Perma culture

Manual

Compiled by

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Creating sustainable food and medicinal gardens

Edited by

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UKUVUNA

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LIST OF ACRONYMS

AI	Artificial Insemination
AIDS	Acquired Immune Deficiency Syndrome
ARVs	Anti Retro Virals
BMP	Best Management Practices
CSA	Community Supported Agriculture
CSOs	Civil Society Organizations
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

INTRODUCTION AND BACKGROUND TO THE MANUAL

Permaculture offers a radical approach to food production and urban renewal as well as to water, soil, energy and pollution management. It integrates ecology, landscaping, organic gardening, architecture and agro-forestry to create a rich and sustainable way of living. It uses appropriate technology to obtain high yields from low energy inputs while at the same time building diversity and stability. The principles of Permaculture work in both urban and rural settings; in backyard gardens and on large-scale farms. This manual was developed to guide new entrants as well as others interested in Permaculture. It was designed and developed by UKUVUNA and its partners.

Purpose of this training material

This manual was designed to enhance learners' understanding of Permaculture. Presented in a simple and user-friendly format, it will take learners through various Permaculture processes. In the end, it will allow learners to apply the knowledge and skills, reflect back on the processes and develop new ideas on the subject.

Among the key topics, the manual provides learners with knowledge about sustainable food production and nutrition practices to alleviate poverty, improve the health status of individuals and communities and to establish clean and healthy environments, through Permaculture.

The manual was compiled to assist organizations, individuals and groups to develop ethics on how to care for the earth and get produce from it in a sustainable way.

Who will benefit from this manual?

The manual will be very useful to the Primary Agriculture Education and Training Authority (PAETA). In fact, units 1-2, 5-6, 8-14 of the manual are in line with PAETA National Qualifications Framework (NQF) Levels 1 and 2, while units 3, 4, 7 and 15 are complementary units, which makes the manual a hands-on tool kit for sustainable livelihood projects. This training manual was developed based on the assumption that, the learner is competent in literacy at NQF Level 2.

This manual will also benefit any member of society, including those living with HIV and AIDS; unemployed people; and youth hoping to take a career in sustainable development studies or Permaculture.

Structure of the manual

The manual is divided into 15 units, each with a specific focus. The topics covered start with design principles; planning gardens; essential knowledge about plants to grow in the garden; animals to integrate with crops; soil improvement for improved production; pest, weed and disease control; harvesting and storage of garden produce; and concludes by discussing how to save seed for the feed and how to prepare food and drink from some of the garden produce. In essence, the manual takes the reader through the entire journey from the planning of the garden to the "stomach" of the consumer.

Each unit of the manual has planned outcomes as well as "points of reflection" to guide the user of the manual to make the most out of it. Illustrations, pictures and diagrams are used to aid the learning process.

The application of knowledge and skills

Throughout the units, learners will be required to apply knowledge and skills by way of activities

through the use of reflection questions. After learning about an idea or skills, the learner applies through practice. This stage is concerned with assessing the extent to which learning has taken place under each unit. It provides the reader with key questions that help determine whether the learner has acquired the necessary knowledge or skills.

Conclusion

Given an increasing number of people infected and affected with HIV and AIDS as well as the slow improvement of quality of life for many people, there is a growing need for individuals and communities to take responsibility of their own health and welfare through learning how to improve their nutrition and develop self-sufficiency and sustainable livelihoods. This manual is an asset for people who need and want healthy living.

UNIT 1:

PERMACULTURE PRINCIPLES AND DESIGNING

LEARNING OUTCOMES

At the end of this Unit, readers should be knowledgeable about:

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

1. What is Permaculture?

'PERMACULTURE' is a tool for sustainable living and 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 all of us. Originally derived from the words 'PERMAnent agriCULTURE', 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 our 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 appropriate approach to food production, urban renewal, water, soil, energy and pollution management. 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 feeds the gardener's food needs

as well as provide 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 or 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:

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

2. Value of Permaculture gardens

Permaculture gardens help to:

a. Empower people by promoting household food security and allowing people to take control of as much food production as possible;
b. 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 Tuberculosis (TB) and AIDS;
c. Empower people to grow their own medicine;
d. Facilitate community pride and give communities a sense of control and a capability to take positive action;
e. Affirm traditional eating habits and indigenous knowledge systems about plants; and
f. 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 pre-designed health products.

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.

3. Permaculture principles for sustainable garden design

a. **Everything in relationship:** The needs of one element are easily met by the products of another element. For example, an onion planted with cabbage will repel pests that eat cabbages. Beans planted with maize will help to restore nitrogen to the soil when maize takes it out.

b. **Diversity rules:** Ecosystems or gardens that survive are usually the ones that contain a lot of diversity. Produce 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 and economic value.

c. **Everything must have a purpose:** Land must not be wasted and every corner of the site and vertical space must be used. All elements in the design should have at least 3 uses.

d. **Work with nature.** After you harvest plants put back all the parts you do not use into the soil. The parts are converted into manure that plants will need for growth and production.

e. **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.

f. **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.

g. **Work with those who want to work**: Gardens provide opportunities for many people. One of these is the opportunity for meaningful work.

h. **Work where it counts:** Make a list of priorities and spend your time working where it is most important.

i. It is better to spend a **lot of time thinking** than a lot of time working.

j. **Take the long view:** Plan for long-term sustainability.

k. **Recycle, reuse and reduce**: Use everything at your disposal and recycle all wastes. It is very important to plan your garden before you begin planting or keeping livestock.

l. **Place elements at 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).*

m. **Every thing must have a purpose:** Design focus must go beyond the limits of the 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.

n. **Design must be for people**: People are the users of gardens. You must establish what the people need and what they like also consider what they dislike and what are their general feelings.

o. **Mistakes are opportunities for learning what to do next:** Never give up, for mistakes are building steps for prosperity.

p. **Use on site resources**: Recycle, utilize existing land and hire unemployed people. Nature is also a "client" of all living and non living organisms should be cared for.

q. **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. The good relationship creates many useful products for both the people and the environment.

r. **Principles of stability:** It is not the number of diverse things in a design that leads to stability, but the number of beneficial relationships in a system that leads to it.

4. Permaculture techniques

Permaculture techniques include, but not limited to:

a. Learning to observe the natural processes like water flow, wind direction, sunlight distribution and taking advantage of them;
b. Learning to observe the effects of humans on the environment;
c. Learning to identify useful resources (especially those people regard as waste) and utilizing them;
d. Making an accurate list (audit) of all available resources;
e. Carefully designing gardens to make the best use of the landscape;
f. Finding clever ways to catch and "harvest" rain water and waste water;
g. Planting vegetation that keep away unwanted pests;
h. Using mulch (layers of dead plant material) to keep moisture in the ground;
i. Maintaining levels of useful nitrogen in the soil by planting both nitrogen and nitrogen fixing plants;
j. Using leftovers of vegetables and fruit to create compost;
k. Collecting seed for future planting (propagation); and
l. Using waste products, such as plastic containers, to create useful gardening tools.

Box 1: Twenty Ways of implementing sustainable gardening ethics in our lives

1. Plan for generating income and enough food for your family and the community.
2. Grow what your family and local people need.
3. Focus more on indigenous plants than exotic species.
4. Plan for sustainability on a long-term basis.
5. Grow traditional food plants.
6. Cultivate the smallest possible land area.
7. Use different plants to suit different weather conditions.
8. Save seeds and grow your own seedlings as far as possible.
9. Use low energy environmental and biological systems to conserve and generate energy.
10. Bring food growing back into the cities and towns, where it has always traditionally been in sustainable societies.
11. Assist people to become self-reliant, and promote community responsibility.
12. Plant forests and restore fertility to soil.

13. Use everything at your disposal and recycle all wastes.
14. Control pests and diseases biologically.
15. See solutions, not problems.
16. Diversify your production.
17. Grow plants for beauty as well.
18. Work where it counts (plant a vegetable; assist people who want to learn).
19. Network with organizations in the same business.
20. Train others, especially your own children.

5. Conclusion

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

Reflection point

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

Permaculture gardening is a way of life.

UNIT 2:

PLANNING FOR SUSTAINABLE FOOD PRODUCTION

LEARNING OUTCOMES

At the end of this Unit the readers will be knowledgeable about:

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

1. 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 does not use a plan? What would happen if managers do 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 of 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.

2. 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 shorter terms. This may entail listing down what needs to be achieved in 6 months, 1 year, 5 years or 10 years.

Goals may be set for specific outcomes such as goal for quality of life, goal for means of production, goal for landscape design, etc.

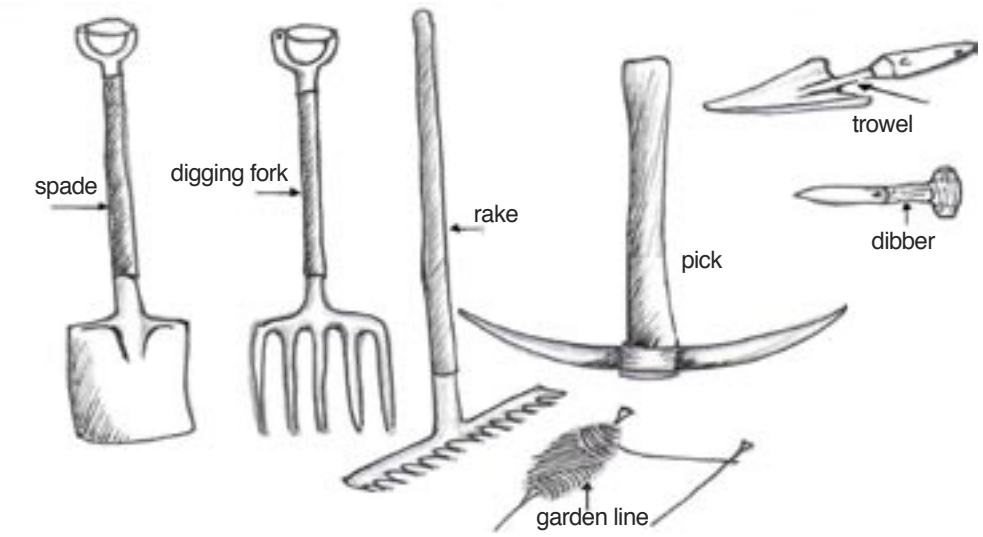
2.1 Assess the site of your garden

a. After you have developed your goals assess the site you wish to grow vegetables, fruits, and other related activities that support a sustainable Permaculture garden.
b. Walk across the garden and observe the patterns of the environment. Consider the vegetation, the soil, the animals, the wind direction and the inclination of the sun. If these components are assessed well it will be easier to identify opportunities to deal with them in the final design plan.
c. 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.
d. Make your garden near a place that will be visible so that you can watch and care for your vegetables easily.
e. In choosing a site, look for a well-drained area. Few plants grow in a poorly drained soil. In such areas, roots will rot because of inadequate air pockets in the soil.
f. 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 may be encouraged where steep slope can not be avoided.

2.2 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:

a. **Tools and materials for preparing the site:** Forks, rakes, wheel barrow, shovels, watering canes, buckets, hosepipes, manure, mulch, vegetable seedlings, herbs, flowers, tree seedlings, fruit trees, gloves, hoes, pegs and sticks and hammers.
b. **Tools for garden maintaining:** Garden shears, hand forks, hand shovels, secateurs, long handle secateurs and straight-bladed saw.
c. **Other tools:** Large tape measure (100m), small tape measure (5m to 30m), strides, thermometer, and a rain gauge.



2.3 Determine the size of the garden you need

You will also need to know how much space each crop you wish to grow requires. How many varieties of plants do you require to grow in your farm? It is important to know the distance apart of all the plants/ crops vegetables 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 space and the horizontal.
Here is some basic information about measurements that you may need to know:

Weight	Length	Area
1 gram = 1 000mg	1cm = 10mm	10 000 square meters = 1 hectare
1 kilogram = 1 000 grams	1m = 100cm	100 sq m = 10m x 10m
1 tonne = 1 000 kg	1km = 1 000m	

In order to get the area of a rectangular shape: multiply length by breadth or width to give you the area. A garden that is 10m length and 5m breadth is 50 square metres. **The area of a circle** is pi x radius squared, with pi being 3.14. A 3m diameter (diameter is radius x 2) circle, the area is 3.14 x 1.5 m squared, meaning 3.14 x 2.25 = 7sqm. **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.

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

Box 2: 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.

a. 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.
b. 30cm is the same as the length of the blade of a garden fork or a hand fork.
c. 1 m is the same as the length of the spade or fork or the handle of a pick.
d. 1.2m is the same as the length of a steel rake.

3. Important factors in selecting plants for your garden

3.1 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 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 species selection should therefore consider temperature and rainfall or availability of water.

3.2 Compatibility of plants

Some plants grow well when they grow alongside certain other plants. Such plants are compatible. 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, if you grow certain vegetables under the dense shade of a tree they will not grow 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 composite pile. Each element has needs; and outputs of one element feed into the needs of another element with minimum energy use. For example, a dam wall can be used for a boundary, a road, firebreaker crop protection.

4. How to gather information about the garden site

The following methods can be used in collecting data:

4.1 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, indicators ecological disturbance. In the case of a school, selected students, teachers and representatives from the surrounding community can participate.

4.2 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.

4.3 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 around you and the presence of productive plant species and infrastructure on the site. This information gives you an idea of what building blocks you have at your disposal to begin with. You will also have to do research on local weather patterns, history of land use and relationships to markets. Asses the nature and condition of the plant and animal species present in the garden and surrounding area, which will 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 range and rainfall patterns.

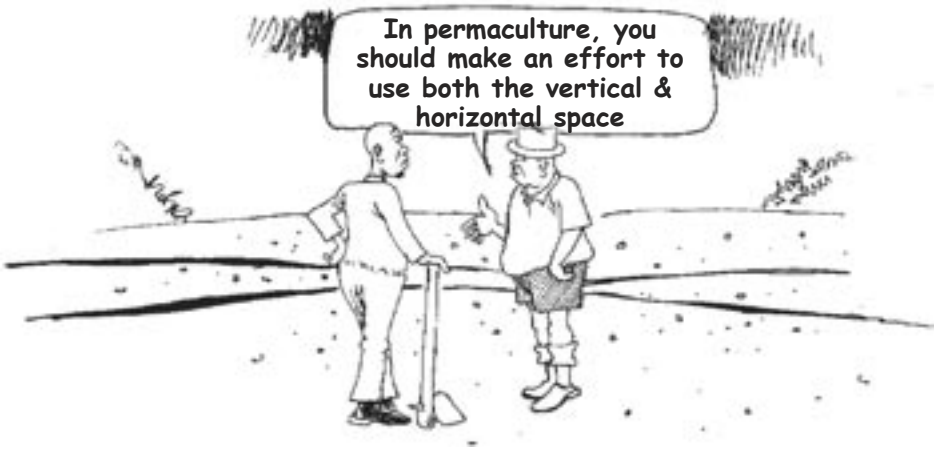
4.4 Interviews

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 and those who are negative.

Box 3: Tips on building your knowledge in 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 into:-

a. Carry a camera, note book and record ideas that you need.
b. Collect and read books, magazines and watch TV programmes that have related topics to your desires.
c. Visit friends, projects, garden centres, and nurseries.
d. List plants you like.
e. Think what is happening in your community: What issues are on agenda in your community or in the country, can your project assist in addressing the issues?

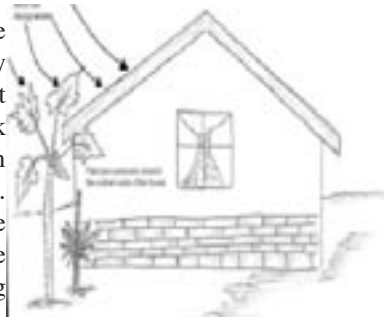


f. Group all plants and other elements you need to see in your garden. An example is shown below:

Vegetables Fruits Medicinal Plants Flowers Animals

5. Garden Design

A well designed garden or homestead addresses the needs of the people and the environment. The elements are working in harmony with one another and this means that the garden has excellent forms, colour, and textures that support each other and they look "happy" together. A garden should be designed to provide you with all what you need by placing plants and animals at 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. Design is about placing the right element at the right place at the right time.



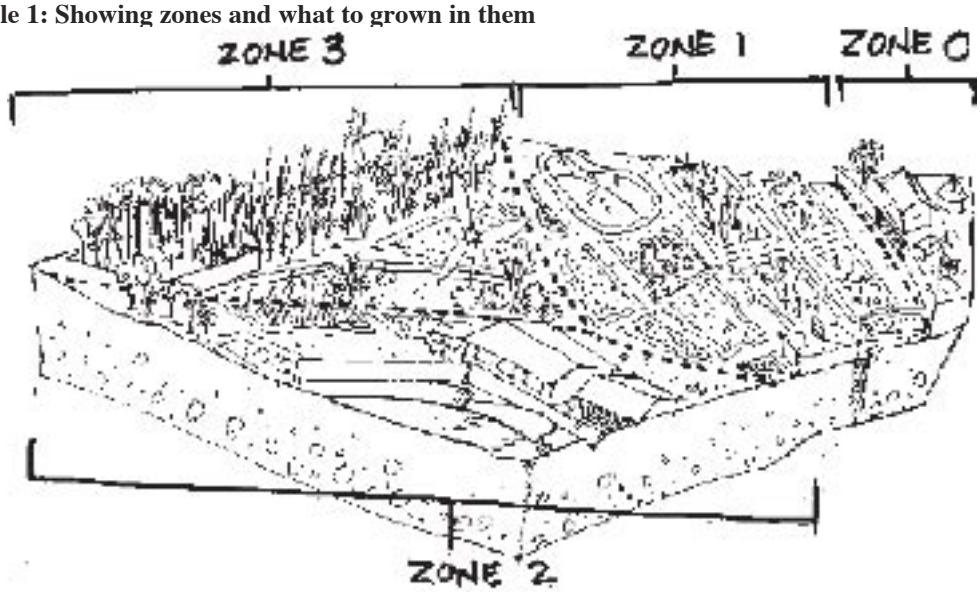
Sunlight reflecting off the roof creates a warmer environment for plants in winter.

5.1 Applying the concept of zones

In designing, it is important to place each element at the right time and at the right place. 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 such as 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.

Orchards, woodlots, 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 address firebreak.

Table 1: Showing zones and what to grown in them



ZONE	WHAT TO PLACE IN THE ZONE
0	The Building: House, office, school or hospital or clinic
1	Intensive herb garden, vegetables, nursery, small worm farm, ground cover plants, annual plants and fish ponds.
2	Intensive vegetable production, or mixed with some perennial species, aquaculture, ducks, rabbits, chickens and small fruit trees.
3	Orchard and agroforestry systems, fodder strips, summer crops such as maize, dry land systems (grains and tubers) alley cropping, perennials, hard herbs and medicinal plants, windbreaks and live fence and bee hives.

5.2 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.

a. **North Slope**: in Southern hemisphere, the north facing slope or wall is very hot in summer and good for plants and animals that can withstand heat.
b. **East Slope**: Gets morning sun and warms up quickly in the morning, very good for the placement of nurseries, vegetable, and herb and medicinal plants.
c. **South Slope**: Cool and moist, ideal for moisture loving plants. Good for water storage.
d. **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.

5.3 Basic tips on design and budgeting

a. Design your homestead for nutrition garden and waste reduction.
b. 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.
c. Budgeting is the process of relating money, materials and human resources required to start a project as well as when the project is running.
d. 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.
e. The next step is to quantify the items needed as well as how often they will be needed. For example, you may need two pockets of tomato seed once at the beginning of the project but you might need onion seed once every three months because you cannot multiply its seed.
f. When you are done with the quantities, you then check the prices of each item and multiply with quantities in order to come up with a budget. Your budget can be annual, monthly or even weekly.

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

6. Tools for tracking your progress

The following documents must be developed:

a. Planning sheet, where you write our plans for a given period of time;
b. Daily record sheet, where you record your observations, inputs and outputs;
c. Monthly record sheet, where you summarise garden records of the month for monitoring and replanning;
d. Production record sheet, where you record what you have produced from the garden;
e. Tools record sheet, where you keep a record of the tools you have for monitoring and possible replacement; and
f. Plant spacing for crops, vegetables fruits and herbs for your observation and personal learning.

7. Conclusion

This module has helped you to be knowledgeable 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 point

1. What do you want to produce in the short term and in the long term?
2. What key factors do you consider in planning a garden?
3. 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.
4. List the kind of indigenous edible plants that grow well in your area.
5. What are the average monthly temperatures in your area?
6. What is the average annual rainfall in your area?

Encouraging open discussion and thinking out of the box for solutions rather than spending time talking about problems

Before...

...and after

Materials for starting a garden

UNIT 3:

NUTRITION AND DIETARY NEEDS

LEARNING OUTCOMES

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

- Principles of nutrition;
- Importance of nutrition in our systems;
- Sources of nutrition;
- Getting a balanced diet;
- Managing HIV and AIDS using good nutrition; and
- The problems that arise from under-nutrition.

1 (a) 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 different types. This is partly caused by families not knowing which foods to grow in order to make balanced diets 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.

1 (b) What is Diet?

To eastablish a sustainable and healthy supporting garden one need to understand what Diet and Nutrition is all about.

What is the difference between Nutrition and Diet

Nutrition is a 3-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 or 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, with 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 fiber;
- Includes a variety of fruits and vegetables;
- Has foods prepared with less sodium or salt; and
- 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."

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

a. Stay alive, move and work;
b. Build new cells and tissues for growth, maintenance and repair;
c. Resist and fight infections;
d. Perform daily activities;
e. Maintain and replenish the body's cells;
f. Grow and repair of tissue;
g. Reinforce the immune system;
h. Prevent chronic diseases;
i. Maintain good mental health; and
j. 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 to keep healthy, keep fit and enjoy ourselves.

1.2 What are nutrients?

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

a. 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 reducing the energy content of the diet), and bioflavonoid (protective against many diseases). Noting that fruits and vegetables contain so many protective nutrients, and improve 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 veggies such as carrots, sweet potatoes, pumpkin and winter squash; and beans and peas such as 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. So it is important to grow a variety of vegetables and fruits in your own garden.

b. 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 bodily 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 supplement for calcium and protein.

c. 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 and 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.

d. The **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.

e. 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.

f. 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.

g. Vitamins and minerals: Most vitamins must be obtained from food, although the body manufactures vitamin D when the skin is exposed to sunlight and others 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.

h. **Antioxidants** include vitamins C and E, beta-carotene. They slow down a person's aging process and fight against cancer, pollution and heart disease.

1.3 Water and your body

Water is important for life and is necessary everyday. Drink 6 to 8 glasses of bottled, spring or filtered water daily to help purge toxins and waste from the body. Water is an essential nutrient because it:

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

Alcoholic drinks remove water from the body and therefore should be avoided or taken in moderation. They can also interfere with the action of medicines.

2. 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:

a) **Mabele, bread, cereal, rice and pasta**: 6-11 servings per day;
b) **Vegetables:** 3-5 servings per day;
c) **Fruit**: 2-4 servings per day;
d) **Milk, yoghurt and cheese**: 2-3 servings per day;
e) **Meat, poultry, fish, dry beans, eggs and nuts**: 2-3 servings per day; and
f) **Fats, oils and sweets**: use sparingly.

Table 2: Showing what the body gets from different types of food

Nutrient	Main function
Sugars and starches	Fuel for energy, movement, brain function they give us energy to walk, talk, run, etc.
Fibre	Keeps the heart healthy, helps remove 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 the 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 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

3. 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:

Table 3: Showing ways to retain food nutrients

Storing and buying Fresh foods	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 to 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 or into a stew or soup, cover and cook until the vegetable is just ready (to preserve vitamins). Use the cooking water from vegetables for stews (so you do not waste vitamin C in cooking water).

4. 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 portable water per day, exercise regularly and sleep for at least six hours every day.

5. 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.

5.1 Acid

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

5.2 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 refined sugars and honey the diet. Use less quickly digested carbohydrates such as potatoes, yellow maize meal and white bread, and instead eat more rice, pasta, sweet potatoes and millet.

5.3 High Cholesterol

Cholesterol is caused by overconsumption of animal fats, and a lack of enough fish, vegetables and fibre fish food. Control of cholesterol can be achieved by reducing consumption of heated oils, animal fats, margarine and processed foods, and eating more fruits and vegetables everyday.

5.4 Obesity

Detoxification is also an important part of treating obesity. Many of the toxins we ingest or make are stored in the fatty tissues: hence, obesity is almost always associated with toxicity. When we lose weight, we reduce our body fat and thereby our toxic load. Exercise will also promote the loss of excess pounds and help further removing of unwanted elements in your body.

6. 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.

6.1 What is HIV and how does it affect the body?

It is important to discuss HIV in South 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 milliliter 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 millimeter 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.

6.2 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.

6.3 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 (eating healthy) 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). These may be found at clinics and hospitals.

6.4 HIV Testing

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, which can take as long as three months is called the “window period”. Know your status, get tested.

6.5 Prevention of HIV and AIDS

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

a. Using a condom during sexual intercourse;
b. Abstinence; and
c. Being faithful to one partner.

6.6 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:

a. Public awareness campaigns on a safe and healthy lifestyle;
b. Effective management of sexually transmitted diseases;
c. Reducing mother-to-child transmission;
d. Providing adequate access to voluntary testing and counselling;
e. Providing post-exposure services;
f. Treatment, care and support;
g. Work to lower the cost of ARVs and make them accessible;
h. Improving the programme of home-based care;
i. Research and monitoring of the disease and the treatments; and
j. 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, 3 or 4 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

7. 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.

Table 4: Vegetables and fruits you can eat in a particular season

January - March	April - June	July - September	October December
Apricot	Artichokes	Apricot	Apricot
Artichokes	Avocados	Artichokes	Artichokes
Beans	Beans	Beans	Beans
Berries	Cabbages	Berries	Berries
Brinjals	Carrots	Brinjals	Brinjals
Cabbages	Cauliflowers	Cabbages	Cabbages
Carrots	Green Pepper	Carrots	Carrots
Cauliflowers	Indigenous vegetables	Cauliflowers	Cauliflowers
Cherries	Mango	Cherries	Cherries
Chillies	Melons	Chillies	Chillies
Cow peas	Nectarines	Cow peas	Cow peas
Cow peas leaves		Cow peas leave	Cow peas leave
Cucumbers		Cucumbers	Cucumbers

Grapes		Grapes	Grapes
Green Pepper		Green Pepper	Green Pepper
Ground nuts		Ground nuts	Ground nuts
Indigenous vegetables		Indigenous vegetables	Indigenous vegetables
Mango		Mango	Mango
Mealies		Mealies	Mealies
Melons		Melons	Melons
Nectarines	Onions	Nectarines	Nectarines
Okra		Okra	Okra
Onions		Onions	Onions
	Oranges	Oranges	Oranges
Peach		Peach	Peach
Pears	Pears	Pears	Pears
Pigeon Pea	Pigeon Pea	Pigeon Pea	Pigeon Pea
Pig weed	Pig weed	Pig weed	Pig weed
Pineapples	Pineapples	Pineapples	Pineapples
Pomegranates	Potatoes	Pomegranates	Pomegranates
Potatoes	Spinach	Potatoes	Potatoes
Pumpkins	Sweet potatoes	Pumpkins	Pumpkins
Round nuts	Tomatoes	Round nuts	Round nuts
Spinach	Wild Mushrooms	Spinach	Spinach
Strawberries		Strawberries	Strawberries
Sweet potatoes		Sweet potatoes	Sweet potatoes
Tomatoes		Tomatoes	Tomatoes
Wild fruits		Wild fruits	Wild fruits
Wild Mushrooms		Wild Mushrooms	Wild Mushrooms

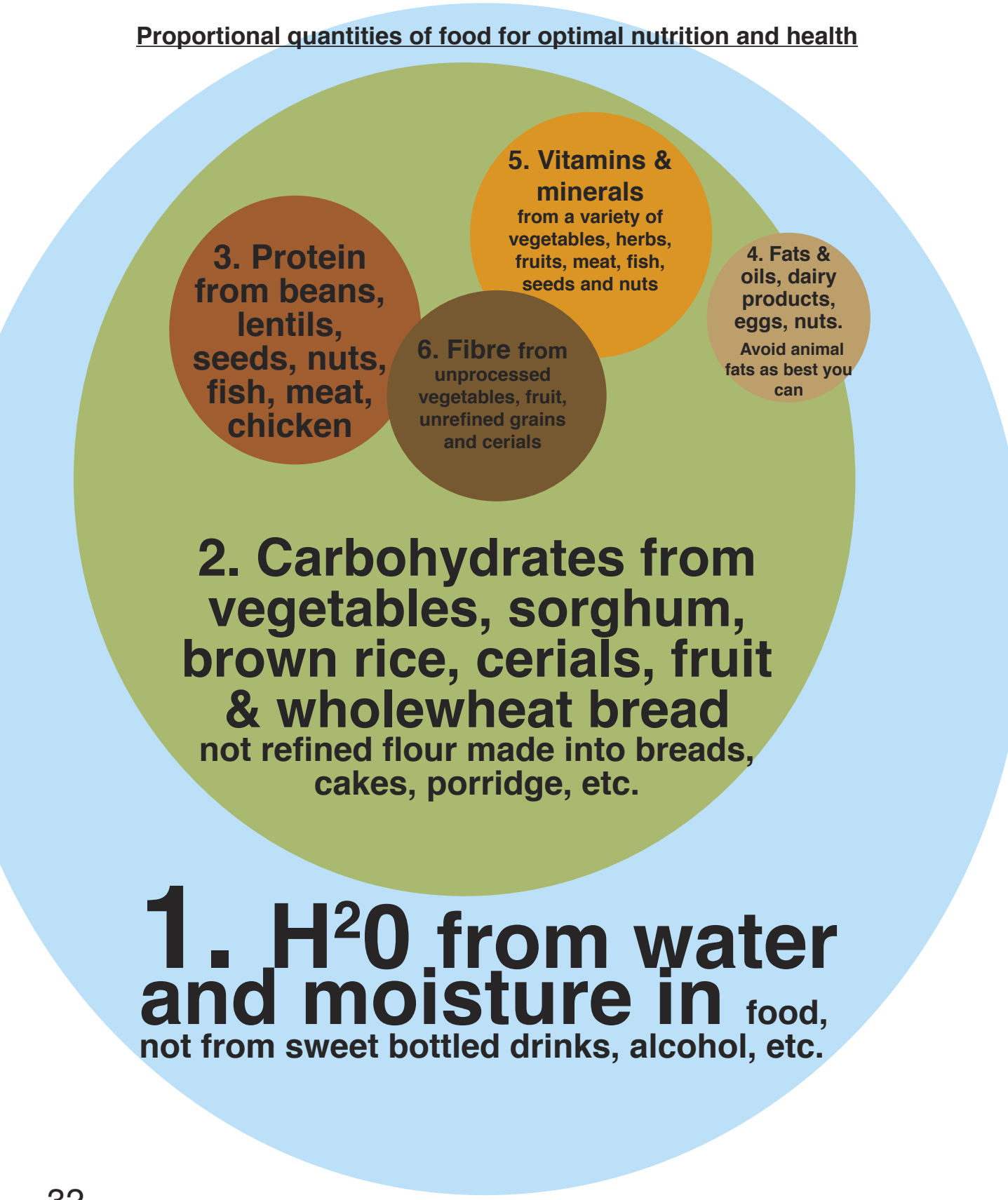
8. Conclusion

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

Reflection point

- 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?

Proportional quantities of food for optimal nutrition and health



UNIT 4:

KNOW TREES AND SHRUBS FOR YOUR GARDEN

LEARNING OUTCOMES

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

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

1. Introduction

Since you are now knowledgeable about Permaculture principles and you have learnt how to implement Permaculture, how to plan for your garden and you understand nutrition, it is important to know about the plants to be grown in the garden for food and nutrition. 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 fence, 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.

2. 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 (which species can flourish in a particular area) and know enough about indigenous trees in our area to be able to select appropriate species. We 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 providing the vital service of providing the planet with oxygen, trees also perform a number of other important functions:

a. Provide detritus and humus (dead plants and animals that decompose and become soil nutrients);
b. Provide shelter for living organisms (birds, spiders, lizards);
c. If it is a legume, it fixes nitrogen in the soil, which becomes available for the plants growing in the same area;
d. Cool the air in the surrounding area through evapo-transpiration (which enables other plants to grow there);
e. “Mines” bedrock minerals, which then become available (over time) to surrounding plants as the leaves die, fall off and decompose in the soil;
f. Can intercept heavy downpours and protect the plants growing under them; and
g. Slow down or deflect (change the direction of) wind.

The difference between a tree and shrub
- A shrub grows less than 5 metres
- A tree can grow at least 5 metres

3. 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.

3.1 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: some have medicinal properties, high value timber, good shade while others have colourful and attractive flowers.

3.2 Exotic plants

Exotic plants on the other side 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: they grow fast and dominate over the indigenous plants.

3.3 Endangered and Extinct Plants

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

Table 5: Showing examples of Endangered and Extinct plants in South Africa

ENDANGERED	**EXTINCT**
Serruria aemula	Orchids in southern Africa:
Leucadendron levisanus	*Encephalartos woodii (cycad)*
Kniphofia leucocephala	*Erica verticillata*
Erica jasminiflora	*Erica turgida*
Frithia humilis	*Euphorbia obesa*
Leucadendron macowanii	*Freylinia visseri*
Encephalartos lebomboensis	*Jordaaniella dubia and*
Lachenalia viridiflora	*Jordaanie la anemoniflora*
Serruria trilopha	
Gerbera aurantiaca	
Serruria furcellata	
Lachenalia liliflora	
Mraea gigandra	
Widdringtonia cedarbergensis	

3.4 Invasive plants

Invasive alien plants are plants from other countries that are a threat to our indigenous species. In

South Africa, these include *Lantana Camara* and water hyacinth.
Invasive alien plants may:

a. Reduce our ability to farm;
b. Intensify flooding and fires;
c. Destroy of rivers through excessive use of the ground water;
d. Pollution of dams and estuaries in the case of plants such as the water hyacinth;
e. Replace indigenous vegetation; and
f. Upset natural ecosystems.

4. Tree Planting

4.1 The history of Arbour Day

The 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.

4.2 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 highlight two specific trees; one common and one rare species.

Year	Common Tree	Rare Tree
2007	*Rhus pyroides*, Common Wild Currant, Gewone Taaibos	*Pavetta schumanniana*, Poison Bride's, Bush Gifbruidbos
2008	*Dioscorea whyteana*, Bladder -nut, Swartbas	*Markhamia zanzibarica*, Bell Bean Tree, Klokkies-boontjieboom
2009	*Helleria lucida*, Tree Fuchsia, Notsung	*Pterocarpus rotundifolius*, Round-leaved Teak, Dopperkiaat
2010	*Rothmania capense and R. globosa*, Cape Gardenia, Bell Gardenia, Kaapse Katjiepiering,	*Cladostemon kirkii*, Tonga-kerrie, Tongakierie

	Klokkies-Katjiepiering	
2011	Genus Pavetta Bride's Bushes	*Nuxia congesta*, Common Wild Elder, Gewone Wildevlier
2012	*Protorhus longifolia*, Red Beech	*Bruguiera gymnorrhiza*, Black Mangrove
2013	*Grewia occidentalis*, Cross berry	*Barringtonia racemosa,* Powder - puff Tree
2014	*Vepris lanceolata*, White Ironwood	-
2015	*Heteromorpha arborescens,* Parsley Tree	-

4.3 How to plant trees

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

a. Select a site;
b. Mark points 6 m apart for planting trees;
c. Dig a hole of about 50cm deep x 50cm wide and 50cm length on each marked point;
d. Pile together topsoil and subsoil;
e. Mix the soil with 10 full shovels of compost and fill the pit;
f. Open a hole in the filled pit, the soil (size of the tree container) to plant the tree.;
g. Remove the plastic/ container carrying the plant;
h. Insert a 50cm x 50mm old pipe at the base of the roots of the trees;
i. Plant the tree and make a basin around it;
j. Water the tree by pouring water in the basin;
k. The pipe will allow water to go directly to the roots whilst the basin will hold water for slowly percolate in the soil;
l. Mulch the basin;
m. Make a "C" bed around the tree for planting vegetables and herbs;
n. When you water the tree other plants also get water; and
o. Water three times a week for the first four months.

4.4 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:

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

5. Developing Orchards

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

a. Are these the fruit trees for this climate?
b. Will the family / community eat or buy these fruits?
c. Is there enough water available for these fruit trees?
d. Where is the best place on the site to plant them? Will they have enough light, wind and protection?
e. Do any specific pests threaten these trees? If so, what can be done to reduce this threat (companion planting, guilds and organic remedies)?
f. Can different varieties of the same trees be planted to increase the yield over time?
g. Are there different fruit trees that produce fruit all year round so that the family has a supply of fruit throughout the year?
h. How do these trees produce fruit (i.e. pollination or are both male and female plants are needed, etc)?
i. 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.
j. Some trees such as most citrus can grow beneath tall trees and may not require full sun to produce fruits.
k. 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.
l. Moisture needs: Place drought resistant trees (carob) and moisture needy plants (stone fruits) in separate groupings to aid watering.

6. Agro-forestry

6.1 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:

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

Sifiso Tafadzwa Nzira, an 11-year old growing food for his family, at their homestead in Tembisa township.

Mixing trees and crops can help in creating more integrated, diverse, productive, profitable, healthy and sustainable land-use systems. Agro-forestry practices include:

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.

6.2 Where does Agro-forestry apply?

Agro-forestry can be applied 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.

7. Using plants as wind breaks

7.1 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; and
- 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.

7.2 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. A windbreak or live fence should at least have three layers to its structure; an herbaceous layer made up of tall hardy herbs that can handle wind abrasion (aloes, wild dagga, vertiver grass…) in front of the break. This layer later serves to stop wind funneling under the main windbreak trees between the ground and the first branches.

b. The second layer is made up of shrubs and small dense trees that are hardy such as Buddleja, Rhus and Elderberry. Mix Pigeon pea, 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.

c. 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, have dense canopies and are relatively tall so they push the blast up and over the garden, allowing a gentle wind through below to swirl harmlessly through the gardens. 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.

8. Alley cropping

8.1 Definition of alley cropping

Alley cropping is an agro-forestry practice in which perennial, preferably leguminous trees or shrubs (such as pigeon pea, *Moringa olifera*) are grown simultaneously with crops. The trees, managed as hedgerows, are grown in wide rows and the 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.

8.2 Benefits of Alley Cropping

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

9. 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 is 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.

9.1 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, 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 soothing agent as well as for treatment of colds, conjunctivitis and hemorrhage.
How to multiply: Seed

9.2 Aloe ferox

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

Desciption: 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.

9.3 Aloe tenuior

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

Description: The fast growing free-flowering aloe forms dense rounded shrub with succulent green leaves. Stem: Many branched aloe with no main stem, up to 1m. Leaves: single shaped, long, narrow, 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 area.

Uses: Medicinal, leaves are used as protective charms, firebreak, hair and skin care, stimulant, boost immune system, sunburn, cancer, scalds, open wounds, high blood pressure, sores, bites, ulcers, roots and leaves are used for pest control.

How to multiply: Seed or cuttings.

9.4 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 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 leonus* for energy.
How to multiply: Cuttings and seed (grow them in river sand beds).

9.5 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 trifoliolate 15 cm long and 6 cm wide. Flowers multi-colored with yellow, red, purple, orange. Fruit is pod and produce seeds like peas but slightly smaller than peas.

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: It can be used as firewood and food (seeds and leaves). It can also be used as fodder, bee forage, windbreak, nitrogen fixing, soil conservation. Pigeon peas are a nutritious, protein rich food popular in central Africa, high in protein. Ripe seeds are a source of flour, 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 females. 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 males, while immature fruits are believed of use in liver and kidney ailments.

How to multiply: Seed and cuttings

9.6 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 palmately 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 in northern faced walls to take advantage of the heat and sunlight. Plant paw paw in rows with pigion 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 pains.
How to multiply: Seed.

9.7 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 tingle pink and occur in clusters at base of thorns or terminally. 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 a live fence because of its thorns. In can also be used to for hair and skin care and to treat sunburn, scalds, open wounds, sores, bites and ulcers.
How to multiply: Seed.

9.8 Carya illinoinensis

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 frost occurs, and temperatures go 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.

9.9 Citrus

Lemon, oranges, naartjies (E)

Description: Citrus includes lemon, orange, grape fruit and naartjies. They are small evergreen tree (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 and grape fruits are 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 treatment of asthma, liver complaints, TB, gout, rheumatism, nausea, indigestion, influenza, dry coughs and sore throats. Lemon juice has a high Vitamin C, 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. 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.

9.10 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 narrowed, shine, are a green above, paler green below. The sand olive's small greenish yellow flowers in occur in auxiliary or terminal groups.

Habitat: Dodonia 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: Live fence. lt's used as medicinal plants for sore throats
How to multiply: Seeds and young cuttings

9.11 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 Vitamins 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 force.
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 row or make jam and juice.
How to multiply: Seed.

9.12 Leonotis leonurus

Wild dagga (E); UmCwili (Z) imVovo (X) Lebake (Sotho);

Description: Wild dagga is an ever green 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 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: It is drought resistant and attracts bees. It has medicinal properties that help in the treatment of colds, flu, cough, bronchitis, headaches, asthma, high blood pressure and snake bites. The leaf and stem make a strong tea to fight the named diseases. 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
Don't use it while on anti-retroviral therapy (ART) as it can interfere with the medication
Don't use during pregnancy since it can cause birth defects.
How to multiply: Seed and cuttings.

9.12 Lessertia microphylla

Cancerbush (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 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 grows in zone 1 or 2. Plant cancer bush 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 tea for spraying pests such as aphids and caterpillars in the garden.

Warning
Don't use if on anti-retroviral therapy (ART) as it can interfere with the medication.
Don't 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.

9.13 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 in 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 crops pests such as fleas and aphids. Branches and leaves are crushed and sprinkled in chicken runs to repel fleas. Infused or brewed leaves are excellent aromatic or herbal tea which is good for refreshing.
How to multiply: Seeds and cuttings.

9.14 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, dense clusters of short lateral rootlets.

The adult leaves are entire with few spines. 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 proceeding 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 sands soils to heavy clay soils, as long as the soil is well drained. They do best, however, in deep, rich soils. 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 fall 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.

9.15 Mangifera indica

Mango (E) Manngo (V)

Description: It is an evergreen sub-tropical tree, spreading habit of growth, fruits vary in size and shape. Mangoes have many varieties which include but not limited to the following:
Haden large yellow crimson fruit, oval in shape, fibreless, ripens in December / January.
Kent oval greenish red fruits, fibreless, ripens in February / March
Kidney large trees bear fibrous fruits, good for archer and chutney, ripens in January / February
Peach medium sized fruits, ripens November / December
Zill large dark crimson fruit, yellow orange in colour, ripens January / February

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

Where to plant: 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 under neath a fully grown mango tree.
Uses: Excellent shade tree, plant away from other trees, unripe and ripe fruit. The seed is used for treating heat stroke, gastro-intestinal, blood, eye and female disorders as well as loss of weight, diarrhoea, diabetes and scorpion bites.
How to multiply: Seed and grafting.

9.16 Moringa oleifera

Drum stick, Horse radish tree (English)

Description: A succulent small/middle-sized shrubby tree (up to 6m). Its leaves are alternate and compound. The flowers are white. Fruit pod-like three sided, yellowish green splitting into three valves and 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. Leaf powder is used to stabilize blood pressure and blood sugar; increase urine flow; remedy for diarrhoea, dysentery, colitis and gonorrhoea; to increase woman's milk production.

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 excellent for liver and spleen and treating pain in the joints. Seed oil is taken for gout

& rheumatism. Crushed seeds are used to clean water.

Roots and bark good for detoxification, The bulbous root can be grated and fried or pickled in vinegar. Gum infusions 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; and
- Moringa is a legume, it improves soil structure, animal fodder and bee forage.

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

Propagation: Seeds or cuttings.

9.17 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: Need 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 **z**one 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. So 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 for small plants. Plant bananas with legumes such as pigeon pea, acacia trees and tephrosia to control nematodes. You can also plant them with coffee trees in case 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, anemia, arthritis, gout, allergies, kidney disorder, tuberculosis, over weight, burns, menstrual disorder and wounds. Juice from banana stem and roots is used for urinary disorders. Banana leaves are excellent for compost and mulch as well as fodder for rabbits and larger livestock.

How to multiply: Seed or suckers.

9.18 Olea europea subs africana

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

Description: Wild olive is a small to medium sized evergreen tree with a dense rounded crown and greyish -green forage. It grows up to 9 m and has leaves that are narrow, opposite, oblong, green above and whitish scales 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 4 m 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.

9.19 Persea americana

Avocado (E), Afulchada (V)

Description: Avocado is an evergreen large 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 ripens in February/ March; Edranol- ripens in August/September; Fuerte ripens from April to August; Hass ripens from September to November; Itzamma- ripens from October to December; Nabal ripens from September to November; Ryan ripen from November to January; and 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 6 m 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.

9.20 Portulacaria afra

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

Description: Succulent shrub or small tree to 3m high. Leave opposite, fleshy, obovate. Flowers in clusters at the branch tips, pink, 250mm diameter. Leaves: alternate, succulent, smooth, midrib prominent beneath. Flowers are greenish and occur in dense, hanging sprays. The fruit are ripe from August to September.
Habitat: It grows in bushveld, on rocky hillsides and hot dry valleys.

Where to plant: Plant it in zone in zone 2 as a boarder plant. Plant it 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 trenchions.

9.21 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.

9.22 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 grows up to 15 m to 20 m. 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 waterberry 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- 4 days. With modern methods a very good jam or jelly is made, using 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. Flowers attract bees and other insects. The wood is durable for poles and furniture.
How to multiply: Seed.

9.23 Tephrosia grandiflora

Puk bush pea (E), Hlozane (Z), Chitupa-tupa (Sh)

Description: Tephrosin (E) is shrubby and hairy. Leaves up to 4 cm long, stalk short, stipules very

small; leaflets 3 5 pairs, distinctly stalked, up to 1,5 cm long by 6 mm wide, tip blunt, square or slightly notched, with small backward-turned point. Inflorescences lateral, short, with one or few rather large flowers. The pod is flat, usually carries five seeds and grows up to 3 cm long by 8 mm wide.

Habitat: Likes growing in well-drained soils which are Soil has 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 zone 1 Plant it as a hedge row or as windbreak for small plants. Rockery spaces have become very popular and 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 pest 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

9.24 Warburgia salutaris

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

Description: It is an evergreen tree which grows up to 20 m 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 can also 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 treats coughs, flu, malaria, venereal diseases, headache and toothache. The powder from the roots or bark is taken in cold or 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.

9.25 Ziziphus jujuba

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

Description: The tree grows up to 6 m 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.

10. 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 point

- List five reasons for growing trees.
- What indigenous tree species grow in your farm/environment?
- Find out from elder people in your area the kind of trees they used to grow and what they used them 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?

Aloe maloti

Aloe ferox

Aloe ferox

Aloe Tunour

Artemisia afra
African Worm Wood

Dodonaea angustifolia

Leonotis leonurus, white and orange

Lessertia microphylla , Cancerbush

Moringa oleifera

Acacia Karoo

Pomegranate

Avocado

Banana

Mango

Grafted plum tree with ripening fruit
(The tree is less than 1m high)

Lemon tree

UNIT 5:

KNOW YOUR VEGETABLES AND CROPS

LEARNING OUTCOMES

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

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

1. Introduction

This section gives general information on the types of vegetables and crops. It also describes how to grow vegetables and what one gets from the vegetables for the body. Vegetables form an important part of people's diets. They provide the much needed vitamins and minerals as well as roughage. Most of the vegetables that people rely on are annuals and must be regularly grown. This unit will discuss both the indigenous vegetables and the exotic. 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.

2. Guidelines in growing selected crops

2.1 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 1 m 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 800 m. 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.

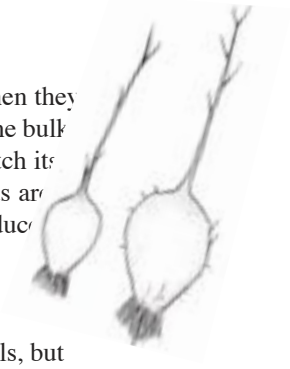
Saving seed

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 of 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 in 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 of them 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 useful source of amino acids, protein, iron, zinc and other minerals.

2.2 Beetroots (Beets)



Description:
Beetroot has a distinctive bright red colour of the 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 a 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 into the open soil into shallow holes 1cm deep and set 20cm apart.

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

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.

2.3 Cabbage

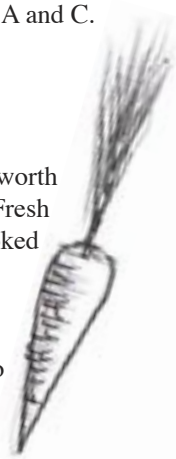
Description:
Cabbage comes in various forms harvested in different times of the year. Most cabbages have white leaves forming the bud of the head. There is also a group of cabbages called red cabbages.

Cultivation
Cabbages needs 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.

Storage
Most cabbages are winter hardy and can be left in the beds are 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.

2.4 Carrots



Description:
The edible part of the carrots is below ground, the roots. 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 before being cooked 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 ground - 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 hole with a crowbar, fill them with compost and sow into these. Sow very thinly in drills 1cm deep and set 15-20cm apart. When the seedlings appear, thin the earliest to 8cm in 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 onion 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.

2.5 Eggplant (aubergines)

Description
The eggplant is also known as garden egg. The plant height range 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 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 ware and mix. The heavy seeds should sink to the bottom. Wash the 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.

2.6 Lettuce

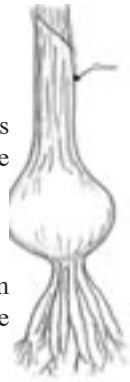
Description:
Lettuce is used for decorative purpose as well as for taste and nutrition. They grow relatively quickly and will be ready from 3-12 weeks after sowing. This means that they can be grow among slower growing crops or used to replace another crop that has already been harvested. You can mix 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 15-30cm 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._

2.7 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 on as an important culinary herb and vegetable.

Cultivation
Onions grow well in winter in sand loamy soils. Plant the onion seeds in beds and thin them as they grow. Plant onions 7-10cm apart in a raised bed. Reduce watering when bulbs are produced. Mix onions with a brassica and salad crops since it helps to repel pest.

Nutritional value and uses
Onion help improve appetite loss and assist in blood formation. Traditionally it is used for the treatment

of dysentery, wounds, scars, asthma, and diabetes are amongst the many traditional uses.

2.8 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.

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: 15 cm wide, 20 cm 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, also know as sugar peas, 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 folicate.

2.9 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 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 growing closer. 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 and select pods and save them separately from the rest of the crop. Remove the seeds from the pods and dry and clean the seeds thoroughly.

Nutritional Value
Soya bean 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.

2.10 Spinach and Swiss Chard

Description
Spinach and chard are related to the beetroot and not to the cabbages and lettuces, to which it bears 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 weeks 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.

2.11 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 with hand watering.
Squash plants are bush. 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 5-6 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 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. The seeds are rich in protein and oil.

2.12 Sweet and hot pepper

Description
Also known as bell pepper, capsicums grow as an annual plant which may grow to between 30cm and 1.5m tall. They are related to chill or hot peppers and other types of pepper and have similar planting and growing needs. They 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 pepper can be eaten fresh or get sun-dried. Larger fleshy ones are cut down one side and the seeds are removed and then the peppers is sun-dried.

Seed saving
Capsicusms 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. It is a good source of vitamins A and C.

2.13 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 and a 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 deeply, 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 and the shoots will begin to grow from the eyes. Plant the sprouted tubers 25cm apart in the trenches and lightly cover with soil, best to plant with the shoots pointing upwards. 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 hoe. This will keep the tubers covered and also support the plant water regularly during dry periods. Tyre potato production is the easiest one, step by step adding a tyre after another.

Nutritional value
Potatoes are a staple which is usually used fresh and boiled, baked roasted or fried. They are sometimes added to soup and stew. They are good source of calories as starch, 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 can be lost during storage or overcooking.

2.14 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, good compost. Create ridges and plant tomatoes on the ridges and mulch with half composted organic matter. Do not use mulch from old tom a toe stalks for they may bring diseases and pests into the field. Sow in mid -spring, plant in early

summer, plant about 45cm, sown rows 75cm. In frost free areas grow tomatoes through out the year. You can also grow tomatoes through out the year if you have a green house. Cherry tomatoes are easy to grow; you can plant them along the boundaries of your garden or within hedge rows. Water tomatoes on the roots avoid putting water on the leaves. All tomatoes will need staking, support them with sticks and strings so that the fruit do not get into contact with the soil. Remove the side shoots of the tomato plant. 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 frozen, but then used only in cooked dishes as they lose their firmness.

Nutritional value
Tomatoes are used widely both in raw and cooked dishes. They can even be used in their unripened state. Tomatoes are more nutritious if they are eaten fresh (uncooked), if cooked do not over cook. They are used in relishes, soups, stews, salads and its high in vitamin C and A.

3. Growing root crops in general

Root vegetables can be planted directly into your garden beds.
The process:

a. When your beds are ready, make small furrows or grooves in the soil using stick;
b. Construct the furrows about 15 cm apart and 2 cm deep;
c. Plant the seeds about 1cm apart in each furrow and then cover them with about 1cm of soil;
d. Water the seeds gently once or twice a day;
e. You must keep the soil damp until you see the seedling coming through the soil. In summer, use a thin layer of mulch to prevent the soil from drying out;
f. 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; and
g. You can replant the beetroot and turnip seedlings from the thinnings that you take out. Carrots are generally not transplanted.

4. Conclusion

In this Unit we learnt 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, one should be able to describe the requisite conditions of growing the vegetables discussed above.

Reflection point

- Why would you grow vegetables in your garden?
- What indigenous vegetable varieties grow in your farm/environment?
- How have farmers in your neighbourhood managed and saved seed from leafy vegetables and root crops?

The pleasure of harvesting food that promotes health for all.

Amaranthus

Spinach and onions

Protecting cauliflower with marigold and basil

UNIT 6:

KNOW YOUR HERBS AND MEDICINAL PLANTS

LEARNING OUTCOMES

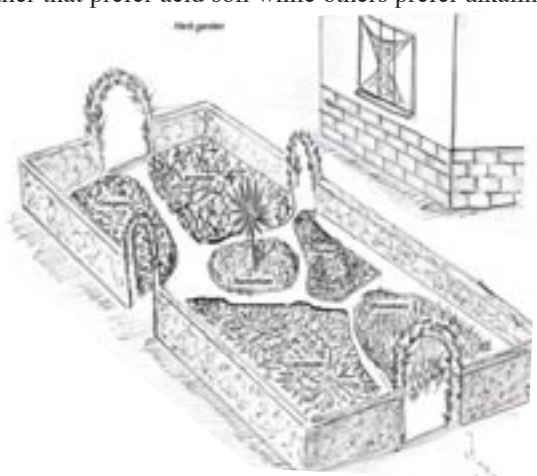
At the end of this Unit the readers should be knowledgeable about:

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

1. 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 the full sun, others on semi-shade while others prefer complete shade. At the same time, there are those which prefer rich compost soil, moist and organic soil, well drained soils and other that prefer acid soil while others prefer alkaline soils.



1.1 Main Uses for Herbs

- Culinary / Kitchen Herbs
- Nutritional
- Medicinal Herbs
- Scented Herbs
- Herbal Teas
- Insect Repelling

2. Types of herbs

2.1 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.

2.2 Perennial Herbs

These are usually herbs that will grow for a few seasons. They often have 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, nutmeg, camphor fennel and evening primrose.

2.3 Shrub Herbs/Trees

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 if you are to consider planting it into the landscape.

3. Considerations for Herb Garden site

For any garden to grow successfully you need to bear in mind what factors of the site are going to influence the site and your design.

3.1 Climatic and Microclimatic Factors

a. Rainfall patterns
b. Temperature regimes
c. Humidity levels
d. Wind speed and direction
e. The impact the sun will have on the site
f. Is the site subject to severe frost?
g. Are their any large trees or buildings that will create a shadow?
h. Is the site subjected to strong winds?

3.2 Topography Factors

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

3.3 Existing Vegetation

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

3.4 Use factors of the Herb Garden

a. Is the herb for decorative value only?
b. Is it to be a specific function, for example, culinary or medicinal?

The use factor will determine what kind of design to follow as it will also need to be functional in order to harvest the herbs.

4. 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.

4.1 Growing and Landscaping with Herbs

Colour
Herbs for colour whilst herbs are to be grown for a specific uses in terms of herbal application, with a bit of imagination one can also improve the overall look of the garden by ensuring good colour

distribution in the garden. In a formal herb garden, the use of strong primary colours repeated 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

Grey Lavender, cleveland sage, cotton lavender, lambs ear, wormwood and mugwort.

Pink Perennial basil, woolly sage, bressingham thyme, wild rose geraniums, roses and bergamont.
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.

Red Pineapple sage, roses, bergamot, poppies and nasturtiums.

Greens Mints and thymes.

5. Types of herbs

5.1 Basil

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

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
The 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. The infusion treats gonorrhoea, diarrhoea and dysentery. It is reputed to be an aphrodisiac.

5.2 Borage

Borage is a robust annual plants which grows up to 1 m high with thick prickly stems; big , broad and rough hairy leaves; and starry flowers that are first pinkish becoming true blue, with shiny black anthers at their hearts. The leaves and flowers edible and the flowers are used in salads and fruit cups. Used medicinally for coughs, bronchitis, as a tea or inhalant. For hay fever, put flowers in hot water and hold on the face. Cultivation is done from the seed.

5.3 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 shrub and grows up to 4 m 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.

5.4 Chives

Chives originated in Europe. They are perennial and make dense tufts of grassy, delicately onion-flavoured, tubular leaves, usually up to 25 cm 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 5 cm from the ground. Chives are often confused with plants of the onion group. 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.

5.5 Coriander

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

5.6 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.

5.7 Lavender

Most lavender plants are native to Southern Europe. They have narrow smooth edged leaves, flowers and in rings about the stalks. They have a delicious scent. They are propagated from cuttings.

5.8 Marjorams

Marjorams are romantic plants of the family Labiatae, native to the hills of Mediterranean counties. 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 into salads, make spice, or cook with majoram leaves. It is grown from the seed, cuttings or root divisions.

5.9 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 for vinegar. It is eaten for its antiseptic effect. It is cultivated from seed.

5.10 Parsley

Parsley may have originally been found in Southern Europe. It is usually a biennial with many divided curly leaves. These and the stalks are strongly and pleasantly flavoured, making it one of the most popular of all kitchen herbs. Leaves for flavouring and in salads. 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 the strong garlic breath. It is cultivated from seed.

5.11 Rosemary

Rosemary occurs naturally in the 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 for cooking salads, in cosmetics and medicine. Rosemary tea is a general tonic and pick-me-up, and stimulates body and skin, it helps the memory and "comforts the brain". If eyes are dim from overwork or strain, eat the flowers. It is cultivated from cuttings.

5.12 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 the juice for convulsions and fits, toothache and earache; an infusion for heart irritant and can be a dangerous remedy. Cultivation is from seed and cuttings.

5.13 Sage or salvia, of the family Labiatae

The sage group of plants belongs 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 for also used as antiseptics. They are grown from seed and cuttings.

5.14 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 there 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; also a vermifuge. Cultivations is from seed or cuttings, by layering or by root division.

6. Preparing herbs and medicinal plants

Medicinal plants and herbs are prepared using different methods.

6.1 Dry Methods

- Select the variety of herbs you like for use;
- Harvest with a scissors or secateur;
- Dry leaves and flowers thoroughly in brown paper bags; and
- When sufficiently dried, grind and mix it together and set aside use in different kind of dishes.

6.2 Herbal Bath

The bath is a good place to start in treating your overall body and enjoying the relaxing benefits of herbs. Begin with a strong herbal infusion of lavender or chamomile flowers to soothe a variety of skin irritations. The stronger you make the tea, the more healing potential it will have. If this is just to soothe and pamper your skin, you may choose to make it weaker than if you were treating hives, rash, or sunburn.

Examples of medical plants for bath:
Bring the water to a boil. Turn the heat down to the lowest setting. Add the herbs (fresh or dried) and let it steep for 30- 45 minutes. Strain the infusion into the tub through a piece of cloth or in a thin, soft, clean cloth. Use this bundle of herbs as a scrub, or hold it on a troubled area as a poultice.

Make a Vinegar infusion to add to the bath to sooth itchiness and aching muscles and softening the skin. Add a cupful (225ml) of the following mixture to the bath. 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.

6.3 Facial steams

To perform facial steam, bring water to a boil in a large pot. Toss in a healthy handful of herbs, cover and let it simmer for a couple of minutes. Then 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; and
- 1 part aloe forex

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

6.4 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.

Box 4: Herbs for the skin

Borage: It is good for dry skin and sensitive skin.
Aloe Vera: The jelly-like juice 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: It heals chapped, burned, irritated or wounded skin. It is good for all skin types, including baby skin. It 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.
Elder flower: 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: It 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 is beloved culinary herb can also help sluggish, devitalised, or sallow skin that needs stimulation and regeneration. 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.

7. Traditional preparations of Medicinal plants

In South Africa, bark, leaves, rhizomes (roots), bulbs, tubers, fruits and seeds are all used as medicine. All different parts of a plant carry different chemicals, or "active ingredients," so it is essential to make sure you are using the right part of the plant.

The plants are either used fresh or they are dried for later storage. Once medicinal plants have been dried they should not be exposed to light or heat for long 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.

7.1 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 chemicals are dissolved into water and a hot infusion results, bit like a cup of tea. With some plants heat can destroy some of the active ingredients. In this case, cold water would be used and the plants will be 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.

7.2 Decoctions (boiled)

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

7.3 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.

7.4 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. Alcohol is also a preservative and ensures the medicine will not go off. 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 sold.

7.5 Syrups

Syrups are tinctures to which sugar or honey has been added. Sugar and honey has a preserving action and increases 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.

7.6 Ointments and Salves

These are prepared by placing usually dry plant material into heated oil or fat. Once the active ingredients are extracted 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.

7.7 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.

7.8 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.

8. Conservation of Medicinal Plants

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.

8.1 Strategies for the conservation of medicinal plants

a. Harvest seed from a population of plants in a specific area, propagate young plants in a nursery, and then plant them back into nature with their parent plants.

b. Encourage plant part substitution, the leaves would be a more sustainable option than the roots. A good candidate for this approach is the indigenous ginger, Isiphepheto (Zulu), *Siphonochilus aethiopica*, which is extinct in Natal.

c. 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.

d. Diverse ecosystems, like forests, often hold more economic value in the form of sustainable harvests of diverse products than agricultural land does. 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.

9. Conclusion

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

It would be good to discuss a number of the important traditional herbs in South Africa partly to illustrate that they are there and to guide people in choosing what to conserve. The African Potato, wild ginger, wild garlic and many others that are actually being promoted in South Africa would be useful.

Reflection point

- 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?

Wild dagga

Comfrey

Parsley

Rosemary

Mint

Thyme

Lavender

Thyme

UNIT 7:

KNOW YOUR SMALL LIVESTOCK FOR THE GARDEN

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:
- Types of livestock; and
- How small live stock can be integrated into crop farming.

1. Introduction

Small livestock play a very vital role in sustainable development if they are integrated well into the farming systems. Animals provide meat, eggs, feather, skin, honey, medicine manure, generate income and balance the ecosystems in the communities. 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, for example, a good way of dealing with the droppings. 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 and cardboard, 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.

2. Apiculture

Apiculture is concerned with keeping bees. Bees are one of the most productive elements for a farm. If you are in 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.

Grass beehive

2.1 Why Keep Bees?

Conservation Bees need forage (food and other resources from plants that bees needs to make honey, propolis and wax) plants that are then protected. More should be planted to provide bee food. It is important to plant species that contribute to bee needs. These plants could be planted 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. Section 4 of this manual helps you to select good plants for the bee forage.

(a) Honey. Honey is a most delicious and nutritious food. It is also 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 swam 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 swam with good forage can produce over 120 jars per year. With good management of forest and the 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.

(b) Propolis - Propolis is the glue that bees use to close open spaces on the hive. It is dark grey in colour. Propolis has medicinal properties. It is anti-viral, anti bacteria and anti biotic. The propolis helps to cure, TB, Flue, cold, head arch, and other diseases and viruses.

(c) Wax The wax is the yellow whitish matter that builds the combs. The wax is used for making candles, soap, polish. It can be sold to generate income.

(d) Pollination - Most plants cannot produce fruit and seeds if the flowers are not visited by certain insects (pollinators) and bee is one of the important insect that is a good pollinator. Avocados, most fruit trees, crops and vegetables can not produce fruits without the bees' involvement. In South Africa, avocado farmers hire bee hives into their farms from bee keepers for pollination. The farmers pay bee keepers for the work done by bees on a daily basis.

Note the following:

• **Security**- place bee hives on the boundary of the farm, people are afraid of the bees.

• **Stings** Bee stings helps you to resist against disease and infections. Too much of the stings are dangerous. Before you keep bees found out if you are allergic to bee stings.

• **Warning** Bees can kill. Register your bee project with the local association. Also find out what by-laws of your local government say about keeping bees. If possible insure yourself, family, neighbours or trespassers against bees attack.

2.2 Bee Family

The Queen Female, mother bee, the largest in the colony, leader of the colony, controls the relationship 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 other queens from other hives. If her family members get lost into another hive, they will not be accepted because of the scent that is different. Her 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 her. She will never fly again and all the drones will die. The sperms are then kept in a sperm sac and only the (workers) female eggs are fertilized. The Queen can lay eggs after 3 days of the mating day. She lays over 3000 eggs per day. The queen can live for at least 3 years.

The Drone is the male bee that is developed from unfertilised eggs. Its role is to mate the queen and dies soon afterwards. When food gets scarce in the hive, most of the drones are expelled from the hive and they eventually die. The drone can not sting and it has a maximum life span of 2 months.

The workers A female bee is smallest in the hive. It is responsible for security, feeding the queen,

building cells, cleaning the hive, decision maker, scouts forages, changes nectar into honey, house keeping, covering and warming the brood, produces wax, entrance guards and nursing the queen. The workers sting and defend the colony. Once a water stings it dies. They communicate with the rest of the hive through pheromones (chemical signals produced by the queen and workers) as they dance and vibrate.

Brood this contains the eggs, larvae and the pupae. The brood are protected by the workers and a constant temperature of about 35 degrees Celsius is maintained. When it is cold, the bees cluster together and burn up more energy through consuming more honey to generate heat.

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

2.3 What do you need to work with bees?

A Smoker is 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 honey cells, filling their stomach with honey, ready for an emergency absconding. These bees will not be keen to fly and attack.

3. Aquaculture

Aquaculture is concerned with the keeping of water animals, which includes fish, ducks and geese.

4. Poultry
Ducks and Geese

Duck and geese are good sources of meat. The meat has very little fat and a unique and delicious flavour. Ducks and geese produce about 25 eggs in a season.

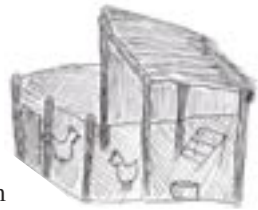
Muscovies, a certain kind of duck, is cheap to keep. They are self-dependent and better foragers than other ducks. They grow fast and seldom get sick. They clean up after your other livestock and eat what the other animals' spillage or their left overs. They come in black and white and various shades of grey and brown, with a bright red crest around their eyes and above the beak, like a cockscomb. Muscovies have never been industrialized or "developed", 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 and can therefore be integrated with fish farming. They fertilise the water and clean water ways. Keep the little ones in a closed house till the age of 2 months. They can swim soon after birth but its it is better to let them swim after 2 weeks.

Feed ducks and geese with 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, control snails and slugs in the garden. Ducks and gees do not scratch mulches in the garden.

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 at any size of the homestead. 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 intruder. A traditional hen can produce over 60 eggs or 40 chicks per year.



4.1 Tips for increasing the survival rate of chickens

a. Keep chicks away from the mother a day after hatching into a warm cage and feed them with starter meal for 3 weeks and then feed them 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.

b. 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 chicken enough space for free ranching and rotational systems for improving the food variety, control pest, plough the soil and fertilise the soil.

c. Chickens can be linked with fruit trees of the garden. In the garden, they are best if they are kept as a chicken tractor or in orchard in rotational systems methods. Feed chickens with vegetables, weeds, earth worms and mixed grains.

5. Rabbitry

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

5.1 Key considerations

a. Keep bucks 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 shot.

b. If rabbits are free ranged make sure the fence is in a concrete foundation or you lay down a 30cm wall of rubbles. This will prevent rabbits from burrowing through the fence.

c. For breeding, take the doe 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.

d. Rabbit manure is of high-quality and easy to handle.

6. Guinea fowl

Guinea fowls are an all-round asset at homestead. Guinea fowls 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 fowls are the best control for ticks and house flies from cattle and goats pens.

7. Vermicomposting

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

8. 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 tape into the ability of bees to produce honey, to pollinate and increase production.

Reflection point

- What factors would you consider in 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 to its productivity.
- Why would a farmer keep worms?

A well-placed hive

Free-range turkey meat is lean protein

Rabbits breed quickly

Applying liguid earthworm fertiliser

UNIT 8:

SOIL IN YOUR GARDEN AND STEPS FOR IMPROVEMENT

LEARNING OUTCOMES

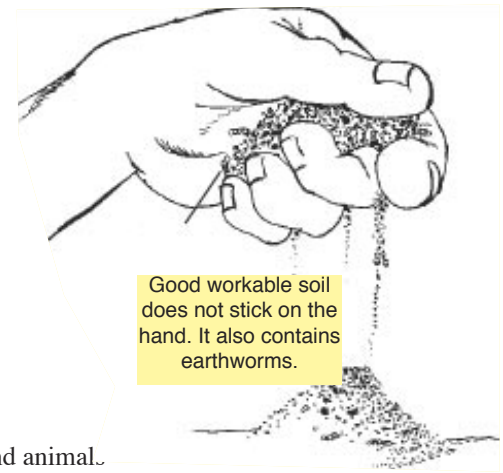
At the end of this Unit the reader should be knowledgeable about:

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

1. Introduction

1.1 What is soil?

Soils are living in that they are inhabited by billions of micro organisms (fungi, bacteria, small insects and worms) and thousands of larger organisms (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.



Good workable soil does not stick on the hand. It also contains earthworms.

1.2 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 soils. One should always remember to test the soil before use to find out whether the soil is clay, sand or loamy. After identifying soil it is then easier to know what methods to use

To test, wet soil and roll into a sausage and see how far it will bend without cracking. From left to right: Sand, sandloam, clayloam, clay

for improving it.

1.3 Enhancing soil fertility

Organic fertilizers are made up of naturally occurring organic materials. These includes 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.

1.4 Minerals found in the soil

Major Elements

Mineral	Use
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

Mineral	**Use**
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

1.5 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.

1.6 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

1.7 Soil analysis

On any site identified for gardening a basic soil survey is necessary to find out the pH (for garden and orchard, drainage capacity and types of vegetation already growing. From there one can decide which species we need to plant and improvement we need to make. Bare soil is soil damaged by people, animals, water, sun, or wind and this soil can be rehabilitated.

1.8 Components of a soil test

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) Sulfur

- Component in three plant amino acids
- Plant vigor

(i) Boron

- Plant vigor

2. 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 smoothing it. 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 clay, the crumb structure will be loosened whilst the sand soil will form a structure that holds water. The secret of a rich and healthy vegetable garden is to feed soil regularly.

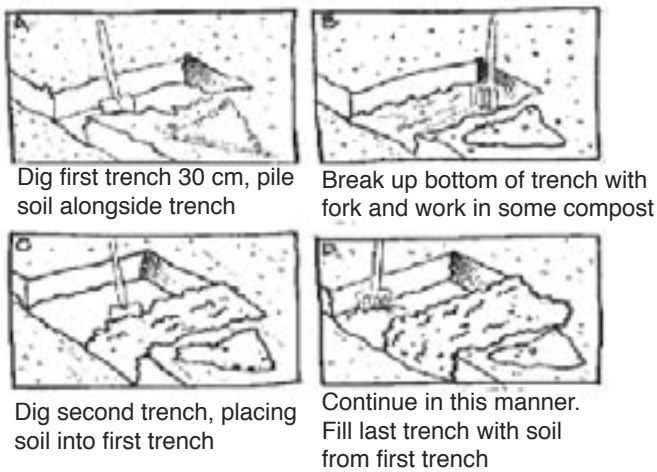
A healthy soil has the nutrients and natural systems which provide a good environment for growing nutritious crops. Permaculture aims to work with nature to prevent problems, rather than to treat them when they have arisen.

2.1 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.

2.2 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.



Double digging method

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

Box 5: Showing 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 pea, lentils, chick pea, soya bean, broad bean, pigeon pea and ground nut.
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.

2.3 Trench Bed

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

2.4 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.

2.5 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.

3. 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.

3.1 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 digging them in the beds to provide organic mater in the soil. Most of the plants used for green manure are legumes such as beans, lucern, cow peas, chick peas, etc they 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 after harvest, 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. Lucern 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 and plant after 2 weeks, crops like cabbages and spinach. Planting lucerne on the edge of the bed helps in soil improvement because it fixes nitrogen in the soil.

3.2 Mulch

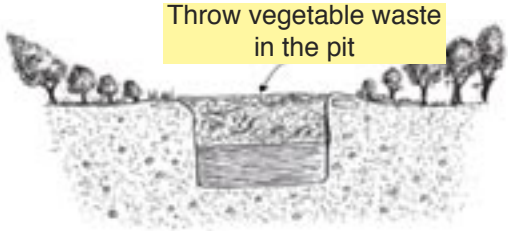
The soil must be covered with a layer of dried leaves, grass cuttings or straw. This is called mulch. Mulch, cover crops and green manure crops, prevent soil erosion, add organic matter and nutrients to the soil, buffer soil from extreme of heat and cold, and protect soil water from evaporation.
There are two categories of mulch: "dead", which is dried out decayed, or dying (straw, dried leaves, recently cut vegetable) and "living", which grows underneath trees and shrubs. Dead mulch must be collected (sometimes from scattered locations), while living mulch needs management (sowing and cutting back, sometimes re-seeding). Mulch is placed on top of the soil and around the plants. You can also use inorganic mulch such as stones and newspaper but this has less advantages.

How to get the most out of mulch?

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

3.3 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.



a. 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.

b. 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 shady place to prevent it high evaporation. Kraal compost can be made near the animal (goats, sheep, horse, donkey or cattle) kraal.

c. Construction of a compost heap

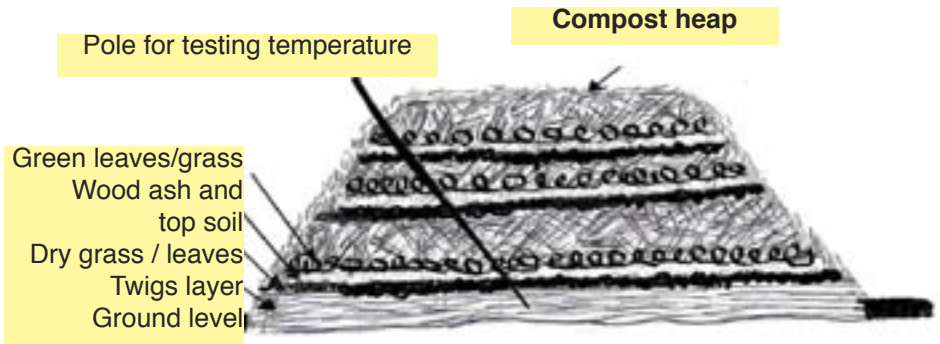
The process for making compost is much the same regardless of the materials used. There are two types of compost heap: aerobic and anaerobic. Aerobic compost is where the compost is created by micro-organisms that use oxygen in the process of decomposition. Aerobic compost is quick to decompose and destroys 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.

d. Guidelines for making aerobic compost

- Lay down a 20cm layer of course 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 from depletion of oxygen;
- Plugs of red wrigglers and earthworms can be added to the heap when it starts cooling down to speed up decomposition and insuring that they are inoculated 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 them 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; and
- 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.

e. 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 soil surface about 10cm deep and use a garden fork to mix it with 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.

Box 6: Tips on materials for compost making

Many diseases causing microorganisms are killed by high heat for example, if the whole compost 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 temperature, 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 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 into compost. Hard cuttings take longer to decompose and some of them could develop roots.

3.4 Animal manures

How to apply animal manure.

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.

3.5 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 makes 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' unique shape 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 eelworm (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.

a. Increasing earthworms in the garden

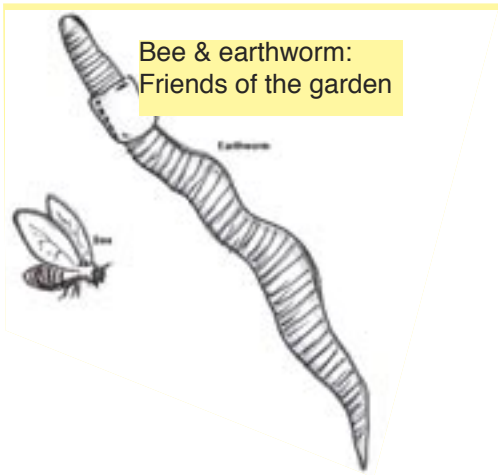
- Maintain soil moisture.
- Always cover the ground
- Make pit beds in the garden to attract earthworm breeding.
- Keep earthworms in boxes and feed with animal manure, kitchen waste and vegetables

b. How to look after earthworms

There are many different ways of keeping worms; indoors or outdoors; on a concrete floor or on compacted ground; in wooden boxes, metal drums, trenches or windrows (long rows on the ground) are just some of the many ways.

Cover the bed with black plastic or shade cloth, and a layer of grass on top. The covering keeps the bed moist and dark (earthworms do not like the light). 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 (they prefer dry conditions). Make sure there is adequate drainage if the worms are contained in drums or trenches, and kept outdoors (in the rain). A bad odour indicates too much water (uncover, check drainage and turn the bed lightly with a fork).


Bee & earthworm: Friends of the garden

Earthworms eat all kitchen scraps (except citrus and onion family): decomposing organic matter (leaves, straw, grass clippings, crop residues, etc.) 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.

Harvesting of earthworm castings is possible a few months after the bed was set up. 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 unfed side. Be careful not to remove the fresh cocoons (about the size of a match head and bright yellow or orange). It takes +/- 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.

Table 6: Earthworm pests and associated control measure

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

Frogs	Remove by hand

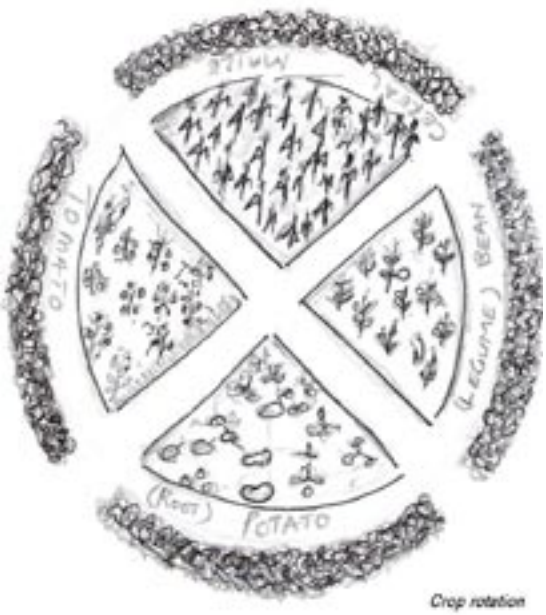
3.6 Making liquid manures

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

The process

- To make good liquid manure, 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; and
- One should not apply the liquid manure more than once a week in small quantities or once every 2 weeks in larger amounts.

3.7 Crop rotation



Annual crop rotation sequence: Cereal (maize), legumes (beans), root (potato), fruit (tomato).

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 every 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 damaged 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.

4. Conclusion

Having understood soil classification, nutrients for the soil and plants, how to prepared the soil,

mulching, development of a 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 very essential when practising gardening.

Reflection point

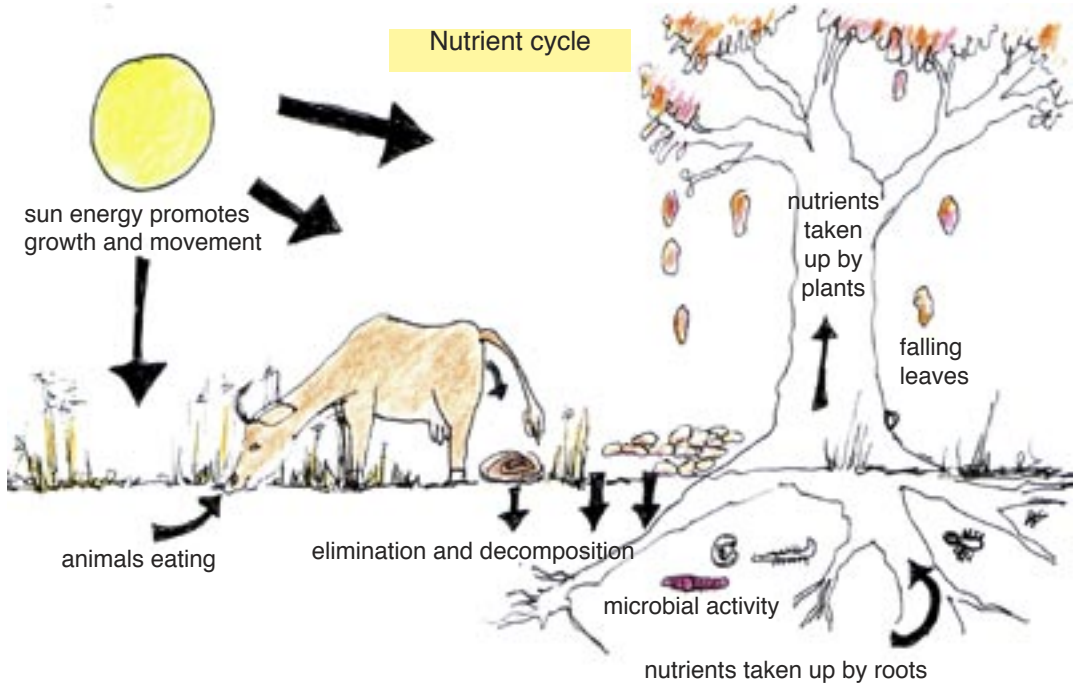
- Explain how feeding the soil can result in a nation with healthy people.
- What are the advantages of using organic manure?
- Describe the ways in which earthworms contribute to the ecology of the garden as well as to its productivity.
- Why should a farmer rotate crops?
- What principles should be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

Pit beds for dry areas.

It is highly recommended that soil cover follows planting. In this image, groundcover has been planted which will take over from mulching.

Vertiver grass planted on swale and the grass a few weeks later, showing rain water use

Horse shoe beds ready for planting. Mulching will follow in the pathway.



Planting a tree, protected with mulch

Plant crops around a fruit tree

Alley cropping

Freshly planted & mulched beds

Compost heap

Turning compost

Earthworm activity

UNIT 9:

MIXING PLANTS IN THE GARDEN

LEARNING OUTCOMES

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

- Essence of planting crops together;
- How you can plant certain crops together; and
- Identifying plants that can grow well together and those that may not need to be planted together.

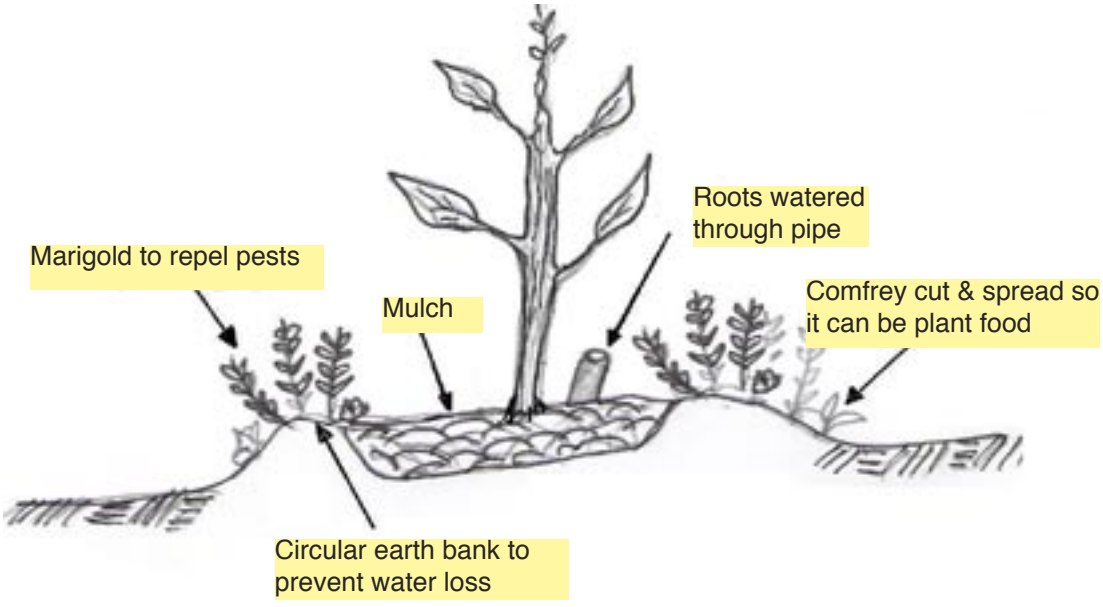
1. Introduction

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.

1.1 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:

a. Reducing root competition;
b. Assisting pest control in various ways;
c. Providing mulch;
d. Providing free nutrients;
e. Providing physical shelter from frost, sunburn, or wind;
f. Assisting us in gathering by creating culinary guilds; and
g. Reducing of competition for light.



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.

Table 7: Examples of crops and their companions in guilds

Fruit	
Melon	Corn, peanut and sunflower
Plum	Horseradish
Raspberry	Tansy
Strawberry	Beans, spinach, borage and lettuce

Vegetables	
Asparagus	Tomato, parsley, basil, nasturtium and marigold
Beans	Carrot, cauliflower, cabbage, beet, borage, maize, marigold, squash, strawberry, tomato, nasturtium, potato, cucumber, savory, collards and sunflowers
Beet	Onion and kohlrabi
Broccoli	Beans, nasturtium, oregano, potato, celery, dill, chamomile, sage, mints, rosemary and onion
Brussels Sprouts	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 morogo.
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
Celery	Beans, leek, tomato, cabbage, cauliflower and onion
Maize	Peas, beans, squash, melon, potato, cucumber, lamb's quarters and sow thistle
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 & Flowers	
Anise	Beans and coriander
Basil	Tomato, beans and cabbage
Bee Balm	Tomato
Borage	Tomato, strawberry and squash
Caraway	Peas
Chamomile	Onion, cabbage, mints and cucumber
Chive	Carrot, grape, parsley, tomato and fruit trees
Coriander	Anise and potato
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
Oregano	Cucumber
Parsley	Tomato, asparagus, carrot and 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

Fruits	
Apple, apricot, peach, plum and pear	Potato, lucerne, clover and cowpeas, nastursium, 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
Vegetables	**Do not grow together with:**
Asparagus	Onion
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
Herbs	**Do not grow together with:**
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 have learnt about the reasons and best ways of combining different types of plants in order to get most out of them and to minimize negative effect that they might have on each other. This should enable you to plan and manage your garden effectively.

Reflection point

- 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.

Mixed planting for best results

UNIT 10:

WATER MANAGEMENT, IRRIGATION AND CONSERVATION

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; and
- Irrigation techniques and technologies.

1. 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.

2. 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 have less chemicals than municipality water. Harvesting and storage is the basis for starting permaculture food production.

2.1 Principles for the day to day water management (PSSS):

a. **Protect**: Protect your sources and storage points from pollution.
b. **Store**: Catch and store all the run-off water you can in barrels, tanks and reservoirs.
c. **Sink**: Put the water into the ground to build the ground water table using pits and swales and mulch.
d. **Spread**: Direct the water to vegetated land put in swales connected to small earth dams and makes use of appropriate irrigation technology. Such as drip irrigation.
e. **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.

2.2 Water use in the garden

It cannot be stressed more 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.

a. 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.

b. 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 sunsets and the evening chill sets in.

c. Do not waterlog the soil because this kills micro-life and plants die from lack of oxygen.

2.3 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, than 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, dry soil must not be left, 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.
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 elements that do not need watering.

3. Irrigation Systems

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

3.1 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.

3.2 Small sprinklers

Independent small sprinklers that spray uniformly in a 6-meter arc around then are ideal for spot watering. The best ones are those that spray, outwards from a central hole, a consistent, dense, yet not heavy spray. These sorts of sprinklers are cheap and are to be 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 provide it with pressurised water.

3.3 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 (about 90 %).It 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.

3.4 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 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. But on steep or bare slopes they work well by collecting run-off and directing it into the pans.

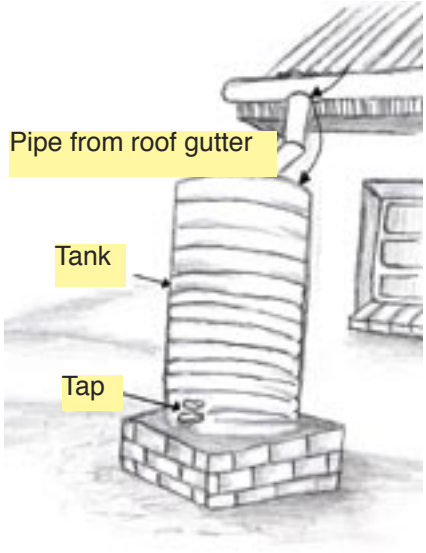
4. Water harvesting and conservation

4.1 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.

4.2 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.



4.3 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, pit beds, where all excess water is sent, nothing is wasted and allowed to flow away.

4.4 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.

5. 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.
In using wastewater from kitchen, bathroom, and laundry it is wise to establish just what chemicals, 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.

5.1 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 in the purification wetland, plant species that grow well in water, 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.

5.2 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:

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

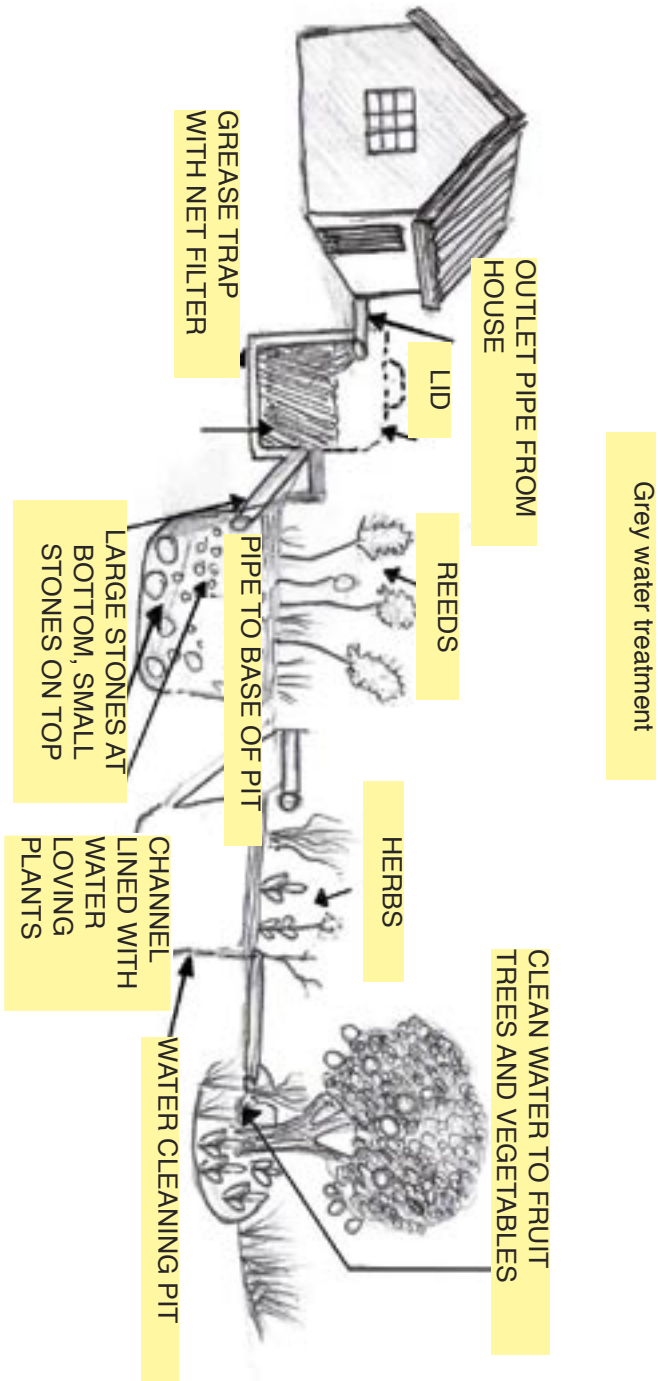
6. Conclusion

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 point

- Why is water 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 it being used?
- How would you calculate the amount of water that would be collected from a roof?



Watering a home garden using waste water from the kitchen

Rainwater collection

Swale keeps rainwater in the garden

Grey water treatment

UNIT 11:

PROPAGATION OF PLANTS FOR YOUR GARDEN

LEARNING OUTCOMES

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

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

1. Introduction

This is a very important module. It will take you through various processes in plant propagation. You will be exposed 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.

2. Establishing a nursery

A nursery should be established 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 people's needs should be taken into account.

2.1 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.

a. The nursery must be established near a water source for easy access. The ground should be level to prevent runoff. Cover the ground with mulch, especially where there 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.

b. A nursery needs different degrees of shade. Some plants prefer heavier shade than others; some plants need different degrees of shade during their development. A tree can provide suitable shade. An inexpensive shade house can be constructed from a framework of poles with a grass roof. Long veld grass or palm fronds can be laid in varying thickness.

c. The soil in a seedling bed should be free of anything that may hinder growth (such as stones, sticks, hard clods of clay). A germination bed should have loosely tilled, aerated, fertile soil for at least 10 to 15 cm. 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.

d. Prepared soil can be put between small stonewalls, 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 15-20cm / thick on top of the soil/straw mix. This system has good drainage and avoids many pests from ground level. Water twice a day.

e. Trees and cuttings prefer to be in their own individual containers. Several types of containers can be used from plastic bags, tins to 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 and you have selected the hardier plants. It is wise to transplant the young plants into individual containers. The plants roots can now be protected in their own ball of soil.

f. Hygiene in the nursery 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 no deeper than 50 cm. For large quantities of soil, you can steam the soil in a drum with holes in it over a fire.

g. It is important to protect the nursery from animals and children. Thorny branches can also 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.

Box 7: The value of nursery

- The soil used should be thoroughly fertilized, seedlings raised in rich soil and without stress because of extra care, benefit 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 attacked can be dealt with more easily.
- Regular watering and control of moisture can be controlled in the nursery.
- The strongest plants can be selected and the weakest can be eliminated.
- 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.

2.2 How to plan and establish a nursery

a. Plan where to put everything you need to start a nursery;
b. Choose a suitable site;
c. Terrace and protect the site;
d. Protect it from strong winds;
e. Establish it near water source;
f. Collect containers for planting seedlings;
g. Collect your soil and materials from a growing medium;
h. Make compost;
i. Collect or buy your seeds; and
j. Plant and look after the seeds and seedlings.

3. Nursery Management

Nursery management involves the following:
a. Having a basic understanding of plants and the way they grow;
b. A sense of responsibility and commitment;
c. A desire to learn;
d. Nursery practice skills; and
e. Nursery management skills.

3.1 Day to day running of a nursery involves the following:

a. Obtaining necessary materials (soil, water, compost, mulch, tools, equipment, and seeds;
b. Preparing the growing medium, seed-beds and nursery beds and potting bags;
c. Seed treatment;
d. Sowing the seeds;
e. Plant cuttings, watering;
f. Caring for seedlings and removing weeds;
g. Transplanting;
i. Caring for tools and equipment;
j. Caring for tools and equipment;
k. Using compost when necessary;
l. Keeping a nursery clean;
m. Controlling pests and diseases;
n. Making compost;
o. Marketing, advertising, serving customers, selling, and giving away plants;
p. Keeping records, experimenting, and research; and
q. Dispatching plants.

3.2 Qualities of a good nursery manager

a. Understand people and their needs;
b. Build up confidence;
c. Know how to plan and make decisions;
d. Be able to follow up and act on decision made without delay;
e. Be a good learner and listener;
f. Be a good teacher and be open for suggestion;
g. Be a good salesman/ lady;
h. Be able to organize, keep and file records;
i. Be able to communicate well with customers;
j. Be responsible, reliable and effective;
k. Have a positive attitude towards environment, business and people;
l. Be able to network with different organizations.

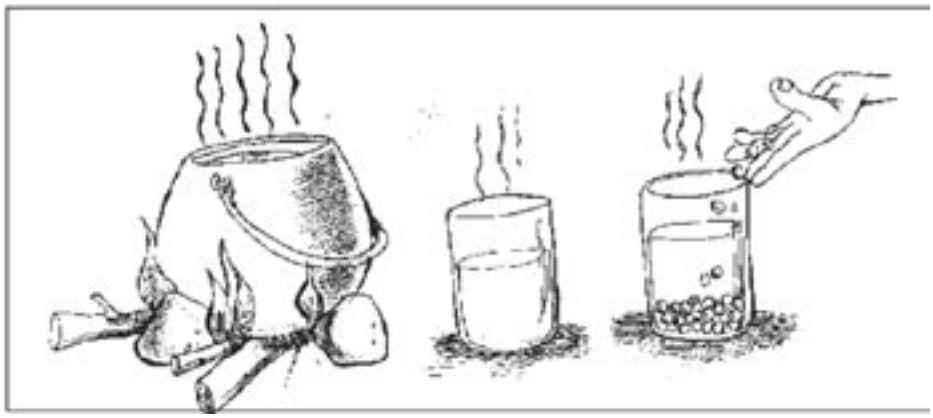
4. Ways of propagating plants

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, sugar can and figs reproduce asexually.

4.1 Techniques for improving seed germination

a. **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 simply by 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..

b. **Soak**: Many seed will quickly germinate 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.



c. **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.

4.2 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.

a. **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 and 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 around or wet 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.

b. **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.

c. **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.

4.3 Seed sowing guide for vegetables in South 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 (Protects 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 variety of plants in Free State, Eastern Cape, Western cape and Gauteng, be aware of frost in Septembers)

September:	Amaranth, bush beans, egg plant, 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

5. Asexual reproduction

So far you have looked at the ways to grow plants from seeds. The other main way to grow plants is from the parts of another plant this is sometimes known as the vegetative methods of growing plants.

5.1 Advantages of vegetative propagation

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

a. 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;
b. Plants grown by vegetative methods usually grow faster than plants that are grown from seeds;
c. 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 are planted; and
d. Some plants such as pineapples and bananas do not produce seeds. The only way to grow these plants is by vegetative methods.

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

5.2 Plant parts used for asexual reproduction

a. 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.

b. Parts of stems or roots

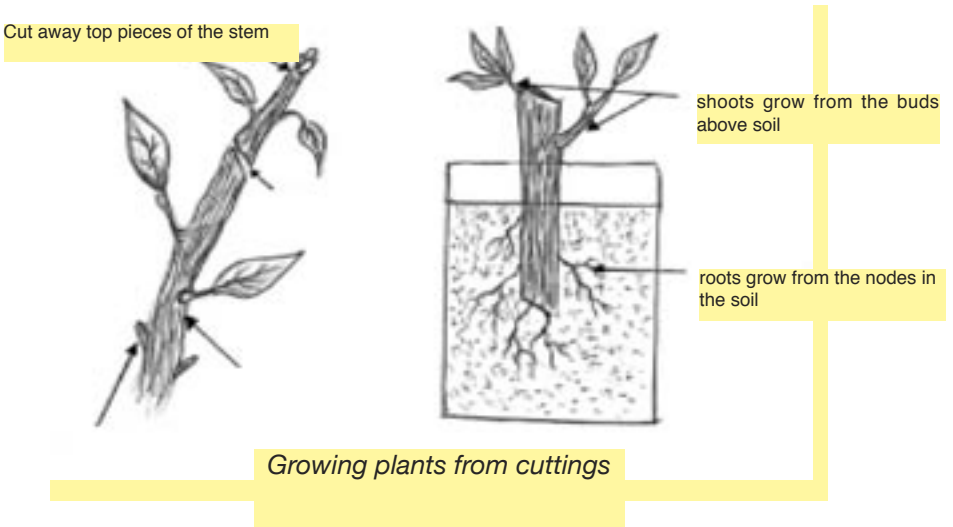
Some plants have special types of stems or roots from which new plants grow. In this section you will learn about these different types of stems and roots and you will see how you can use them to grow new plants.

c. 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.

5.3 Growing plants from cuttings

Cutting is a common and fast method of 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 take generally 3 to 9 months to develop sufficient roots before they can be transplanted.

Figure 7: Illustration of grafting

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.

5.4 Rooting plants

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.

5.5 Layering

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.

Figure 8: Illustration of layering

5.6 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. For example you can take a (scion) top branch of a peaches tree and join it with a (rootstock) part of a plants where roots are of a plums and nectarines to grow good peach or graft Naartjies onto Orange rootstock. This gives you variety within a small garden context where growing many different species of trees are not possible. **Rootstock** and **scion** must come from plants that can be grafted together. The cambium layers of both must touch. 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. Graft deciduous plants in winter.

6. Conclusion

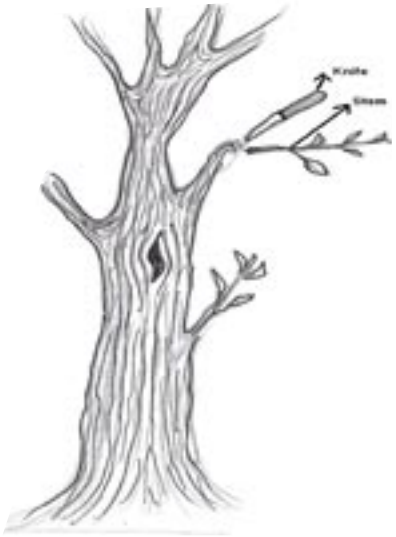
In this module you learn about plant propagation using seed as well as vegetative parts of plants. You also learnt about how to take care of the seedlings and how to transplant them effectively. You

learnt about when to propagate certain plants in South Africa, given the climate.

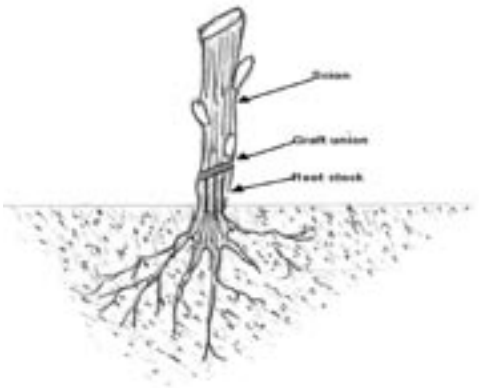
Reflection point

- What are the advantages of sexual reproduction?
- Why is grafting important?
- What can you do to ensure that the seed you save 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?

Cutting a scion for grafting



Scion grafted on a rootstock



Use a sharp knife when grafting

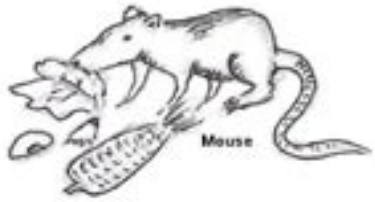
Sowing seeds

Healthy plants for sale

UNIT 12:

MANAGE PESTS, DISEASES AND WEEDS 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; and
- Be able to control pests, diseases and weeds in the garden.

1. Introduction

Pest, disease and weed management are an important part of Permaculture. This module will share with you various things regarding pests, diseases and weeds. Pest and disease control in Permaculture uses an integrated holistic approach to creating health and vigour in a garden. If all the correct steps have be taken towards sourcing seeds, land clearing, soil preparation, plant and animal species selection and placement, combined with cultivation and management strategies that are in tune with the biological rhythms of the gardens, then effective pest control and disease resistance is achieved.

1.1 What are pests?

These are insects and animals that affect the crop production systems. They are those animals and insects that are at wrong place at the right time. A pest develops from egg larva- pupa adult. Illustration in circle form The larve is the most dangerous stage in the pest life circle.

The following chain helps you to set strategies for managing pest and diseases.

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

Where do you need to pay most attention for pest and diseases management on this this chain? What factors can increases pests and diseases in the garden and how can you manage them?

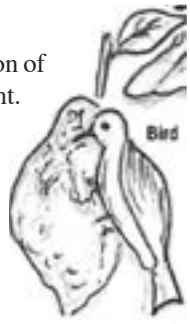
The following points are area which needs special attention when managing pest and diseases:

- Source of water- Untreated grey and black water can cause diseases on plants;
- Guide lines for 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 un wanted 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 pestcides, pest control methods (Too much of something is dangerous; proper measurements is encouraged, record and allow institutes to research on the methods you are practices);
- **Soil management-** Poor soil develiops poor plants, unhealthy plants are easly attacked by pests and diseases; and
- **Type of compost-** poorly made compost is not good for the plants.

1.2 Relationship between pests, plants and animals

Healthy soils lead to healthy plants and animals and thus healthy people. If plants are attacked by pests and succumbing 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, natural selection at work, leaving space and energy available to the healthy plants. We need to realise that a pest is an organism in the animal kingdom that is in the wrong place at the wrong time, or anything out of balance with its environment. We really need to fix the problem not the symptom and encourage a biological system of control to maintain homeostatic balance in the garden.



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

1.3 Basics of pest control in Permaculture

Permaculture pest control systems such as chickens, ducks, companion planting, trap plants, creating habitats for pest predators (wetlands, logs, etc), non tillage, encouraging birds, are the main strategy in pest control while companion planting, maintaining healthy soils, following the calendar and practicing good garden hygiene is the best way to avoid serious disease epidemics.

1.4 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 the garden, record 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. Once you know your pests then you can find out how they came to be there and out of that create a strategy to deal with them. The same applies to diseases. They must be identified (use one of many organic gardening books listed in the appendix) and their time and place of infection recorded. This process can also tell you about your soil conditions and the quality of your genetic stock.

2. Pest and disease control

2.1 Control of caterpillar and larval infestations

Cut 1 kg 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.

2.2 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 in the following year into plants, which are susceptible to fungal attack. Add 10 g of dried Casuarina leaves to 2 litres cold water and bring to the boil and leave it boiling for 20 minutes. Then let the tea cool down. Now add a further 8 litres water and stir well for 10 minutes. The tea is then strained and can be sprayed in the evening (10 litres to 100 square meters), either under affected plants or as a preventative 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.

2.3 Control of slugs

Slugs breed in gardens that have a lot of water and when manure undecomposed is thrown on the gardens. Logs can and should be strewn around the garden to encourage slugs and snails to incubate there during the day, so in the morning when you can lift up the logs and collect them to feed to the chickens. Encourage chickens and small ducks to live in the garden. Tobacco dust also kills snails.

2.4 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 often runners, grasses and weeds with fleshy bulbs, which thrive on a compost heap and will spread once the compost is applied to the gardens. Take roots and shoots from the weed in question and the whole plant in the case of chickweed and place them in a 210-litre barrel of water. Stir the contents around a little everyday. Once the plants have completely decomposed (2-3 weeks), the liquid is sieved and sprayed on the garden. Wherever these weeds grow spray on three consecutive evening, 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 eat many insects and other pests.

2.5 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 filled, that is, intercropping, you make it difficult for disease and pests to spread. The alternative is to rotate crops.

2.6 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 eg fever plant, khaki bush, pg weed, worm wood in between the different crops you have planted because this also helps to control pests and diseases.

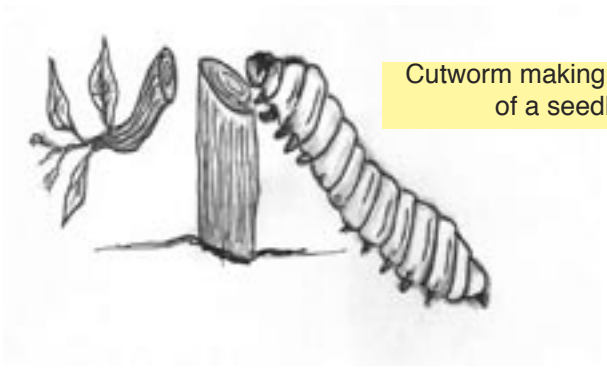
This is because many natural enemies of pests come to the crop plants from the wild areas.

3. How to fight specific pests

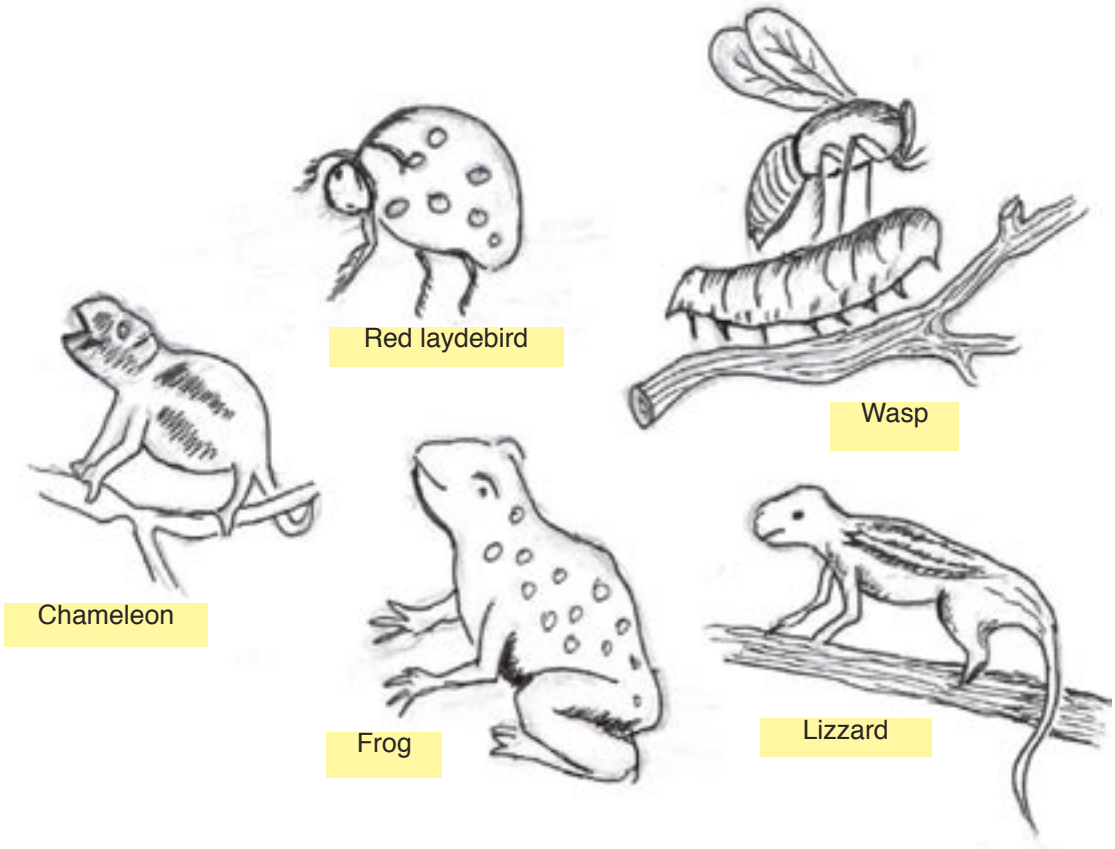
The pests that have been selected for discussion are those which tend to be common in South Africa as well as those that have a big negative effect on production.

Table 8: How certain pest feeds 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	Aphids
green, black insects on sample	
Leaves with discolouration or	Red spider mites, sucking organisms
damaged by small organisms	
Leaves coated a light powder	Powdery mildew
Rusty red spots on leaves	Rust fungus
Blackened veins or vascular	Bacterial wilt
bundles	
Small wilted collapsed plant	Bacterial wilt
wet soil	
Roots nodes	Nematodes
Predator (useful insect)	**Pest (food)**
Spider	Red spider mites,aphids
Lady birds	Aphids
Lizards	Caterpillars
Chameleon	White flies,
Mole snakes	Slages and snails
Frogs	Cut worms
Wasps	Aphids and white flies
Praying Mantis	Aphids and white flies



Cutworm making short work of a seedling



Friends for the garden - insects on the menu

Table 10: Plants that encourage helpful insects in the garden

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

Table 11: Plants to use for repelling specific pests

Plants for spray	Animals Repelled
African wormwood	Plant as screen in garden as w 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	Great for seeds storages; However permaculture does not encourage planting of gum trees
Fennel	Most plants dislike it, so it is good to plant at the edge of the garden. It is good to attract 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 improve improve growth of the plants.
Horseradish	Plant at the corners of potatoe beds for repelling potatoe bugs. Good for fruit tree, spray the fruit trees just after flowering before fruiting.
Horsetail	Slugs
Marigolds	Excellent for pest repelling, plant in all corners of the garden, repels bean beetles, nematodes, aphids, mosquitoes, and a wide variety of other pests.
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, improves flavour and repels white flies and red spider mites.
Parsley	Repels sparagus beetle, plant it with onions or create border for a variety of vegetable beds.
Pepper (hot)	Plant with cabbages, maize, it repels cabbages moth. Plant it on the borders of vegetable beds helps to repel most flying pest.
Pig weed (theepe)	Plant it with potatoes, onions, corn, and Sweet potatoes, thin the weeds for green manuring or mulching. Good for returning nutrients back into the soil.
Rhubarb	Repels black spot, plant on the borders of the beds, good for soil erosion.
Rosemary	Grow rosemary with cabbages, beans, sage, tomatoes, carrots, it repels 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, it repels cabbage flies, bean beetles, and carrot flies.
Southern worm	Cabbage worm
Thyme	Repels cabbage worm, plant it on the borders of the vegetable beds with cabbages.
Tomato	Asparagus beetle, plant with nastursium, and coriander.
Wormwood	Repels flea beetle and plant it as a border plant.
Yallow	Plant along borders, paths, and near aromatic herbs. Attracts predatory wasps.

Conclusion

In this module you have learnt that there are many inexpensive ways of preventing diseases and pests in the gardens. Where these occur, you have also learnt how to treat them using concoctions and sprays as well as inter-cropping, crop rotation and balanced garden systems.

Reflection point

- What are the main pests in your garden and in the school garden?
- What kind of solutions have you learnt to deal with the pests in your garden?
- Examine the different plants growing in your for any diseases.
- Look for at least 10 plants that have properties to repel or kill pests and plant them in your garden or school. Find out which ones are the most useful?
- 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?

Ladybird on lunch

Organic spray to get rid of cabbage moth

The effects of uncontrolled pests

UNIT 13:

HARVESTING CROPS

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:
- Proper timing of harvesting; and
- Effective methods of harvesting.

1. Introduction

It is important for you to know how to harvest 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 modules explains how to harvest selected and commonly grown garden crops.

2. Harvesting of specific crops

The following information is a step-by-step process of 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 and cused for compost making.

Carrots: Harvesting begins at a very early stage as the thinning, although they are rather tedious 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 aubergines 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 flesh is slightly soft when pressed, and not left on the plant to mature further. 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 are required. The loose-leaved varieties are usually picked leaf by leaf. Cabbage-type varieties can be picked in the same way if you wish. For those which form a head, pick as soon as they feel plump and firm. Do not leave them too long in the ground 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 form 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.

Onions: These vegetables take up two to five 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.

Potatoes: Pick three months after planting when the leaves and the stems are dry. Dig them out with a fork, so that they do not 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.

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.

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 to12 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. Turnips leaves can be eaten like spinach.

3. Conclusion

In this module you have learnt about the proper timing of harvesting and how to harvest at least 15 different types of plants that are commonly ground 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:

SEED SAVING: COLLECTION AND STORAGE

LEARNING OUTCOMES

At the end of this Unit the reader should be knowledgeable about:
- How to select appropriate seed;
- Basic ways of saving seed; and
- Reasons for seed saving by farmers.

1. 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 sustainable livelihoods. Firstly, it is a 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 seeds, often adapted especially for the environment in which it is grown. Saving our own seed gives us independence to grow our gardens without having to buy seed and rely on seed companies.

Hybrid seeds are a product of crossing two plant varieties, which produces plants that highly productive is accompanied by the necessary fertilizer and chemical support. The disadvantages of hybrid seed is that it is unstable, produces less in the second generation and is therefore not meant for multiplication. This can result in farmers having to depend excessively on seed, chemical and fertilizer companies many of which are merging. 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, their impact on the ecology and on the independence of the farmer to choose, improve and multiply seed is negative. Their effect on health is not well understood yet. For these reasons, GMOs are discouraged in Permaculture.

2. Seed saving techniques

We want to choose our strongest, healthiest plants for seed. Do not save seed from unhealthy or poor producing plants, 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.

2.1 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.

2.2 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.

2.3 Seed cleaning

a. Boil water in 2 tins or pots;
b. 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;
c. Put the seed in a bag made of cloth;
d. Put the bag with the seed in the tin with water that has cooled down;
e. If the water becomes too cold take out the bag and add boiling water from the other tin;
f. Do not pour the boiling water onto the seed. It will destroy the seed;
g. Put the bag with seed back into the cool water and stir continuously;
h. Put the seed onto a news paper and place it in the shade to dry; and
i. Treat the dry seed with fungicide, plant or store it.

2.4 Storage

Seeds should be well dried 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 keep store in a cool dry place. Powdering the seeds with wood ash protects seed against insects. So can dried khakibos, layers of eucalyptus leaves.

Collect seeds by threshing them into a plate

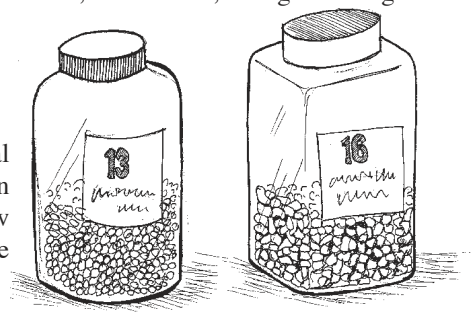
Hang seeds in paper bags to dry

2.5 Protection of seed from pests and disease

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

2.6 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.



2.7 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.

2.8 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 deal with seed security. 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.

3. Conclusion

In this Unit you 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 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 farmers.

Permaculture trainees gathering data on seed saving

Scoop out seeds and dry away from direct sun

Variety of seeds ready to be stored for the future.

UNIT 15:

RECIPES AND FOOD PREPARATION

LEARNING OUTCOMES

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

- Different ways of preparing food; and
- Key considerations when preparing specific foods

1. 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.

2. 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.

a. **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.

b. **French dishes:** Bay leaves, chives, chervil, garlic, parsley, rosemary, sage, tarragon and thyme.

c. **Fruit:** Fresh Bergamot leaves and flowers, fresh young borage leaves and flowers, fresh lemon balm leaves and fresh lemon verbena leaves.

d. **Indian dishes:** Coriander seeds, curry plant, fennel seeds, garlic and ginger.

e. **Game:** Bay leaves, fresh parsley and rosemary.

f. **Lamb:** Basil, bay leaves, coriander leaves and seeds, dill, garlic, ginger, lemon balm, marjoram, mint, parsley, rosemary and thyme.

g. **Mexican:** Coriander leaves and seeds, oregano and parsley.

h. **Pork:** Anise leaves and seeds, coriander leaves and seeds, dill leaves and seeds, garlic, ginger, marjoram, oregano, sage and thyme.

i. **Potatoes:** Chives, dill leaves, garlic, parsley, rosemary and thyme.

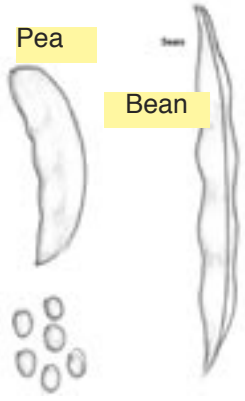
j. **Salad dressing:** basil, chives, coriander, dill, garlic, ginger, horseradish, lemon grass, parsley, rosemary, tarragon and thyme.

k. **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.

l. **Sauces:** Basil, bay leaves, chives, dill, garlic, ginger, mint, parsley, sage and tarragon.

m. **Tomatoes:** Basil, chives, garlic, marjoram, oregano, parsley, rocket and thyme.

3. Tips on how to prepare selected dishes



3.1 Beans and tomatoes (easy and fast to prepare)

You will need: 1 cup (250g) soaked beans; 1 cup (250g) chopped tomato
grated cheese.

Method

- Boil beans until soft (don't add salt)
- Add tomatoes
- Bring to the boil and simmer slowly for ten minutes;
- Add freshly chopped herbs; and
- Sprinkle grated cheese over before serving.
  (You can also add minced meat or chopped leafy greens and simmer together with the vegetables).

3.2 Bean Broth

You will need beans, water and salt.

Method

- Boil the beans (using more water then usual) until they are well cooked. Drink the broth or use it with other soups; and

- 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).

3.3 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
- Boil 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 ten minutes; and
- Add a squeeze of lemon juice to serve.

3.4 Carrot and turnip soup

Ingredients
- carrots and turnips;
- water;
- salt; and
- Fennel and parsley.

Method
- Chop carrots and turnips and bring to the boil with water;
- Cook slowly until soft and then mash them; and
- Add salt and serve with freshly chopped fennel and parsley

3.5 Chicken stew

Ingredients
- pieces of chicken;
- onion;
- garlic;
- oil;
- potatoes;
- carrots;
- pumpkin
- water; and
- green vegetables.

Method
- Prepare onion and garlic in a little oil;
- Add the chicken, potatoes, carrots and pumpkin;
- Add water just to cover;
- Bring to the boil and then simmer until vegetables are soft;
- Mash vegetables and chicken together; and
- 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 vegetables until smooth. Cut the chicken into small pieces, cook separately and then add to the vegetables).

3.6 Maize samp and cow peas (Umngqusho)

Ingredients:

- Water, tab
- Maize samp
- Cow peas (dried or raw) sugar
- Sunflower
- Salt (iodated)
- Parsely

Method

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

3.7 Sorghum and Dried Beans (ikhobe)

Ingredients

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

Method

Wash soghum 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.

3.8 Beef Meat stew with vegetables

Ingredients

- Water, tab
- Beef, fatty, raw
- Onion
- Carrot, fresh only, raw
- Tomato, fresh and skin, raw
- Sunflower oil
- Salt (iodated)
- Table spoon herbs

Method

Boil beef until a bit tender. Add vegetables, herbs such as thyme or rosemary and salt into the meat and let simmer for 20 minutes.

3.9 Chicken heads and feets with Mabele pap

Ingredients

- Water, tab
- Chicken, feet, raw
- Chicken, heads, raw
- Salt, iodated
- Tablespoon thyme
- Table spoon Fennel

Method

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

3.10 Mutton stew with vegetables

Ingredients

- Water, tab
- Mutton, meat, raw
- Onion
- Carrot, fresh only, raw
- Potato, without skin, raw
- Sunflower oil
- Salt iodated
- Rosemary dryness

Method

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

4. Tips on how to prepare selected drinks

4.1 Energy drink

The ingredients are 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; and
- Add a teaspoon of honey or sugar if you like the drink sweet.
  (If you have diarrhoea or difficulty in digesting the milk, replace it with water).

4.2 Anti-diarrhoea drink

You will need salt, sugar and water.

Method

- Sugar and salt mixture;

- To one litre of clean water, add half a teaspoon of salt and eight teaspoons of sugar;
- Stir or shake well; and
- The water should taste no saltier than tears.

5. Recommendations for lack of appetite

a. Try different foods until you find those that you like and try to have a mixed diet.
b. Eat smaller meals more often.
c. Eat whenever your appetite is good do not be too rigid about fixed times for meals.
d. Try to eat and drink a lot of water, milk, yoghurt, vegetable soups, herbal teas or juices throughout the day.
e. Drink mainly after, and in between meals - do not drink too much before or during meals.
f. Add herbs like thyme to food and make it look and taste interesting.
g. Avoid fizzy drinks, beer and foods such as cabbage, broccoli and beans that create gas in the stomach and can make you feel bloated.
h. Try rinsing your mouth out before eating as this can make food taste fresher.
i. Take light exercise such as walking outdoor, for example, and breathing plenty of fresh air to stimulate an appetite.
j. Eat in a well-ventilated room away from cooking or unpleasant smells.
k. Eat with your family or friend. If you have to stay in bed, they can join you at your bedside.
l. Avoid alcohol. It reduces appetite, weakens the body and interferes with medicines.

6. Recommended foods for someone with vomiting problems

a. Eat soft foods and go back to solids foods when vomiting stops.
b. Try not to lie down until one or two hours after eating.
c. Drink plenty of fluids after meals.
d. Drink fennel, ginger and thyme tea.
e. Take vegetable soup, especially celery, parsley and turnips.
f. Try not to prepare food yourself.
g. Drinking lemon juice in hot water or in herbal or ginger tea.
h. The smell of preparing or cooking food may worsen the feeling of nausea.
i. Ask somebody to prepare food or eat foods that require little preparation.
j. Keep drinking small amounts of water, soups and spice teas.

7. Strategies to deal with colds, coughs and influenza

a. Drink plenty of water or other fluids and have plenty of rest.
b. Prepare special teas for colds and drink them for as long as symptoms last.
c. 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.
d. 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.
e. 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. Artmisea Afra, mint or thyme leaves can be added. Hot water can work on its own.
f. Try garlic tea or cough syrup to ease the symptoms.
g. Drink lots of water or other fluids.

8. 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 such as colds and diarrhoea. The next part will explain some of the technical words that have been used in the manual.

Reflection points

- What are the most common dishes in your family and what nutrients do they have for you?
- What can be done to ensure that you benefit from the wide variety of plants in your garden, whether at school or at home?

GLOSSARY OF TERMS

Acid: having a pH below 7.0, as opposed to alkaline
Alkaline: having pH above 7.0. The higher the ph numbers the more alkaline.
Annual: a plant completing its full life cycle within1 year, perpetuated by seeding.
Asexual: by means other than by union of gametes.
Biennial: plants completing their growth cycle over a period of two years.
Bio intensive gardens: it is a combination of bio-dynamic and organic intensive methods.
Bud: a dormant or undeveloped, branch, leaf, or flower, usually enclosed by protective scales.
Bulb: a modified bud with fleshy scales, usually grown underground.
Cambium: the layer of delicate, rapidly-dividing living cells that form wood internally and bark externally.
Compost: decomposed vegetable debris, broken down by bacteria into a form of humus that feeds plants and improves soil structure.
Conservation: to make the most of everything you have by allowing nothing to go to waste.
Cooperatives: groups that work together towards a common goal, e.g. growing vegetables together for improving our livelihood.
Cultivar: a plant selected for outstanding characteristics and reproduced vegetative rather than by seed.
Cutting: a severed part of a plant used in propagation.
Deciduous: a plant that sheds leaves during the dry season in order to conserve water.
Division: separation of plant roots or cutting the entire plant to make several plants.
Dormant: at rest and not growing.
Ecosystem: biological community of interacting organisms and their physical environment.
Evergreen: this refers to plants that do not lose their green condition throughout the year.
Graft: a branch or bud inserted into another plant with the intention that it would grow there.
Green manuring: incorporating a cover crop such as grain or clover into the soil to improve structure and fertility.
Ground cover - low lying plants like strawberries that protect the soil from erosion.
Herb: A plant grown for its parts as flavour, seasoning, or odour.
Hot bed: a structure similar to a cold frame but supplied with heat.
Humus: decayed animal and vegetable matter.
Hydroponics: growing plants in some medium other than soil; typically gravel and nutrient solutions.
Indigenous: original or native to the country.
Insecticide: a material used to kill or control insects.
Inter planting: the method to utilize the garden area by planting late crops alongside early maturing crops (such as beans among lettuce, etc.).
Leaching: a loss of water soluble plant nutrients by the movement of water through the soil.
Loam: soil of equal parts of silt and sand and less than 20% clay.
Layering: propagating a plant by covering a portion of the stem with soil or other rooting medium to force roots on the covered portion.
Medium: it refers to the soil, potting soil, sand or other mixture that a plant may be grown in.
Micro climate: the localized climate around landscape features and buildings; important for selecting sites for specific crops or species.
Mulch: any protective covering for soil such as straw, wood chips, hay, plastic, etc. used to control weed growth, cut down on evaporation, improve soil structure, etc.
N.P.K: symbols used for the “big 3” nutrients needed by plants for growth; nitrogen, phosphorus, and potassium.
Nutrient: one of the 16 chemical elements needed by plants to complete life cycle.

Organic farming: it is the method of growing without the aid of poisonous fertilizers, herbicides, insecticides, fungicides, or pesticides.
Organic matter: plant and animal material in various stages of decomposition.
Perennial: plants living in the garden three or more years.
Pesticide: a chemical used to kill or control pests.
PH: a measure of acidity or alkalinity, especially in soil, expressed numerically from 0-14 with 7 as neutral.
Photosynthesis: the manufacturing of carbohydrates within green leaves by energy derived from light and utilizing, carbon dioxide and water.
Pollination: the transferring of pollen.
Polyculture: the planning of multiple crops in the same ground or area.
Recycling: re-using materials that are no longer serving a use.
Rhizome: a horizontally extended, usually underground, stem often enlarged by food storage, usually creeping, and from which shoots and roots sprout.
Root: the part of the plant that absorbs water and nutrients from the soil or air.
Runner: a slender, prostrate branch rooting at the end or at a join.
Rootstock: underground stem or rhizome.
Rotation (crop): planting different crops on the same ground at different times to balance the drain on nutrients and to control plant diseases.
Sampling: Young tree.
Scarification: Small cuts made on seed skin to aid the seed to germinate.
Shrub: a woody plant branched from the base, less than 5m tall.
Sucker: a shoot arising from the roots or beneath the ground's surface (corn) or side shoots developing from the main stem as in tomatoes.
Sustainable: practices that improve rather than damage (removal explanation) e.g. lasting positive effects.
Thinning: the removal of surplus plants to allow room for sufficient development of the remaining plants.
Tree: a woody plant with one main stem at least 5m in height.
Tuber: a thickened portion of an underground stem or branch provided with eyes (buds) on the sides, from which new plants are formed. tubers are usually more round in shape than rhizomes and store food.
Urban agriculture: an activity that produces, processes and markets food and other products, on land and water in urban and peri-urban areas, applying intensive production methods, and (re)using natural resources and urban wastes, to yield a diversity of crops and livestock.

CONTACT ORGANISATIONS

1. Afristar Foundation, P O Box 68562, Bryanston, 2021, Gauteng, National and SADC, Tel: 011 7065614, Fax: 011 463 8967, afristar@telkomsa.net
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3. Ecolink, P O Box 727, White River, Mpumalanga, 1240, Tel 013 751 2120, Fax: 013 751 3287,
4. Life-Source, 86 Frans Oerder Street, Groenkloof, 0181, City of Tshwane, Gauteng, Tel/Fax: 012 346 2657, lifesource.za@gmail.com
5. Medicinal Edible Garden Association, P.O. Box 1178, Parklands, 2121, Tel: 011 477 3236, info@mega.org.za
6. National Botanical Institute; Private Bag X 7, Claremont 7735 011 799 8800 Fax: 021 762 3229, www.nbi.ac.za

7. Ecolink, P O Box 727, White River, Mpumalanga, 1240, Tel 013 751 2120, Fax: 013 751 3287, eco.link@mweb.co.za
8. Food and Trees for Africa, P. O. Box 2035, Gallo Manor, 2052, 011 803 9750
9. Mupo Foundation. PO Box 500, Vuwani 0952. Tel 015 962 5846 Cell 079 493 5200
10. National Botanical Institute; Private Bag X 7, Claremont 7735 011 799 8800 Fax: 021 762 3229, www.nbi.ac.za
11. Share- Net, P O Box 394, Howick, 3290, Tel: 033 3303931, Fax: 033 330 4576, sharenet@futurenet.co.za
12. Ukuvuna Urban Farming Projects: P. O. Box 6032, Midrand, 1685, Tel 011 805 7768, Cell 083 665 3356, jonzira@yahoo.com
13. Ubuhibi Media, PO Box 891700, Lyndhurst 2106, www.ubuhibi.com, info@ubuhibi.com

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Conserver Awards. SA Dept Environmental Affairs 1997
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