
By topworking, it is possible to have two or more different cultivars of the same genus on the same tree

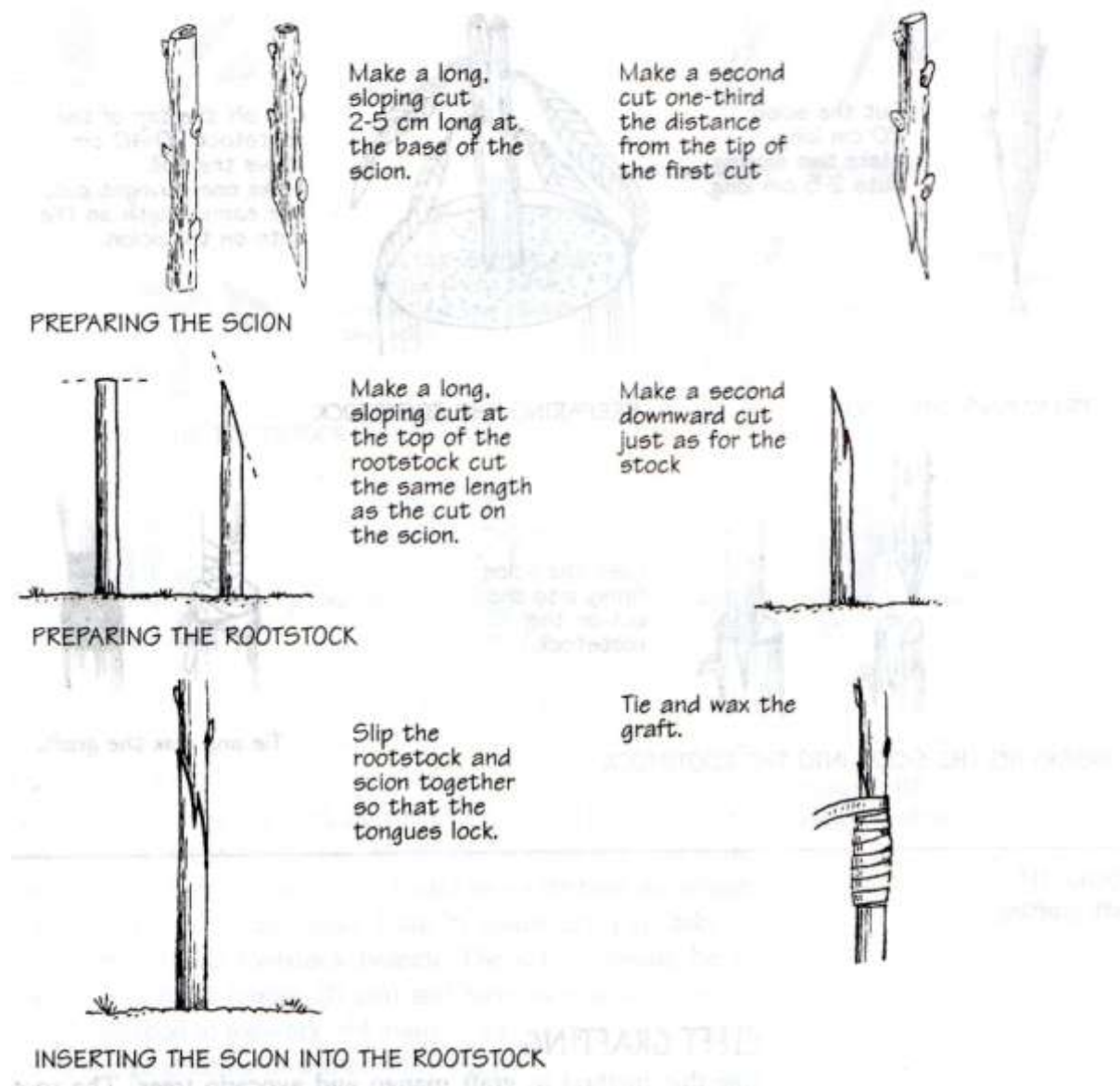


The *cambium* layers of both must touch. This is the layer of actively dividing cells between the woody part of the stem and the bark. Do not place the scion upside down. It is best to graft on a cool cloudy day. You must care for the graft until the rootstock and the scion are properly joined. The best time to graft depends on the method, but is safest during winter, when the trees energy is concentrated below ground. This will reduce the risk of 'bleeding'.

There are many grafting techniques, so we will cover two of the simplest here.

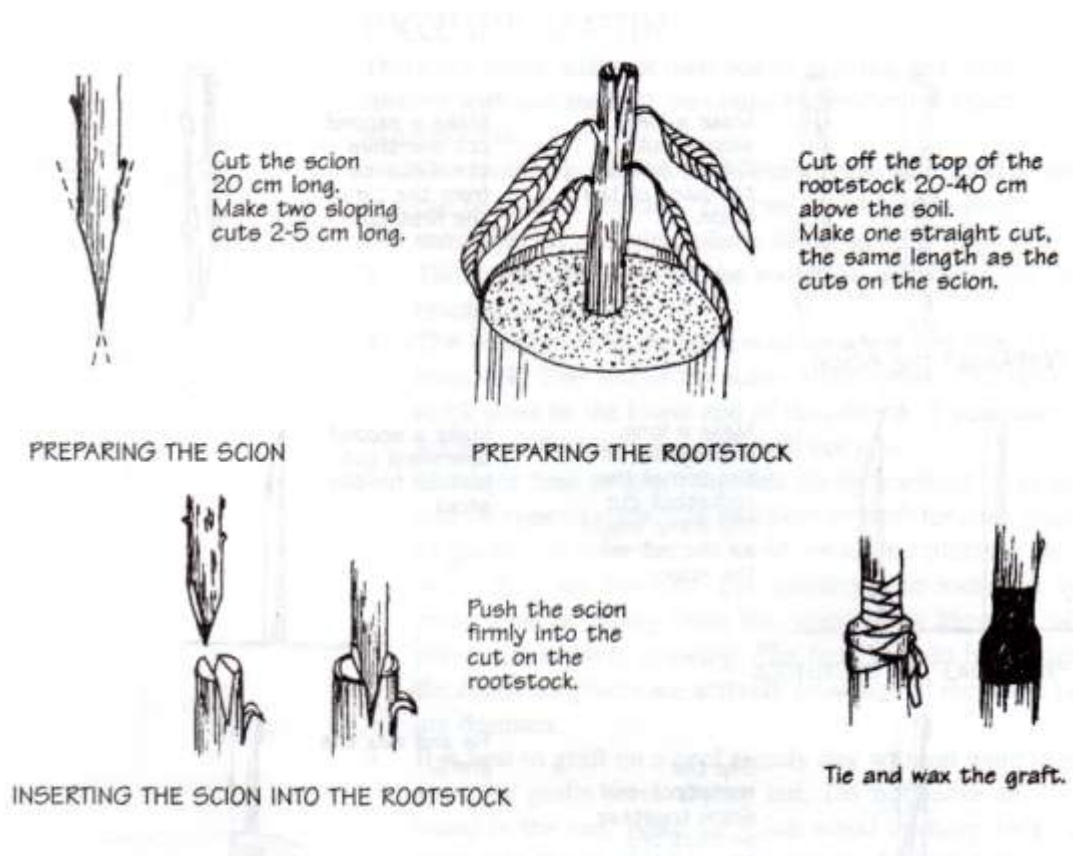
Whip or tongue grafting

This is used for thin stems - no wider than your thumb, and the root stock and the stem must be the same thickness. The scion should have three buds, and the with the grafting point cut below the third bud. Make clean cuts as these will stand a better chance of taking.



Cleft grafting

This is the method used for grafting mango and avocado trees. Root stock needs to be six to eight months old, or as thick as your finger. Again, the scion must be the same thickness as the root stock, and have three buds. Cut a clean graft point below the third bud.



Caring for grafted plants

- The first five days after grafting is critical.
- Check all grafts and re-wax them if there are sign of cracking.
- Cut off any shoots that appear from the root stock (below the graft point) as these will compete with your scions.
- Water regularly but do not feed with manure, compost or fertiliser during the first year as the graft needs to take before the tree grows rapidly.

Conclusion

In this module we have discussed methods of plant propagation using seed as well as from the vegetative parts of plants. You also learned about how to take care of the seedlings and how to transplant them effectively. You learned about when to propagate certain plants in South Africa, given the climate, and how to graft fruit trees.

Reflection points

- What are the advantages of sexual reproduction?
- Why is grafting important?
- What can you do to ensure that your seed stock keeps improving?
- What are the advantages and disadvantages of buying seed from seed companies?
- What should you do to ensure that you have a productive nursery?

Unit 12: Pests – Getting rid of unwelcome guests in your garden

LEARNING OUTCOMES

At the end of this Unit the reader should:

- Understand pests, disease and weed management
- Understand and design natural habitat for pest predators
- Understand and apply inter-planting
- Understand natural sprays for specific pests, make and use them
- Understand supportive strategies
- Know plants and their helpful insects
- Be able to control pests, diseases and weeds in the garden

Introduction

Pest, disease and weed management is an important part of Permaculture. There is nothing worse than seeing a crop destroyed, so it is important to plan ahead; to know what is likely to consume which part of your crop and have protective strategies. We examine the whole array of garden enemies in the broader environment, so that the actions we take to eliminate them don't have harmful consequences, like polluted water and dead bees. We look at ways in which to protect our harvest as well as the environment. Pest and disease control in Permaculture is an integrated holistic approach that creates health and vigour in a garden of diversity. If all the correct steps have been taken to source seeds, clear land, prepare soil and plant them; and in selecting plant and animal species carefully and in a system; combined with cultivation and management strategies that are in tune with the biological rhythms of the gardens, then effective pest control and disease resistance can be achieved.

What are pests?

These are insects and animals that affect the crop production systems. They are those animals and insects that are at the wrong place at the right time. Insect pests develop from eggs to larva to pupa and then to adult. For a gardener, the larval stage is the most dangerous of the pest's life-cycle.

The following chain will help you to set strategies for managing pests and diseases:

Seed – land preparation – inputs – production – harvesting – handling – consumption

Where do you need to focus attention on pest and disease management along this chain? What factors can increase pests and diseases in the garden and how can you manage them?

The following points need special attention when managing pest and diseases:

- Source of water: Untreated grey and black water can cause diseases in plants
- Quality management: Poor management of the garden can cause pest and diseases to multiply in the garden
- Buffer zones: Fields without buffer zones can allow the inflow of unwanted pollution and pest in the garden
- Hygiene: Lack of good hygiene in the garden allows pest to multiply and some elements can pollute vegetables. Home made pesticides, pest control methods (Too much of something is dangerous; proper measurements are encouraged, record and research on methods you are practicing)
- Soil management: Poor soil results in poor plants, and unhealthy plants are easily attacked by pests and diseases
- Type of compost: Poorly made compost is not good for the plants, and can spread diseases.

Prevention is better than cure. The better you prepare, the more you harvest.

Relationship between pests, plants and animals

Healthy soils lead to healthy plants and animals which lead to healthy people. If plants are attacked by pests and succumb to disease, it is a symptom of disharmony somewhere in the ecological processes of the garden. Pests and diseases are nature's dustmen and street sweepers; they come to remove weak and uncompetitive plants. What you see as destruction is natural selection at work, because in nature, space and energy want to go towards the healthy plants.

We need to realise that a pest is an organism in the animal kingdom that is doing what it is was born to do: Eat what looks as if it's dying. These organisms are actually on a mission to restore an out-of-balance system. We really need to fix the problem, not the symptom, and encourage a biological system of control that maintains a balance in the garden.

We can sit back and watch pests build up in the garden to encourage the immigration of predator species, or create spaces to attract them, so that further cultivating occurs in a more balanced environment. This can be likened to strengthening the immune system of the garden. But occasional epidemics occur and it is wise to treat them manually or through spraying herbal preparations. As the gardens evolve, these pests should become more scarce, especially if you are using good quality organic seed and genetic stock, that is appropriate to the environment.

Basics of pest control in Permaculture

Permaculture pest control systems: Chickens, ducks, companion planting and trap plants; creating habitats like wetlands and logs for pest predators; practicing non tillage and encouraging birds - these are the main strategies to prevent pest infestations. Avoid serious disease epidemics through companion planting, maintaining healthy soils, following the calendar and practicing good garden hygiene.

Learning from observing, collecting and identifying fauna in your garden

It is a good idea to collect the different species of insects you see in your garden, to stick them in a book and write down where and when you found them and on what plant. This will familiarise you with the insects that live in your garden and once you have identified them you will know whether they are predators, pollinators or pests. You have to devise a strategy to deal with pests and encourage the pollinators. Diseases also have to be identified and for this you

need one of the many organic gardening books listed in the appendix. Record the time and place of the infection. This process can alert you to gaps in your pest control system, tell you about your soil conditions and the quality of your genetic stock.

Pest and disease control

Control of caterpillar and larval infestations

Cut 1kg of fresh nettles. They can be in flower, but should not yet have formed seeds. Place the nettles in a wooden, clay or enamel vessel and pour 10 litres cold or lukewarm water on them. Leave this standing for 24 hours and then pour through a sieve. This extract helps against larval and caterpillar infestation and should be applied three times within several hours. It is sprayed finely over plants.

Control of fungal attacks

Reasons for fungal attacks relate to the use of improperly decomposed manure on the beds and the planting of seeds from poor quality parent plants, which grow the following year and are then susceptible to fungal attack. Add 10g of dried Casuarina leaves to 2 litres cold water. Heat and boil for 20 minutes. Let the tea cool. Now add a further 8 litres of water and stir well for 10 minutes. Strain the tea and spray in the evening (10 litres to 100 square meters), either under affected plants or as a preventive treatment. If trees show fungal growth, the trunks and thicker branches must also be sprayed. In cases of severe and prolonged attack, this treatment can be repeated on three consecutive evenings.

Control of slugs

Slugs breed in gardens that have a lot of water and when manure, that hasn't yet decomposed, is thrown on the gardens. Logs can be strewn around the garden to attract slugs and snails, so in the morning you can lift up the logs and collect them to feed the chickens. Encourage chickens and small ducks to live in the garden. Tobacco dust also kills snails.

Control of weeds

Liquid manure made from weeds, can be used to rid the garden of the same weeds. Often it is good to make the liquid manure from weeds that cannot go onto the compost heap. These are the runners, grasses and weeds with fleshy bulbs, that, if they invade your compost heap, will spread all over your garden. Collect all the weeds, take the roots and shoots - the entire plant if it is chickweed - and place them in a 210-litre barrel of water. Stir the contents around a little every day. Once the plants have completely decomposed in 2 to 3 weeks, the liquid is sieved and sprayed on the garden. Wherever these weeds grow, spray on three consecutive evenings, and this can cause them to disappear entirely.

Various sprays can be made from simple substances like garlic, onions, khakibos, tansy and soap. Intercropping with herbs like rosemary, lavender, and mint will also help to keep non-beneficial insects at bay. It is good to create a conducive environment in the garden to allow predator insects like ladybirds and wasps to control insect pests. Lizards and frogs are also useful for insect control. Birds and bats eat many insects and other pests.

Inter-cropping as a strategy to control weeds and disease

Inter-cropping means planting two or more different kinds of plants together in the same area. If there is a big area of one kind of plant, the pests are likely to thrive because diseases and pests can then spread so easily from one plant to another. Through growing different plants in the same field, that is, intercropping, you make it difficult for diseases and pests to spread. The alternative is to rotate crops, although some crops within the companion system will benefit from being moved the following season, such a root vegetables, to prevent the build-up of pathogens (fungus) in the soil.

Build healthy soils and retain wild plants

Healthy plants grow in healthy soil, which is well fed and well watered. Disease is less likely to spread in healthy soil. Leave areas of wild plants like fever plant, khaki bush, pig weed and wormwood between the different crops as this also helps to control pests and diseases. This will invite the many natural enemies of pests to move in from wild areas and protect your crop.

Identifying Problems & Pests

The pests that have been selected for discussion are those which tend to be common in South Africa as well as those that have a big negative effect on production.

How certain pests feed on crops:

Sign of damage	Pest
Chewed leaves	Caterpillar, locust and grasshoppers
Stem eaten away near ground	Cutworm, slages and snails
Leaves distorted many small green, black insects on sample	Aphids
Leaves with discolouration or damaged by small organisms	Red spider mites, sucking organisms
Leaves coated a light powder	Powdery mildew
Rusty red spots on leaves	Rust fungus
Blackened veins or vascular bundles	Bacterial wilt
Small wilted collapsed plant, wet soil	Bacterial wilt
Roots nodes	Nematodes

Predator (Useful Insect)	Food they like
Spider	Red spider mites, aphids
Lady birds	Aphids
Lizards	Caterpillars
Chameleon	White flies
Mole snakes	Slugs and snails
Frogs	Cut worms
Wasps	Aphids and white flies, Praying Mantis
Praying Mantis	Aphids and white flies

Attracting helpful insects into the garden

Plants	Helpful Insects
Amaranth	Ground beetle
Anise	Wasp
Asters	Spider
Chamomile	Hoverfly and Wasp
Cher	Hoverfly, Wasp and others
Chrysanthemum	Predatory thrips
Coreopsis	Syrphid fly
Clover	Ground beetle and woolly apple aphid parasite
Dandelion	Wasp
Daisy	Attracts wasps and bees
Fennel	Hoverfly and wasp
Goldenrod	Hoverfly, praying mantis and other predators

Hawthorne	Diamondback moth parasite
Hyssop	Hiverfly, wasp and others
Ivy	Hoverfly and wasp
Marigold	Hoverfly
Milkweed	Several parasites
Mints	Hoverfly, wasp and others
Mustard	Various parasites
Ragweed	Parasites of Oriental fruit moth and strawberry leaf roller
Soybean	Wasp

Plants	Helpful Insects
Stinging nettle	Many
Strawberry	Parasites of oriental fruit moth
Sunflower	Lacewing and wasp
Tansy	Ladybug
Yarrow	Ladybug and wasp

Plants to use for repelling specific pests

Plants for Spray	Animals Repelled
African wormwood	Plant as screen in garden as windbreak for vegetables. It repels most flies, including whitefly
Eboza	Good as a small hedge plant or live fence. Repels bagrada bug which eats vegetables.
Elderberry	Aphids, carrot fly, cucumber beetle, peach tree, borer and root maggot
Eucalyptus / gum tree	Great for seed storage; however permaculture does not encourage planting of gum trees – so use whats available

Fennel	Most plants dislike fennel, so it is good to plant at the edge of the garden. It attracts predatory wasps in the garden.
Fever plant	Plant as a live fence or windbreak. The smell of the plant repels a wide variety of pests in the garden
Garlic	General, plant near roses, raspberries, carrots, cabbages to improve growth of the plants.
Horseradish	Plant at corners of potato beds for repelling potato bugs. Good for fruit tree, spray the fruit trees just after flowering before fruiting
Horsetail	Slugs
Marigolds	Excellent pest repellent. Plant in all corners of the garden to keep bean beetles, nematodes, aphids, mosquitoes, and a wide variety of other pests away.

Plants for Spray	Animals Repelled
Marjoram	Improves flavour of the crops, vegetables and other herbs.
Mint	Plant mint with cabbages, pig weed, tomatoes, repels potato beetle, ants, white flies and cabbage moth.
Nasturtium	Plant with tomatoes as it improves their flavour and repels white flies and red spider mites.
Parsley	Repels asparagus beetle, plant it with onions or create border for a variety of vegetable beds.
Pepper (hot)	Plant with cabbages and maize to repel cabbage moth. Plant the borders of vegetable beds to repel most flying pests.
Pig weed (theepe)	Plant it with potatoes, onions, corn, and sweet potatoes, thin the weeds for green manuring or mulching. Good for returning nutrients to the soil.
Rhubarb	Repels black spot. Plant on the borders of the beds, good for preventing soil erosion.
Rosemary	Grow rosemary with cabbages, beans, sage, tomatoes, carrots to repel cabbage flies, bean beetles and carrot flies.

Rue	Planted as a screen it repels flies, mosquitoes and other insects
Sage	Grow sage with cabbages, beans, rosemary, tomatoes, carrots to repel cabbage flies, bean beetles and carrot flies.
Southern worm	Cabbage worm
Thyme	Repels cabbage worm. Plant it on the borders of the cabbage beds.
Tomato	Asparagus beetle, plant with nasturtium, and coriander.
Wormwood	Repels flea beetle and plant it as a border plant.
Yarrow	Plant along borders, paths and near aromatic herbs. Attracts predatory wasps.

Conclusion

In this module you have learnt that there are many inexpensive and environmentally friendly ways of preventing diseases and pests in gardens. You have also learnt how to treat them should they arrive uninvited, by using your own concoctions and sprays and practising inter-cropping, crop rotation and balanced garden systems.

Reflection points

- What are the main pests in your garden
- What kind of solutions have you learnt about to deal with the pests in your garden?
- Examine the different plants growing in your garden for diseases.
- Look for 10 plants that repel or kill pests.
- What is a weed and why should weeds be removed?

What do you see as the disadvantages of using inorganic chemicals to control pests and weeds?

Unit 13: Harvesting

LEARNING OUTCOMES

By the end of this Unit the reader should have learned about:

- Proper times for harvesting
- Effective methods of harvesting

Introduction

It is important for you to know how to harvest in a timely and appropriate manner in order to avoid loss of garden produce. For a good harvest, proper techniques have to be implemented and this module will help you understand how to harvest different crops. This module also explains how to harvest selected and commonly grown garden crops.



Harvesting of specific crops

The following information is a step-by-step process for harvesting individual crops.

- Amaranth: Leaves can be harvested from 30 to 50 days after sowing. Harvest the whole plant or cut the leaves down to 15cm to allow the plant to regrow.
- Beans: Pick beans seven to ten weeks after planting before they become hard and leathery. Pick twice a week. The more you pick the more beans your plants will produce.

- **Beetroot:** Pull the young beetroot (beets) from the ground while they are still quite small. This will be about 7 weeks after sowing. Continue to pull as required. You may need to use a fork to help ease later crops, or those in heavy soils, from the ground. If possible, do not break the thin root attached to the bottom of the globe, because this will “bleed”, causing the beetroot to lose a lot of its colour. For a similar reason do not cut off the leaves; instead, twist them off, leaving about 5cm on the beet. Beetroot leaves can be eaten like spinach.
- **Broccoli:** Pick eight to 10 weeks after planting when the heads are firm and before the little yellow flowers appear.
- **Cabbage:** Pick 10 to 12 weeks after planting when the heads are firm (20 to 30cm across) and before they start to split open. Cabbages are harvested by cutting with a sharp knife just below the lowest leaves. The roots should be dug up, smashed up and used for compost making.
- **Carrots:** Harvesting begins at a very early stage as part of the thinning-out process, although they are so small they take time to clean. Early carrots can be dug up from late spring onwards, approximately 7 weeks after sowing. Main crop carrots take a bit longer and are ready from 10 weeks onwards. Leaves are 15cm and 20cm high. Shorter varieties can be pulled, but longer ones and those that have been growing in heavier soils will need digging out with a fork.
- **Cauliflower:** Pick 10 to 12 weeks after planting when the heads are firm and measure 10 to 15cm. Break the outer cauliflower head to protect it from the sun. This will stop the heads from turning brown.
- **Eggplant:** The skin of eggplant (also called brinjal and aubergine) becomes tough as they mature and the flesh becomes fibrous. It is therefore best to pick the fruit while they are still slightly immature, when the skin is shiny and the flesh slightly soft when pressed. The plants continue to produce fruit over a long period. Pick 12 weeks after planting when they are firm and shiny.
- **Lettuce:** Lettuces can be harvested whole or leaves can be taken from the plants as required. The loose-leaved varieties are usually picked leaf by leaf. Cabbage-type varieties can be picked in the same way. Those that form a head should be picked as soon as they feel plump and firm. Do not leave them in the ground for too long after maturing, because they may bolt. Pull the whole lettuce from the ground or cut below the bottom leaves if you want the plant to resprout. Loose leaved varieties mature earlier, and leaves can be picked as soon as they are large enough, which is usually from about 7 weeks after sowing.
- **Green peppers:** Pick 10 to 12 weeks after planting when they are firm. The pepper should be 8cm to 12cm long. Do not let them get soft.
- **Kale:** Harvest from the top of the plant at the growing point between 60 to 80 days from transplanting. You should leave behind any old or yellowing leaves. Remove these side shoots for eating when they are 10cm to 15cm long.
- **Maize:** Pick 10 to 12 weeks after planting when the cobs are full and the hairs on the end are brown and dry. Hold the plant by one hand while twisting or breaking off a cob.
- **Onions:** These vegetables take up to 5 months to be ready. Wait until the leaves are dry and brown. Pull them out and dry them in the shade.
- **Peas:** Pick the pods as soon as the peas have swollen and are large enough to eat. Mangetout (snow) peas and similar types should be picked before the pods get tough. Keep picking the peas as they mature. The peas of many modern varieties, which have been created for agricultural needs, mature at the same time, and this can be a problem for the garden. Pick peas 10 to 12 weeks after planting when the pea pods are hard and dark green. Do not wait until they are hard and leathery pick twice a week.

- **Peppers:** The first fruits can be harvested 60 to 80 days after transplanting. The fully ripe fruit are usually red but some varieties produce yellow fruit. You can also use the fruit when they are still green. The plants continue to produce fruit over a long cropping period. Cut fruit from the plant when they are as ripe as you want them.
- **Potatoes:** Pick three months after planting when the leaves and the stems are dry. Dig them out with a fork, taking care not to damage the crop.
- **Pumpkin:** Mature fruit can be harvested from 3 to 4 months after sowing. Harvest when the skin is beginning to harden and before the seeds are ripe. Tap them and listen for a hollow sound. Some also wait until the stalk withers, when no more goodness will be transferred to the fruit.
- **Shallots:** When the foliage shrivels in midsummer, ease the shallots from the soil with a fork. Place them on staging in a greenhouse or on racks of wire netting to dry. Once the leaves have completely dried, remove any damaged or diseased ones.
- **Soya beans:** You can harvest the crop about 120 days after sowing. The plants should be pulled out or cut and heaped in rows to dry. The plants are then threshed.
- **Spinach:** Start harvesting as soon as the leaves are big enough, which is usually 8 to 12 weeks after sowing. Do not strip the plant, but just take a few leaves to start with and until the plants are mature. Break or cut the stems, but avoid pulling because this may loosen the plant and precipitate bolting. Continue harvesting until the plants start to run to seed, that is when the central stem starts to elongate. When harvesting winter spinach, do not over pick.
- **Spring Onion:** Spring onions (scallions) are ready for use at about eight weeks from sowing. Simply pull them the ground. If the soil is compacted, they can be eased out with a hand fork.
- **Tomatoes:** Pick carefully eight to ten weeks after planting when they are almost red. Be careful not to break the branches. Leave a short green stem on the tomatoes, so that they stay fresh longer.
- **Turnips:** Pick seven to nine weeks after planting when the roots are 5cm across or bigger. Turnip leaves can be eaten like spinach.

Conclusion

In this module you have learnt about the proper timings for harvesting and how to harvest at least 15 different types of plants that are commonly found in gardens and fields in South Africa.

Reflection points

- What are the key considerations in deciding when to harvest?
- What kind of problems could you face if you harvested a crop too early?
- What sort of problems are you likely to face if you harvest after the appropriate time?

Unit 14: Collecting & storing seed

LEARNING OUTCOMES

By the end of this Unit the reader should have learnt about:

- How to select appropriate seed
- Basic ways of saving seed
- Reasons for seed saving by farmers and gardeners

Introduction

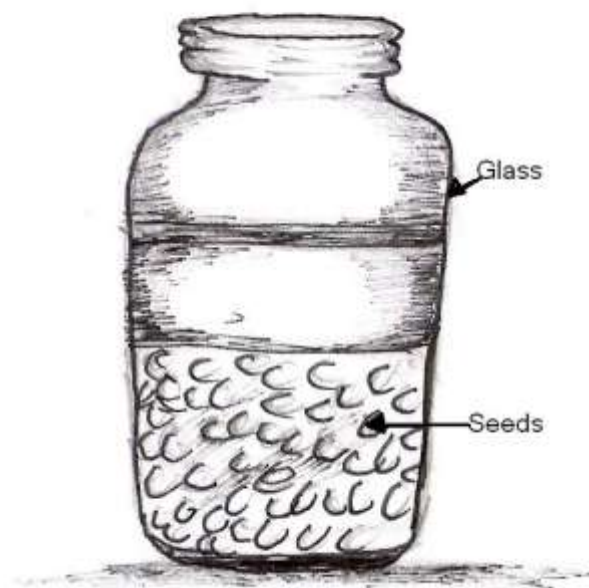
Seed is the reproductive part of a plant which is produced when the male and female parts of the flower meet during pollination. Seed saving is a very important step towards creating and sustaining livelihoods. Firstly, it is the natural cycle of a plant: a seed germinates, grows into a plant, produces food, reaches maturity, flowers and goes to seed, which will then germinate and begin the cycle again. Saving seed is important because it allows us to select strong, disease-resistant plants, often adapted especially for the environment in which it is grown. Saving our own seed gives us independence to cultivate plants without having to buy seed and rely on seed companies.

Hybrid seeds are a product of crossing two plant varieties, which produces plants that can be highly productive if accompanied by the necessary environmental conditions (rainfall/soil) alongside fertilizer and chemical support. The disadvantages of hybrid seed is that they are unstable, if exposed to less than ideal conditions. Another disadvantage is that they produce less in the second generation and are therefore not good to save and multiply. This can result in farmers having to depend excessively on seed, chemical and fertilizer companies, without a guarantee that these inputs will increase yields. The result is that over-reliance on soluble fertilisers without adding organic matter can seriously deplete soil nutrients. The combination of decreasing soil structure and ever-reducing yields can get many farmers deeper and deeper into debt.

There is another kind of seed that can be produced by inserting genes from an unrelated family of plants or even animals. The resultant seed and plant is called a Genetically Modified Organism (GMO). Although GMOs are meant to reduce the cost of pesticides and other chemicals, the reality has been found to be somewhat different. The resulting impact on the ecology and on the independence of the farmer to choose, improve and multiply seed is negative. While the effect of GMOs on health is not well understood yet, the fertilisers that they depend upon is. These have been found to reduce T-cell proliferation, damaging the body's immune system (increasing susceptibility to HIV infection, and opportunistic infections for those already living with HIV/AIDS). For these reasons, GMOs and chemical inputs are discouraged in Permaculture.

Seed saving techniques

We want to choose our strongest, healthiest plants for seed. Do not save seed from unhealthy or poor producing plants, as the characteristics of the plant you choose for seed will be passed on to the next generation. Look at size, flavour, resistance to pests and disease, and the general condition and performance of the plant throughout its growing season.

Seed storage in a glass jar

Collection

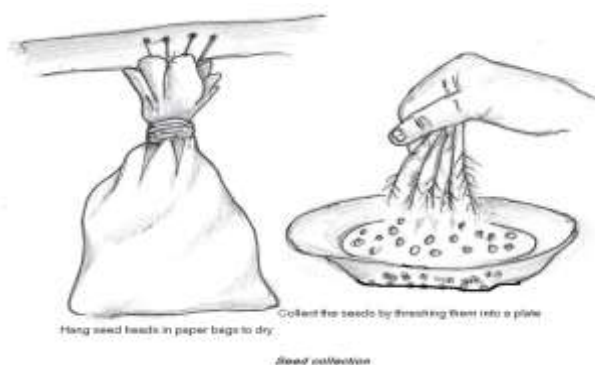
Collect seed on warm dry days. Collect seed from pods and flowers when they are dry. Collect seed from soft fruits and vegetables when they are ripe.

Release seed from pods

Clean away as much organic material as possible. Soft fruit seeds such as tomato can be rinsed before drying or spread out onto paper and then dried. Check for insects, insect damage and disease.

Seed cleaning

- Boil water in 2 tins or pots
- Leave one tin of water to cool so that the water does not burn your hand or until it is at a temperature of between 52 and 54 degrees Celsius
- Put the seed in a bag made of cloth
- Put the bag with the seed in the tin with water that has cooled down
- If the water becomes too cold remove the bag and add boiling water from the other tin
- Do not pour the boiling water directly onto the seed. It will destroy the seed
- Put the bag with seed back into the cool water and stir continuously
- Put the seed onto a newspaper and place it in the shade to dry
- Treat the dry seed with a low-toxicity fungicide like sulphur dust, before planting or storing



Storage

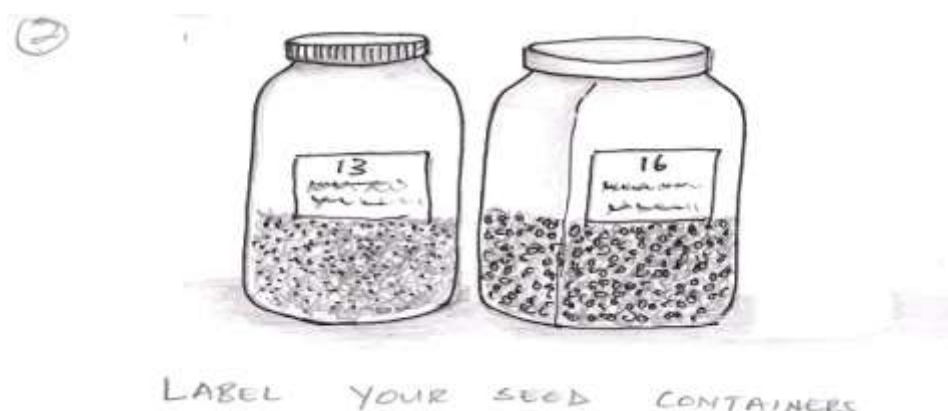
Seeds should be dried well before storing. They should be stored in a warm dark and dry environment. Seeds can be stored in glass jars, film canisters, envelopes and paper bags. Be sure there is no moisture inside the containers and store in a cool dry place. Dusting the seeds with wood ash protects seed against insects. So can dried khakibos and layers of eucalyptus leaves.

Protection of seed from pests and disease

Protect seeds from pests and diseases by mixing the seeds with strong smelling plants like *Lippia javanica*. *Lippia* repels most unwanted insects that can attach and destroy seeds. You can also use wood ash, smoke, chillies, tephrosia leaves, khakibush, marigold, neem powder or garlic to protect seeds.

Seed labelling

Label seeds with the variety, date and any other essential information. The date is important so that you know when the seed has lived for too long to germinate and grow properly. The seed type and variety helps you to be precise when choosing what you would like to grow.



Testing seed

Test your seeds by putting them into a jar of water. The seeds that sink to the bottom are alive; the ones that float have air pockets, indicating that they are dead.

Seed banks

One way of ensuring that seed continues to be available is to multiply it and store it in a place where others have access to it. Some communities are known to have seed banks which farmers use to share seed and to multiply. This increases their ability to secure seed for the future. Some individuals go further and keep seed for multiplication and sell to others. The sale of certain types of seed may be prohibited in some countries where only certified seed should be sold.

Conclusion

In this Unit you have learnt various ways of harvesting and saving seed. In addition you learnt about how to store seed properly and protect it from pests and diseases. This enables you to make informed decisions on how best to preserve seed.

Reflection points

- Why is it important for farmers and gardeners to save seed?
- What should you do to ensure that the quality of seed remains good before it is planted?
- What kind of seeds in your community tend to be kept for multiplication by farmers and why?
- Suggest reasons why some traditionally grown varieties are no longer saved by farmer

Unit 15: Recipes & food hygiene

LEARNING OUTCOMES

By the end of this Unit the reader should have learnt about:

- Different ways of preparing food
- How to cater for those affected by HIV/AIDS
- Key considerations when preparing and storing specific foods

Introduction

As a way of concluding the manual, we will discuss a few recipes and remedies that you could use to benefit from the Permaculture garden and fields. Apart from the ecological importance of Permaculture, you can eat good food and be healthy, as well as cure some of the common diseases that might affect you. Always keep the kitchen hygienically clean and wash hands before preparing food, and before serving and eating.

Cooking with Herbs

Below are tips on what kind of herbs go together with different dishes. There are some herbs that combine well with fish and others that are suitable for salads.

- **Fish:** Basil; chives; chervil; coriander leaves and seeds; dill; fennel leaves, seeds and bulb; garlic; ginger; horseradish; fresh lemon balm; fresh lemon grass; marjoram; oregano; parsley; fresh rocket; tarragon and thyme.
- **French dishes:** Bay leaves, chives, chervil, garlic, parsley, rosemary, sage, tarragon and thyme.
- **Fruit:** Fresh Bergamot leaves and flowers, fresh young borage leaves and flowers, fresh lemon balm leaves and fresh lemon verbena leaves.
- **Indian dishes:** Coriander seeds, curry plant, fennel seeds, garlic and ginger.
- **Game:** Bay leaves, fresh parsley and rosemary.
- **Lamb:** Basil, bay leaves, coriander leaves and seeds, dill, garlic, ginger, lemon balm, marjoram, mint, parsley, rosemary and thyme.
- **Mexican:** Coriander leaves and seeds, oregano and parsley.
- **Pork:** Anise leaves and seeds, coriander leaves and seeds, dill leaves and seeds, garlic, ginger, marjoram, oregano, sage and thyme.
- **Potatoes:** Chives, dill leaves, garlic, parsley, rosemary and thyme.
- **Salad dressing:** basil, chives, coriander, dill, garlic, ginger, horseradish, lemon grass, parsley, rosemary, tarragon and thyme.

- **Salads:** Basil, Bergamot leaves, and flowers, young borage leaves and flowers, chervil, coriander, young dandelion leaves, finely sliced fennel bulb, nasturtium leaves and flowers, parsley, rocket, salad burnet and watercress.
- **Sauces:** Basil, bay leaves, chives, dill, garlic, ginger, mint, parsley, sage and tarragon.
- **Tomatoes:** Basil, chives, garlic, marjoram, oregano, parsley, rocket and thyme.

Tips on how to prepare selected dishes

Beans and tomatoes (easy and fast to prepare)

You will need: 1 cup (250g) soaked beans; 1 cup (250g) chopped tomatoes; parsley; basil leaves and grated cheese.

Method

7. Boil beans until soft (don't add salt)
8. Add tomatoes
9. Bring to the boil and simmer slowly for ten minutes
10. Add freshly chopped herbs
11. Sprinkle grated cheese over before serving

(You can also add minced meat. If adding or chopped leafy greens then add these to and simmer at the end to prevent the loss of nutrients)

Bean Broth

You will need beans, water and salt.

Method

- Boil the beans, using more water than usual, until they are well cooked and then add salt. Drink the broth or use it with other soups
- Serve to family who do not have diarrhoea

(You can also boil rice, maize meal or millet with the broth to add carbohydrates for more energy)

Beef and lentils

You will need minced beef onion, margarine, lentils (soaked overnight), carrots, salt, pepper, water, spinach or other green leaves and lemon juice.

Method

- Lightly fry beef and chopped onion for 5 minutes in a large saucepan
- Add margarine
- When meat is brown add lentils, chopped carrots, salt and pepper
- Add water, cover and cook until lentils are tender (about 30 minutes)

- Add chopped green leaves and boil another 5-10 minutes
- Add a squeeze of lemon juice to serve

Carrot and turnip soup

Ingredients

- 1 x Onion
- 4 x carrots and
- 2 x turnips
- 2 pints of water
- salt
- Fennel and parsley

Method

- Lightly brown the onion with a small amount of oil or margarine
- Chop carrots and turnips and bring to the boil in water
- Cook slowly until soft, strain off the water, and then mash
- Add salt and serve with freshly chopped fennel and parsley

Chicken stew (to serve 4)

Ingredients

- 4x pieces of chicken
- 2 x onion
- 1 x clove garlic
- oil
- 4 x potatoes
- 3 x carrots
- ¼ pumpkin
- 1 x pint water
- generous handful of green vegetables steamed on top with the lid on.

Method

- Prepare onion and garlic in a little oil
- Add the chicken, potatoes, carrots and pumpkin
- Add water just to cover, and bring to a boil
- Mash vegetables and chicken together
- Place finely chopped greens to the top of the mixture and return the lid.

- Simmer gently to steam the greens Bring to the boil and then *simmer until vegetables are soft
- Mash vegetables and chicken together
- Add finely chopped greens before serving

(If you have a sore mouth, cook the stew without the chicken and mash the vegetables until smooth. Cut the chicken into small pieces, cook separately and then add to the vegetables)

Maize samp and cow peas (Umngqusho)

Ingredients:

- Water
- Maize samp
- Cow peas (dried or raw)
- Sugar
- Sunflower
- Salt
- Parsley

Method:

- Wash cow peas and samp
- Add both to boiling water in a saucepan
- Simmer for 1 hour and 30 minutes, replenishing water when necessary to obtain a soft, but not watery consistency
- Add salt, parsley and sunflower oil
- Let it simmer for another 30 minutes

Sorghum and Dried Beans (ikhobe)

Ingredients:

- Water
- Wheat (whole grain, raw)
- Sorghum (whole grain, raw)
- Beans (dried, raw), sugar
- Sunflower oil
- Salt
- Thyme or rosemary

Method:

Wash sorghum and dry beans. Add 100g of water in a saucepan with grains. Simmer for 1 hour 30 minutes. Add salt, herbs and sunflower oil. Let it simmer for 30 minutes.

Beef Meat stew with vegetables

Ingredients:

- Water (pint)
- Beef (fatty, raw)
- Onion x 1
- Carrot, fresh only, raw x 2
- Tomato, fresh, raw, with skin x 4 medium size
- Sunflower oil x table spoon
- Salt x 1 pinch
- Tablespoon herbs

Method:

Lightly brown the beef in a little oil until tender. Add vegetables and garden herbs (thyme or rosemary) and salt to the meat. Pour over the water and simmer for 20 minutes without the lid to allow the mixture to thicken.

Chicken heads and feet with Mabele pap

Ingredients:

- Water
- Chicken feet, raw
- Chicken heads, raw
- Salt
- Tablespoon thyme
- Table spoon fennel

Method:

Dress the feet and heads. Cook for 20 minutes. Add salt, fennel and thyme leaves, simmer for 10 to 15 minutes. Serve with mabele pap.

Mutton stew with vegetables

Ingredients:

- Water
- Mutton, raw
- Onion
- Carrot, fresh, raw
- Potato (keep skins on for more nutrients)
- Sunflower oil
- Salt
- Rosemary

Method:

Cook mutton for 1 hour. Add chopped vegetables, rosemary, oil and salt. Simmer for 30 minutes. Serve with mabele pap or brown rice.

Jolof Rice

Ingredients:

- Serves 5 people
- 4 tbsp peanut or other vegetable oil
- 1 x 2.5kg chicken, cut into serving pieces
or about 2kg chicken pieces
- 450g lean stewing beef, cubed
- 2 medium-size onions, chopped
- 1 garlic clove, finely chopped
- 2 large ripe tomatoes, chopped
- 2 tsp tomato puree
- 1 hot green chilli (fresh or canned), finely chopped
- ¼ tsp cayenne pepper
- 450g smoked ham, cut in medium-sized cubes
- 200g long-grain white rice
- 1 chicken stock cube
- 1 beef stock cube
- 1 head of cabbage (about 500g), washed and cut into 8 pieces, to serve
- 1 aubergine (about 400g), peeled and cut into chunks, to serve
- 1 small pumpkin (about 600g), peeled, seeded and cut into chunks, to serve

Method:

- Heat half the oil in a heavy saucepan over medium heat and brown the pieces of chicken and beef. Remove them from the pan and set aside.
- Reduce the heat and add the remaining oil. Add the onions and garlic and cook for 3-4 minutes.
- Add the tomatoes, tomato puree, chilli, salt and cayenne to the onions and garlic. Stir and cook for 5 minutes.
- Transfer the mixture to a deep saucepan. Stir in the cubed ham and rice and crumble over the stock cubes. Pour in enough water to cover the mixture by about 15mm (½ in), bring to the boil, cover and reduce the heat to low. Cook about 20 minutes or until the rice is cooked and the chicken is tender.
- Remove the rice mixture from the heat and let it sit, covered
- Meanwhile, boil or steam the cabbage separately from the aubergine and pumpkin chunks until all are just tender.
- Serve the vegetables with the Jolof Rice.

Each serving provides:

- Kcal: 1739
- Protein: 197.4g
- Fat: 82.1g (of which saturated fat: 22.4g)
- Carbohydrate: 53.8g (of which sugars: 17.3g)
- Fibre: 8g

Nutrition Points:

- This dish is high in vitamin B6 and in zinc and folic acid.
- This dish contains a moderate amount of vitamin C.
- This dish contains a low amount of calcium.

Serving Suggestions:

- Use brown rice for added nutrients, but add a little more water.
- For a different vegetable side dish, try a mixture of carrots, leeks or broccoli.
- If you can't buy smoked ham, use an un-smoked ham.
- Jolof Rice is made in many ways over much of central and southern Africa, so be creative. For instance, you can make your version with raw pork instead of ham (just be sure to brown your pieces of pork along with the chicken and beef) - or leave ham or pork out altogether!

Peanut Stew with chicken

Ingredients:

- Serves 5 people
- 2 tbsp olive, sunflower or other vegetable oil
- 1 medium-sized onion
- 170g peanut butter (about ½ of a medium-sized jar)

- 450ml vegetable or chicken stock (made up with 450ml boiling water and about $\frac{3}{4}$ crumbled stock cube)
- 1½ x 200g tins (300g) of chopped tomatoes
- salt and pepper
- $\frac{1}{4}$ tsp cayenne pepper
- 75g cabbage, finely chopped
- 1½ -2 medium-sized sweet potatoes, chopped into large bite-sized portions
- 2 medium-sized carrots, chopped
- 6 okra pods, stems trimmed
- 5 large chicken portions, cooked
- 500g polenta (or cornmeal), to serve

Method:

- In a large saucepan over medium-low heat, gently fry the onion in the oil until it is soft.
- Add the chicken or vegetable stock, peanut butter, canned tomatoes and cayenne pepper and season with salt and pepper. Let the mixture cook a little until the ingredients are well blended.
- Add the cooked chicken portions and stir to coat them with the tomato mixture. Stir in the sweet potatoes, and let them simmer until just tender.
- Add the cabbage, carrots and okra, reduce the heat, cover and cook until the vegetables are ready.
- Meanwhile, prepare the polenta (or cornmeal) by whisking it into boiling water according to packet instructions with $\frac{1}{4}$ to $\frac{1}{2}$ tsp salt. Simmer the mixture, stirring occasionally, until the mixture is thick enough (according to your preference).
- Serve each person a chicken portion and a portion of the polenta, topping them both with some of the peanut stew.

Each serving provides:

- Kcal: 780
- Protein: 42.5g
- Fat: 45.9g (of which saturated fat: 10.4g)
- Carbohydrate: 51.3g (of which sugars: 19.8g)
- Fibre: 9g

Nutrition Points:

- This dish is high in vitamin C.
- This dish has a medium amount of zinc.
- This dish is low in saturated fat.

Serving suggestion:

- Instead of polenta try serving this stew with Cornmeal Dumplings (see side dishes) or, for extra nutrients, or serve it with brown rice.

Coconut Pudding

Ingredients:

- Serves 5 people
- butter for greasing
- 2 eggs
- 2 tbsp sugar
- 240ml coconut milk
- 1 banana, peeled and mashed
- 125g freshly grated coconut
- ¼ tsp ground cinnamon

Method:

- Heat the oven to 180C/350F/gas 4. For 5 portions, butter a 500ml capacity baking dish.
- In a large mixing bowl beat or whisk the eggs until pale and creamy. Add coconut milk slowly, while beating the mixture.
- Beat in the mashed banana. Add the grated coconut and stir well. Pour the mixture into the buttered baking dish, sprinkle with cinnamon and bake for 45 minutes. Serve hot, cooled or chilled.

Each serving provides:

- Kcal: 167
- Protein: 3.7g
- Fat: 11.4g (of which saturated fat 8.5g)
- Carbohydrate: 13.2g (of which sugars 12.7g)
- Fibre: 2g

Nutrition Points:

- This dish is high in potassium.
- This dish contains a medium amount of vitamin E.
- This dish contains low amounts of vitamin C and vitamin B6.

Recommendations for lack of appetite

- Try different foods until you find those that you like and try to have a mixed diet.
- Eat smaller meals more often.
- Eat whenever your appetite is good. Don't be too rigid about fixed times for meals.
- Try to eat and drink a lot of water, milk, yoghurt, vegetable soups, herbal teas or juices throughout the day.
- Drink mainly after, and in between meals - do not drink too much before or during meals.
- Add herbs like thyme to food and make it look and taste interesting.

- Avoid fizzy drinks, beer and foods such as cabbage, broccoli and beans that create gas in the stomach and can make you feel bloated.
- Try rinsing your mouth out before eating as this can make food taste fresher.
- Take light exercise such as walking outdoor, for example, and breathing plenty of fresh air to stimulate an appetite.
- Eat in a well-ventilated room away from cooking or unpleasant smells.
- Eat with your family or friends. If you have to stay in bed, they can join you at your bedside.
- Avoid alcohol. It reduces appetite, weakens the body and interferes with medicines.

Recommended foods for someone with vomiting problems

- Eat soft foods and go back to solids foods when vomiting stops.
- Try not to lie down until one or two hours after eating.
- Drink plenty of fluids after meals.
- Drink fennel, ginger and thyme tea.
- Take vegetable soup, especially celery, parsley and turnips.
- Try not to prepare food yourself.
- Drink lemon juice in hot water or in herbal or ginger tea.
- The smell of preparing or cooking food may worsen the feeling of nausea.
- Ask somebody to prepare food or eat foods that require little preparation.
- Keep drinking small amounts of water, soups and spice teas.

Strategies to deal with colds, coughs and influenza

- Drink plenty of water or other fluids and have plenty of rest.
- Prepare special teas for colds and drink them for as long as symptoms last.
- A cold normally lasts about a week. If it lasts longer, or other symptoms are present such as a high fever or a cough with lots of mucous, blood or odorous discharge, see a health worker because there may be an underlying infection.
- Coughing is how the body cleans the lungs and throat by getting rid of mucus and germs. Therefore, do not take any medicines to stop coughing but try to loosen the mucus.
- Breathe in hot vapours. Take a bowl or pot filled with very hot water and covers the head with a towel. Breathe in the vapours deeply for ten minutes, twice a day. Artimisea afra, mint or thyme leaves can be added. Hot water can work on its own.
- Try garlic tea or cough syrup to ease the symptoms.
- Drink lots of water or other fluids.

Solutions for people living with HIV/AIDS

Energy drink

The ingredients are a large clove of garlic, turmeric, finely chopped fresh or ground ginger, water and milk.

Method:

- Boil together all the ingredients
- Simmer for ten minutes
- Cool slightly
- Add a teaspoon of honey or sugar if you like the drink sweet (If you have diarrhoea or difficulty in digesting the milk, use water only)

Rehydration fluid

In the case of dehydration, when commercial products are not available, you can make your own with:

- 1 level teaspoon of salt
- 8 level teaspoons of sugar
- 1 litre of clean drinking or boiled water and then cooled
- 5 cupfuls (each cup about 200 ml.)

Children suffering from mild/moderate dehydration should continue on formula milk, but if rehydration is still needed, then their solution should be lower – containing less than half the salt and sugar than for adults.

Note: this rehydration solution will not cure diarrhoea.

Juices & smoothies

Ideal for people with appetite problems, to ensure that they can consume more calories and nutrients, building muscle tissue & preventing wasting.

These involve blending fruit with milk, yogurt and/or ice cream. Try making it with evaporated milk, or soya milk or yogurt, all of which contain higher levels of protein. Topped off with a dollop of ice cream, it will boost the fat content, and be delicious!

These are ideal for people with no appetite, or too little energy to cook. They taste much better than the expensive supplements. And if you're growing your own fruits in your garden, then you don't even have to go to the market. Soon you'll have enough energy to get back in to the garden.

Puréed Foods

Puréed foods may be required for people with very painful mouths or swallowing difficulties. All parts of the meal should be puréed to a smooth consistency, including soups and desserts. Pips, skins and fish bones should be excluded.

Avoid adding water to foods in order to purée them as this dilutes nutritional content.

Instead, extra energy should be added by using milk, cream, gravy or juice in place of water for blending. Grated cheese and butter can be added to vegetable purée.

Fluids or Liquid Foods Only

As with puréed foods, nutritional content of liquid foods is diluted. It is even more important to fortify these foods with both protein and energy. Soups should be based on protein foods (meat, fish and/or beans). Water should not be used as an ingredient where a liquid with nutritional value can be used instead. Fluids should be the consistency of pouring custard.

Anti-Candidiasis

Candida albicans is a type of yeast that can cause thrush. Some people feel that diet has a role to play in controlling this uncomfortable condition. The basic principles of an anti-Candida diet are to exclude foods which contain yeast, and also to eliminate foods which are high in sugar as these are claimed to act as a food source for the organisms.

Avoid the following (including products containing any of these): sugar, honey, syrup, marmite, stock cubes, oxo, bread, yeasted cakes, soft cheeses, soy sauce, vinegar, alcohol, mushrooms, and sauerkraut. Some fruits are also susceptible to fungal growth, and so all fruit should be peeled. Avoid grapes and melons.

Finally, live yogurt may be beneficial in controlling *Candida* and so this should be included wherever possible.

Children

Children's food should be prepared with less fibre and more protein. Make it colourful to increase their interest.

Personal hygiene & food safety

What is personal hygiene?

Personal hygiene means keeping your body clean, especially your hands when preparing food. Bacteria lives on the surface of your skin, and can be easily transferred, so avoid any habitual behaviour that may contaminate food, such as touching your mouth or hair, scratching your skin or smoking.

The purposes of food and cooking hygiene are to prevent food contamination the transmission of disease, and to prevent food poisoning.

Many of the herbs grown in the garden are anti-bacterial. Traditionally people all over the world have used herbs like rosemary and thyme, which are steeped in boiled water and used for wiping surfaces and cleaning floors to protect us from the bacteria which is harmful to our families.

Washing your hands:

Your hands are the main point of contact between you and your food. They are therefore the main route for transferring harmful bacteria which results in food poisoning. Keeping your hands clean is the simplest and most effective way of ensuring that you and your family remain safe from harm.

Hands must be scrubbed thoroughly using soap and water:

- Before starting to prepare food
- After using the toilet
- After handling any kitchen or other waste
- After blowing your nose, coughing, sneezing, or when any contact is made with other parts of your body
- After tea or lunch break
- After coming in from the garden
- Between handling raw and cooked food
- After touching or using tobacco in any form

Remember:

- Keep your nails short & clean – as they harbour bacteria
- Do not use nail varnish
- Having washed your hands, they should be dried on a clean towel. If one is not available then shake them dry, avoiding contact with other materials or surfaces.
- Cuts or lesions should be covered with a waterproof dressing
- Do not lick your fingers or hands while or after eating.

Hair:

- Hair should be kept clean
- A clean hair covering should be worn to prevent hair falling into food
- Facial hair should be kept clean and tidy
- Never touch or comb your hair in a food preparation area

Clothing:

- Keep your clothes clean and free from bacteria at all times
- No jewellery should be worn, as bacteria hides in the crevices

Food Safety:

These rules are vital when preparing food, especially for people who may be immune-compromised:

- Always use fresh ingredients, purchased and/or harvested that day
- Avoid contaminated meats, and if you must use meat purchased the before the day of preparation, then keep it refrigerated
- Take extreme care in preparing raw foods
- Keep the amount of time chilled and frozen foods are out of the fridge or freezer to a minimum.
- Peel all root vegetables – feed your compost heap with the peelings.
- Cheese and other dairy products must be pasteurised. Soft-ripened cheeses can only be used if well cooked.
- Do not use offal or shellfish (except prawns, which are safe when cooked).

- Do not use pâtés or other foods bought over the counter as these cannot be guaranteed free from bacterial amination.
- Any foods which will not be cooked (e.g. fresh herbs, fruit or salad) should be washed in water that has been boiled or 10 minutes and left to cool, to reduce risk of contamination with *Cryptosporidium*. Bottled waters and water that has been treated with domestic filters are NOT suitable alternatives.
- All food should be cooked thoroughly, especially meat, fish, poultry and eggs.
- Cooked food must reach a temperature of 75 degrees in the cooking process and must be served at a temperature of 65 degrees or above. If in doubt, cook for longer.
- Cold foods must be chilled down to temperature of 8 degrees or below.

Food Storage:

Secure food storage for dried materials (flour/maize) to prevent contamination by vermin.

Always check use-by dates. (If you do find out-of-date foods in the store cupboard please throw them away). Don't open new packets until existing stocks have been used up.

Make sure raw and cooked foods are securely covered and stored separately. They should not be kept on the same shelf in the fridge; cooked foods should be put on shelves above raw foods.

If products such as maize & flour have been put in separate containers don't add new supplies until the container has been emptied and washed. Label with an expiry or use-by date.

Cooking Utensils:

- Wash pots, pans and plates thoroughly with soap and clean, warm water.
- Do not use the same utensils to prepare raw and cooked foods.
- Use separate utensils for meat and veg preparation
- Do not share cutlery when eating.
- Do not reuse serving utensils until they have been washed.

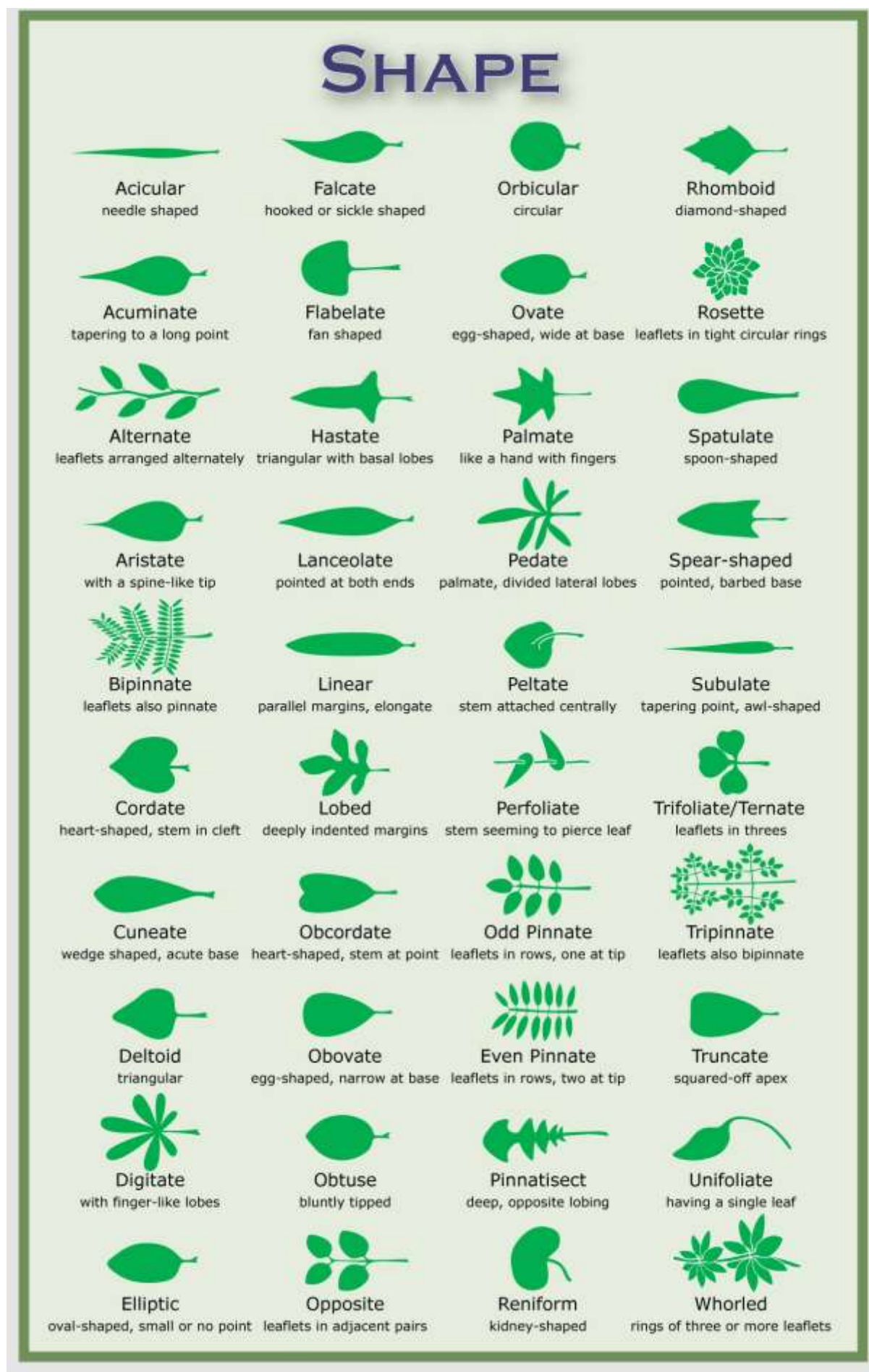
Conclusion

In this unit you have learnt about how to prepare nutrient rich dishes and drinks as well as some remedies that you could use to relieve common diseases illnesses such as colds and diarrhoea, and stimulate the appetite for quick nutrient absorption for PLWHIV/AIDS. You have also learned to prepare and store food safely. There may have been some technical language used in this Unit. Please refer to Unit 3 for further explanation.

Reflection points

- What are the most common dishes you cook in your family, and what nutrients do they contain?
- What can be done to ensure that you benefit from the wide variety of plants in your garden?
- What could you make, using produce from your garden, for a friend or relative who is HIV+ and struggling with their appetite?
- What can you do to improve hygiene in the kitchen and around the home?

ANNEX 1: Leaf terminology



Annex 2: Diagram of Leaf Margins

MARGIN



Ciliate
with fine hairs



Crenate
with rounded teeth



Dentate
with symmetrical teeth



Denticulate
with fine dentition



Doubly Serrate
serrate with sub-teeth



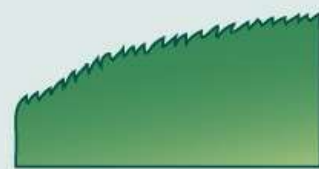
Entire
even, smooth throughout



Lobate
indented, but not to midline



Serrate
teeth forward-pointing



Serrulate
with fine serration



Sinuate
with wave-like indentations



Spiny
with sharp stiff points



Undulate
widely wavy

Annex 3: Diagram of Leaf Venation

VENATION



Arcuate
secondary veins
bending toward apex



Cross-Venulate
small veins connecting
secondary veins



Dichotomous
veins branching
symmetrically in pairs



Longitudinal
veins aligned mostly
along long axis of leaf



Palmate
several primary veins
diverging from a point



Parallel
veins arranged axially,
not intersecting



Pinnate
secondary veins
paired oppositely



Reticulate
smaller veins
forming a network



Rotate
in peltate leaves,
veins radiating