Green Club Manual

Elementary School Food Gardens and Mini-forests

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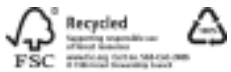


Printed on recycled paper

Contents

How to use this manual

This manual is written for elementary school teachers who are leading or involved with Green Clubs. It is also a useful resource for elementary school PTA committees. The manual assumes that the school Green Clubs are made up of a mix of different-age children. You may need to adjust some of the activities to suit specific age groups – particularly the younger children. Please be flexible and adaptive in how you use the resources in this manual and you will find it most useful.

Green Clubs should meet regularly and be open to as many students as possible for school gardens and school forests to be successful. Students learn to love plants, gardening for food and the environment.

Manual structure

The following chapters are included:

1. Why have a school garden?
2. Planning a school garden.
3. Growing a school food garden.
4. Growing a mini forest at school.
5. Ideas for working with the community.

Within each of the main chapters are topic sections. Each topic includes:

- Background reading on the topic for teachers.
- Suggested activities for children for the teacher to draw ideas from. But please also develop your own activities based on your own experience and the ages and interests of your students.

The activities for children are presented in the following format:

- Name of activity
- Time
- Purpose
- What you need
- What to do

Supplementary posters are also included with this manual to be used as teaching aids with the Green Clubs and in the class.

This manual aims to help you with practical background information, technical methods and ideas on teaching the children. But nothing will replace the passion, interest and commitment of you, the teacher. You need a passion to have the wonderful opportunity to help children to learn about nature, growing food and their own relationship with plants and trees and the environment. This can contribute to a great change in Eritrea and the world.

Toolbox contents

The materials are supported by a Toolbox of items to use with activities.

Item (Alphabetical order)	QTY
• **1 Metal box for storage of the items.** • **2 padlocks.** The box can be locked if your school does not have a safe storage room, but if you choose to lock the box, please ensure all teachers can have access.	
Aluminium foil –large rolls (to make solar cooker) 150m x 44cm, or 150x 30cm.	5 rolls
Animal pictures, series 1: A4 size, 20 cards in each set (cat, dog, bird, camel, goat, cow, horse, chicken, fish, lion, monkey, rabbit, snake, leopard, ostrich, tortoise, zebra, elephant, hyena, fox).	10 sets
Animal pictures - ENDANGERED AND VULNERABLE, series 2: A4 size, 7 cards in each set, (African wild ass, nubian ibex, African elephant, greater kudu, Soemmerring's gazelle, ostrich, leopard).	1 set
Animal pictures – African Animals, series 3: A4 size, 17 cards in each set, (rhinoceros, chameleon, lizard, aardvark, buffalo, eland, impala, crocodile, Arabian bustard, hedgehog, hippopotamus, giant golden mole, green turtle, Egyptian goose, gorilla, dolphin, warthog).	1 set
Animal Food Pictures: A5 size, 13 cards in each set, (meat, seeds, mice, bananas, hay, hen, insects, lizard, tree, fruit, bird, water, milk - with words).	1 set
Ball of nylon string (for web of life game) about 50 metres long	2 balls
Bird Identifier: Picture Card	10 sets
Brightly coloured twine (for hanging up artwork) roughly 80 metres	2 balls
Chalk, assorted colours, calcium carbonate, in box of 100	13 boxes of 100
Clear plastic bags –Polythene (plain) (for tree transpiration activity) - approx A3 size (297*420mm). 60/kit *(please re-use for each class).*	60
Clear plastic bags - Heat resistant (for solar cooking). A4 size (210 × 297 mm) 50 / kit. *(please re-use for each class).*	50
Clock with a second hand for a classroom. Analogue display. 350mm diameter. - Battery for clock. 1xAA. 1 Pack of 4	1
Clothes pegs (for hanging up artwork in classroom) 40/kit	40
Colouring pencils, Set of 12 assorted colours. Metal box.	12 packs
Composting poster: Simple Steps to Making compost	1 poster
Crayons, wax, 8 colours per pack/box of 10 packs.	6 boxes of 10 packs.

Deforestation Information Cards	10 sets
Drawing pad white, A3, 50 sheets. pack of 10	2 packs of 10
Ecosystems of Eritrea: Map	1 poster
Elastic bands: packet of 100 *(please re-use for each class).*	2 packets
Eye dropper (Pippet) 155 mm. Plastic. graduation 1 mm	2
Marker, flip chart, assorted colours (tip-4.5mm)/pack of 4	6 packs
Glue, classroom use, bottle, approx. 170 ml.	10 bottles
Greenhouse information cards	10 sets
Hand washing poster: Steps to wash your hands	1 poster
Hand washing poster: Don't spread germs	1 poster
Hygiene, sanitation, water, health Information Cards	10 sets
Inflatable globe, (diameter of 42cm), without stand	1
Insect identifier: Picture Cards	10 sets
Plastic binoculars for kids. Magnification 3 x.	10
Magnifying glass: Magnification x 4, or x 5, plastic handle	8
Masking tape (for making a solar cooker) 50mm x 50m. auto grade	4 rolls
Measuring containers (PP beaker) measurement 10ml . 1 of each/set Capacity 1000 ml (1), 100ml (1) and 25ml (1).	1 set
Measuring spoons (for waste activity and soil activity) 1 of each/set • tablespoon approx. 15 mil (1) • 1/2 tablespoon approx. 7-8 mil (1) • teaspoon (1/3 tablespoon) apprx. 4-5 mil (1)	1 set
Measuring tape – length 5 metre, retractable	10 pieces
Paint, black, for blackboards. 500 ml per tin NB: The inside lid of the metal box can be painted with blackboard paint and used as a blackboard. The blackboard paint can also be used on a smooth surface e.g. wood or on a wall.	4 tins
Paint brushes for blackboards 50-60mm	2 brushes
Paper, white, A4, 1 ream – 500 sheets	3 reams
Paper, black, A4, 1 ream – 500 sheets *(please re-use for each class).*	1 ream
Pencil, black, HB grade. Box of 10	13 boxes of 10
Plant information cards	10 sets
Red food dye – small bottle 100ml	1 bottle
Red Sea Zoo	10 copies
RRR - Reduce, Reuse, Recycle Poster	1 poster
Plastic wrap (for experiment to understand the water cycle and condensation) 300 mm X 300 m. catering size. *(please re-use for each class).*	1 roll
Ruler, plastic, 30cm. Pack of 10	5 packs of 10
Scissors, blunt, safe for school use. 135mm. Box of 10	7 boxes of 10
Seeds: packets of corn and beans	1 set
Seed Poem	10 copies

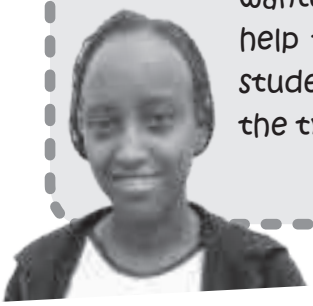
Gardening equipment: 5 of each • Hand trowel (Green club), 285*87mm, carbon steel (5) • Weeding fork (green Club), 285*80mm, carobon steel (5) • Spade (Green club). Wooden shaft and plastic handle 940mm Blade (235*140mm) (5)	1 set
Soap: toilet bar, approx 110g. Wrapped.	50 bars
Soil Texture Chart	10 copies
Solar cooker kit	1 kit
Stapler: metal base half strip accepts 26/6 staples.	5
Staples: 26/6. 5000 per box	2 boxes
Sticky Tape: transparent 1,5cm x 10m/box of 20	2 boxes
Thermometers: spirit filled - 10 degree C + 100 degree C. Child safe easy to read (for measuring temp of weather and water)	3
Water cycle definition card	10 sets
Water cycle picture cards	10 sets
Water testing kit: Bacteriological H_2S field testing kit	40 kits
Web of life cards: A5 size, 19 cards in each set. (hyena, vulture, cheetah, hunting dog, lion, baboon, giraffe, impala, wildebeest, tree, grass, bacteria, dung beetle, fungi, seeds, sun, water, bird, insects).	1 set
What is climate story	10 sets
Weather picture cards: A5 in size, 7 cards in each set, (rain, windy, cloudy, sunny, hot, cold, storm).	1 set
Zoo Pictures	10 sets

Books

These books can be stored in your school library to allow all students access to these.

Title/ISBN	Quantity
Book of Eritrean medicinal plants ISBN 99948-53-00-7	1
Jaws Discovery series- 8 books 1. *Deserts : The driest places in the world* ISBN:9780435898564 2. *Disaster! Natural disasters of the world around us* ISBN: 9780435898939 3. *In Danger! Endangered species of the world* ISBN 9780435898595 4. *It Works! Jaws Discovery* ISBN 9780435898908 5. *Patterns in Nature* ISBN 9780435898588 6. *Sensation JAWS Discovery* ISBN 9780435898526 7. *Shapes in the world around us* ISBN 9780435898557 8. *Water: Nature's liquid miracle* ISBN 9780435898571	1 of each
Africa's most amazing animals ISBN: 1410930920	1
The oceans most amazing animals ISBN: 1410930971	1
My First Book of Southern African Insects ISBN: 9781770072138	1
Let's Go Picture Dictionary, Monolingual English Edition, Paperback ISBN 9780194358651	1

1 Why have a school garden?



> “Our school used to have no trees at all. We wanted to make the school attractive. The trees help to keep the air clean from pollution. If a student wants to plant at home they can take the trees from Green club home.”
>
> Lidia Ghirmai, Green club student

Introduction

Gardening can be a magical experience for children. They love to be involved in growing food, gathering food and of course eating and sharing food.

Gardening and growing trees may also help a school to provide a small amount of food for students at certain times of year or provide some income through the sale of produce. Importantly it can also encourage the ideas of small food gardens and environmental restoration of tree planting to spread back into their homes and community.

It is important for children living in an urban or rural area to have a connection with how to grow food. It will give them a chance to explore new methods and ideas that may come in useful to them later in life. A school garden and tree program can also be an opportunity to collect and perhaps even reintroduce varieties of plants and trees into the local community. In this way the school can become a ‘genebank’ of varieties of trees and food plants.

This manual hopes to inspire schools and their Green Clubs to start up, continue and expand the activities they are doing around growing food in schools and in the community.

Principles of a food garden and tree planting

This manual recommends setting up school garden and tree planting following six basic principles:

1. Low input and organic gardening methods
2. Sustainable water use
3. Maintaining biodiversity
4. Use of legumes
5. Building on and respecting local knowledge
6. The importance of trees

These are described below and then covered in more detail in the relevant sections of the manual.

1. Low input and organic gardening methods

School gardens should make use of resources easily available in the community and around the school. We do not encourage the use of chemical fertilizers, pesticides or herbicides because they are expensive, dangerous for health and bad for the environment. So the alternative is to use natural methods to grow foods like most farmers of Eritrea. But within the school ground there will be special challenges as the soil may not be good.

2. Sustainable water use

Using water carefully and within the limits of what is available is going to be the biggest challenge for a school garden. For some schools, this may mean only having a garden at certain times of year when there is enough rain. For schools with a more reliable water source, it may be possible to extend this time. Plants and trees need water to grow. There are methods to reduce wastage of water that can be taught to the children.

3. Maintaining biodiversity

You may have already learned about biodiversity in other modules. Within agriculture there are varieties of food and other useful plants grown by people. Generations before us have bred these plants and taken care to hand them on to us as we should do to future generations. We call this agro-biodiversity. In a school garden and mini forest, a school can make a small but important contribution to learning about and helping to preserve this important heritage and resource for food security – the plants we eat and use.

4. Use of legumes

Legumes are a special group of plants that have the ability to take nitrogen from the air and put it into the soil to help plants grow. Nitrogen is an important nutrient needed for plants to grow. Legumes are important to include in garden plans and in our mini forests. Many legumes are used everyday in Eritrea such as chickpeas for making shiro and acacias for firewood and fodder.

5. Building on and respecting local knowledge

These principles can be seen in traditional agriculture across Eritrea. In the different parts of Eritrea there is much knowledge and wisdom about agriculture, growing and eating food and managing our environment. We should aim to teach our children to respect this knowledge and continue to pass it on from generation to generation.

6. The importance of trees

Trees are important for many reasons. Returning much of Eritrea to tree cover is necessary to stabilize the current degradation of soil, water and biodiversity. Trees provide many of our needs.

Basic principles of food gardening and tree planting

We are what we eat … we depend on the soil

This section of the manual explains in a little more detail the basic principles of a natural and sustainable approach to gardening and trees for schools. These ideas apply to all agriculture, and if understood, will help equip the children with skills to apply later in life and at home.

Understanding soil fertility – the role of organic matter

The key to establishing a successful school food garden and mini forest is to understand the role of organic matter and how it moves or cycles to build soil fertility to help plants grow. To begin with, you will need to collect whatever organic matter is available to add to the soil. Over time, the garden and trees themselves may provide much of the organic matter needed.

What is organic matter? Examples of organic matter are: cow dung, leaves, sticks and branches, paper, grasses, vegetable scraps, fruit peel and banana peel.

Water

Being wise with water is essential for a school food garden and trees program. Each school will need to decide what is possible for them based on the water they have available. Mulching is essential to keep moisture in the soil. More organic matter in the soil helps to absorb and hold more water. Some schools may be able to make use of rainwater tanks, runoff *greywater* or surface runoff.

Water management is covered in more detail in the *Healthy Schools* book.

Diversity in the garden

Diversity – which means different types and varieties of plants – is very important. Diversity in plants is important for a balanced agro ecosystem, which helps to reduce pest problems and keep soil fertile. It's also very important for our diet. The different plants and trees we grow are all part of biodiversity. School food gardens and trees can contribute to conserving and sharing these varieties. School gardens and fruit trees could become a place for local communities to plant and later collect seed from rare or important food and useful species.

It is a sad fact that 75% of vegetable varieties have disappeared from commercial production in the last century. This is due to the commercialisation of agriculture and the demand for food that is uniform in shape, size and colour. This enormous loss in varieties is a great loss for biodiversity and threatens food security and our diet for coming generations.

Drum under roof runoff down pipe for rainwater storage within schools.

Collecting 'grey water' from hand washing and washing of dishes for use on a garden area.

Students carrying water from home in plastic containers.

Teaching tip:

100 years of agricultural change

Some trends and figures relating to agro-biodiversity:

- Some 75% of plant genetic diversity has been lost to commercial production since the 1900s as farmers worldwide have left their multiple local varieties and 'landraces' for genetically uniform, high-yielding varieties.
- 30% of livestock breeds are at risk of extinction; six breeds are lost each month.
- Today, 75% of the world's food is generated from just 12 plants and five animal species.
- Of the 4% of the 250,000 to 300,000 known plant species that are edible, only 150 to 200 are regularly used by humans and only three – rice, maize and wheat – contribute nearly 60% of calories and proteins obtained by humans from plants.
- Animals provide some 30% of human requirements for food and agriculture and 12% of the population live almost entirely on products from ruminants.

Source: FAO (http://www.fao.org/FOCUS/E/Women/Biodiv-e.htm)

By growing a mix of plants and trees in the school garden, children learn the importance of a mixture of plants to create a balanced and adaptable ecosystem. The same message is carried through in the choices they make about what they eat and their own health.

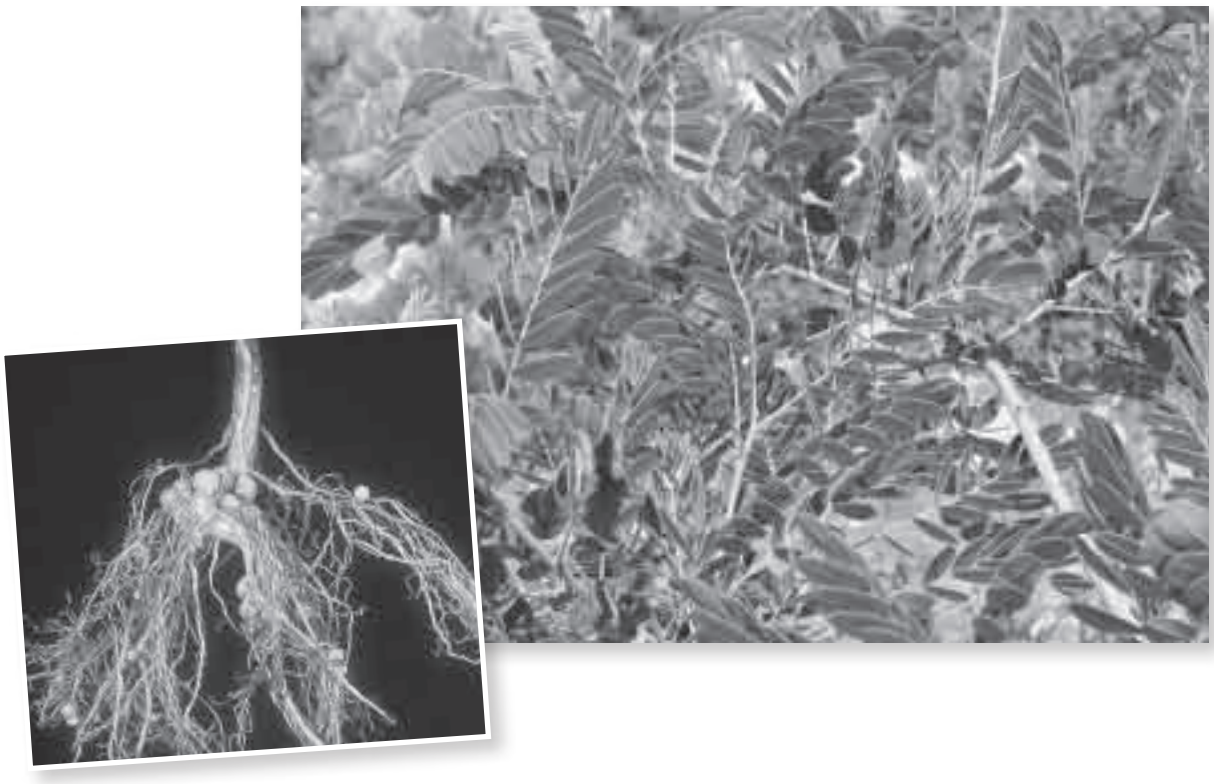
About a century ago, 30% of the landmass of Eritrea was covered by forest. By 1952, the amount had decreased to 11%. In 1960, forest cover was estimated to be a mere 5% of the total area of the country. Currently the percentage of the area covered by forest is estimated to be as little as 1% or even less.

Source: Ministry of Agriculture, Asmara

Legumes

Legumes include plants grown to eat, such as chickpeas and lentils and trees such as acacia, Leucaena sp and Sesbania sesban. Growing trees together with agriculture is called **agro forestry**.

Legumes are a special type of plant with the ability to put nitrogen into the soil. Nitrogen is an important nutrient for plants to grow. Legumes put nitrogen into the soil through 'root nodules'. These nodules are a special type of living organism called *micorhizal fungi* and they have a special relationship with legume plants. They are able to take nitrogen out of the air and 'fix' into the soil living in a partnership relationship with the plant.



Left: the root system of a typical plant from the legume family. Nitrogen fixation occurs in the root nodules that contain bacteria. Almost all legumes can fix nitrogen. The legume family includes many important crop species such as chickpeas, common bean, peanut, and lentil. Right: a legume plant.

Legumes all look similar

One method of using legumes is to grow legume trees either in or around the garden or field. When these trees are cut, the leaves are used as mulch, the branches can be taken for firewood and the legume roots release nitrogen into the ground

Local knowledge

Schools in the rural areas are likely to be surrounded by 'farming professors'. These professors are the wise women and men who have been growing food on the land all their lives. Try to involve these experts in the school food garden. They can provide you with advice to help you to avoid mistakes like planting at the wrong time, or to deal with problems when they arise. Having these wise farmers come to the school will also help the children to recognise that their own community and families are a source of great knowledge. Later in this manual, we suggest ideas on collecting varieties of seeds and plants and planting them in the school food garden. This is an activity that is very good to involve the village 'experts' in.

Functions of a tree

1. To provide food, fibre, fuel, fodder, building materials and medicine
2. To bring up nutrients from sub soil
3. To break up hard ground through deep roots that also bring up deep nutrients which are returned to the surface of the soil as mulch
4. To pump water into the air
5. To collect dew at night on leaves which then drips to ground
6. To provide habitat for birds and animals – nests etc
7. To stop soil from washing away – through roots holding soil and mulch covering soil
8. To increase infiltration of water into the ground
9. To release water slowly – water is held in organic matter and root mass
10. To provide habitat for soil micro organisms in the ground by making ground soft and high in organic matter
11. Leaf litter dropped by tree enriches surface soil fertility
12. Keeps the soil cooler in the day and warmer at night
13. Can protect soil and plants underneath from frost or cold weather
14. Creates a micro climate for other plants

Don't be concerned if you are inexperienced at gardening

You can start a school garden and a school mini forest even if you are not experienced in agriculture. Your attitude and interest as a teacher will be the most important factor for success.

As a teacher you need to lead the children and aim to involve their families in every step. By supporting the children and their families to take responsibility for the school garden and tree planting, they will gain so much more from the whole experience.

Case study:

Best Performance Award, Ministry of Agriculture, Asmara

The award is based in the percentage of trees not only planted, but surviving. Also points were given for their awareness raising in the community. In 2008, Fithi Junior school won this award for its Green Club. The award was presented by the Ministry of Agriculture in Asmara and the school presented with 4000 Nakfa.

Green Club teacher at Fithi Junior School, explaining the tree planting process to students.

Activities for students:

What are the important things needed to grow plants?

Activity 1: The Roots of Plants

Time: 30 minutes.

Purpose: To investigate the structure and the function of roots.

What you need:

- Root bound plant in pot
- White or black plastic sheet
- Toolbox: Magnifying glass

What to do:

1. Soak the whole pot in a bucket of water overnight then wash the soil from the roots with some more water.
2. Place the plant on a white or black plastic sheet and have the students help to spread out the roots.
3. Ask the students:
   - Are there more roots than branches?
   - Is the pattern of roots different? If so, how?
   - Is the spread of roots greater than that of the branches?
1. Look at the roots with a magnifying glass. What do the students notice?
2. Draw the roots of the tree for later reference.
3. Replant the tree in a suitable place in the garden. Use plenty of water to wash the soil back around the roots so there are no large pockets of air.

Activity 2: The tops of plants

Time: 30 minutes (ongoing as students watch the plant grow).

Purpose: To observe the growth of roots and leaves of plants.

What you need:

- Potatoes
- Clear jar
- Toolbox: toothpicks or thin sticks

What to do:

1. Select a ripe potato.
2. Stick three toothpicks into it so it can be suspended in a glass jar.
3. Keep in light place.
4. Watch the root develop first.
5. After top growth starts (this takes about a month), cut the tip off the growth so the plant branches out.
6. Plant in a pot containing good soil when the plant is about 30 cm high.

Extension Idea: Cut off the top of a carrot and place it on a plate with water on it – or in a pot with soil in it. Watch how the carrot top grows into a complete carrot.

Activity 3: How does a plant grow?

Time: 30 minutes (a few weeks to allow time for the plant to grow).

Purpose: To experiment with light and air on the growth of a plant.

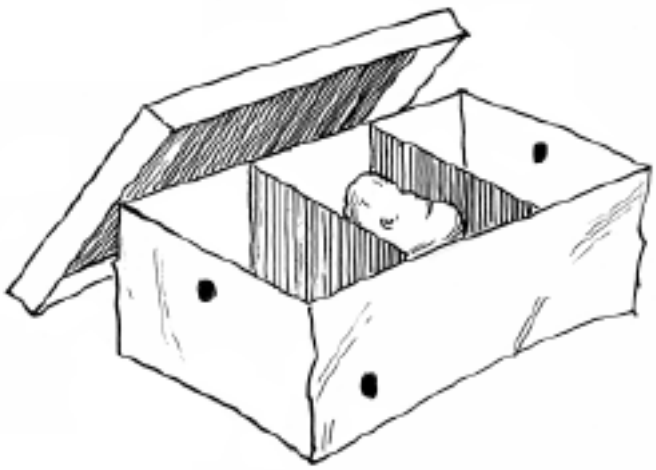
What you need:

- Cardboard box with lid and 2 extra pieces of cardboard
- Soil
- A potato

What to do:

1. Find a cardboard box with lid.
2. Put two extra walls in the box. Make three holes, one in each of the walls and in one end of the end walls of the box. All three holes should be in different positions in the walls.
3. Put a potato in the compartment where there is no hole in the end wall.
4. Put on the lid and wait for a few weeks. You will get the best result if you do this experiment in Spring.

Conclusion: Students can list on a piece of paper what they think plants need to grow.



Good reasons for creating a school food garden and trees in a mini forest

Why have a school garden?

It's good for nutrition and health

Many communities suffer from a shortage of food at different times of year. Many children have poor nutrition. Schools have land and so it makes sense that some food should be produced where water and other resources are available to do so. Access to a little bit more leafy greens and fruits can make an important contribution to increasing consumption of **vitamin A** and other **micro nutrients**.

Creating food gardens is a fun way to involve children in preparing and eating nutritious food. Experience shows that a hands on and playful approach to learning is an effective way to teach children about nutrition and health. Developing children's skills in this area will help them later on in life to grow and eat a diverse range of foods.

It's good for the environment and the local community

A school garden and trees make the school area more beautiful. Making a school food and tree garden involves working together. It builds social skills and school spirit. School gardens allow children to interact with their environment and learn how to make positive changes.

Students working in their school garden.

Seed saving.

Students discussing their garden.

Watching seeds and plants grow is exciting and requires patience, care and understanding of the season and life cycles. These skills encourage self-reliance and are empowering for children.

Local communities rely on agriculture. It is good for schools to forge a bridge between farming communities and their own education of children. School gardens and tree planting provide a great opportunity for schools and local communities to connect. By involving the local community, there is an opportunity to share local farming knowledge and build respect of farmers, food production and the environment within the school and community.

School children can be led to love and care for plants, trees and the environment.

Involving children in multiple learning styles

Children have diverse learning styles and this leads to new ways of teaching. They like to work in small groups, and do practical activities with any task they do. Food gardens and trees provide an opportunity to address all of these key requirements for successful learning.

Garden based learning gives children a place where they can explore and learn at their own speed. They provide children with hands on learning. Blackboards of the classroom are replaced with the seasons, sun wind, water and soil.

Planning for a school food garden and trees in a mini forest

"Most schools do not have enough water or even any water. The solution is children who have a love of plants and the support of their families. A teacher must be a guide for everything and a solution will be found." (Abraham Berhe, Head of Zoba Makel, School schools Summer campaign)

This chapter provides information on getting ready to start a school garden and tree-planting program. It is divided into the following sections:

- Early Planning
- Selecting a Site
- Soil

Early planning

Background information

It is very important to start planning early to have a successful garden and tree planting for food production in your school. Often, the idea to start a food garden or tree planting will come from a few interested teachers or parents. The challenge is to get the whole community interested and supportive of this idea. Try and get as many individuals in support before you get started.

Choosing the areas for the garden and trees is important. You need to think about the relationship to buildings, access to water, protection from wind, creating a good **microclimate**, protection from grazing animals and damage from children playing. Working with the seasons and with local knowledge is important.

When you plan the garden area, be imaginative. Draw on ideas from nature. Not everything needs to be in straight rows – in fact, this is rare in nature. Think about access and pathways for the students and shaded areas for learning in the garden – and don't forget about an area for compost.

Deciding on what type of garden

Having decided on growing a garden, the teacher and students need to think about what type of garden they would like for their school. You could have a garden for nutrition that includes local foods, such as vegetables. It could also be a medicine garden to support the well being of the school community. The teacher and students could plant a fruit tree garden or a biodiversity forest with native species of trees.

Linking to the whole school community

There are many members of the local community that could be asked to be involved with the planning of a school garden and mini forest, such as:

- Community health workers
- Leaders
- WASH and HEALTH committee
- PTA
- Local agriculture officer/Ministry of Agriculture Nurseries
- School director
- Other teachers

Gathering support.

What is needed to get the garden started

Before you get started, you will need to work out what you need for a school garden and tree-planting program. The list below gives some ideas:

School gardens	School Biodiversity Forest
Water source	Soft soil
Seeds	Tools for digging
Tools for digging	Water source
Watering containers	Containers for trees
Organic matter for mulching	Seeds for trees
Animal manure	Digging tools for earthworks
Soft soil for nursery	Mulch material
Edge materials for garden beds	Containers for watering
Bags or containers for small gardens	

Reliable access to enough water will be a big challenge for many school gardens. There could be costs involved in collecting and using water. It may only be possible to maintain a school garden at certain times of year when there is rain or more water available. In many cases, the children will need to bring water from home at some times.

Building a sense of ownership

People need to feel connected to the garden and feel a responsibility to take care of the plants. Watering and protection from grazing animals will be ongoing tasks. Involvement of the Green Club as well as classes may all help to build a wide sense of involvement and responsibility for school food garden and trees.

Some of the activities a teacher could organise to build support and plan for a school garden and mini forest are:

- Hold a meeting with the PTA
- Hold a meeting with parents
- Invite the agriculture extension officer from your Sub Zoba
- Have a meeting with your local nurse or health officials

Activities for students:

Activity: What's good for you?

Purpose: To investigate the vitamins and minerals in vegetables and fruit.

Time: Approx. 30 minutes.

What you need:

- Pens
- Notebooks
- Large paper
- Markers or coloured pencils

What to do:

1. Divide students into 4 groups.
2. List the fruits and vegetables you eat on the large paper.
3. Next to the names, draw pictures of the fruits and vegetables.
4. Research the vitamins and minerals in these fruits and vegetables and the role they play in nutrition. Check in your library for further information, or see the Nutritional Table on page 115.
5. Identify some fruit and vegetables you could plant in your school garden to increase your vitamin and mineral intake for a more healthy diet.

Activity: Fruits and vegetables – where are they from?

Purpose: To develop an awareness of where fruits and vegetables in Eritrea come from.

Time: Approx. 30 minutes.

What you need:

- Pens
- Notebooks
- Large paper
- Markers or coloured pencils

What to do:

1. From the 'What's Good For You Activity', each student should select 1 fruit or vegetable from the list of names on the large paper.
2. Each student will then research this fruit or vegetable in detail.

   ❁ How is this fruit or vegetable grown? Is it grown on a tree (e.g. papaya) or on a vine (e.g. watermelon)?

Papaya is an example of a fruit that is eaten in Eritrea.

- Where is the chosen fruit or vegetable grown? Does it grow in Eritrea (e.g. bananas) or is it imported from another country?
- Is it used fresh or processed? If processed, where and how?

3. Suggest a favourite recipe or way of serving and eating the selected fruit or vegetable.
4. Present the information on a poster and display it in the classroom.

Activity: Different types of school gardens

Purpose: To research different types of school gardens.

Time: Approx. 30 minutes.

What you need:

- Pens
- Notebooks

What to do:

1. Ask students to list the benefits of a school gardens.
2. As a class, discuss the different types of gardening techniques. The teacher can introduce local plant gardens, herb gardens, fruit and vegetable gardens, mini forests.
3. Students in groups research different methods. As a class, decide on a method or methods for your school garden.
4. Research what materials and design you will need for your school garden, and how you will obtain them.
5. Present the plan to the School Management.

A vegetable garden.

Selecting a site

Background information

Food plants need plenty of sun, enough water and protection from wind and animals. Plants and trees need to be chosen to suit the climate, soils and seasons. You need to choose an area that will not be damaged by children playing, but at the same time will benefit from any available water runoff.

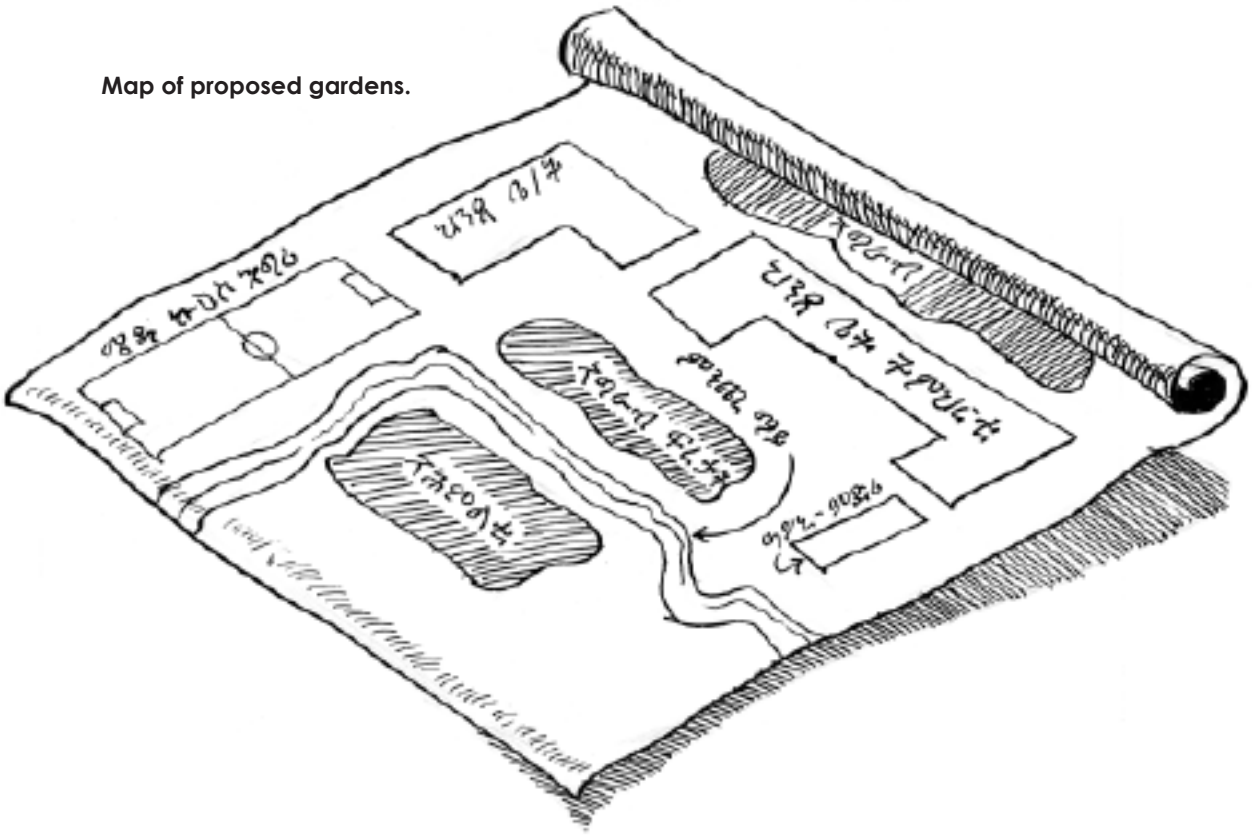
You might want to involve the community and whole school in a special event to start the garden. The garden can be a source of inspiration, beauty and joy for everyone including the children, people who visit the school, parents and teachers. It can also be a source of income for the school.

There will be many challenges. Experienced local farmers and gardens can help with advice on site selection, what to grow and when and the best ways to keep plants and trees going at difficult times like dry season or droughts.

Location

Make a map of the school area showing buildings, water sources, existing vegetation. Consider the different soil types within the school area. Consider how different areas are used for play, sport and other activities. Mark out the spaces that would be best for a garden, best for trees, best for regeneration areas, etc. Where is waste currently disposed of? Could this be a good place for a compost area?

Map of proposed gardens.



Sun access

Choose a place with at least 6 hours of sun a day. Morning sun is the best type for food gardens. A nursery is going to need some shade – perhaps under a tree or a trellis. In very hot places or at hot times of the year, it may be desirable to have more shade on your garden. This is to reduce evaporation and help to keep plants alive.

Fencing and security

Is the garden site protected from animals? If not you will need to consider a fence. This could be a fence for the whole school compound or a living fence for the school garden area. See the section on 'Living Fences' in this manual.

Water

The first thing to consider is water? Is it available? At what time or months of year? If there is no water, then you may need to develop community based activities where gardens and trees are planted around homes instead of the school. If the school children have water at home, they may be able to carry water to school for the gardens. If there is little water, it may be better to do only tree planting during the rainy season with a nursery of trees for the rest of the year.

The plants and nursery may need to be watered every day. So it's important to think about how the water will be carried or piped to these areas. A collection of small containers and tins with holes may be needed for children to use when they water the garden.

Watering of plants with a recycled plastic container into a second container with holes in it.

Wind

Wind can quickly dry out a garden. If possible, choose an area that is protected from strong, dry winds. This protection from wind could come from a wall or school building. If more protection is needed, you might want to plant a windbreak of shrubs and trees along the side of garden exposed to the strong winds. You should look for and plant strong indigenous Eritrean trees and shrubs that will not die in dry conditions or are tolerant of drought.

Existing vegetation

As we are trying to improve the school environment, we don't want to encourage you to cut down trees in order to make a school garden. Put the garden in a clear place. If there are some existing plants, then they may be able to be included in the garden design and provide a small shady area, or be pruned for biomass production for mulching and compost making. Even a small, clear place can be enough to get started.

Protect your school garden from winds by planting a shelterbelt of trees and shrubs. This can take the form of a double row of trees, with larger trees behind and smaller shrubs in front.

Some trees, including eucalyptus, are not so good close to gardens. They can slow down growth of plants close to them and also are very thirsty or competitive for water – their roots may be stealing all the moisture from carefully watered plants. Many schools may already have eucalyptus planted. Don't cut them down! They are trees and are important for firewood and building materials. But you might want to interplant local species between them or set aside another area for a mini forest.

Local species may be better adapted to local conditions and more resistant to drought. They may grow slower – but they may live for longer. Fruit trees usually do not have invasive root systems and can be planted close to gardens.

Trees and other vegetation within the school area.

Eucalyptus trees have long roots, that take a lot of water and nutrients from the soil.

Acaia tree has shallow roots that use less water.

Eucalyptus trees can slow down growth of plants close to them as they compete for water and nutrients. They are an introduced species and not indigenous to Eritrea.

Activities for students:

Activity: Mapping a School Garden

Time: 30 minutes + 30 minutes.

Purpose:

- To encourage students to think about the requirements for a garden site.
- To enable students to explore their school compound, improve their powers of observation and their recording skills.

What you need:

- Examples of maps.
- Pens or pencils.
- Copies of an outline map of the school site or paper for students to create their own.
- Clip boards or something solid for student to rest against while they are creating maps.

What to do:

Before the lesson

1. Draw a large outline map of the school compound. Be sure to include major features such as buildings, play areas, paths, fences, etc.
2. You may like to include a map key. Use symbols to represent the features mentioned above as well as trees, grass, dirt, rocks, etc.
3. If you are able, make enough copies so that, when divided into small groups, each student in your class has access to a copy to work with.
4. If you are unable to make copies, draw this onto a chalk board and have your students copy it down in note books or onto other paper, ready for your lesson.

During the lesson

1. Talk to your students about the requirements for a garden, referring to notes in this section.
2. Ask students if they have ever made a map before (some may have made maps to buried treasures with their friends).
3. Tell them that they are going to make a map of their school compound today. Remind them that maps are views of an area from above – like what you would see from flying in an airplane.
4. Divide the group into teams of three or four students (or larger if necessary).
5. If you have made copies of the map, distribute one map to each

group. If not, then ask each group to copy the outline map you have drawn on the chalkboard.

6. Familiarise the students with the study area by having them identify features on the map, discussing the symbols used in the map key, so that all students use the same symbols to mark any of these features.
7. Explain to the students that they are going to survey the school area to determine the best place in the school compound to plant a vegetable garden and the best place to plant trees. In making their decision, they need to take note of different things such as soil, access to water, existing vegetation, wind exposure and protection, and sun exposure.
8. Ask the groups of students to head out into the school compound (encourage each group to go to a different location) and make their observation.
9. Each group should look for and mark on their map the following features:
   - current buildings
   - water sources
   - existing vegetation
   - different soil types
   - areas used for play, sport and other activities.
   - areas where waste is currently disposed of
   - areas protected from strong, dry winds
   - a place that gets enough sun.
10. Allow about 30 minutes for students to create their maps. Periodically check with each team to see how they are doing and lend assistance as needed.
11. When all of the groups have finished, bring the teams together. Lay out all of the maps and spend some time comparing student's observations.
12. Back in the classroom, combine all group maps into one comprehensive class map of the school compound showing all of the features above.
13. Split your class back into groups and ask each group to come up with a plan of where it would be best for a garden, best for trees, best for a regeneration area, best for a compost heap etc.
14. When the groups have made their decisions, ask them to report back to rest of the class.
15. Ask them to explain why they made their selection.

Extension Ideas: You could ask a panel of students to assess the presentations and choose 3 of the best ones for presentation to the school PTA.

Soil

Good soil rich in humus.

Background information

You can make a garden in most type of soils. You are lucky if your school has fertile, soft soil, but don't worry if it does not. By adding compost and other organic matter, such as dung, you can improve almost any soil. How to do this is covered in Appendix C.

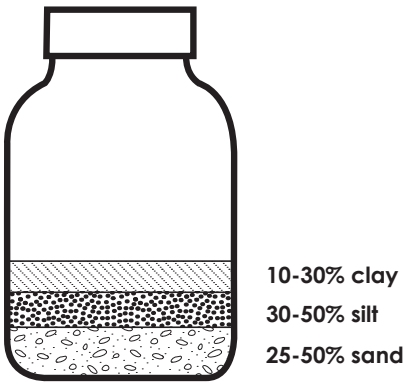
The best soil for growing a food garden is deep, loose, fertile, well drained and full of organic matter. It is better to work with the soil you have than to bring in soil from outside, which will take a lot of effort and resources. It is interesting for the children to learn how to improve soil and see it get better and more fertile over the years.

Determining soil type

Soil structure

Soil can either have a lot of clay, a lot of sand, or somewhere in the middle. A simple test is to take some soil and moisten it with a little bit of water and rub it between your fingers. Clay has small particles and will feel silky, while sand has larger particles and will feel rough. Silt particles are in between the two. A very good soil is called a sandy loam and is a mixture of all three of these.

A more detailed test of soil structure can be done by mixing four tablespoons of soil and two cups of water in a jar. Shake it up and let it



Soil components separated in a jar of water.

Different soil types in Eritrea.

Sandy soil and loam soil.

settle for a week. Observe the layers to determine the composition of your soil, which is composed of organic matter, clay, silt, sand and gravel. Dark water means the soil has a lot of organic matter.

Clay soil is often more fertile, but sometimes the fertility is locked up in the clay. Sandy soils have less fertility and nutrients are easily washed away. But both soils can be improved by adding organic matter.

Organic matter

Organic matter is the most important ingredient for successful school gardens and trees. Organic content of soil is made up of humus and soil micro-organisms including worms.

Organic matter feeds soil micro-organisms. These micro-organisms convert organic matter into humus. Humus then releases nutrients for plants to grow. Unless you look after your soil micro-organisms by feeding them with organic matter, your soil will not improve and will become depleted. Organic matter and humus also help to make soil soft and easy for plant roots to grow. It helps to hold water in the soil and prevents it from drying out too quickly.

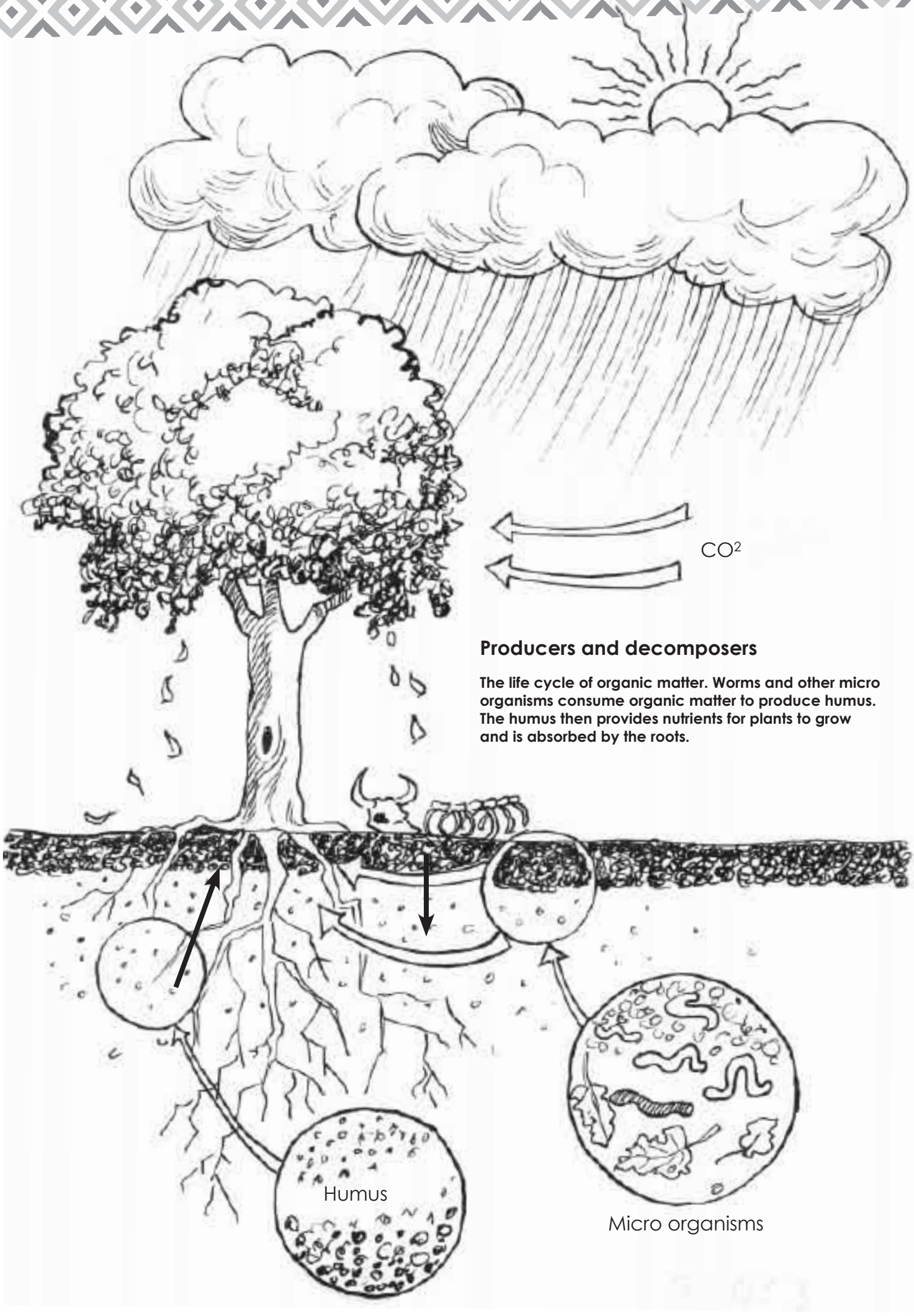
Worms are one of the easiest-to-see 'animals' among the micro-organisms in the soil. If you find a lot of worms in the soil, this is a very good sign. Worms consume organic matter and turn it into humus. Children need to recognise worms as a sign of good soil and learn to love and care for worms. Worms make fertile soil.

Acidic or alkaline soil

Soils in Eritrea are often alkaline. The best soils for growing a food garden are closer to neutral. Whether your soil is too acid or too alkaline, the solution to both problems is to add more organic matter such as compost or dung. This shifts the soil to a more neutral position.

Possibility of contamination

It is important to find out if there is any risk of contamination of the soil where you are thinking to start a food garden. Have any chemicals ever been dumped there? Food plants should not be grown if there is any risk of contamination. Many chemicals leave dangerous heavy metals in the soil that can accumulate in plants. Don't make a food garden if any dangerous or unknown chemicals have been poured into the soil in that area.



Producers and decomposers

The life cycle of organic matter. Worms and other micro organisms consume organic matter to produce humus. The humus then provides nutrients for plants to grow and is absorbed by the roots.

Garden and buildings

A well-planned school garden can make the school area more beautiful and also help to keep buildings cooler and more comfortable. Some possibilities for using vegetation to cool buildings are shown in the pictures below:

School classroom with trellis structure covered in vines.

Garden next to building, with a cover and a scarecrow to keep birds away.

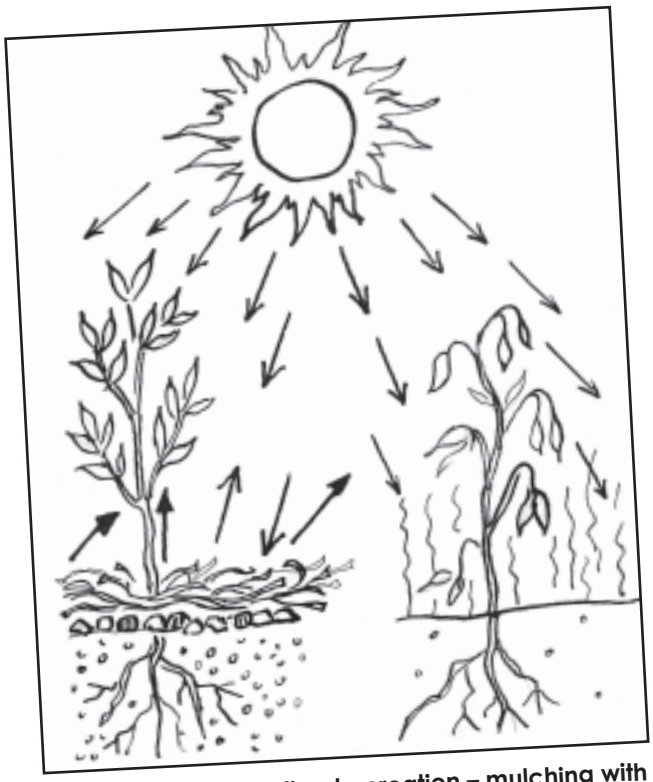
School classroom with tree shelterbelt on one side.

Micro-climate

Climate is determined by the location and geography of a given area. Eritrea has different climate zones due to the altitude and rainfall. Micro-climate refers to the changes in climate conditions that occur due to more localised factors. This can include things as simple as the effect of a brick wall that protects from wind or catches the sun. The flow of water and the amount of shade can also create micro-climates. Plants themselves, and buildings, create different micro-climates. Many different micro-climates can be found in a small area.

On a wider scale, the mountains and valleys of Eritrea create many different micro-climates.

Micro-climates will exist within the school compound, and more can be created through careful planning and observation. Most food plants want a moist, protected micro-climate. Different trees will prefer, and create, different micro-climates.



Examples of micro climate creation – mulching with stones and straw to reduce water evaporation.

Acacia tree with a micro-climate created underneath. It has rich soil high in organic matter, shade from the sun and therefore higher moisture content in the soil.

Activities for students:

Activity: Soil comparison

Time: 30 minutes + 30 minutes (+ standing time over night)

What is Soil made of?

Purpose: To investigate soil composition to find out what it's made up of.

What you need:

- Jar with lid or a large plastic drink bottle (one for each student)
- Toolbox: scissors
- Spoon
- Dirt
- Water
- Paper
- Toolbox: Magnifying glass (optional)

What to do:

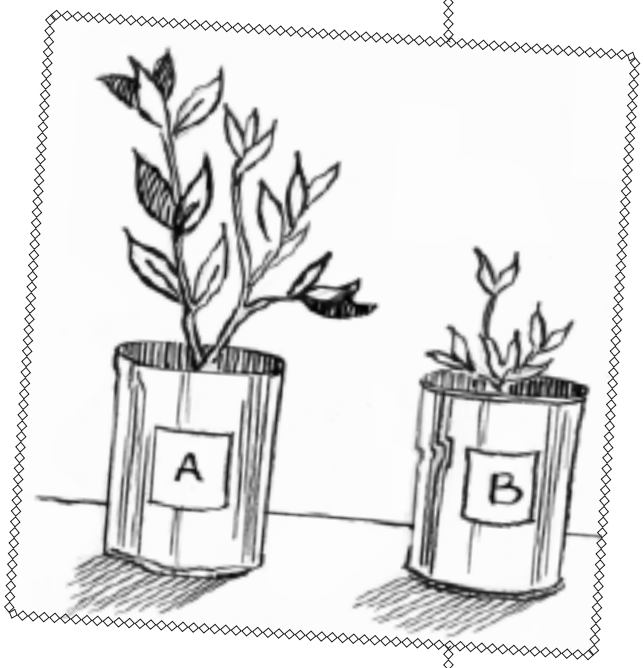
1. Split your class into small groups and ask each group to go out and collect soil samples from your school compound, one sample per student. Encourage your students to collect soil from different areas. You could also ask students to bring a sample of soil in from home.
2. Set up a work area where it does not matter if it gets dirty – or get your students to cover their school desk with newspaper.

3. Using the scissors, each student should cut off the top of a plastic bottle, throwing away the top half. If they have a jar, you don't need to do this step.
4. Ask students to fill the bottle or jar halfway with the soil sample they collected. Add water nearly to the top.
5. If they are using a jar, tell them to put the lid on and tighten it securely.
6. Shake the jar vigorously for a half a minute, and then set it down.
7. If they are using the cut-plastic bottle, tell them to use the spoon to mix the soil and water together vigorously.
8. Make a label for the jar or bottle with their name and the location from where it was collected.
9. Each student should draw a picture of each jar full of soil after it has been shaken.
10. Let the jar or the bottle stand until the dirt and water settle (you can do this in the morning, then check in the afternoon or come back to continue the experiment the next morning). The soil will settle into layers.

Next session

1. Ask your students to observe the layers in the jar or bottle, and see what they can tell about them. Ask them to take notes on the following:
   - How many layers are there?
   - Which layer is made of the biggest particles?
   - Which is made of the smallest?
   - Can you guess why?
2. Now the dirt has settled, students should draw a picture of their jar/bottle to make picture comparisons to the one they drew earlier.
3. To further examine the different layers and what they are made of, ask your students to sort out the soil materials and examine them.
4. Use a spoon to skim off the objects floating in the water. Place them on a paper towel/piece of paper.
5. Then ask them to carefully pour off the water on the top and scoop out the grains of the next level onto another paper towel/piece of paper. Do the same if there is another level.
6. After each layer has been placed onto paper, they can be examined with a magnifying glass (if you have one). What else can your students tell about the different layers after further examination?
7. In their groups, ask students to compare their findings with samples collected in other areas.
8. What conclusions can they make about the different samples from different areas?

Activity: Are all soils created equal?



Time: 1 hr + growing time.

Purpose: To investigate local soil quality and the impact it has in supporting plant life.

What You Need:

- Soil (collected from different locations)
- Toolbox: small spade
- Cut-off plastic bottles or drink cans (with holes in the bottom)
- Water
- Bean seeds
- Tall stakes
- Pencil or pen
- Ruler
- Paper (graph paper optional)

What to do:

1. Before you begin, ask your students to prepare their 'cut-off' plastic bottles or drink cans by poking drainage holes in the bottom (use a nail to make holes).
2. Take your students outside and get them to look in the school yard for areas where plants grow poorly. Is the soil trampled and hard? Is the soil soft and loose where plants grow well? Look for sandy or heavy, clay-like soil.
3. Ask students to gather samples of different soils and fill a cut-off plastic bottle or drink can with each kind. Label their 'cut-off' plastic bottle or drink can with the location where they collected their sample, e.g. 'Hard, baked soil near the path,' 'Loose, fluffy soil from the flower bed,' etc.
4. Water the plastic bottles or drink cans, then plant two or three bean seeds in each.
5. Put a stake in each pot for the beans to climb.
6. Keep the pots moist (but not soggy) while the beans sprout.
7. Ask your students to monitor which beans sprout first.
8. Encourage your students to measure the height of the plants every few days until the beans flower.
9. Record the growth of the plants to graph the changes.
10. Once all plants have flowered, ask students to compare their growth records. Which bean grew and flowered first? Which last?
11. Ask students to decide which soil was the best. Give reasons why.
12. Ask students to make suggestions about how the soil in different areas could be improved to encourage better plant growth.

Activity: Feeding and caring for worms

Time: Initial set up 1 hour; management and maintenance on-going.

Purpose:

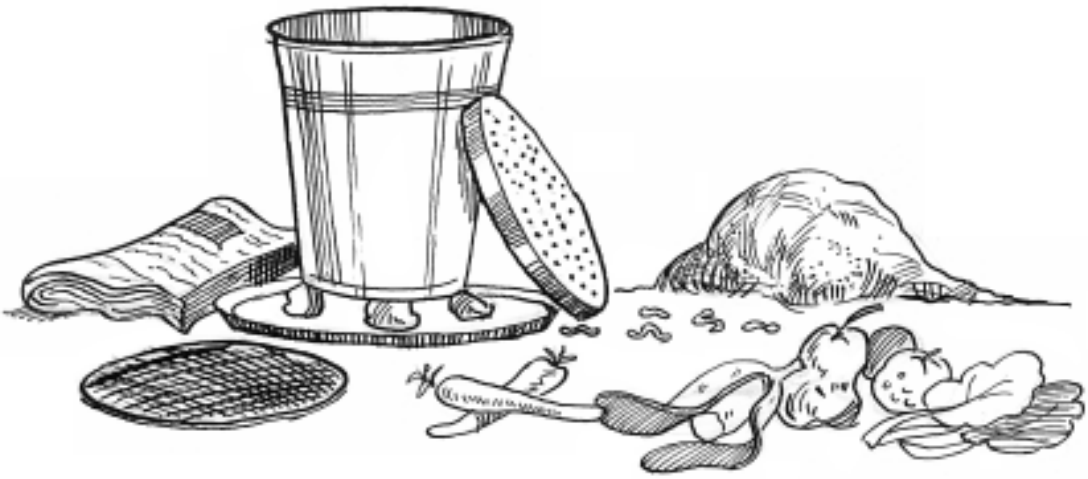
- To learn the role worms play in breaking down organic waste.
- To gain practical experience by beginning a worm farm.

What you need:

- 2 containers of the same size, made of plastic, wood or any other lightweight, waterproof material. You can use 2 plastic buckets, 2 polystyrene boxes with lids, 2 large plastic food storage containers, etc.
- A strip of insect screen to fit into the bottom of the containers.
- Shredded newspaper.
- A bucket of garden soil.
- Water.
- Food scraps (see suggestions below).
- Worms – not ordinary earthworms; you will need to get some advice and source worms called 'reds'.

Introduction:

Worms keep the soil healthy by making channels for air and water and by eating plant waste (organic materials). A worm farm is an excellent way of making compost from everyday kitchen scraps. It is on a smaller scale than a compost heap and provides rich material that can be used in potted plants, seedling and vegetable gardens.



What to do:

1. Take one of your containers and make some holes in the lid and in the bottom. If your container does not have a lid, cover it with insect screen.
2. The holes will allow oxygen in and let liquid drain out. Make your holes evenly spaced. The bigger the container, the more holes you will need. Use a pen or a nail to make the holes.
3. Spread the insect screen in the bottom of the container over the holes. This lets the liquid through but stops the worms falling out.
4. Fill your container about 3/4 full with torn-up leaves, newspaper and card board. Dampen this with water before you add it to the box. It should be soaked through, but there should not be extra water collecting in the bottom of your container.
5. The torn-up leaves, newspaper and cardboard form the worm bed (just like a garden bed but for worms not plants)
6. Add some garden soil – this will help your worms digest all the scraps you add to your worm farm.
7. It's now time to add some worms to the container! How much you put in depends on the amount of food scraps you plan to compost – about two handfuls is a good amount to start with. Worms can double their population in three months and can be used to start another worm farm, or they can be given to friends or neighbours to start their own worm farm.
8. Place the container with the worms over the second container (the one without the holes), allowing any water to drain down into the bottom container.
9. Next, add some food scraps to the worm bed in the top container. You need to feed your worms regularly but in small amounts. Worms like to eat:
    - Food leftovers (cooked vegetables and stewed fruit leftovers, no meat).
    - Fruit peelings (not orange or lemon peel).
    - Vegetable scraps and peelings (not too many onions).
    - Stale biscuits and cakes.
    - Coffee grounds and tea bags/leaves.
    - Crushed egg shells.
    - Saw dust.
    - Soaked cardboard/paper.
10. Make sure you don't overfeed your worms. Start by putting a small amount in one corner underneath some newspaper. See how long it takes your worms to break it down. This should give you an idea of how much to feed your worms at one time. Place your food scraps in a different spot each time.

11. Cover the worm bed with newspaper or a piece of hessian, then cover with a lid. Place the worm farm in a cool and shady spot in your garden or school compound; worms like it better if it's damp and dark.
12. Add water to the box whenever it gets dry. It should be the consistency of a damp sponge. If it is too wet, the worms will die. If it gets too wet, mix dry, shredded newspaper throughout the bedding.
13. Harvest the compost made by the worms (called worm castings) by moving it all to one side of the container; add fresh bedding to the empty side. Many of the worms will move to the fresh bedding in a few days.
14. The valuable worm castings (which look like crumbly soil) can then be taken out and used to feed plants, or added to seedling mixes and potting soils.
15. Collect the worm juice from the bottom container. You can mix this with water and sprinkle it on your garden.

http://healitall.com/wordpress/wp-content/uploads/2008/12/worm-compost.jpg

3 Making a school food garden

'A young plant or seedling is like a child and a teacher must take on the role of the mother of these children' (Abraham Berhe, Head of Zoba Makel, School schools Summer Campaign)

This chapter covers all the steps needed to make a school food garden. It's a good idea to follow each section in order to begin with, but if you need to, you can change the order. Once the garden is established, you will probably jump back and forth between the different activities depending on what stage the garden is at – for example, adding or making more compost or collecting and drying seeds.

A school food garden can be small or big. At its simplest, it could be a small container garden for each child in the Green Club.

The main units are:

- Fencing and living fences.
- Water harvesting and preparing the ground.
- School garden infrastructure.
- Collecting materials.
- Plant propagation – growing the seeds.
- Keeping the soil fertile.
- Natural pest management.
- Saving seeds.
- Harvesting and cooking from the garden.

The simplest type of garden could be a container garden prepared by each child in the Green Club.

General planting selection ideas

Background information

A few general tips for choosing plants in your garden are included here first:

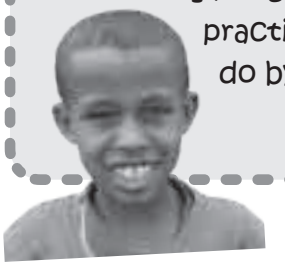
Choosing plants with multiple uses

You can involve the children in the choice of plants for the garden. Ask the school children's families to share a small quantity of seeds of their special local varieties. The children can share stories in class about where these varieties came from and any special information that goes with them. These will be well suited to the local climate and soil and will be better able to resist local pests and disease. You can also save your own seeds for replanting later on (see Appendix B).

Multiple layers of plants

There are different ways of planting that allow you to fit more plants into a smaller space. Some plants grow well with each other – this is sometimes called **companion planting**. Some plants will grow well under other plants – this is called 'stacking' of plants.

Examples of multiple layers of plants in a garden, a passion fruit vine on the edge of the garden climbing and cabbage on the ground between corn plants;



"I like green club because we can put ideas into practice. Not just hearing teacher's ideas but we do by ourselves."

Fitsum Rezene, Green club student

Seasonal planting

Collecting local, seasonal planting knowledge is something that will need to involve adults as well as the children.

In the activities, we show how you can get children to learn from the adults about the seasons for planting in your area.

Suggested vegetable and fruit trees of Eritrea, according to Agro-ecological Zone

Zones	Description of Area	Suggested vegetables to grow	Suggested fruit trees to grow
Central highlands	Altitude of over 1500m and 500mm annual rainfall. A warm to cool semi-arid climate and potential evapo-transpiration ranges between 1,300-1,800mm.	**Energy foods** Potatoes, pumpkin, squash, amaranth, spinach, pumpkin, squash, lettuce, carrot. **Protective foods** Onion, garlic, amaranth, spinach. **Protein foods** Amaranth.	Avocado, guava, grape, opuntia, orange, lemon, mandarin papaya, passion fruit.
Eastern lowlands	This area stretches from the coast– 600 m The coastal plains are hot and dry with less than 200mm of annual rainfall. Potential evapo-transpiration over 2,000mm.	**Energy foods** Potatoes, pumpkin, squash, amaranth, water melon, egg plant. **Protective foods** Onion, garlic, amaranth. **Protein foods** Amaranth.	Sweet orange, lemon, mandarin, passion fruits, papaya, moringa, guava, mango, lime, lemon, orange, mandarin, date palm, opuntia, grape.
Western lowlands	Lies at an altitude of 600-1,500m. Has a worm –semi arid climate. Evapo transpiration 1,500-2,000. Average Annual Rainfall of 300mm.	**Energy foods** Potatoes, pumpkin, squash, amaranth, water melon, egg plant. **Protective foods** Onion, garlic, amaranth. **Protein foods** peanuts, chickpeas	Sweet orange, lemon, mandarin, passion fruits, papaya, moringa, guava, mango, lime, lemon, orange, mandarin, bananas, grape.

Source: Ministry of Agriculture, Asmara

Suggested trees of Eritrea, according to Agro-ecological Zone

Botanical name	Local name	Suggested zone	Used for
Acacia abyssinica	Chea	*CH, **ELL ***WLL	Shade, landscaping, bee foraging, fore wood
Acacia polycantha	Ghomoro	CH, ELL, WLL	Life fence, landscaping and shade. Bee foraging, fire wood
Acacia saligna	-	CH	landscaping and shade and firewood
Acacia senegal	Tsaeda kenteb	ELL, WLL	Gum Arabic extraction, Life fence, landscaping and shade, fire wood
Adansonia digitata	Duma, Himeret, Asa, Dira, Dairi	ELL, WLL	Landscaping, medicinal and fruits for human consumption
Agave sisalana	Eka, Anjeba, Yaa	CH	Life fence, animal feed, construction
Annona muricata	Anona	WLL	Fruits for human consumption landscaping shade and for building houses
Arundo donax	Shambuko	CH, ELL, WLL	Life fence, and for building houses
Azadirachta indica	Nim	ELL, WLL	Medicinal purpose, firewood landscaping, bee foraging and shade
Boswellia papyrifera	Meker, Wal wal, Imela, Lawlow, Lawlan	WLL	Gum extraction
Cajanus cajan	-	CH	Animal feed and human consumption
Carica papaya	Papayo, Pabayo, Bobaye,	CH, ELL, WLL	Fruits for human consumption, bee foraging and medicinal purpose
Casmiroa edulis	Cazmir	CH	Fruits for human consumption, landscaping, bee foraging, construction, and shade
Casuarina cunninghamiana	-	CH	Landscaping, shade and construction
Citrus limon	Lemin, Lebun, Lomen, Lemun, Lemuna	CH, ELL, WLL	Fruits for human consumption and medicinal purpose
Citrus paradisi	Grape fruit	CH, ELL, WLL	Fruits for human consumption
Citrus reticulata	Manderin	ELL, WLL	Fruits for human consumption
Citrus sinensis	Aranshi, Burtukan	ELL, WLL	Fruits for human consumption
Cordia africana	Awhi, Madre, Chergelo, Ghunja	CH, ELL, WLL	Fruits for human consumption, landscaping, firewood, construction ,bee foraging and shade
Cupressus lusitanica	Tsehdiferenji	CH,	Landscaping, life fence, firewood, construction and shade
Delonix elata	Refna, ref, Amaito, Burumbra, Abumbu, Yebusus	ELL, WLL	Landscaping, firewood and shade
Delonix regia	-	CH, ELL, WLL	Landscaping, firewood and shade
Dodonea angustifolia	Tahses, Tases, Kedkida, Tesesa	CH, ELL, WLL	Landscaping, medicinal purpose, firewood, life fence and shade
Bougainvillea buttiana	Bogainvilllea	CH, ELL, WLL	Landscaping, life fence and firewood
Bougainvillea globra	Bogainvilllea	CH, ELL, WLL	Landscaping, life fence and firewood

NB. Abbreviation for * CH= Central highland
**ELL= Eastern lowland
*** WLL= Western lowland

Botanical name	Local name	Suggested zone	Used for
Bougainvillea spectabilis	Bogainvilllea	CH	Landscaping, life fence and firewood
Dovills cafra	Koshem	CH	Landscaping, life fence, and firewood
Lantana camara	Bun tilyan	CH	Landscaping, bee foraging, life fence and firewood
Eriobotrya japonica	-	CH, ELL	Landscaping, shade fruits for human consumption and firewood
Erythrina abyssinica	Zuwawue, Felei, Kuara	CH	Landscaping, shade, medicinal purpose and firewood
Eucalyptus camaldulensis	Keih-kelamitos, Kalabitos	CH	Landscaping, shade, bee foraging, construction, firewood and medicinal purpose
Eucalyptus cladocalyx	Keih-kelamitos, Kalabitos	CH	Landscaping, shade, bee foraging, construction, firewood and medicinal purpose
Eucalyptus globulus	Tsaeda-kelamitos, kalabitos	CH	Landscaping, shade, bee foraging, construction, firewood and medicinal purpose
Eucalyptus rudis	Kelamitos megdalina, Kalabitos	CH	Landscaping, shade, bee foraging, construction, firewood and medicinal purpose
Euphorbia abyssinica	Kolqual, Kulunqual, Kulankala	CH	Landscaping, bee foraging, firewood, construction and shade
Euphorbia tirucalli	Kenchib	CH	Life fence
Faidherbia albida (Acacia albida)	Momona, Melmelet, Momon, Sola, Gerbesha, Ochea	CH, WLL	Landscaping, shade, bee foraging, animal feed firewood, and agro- forestry
Ficus carica	Beles-telian, Daero-telian	CH	Frutis for human consumption
Ficus elastica	---	CH	Landscaping
Ficus sycomorus	Saghla, Shaghla, Subula, Bamba, Saghila	CH, WLL	Frutis for human consumption, animal feed
Ficus thonningii	Shibaka, Dalgus, Gerina	CH	Landscaping, firewood and construction
Ficus vasta	Daero, Maraito, Mentaro, Shaile, Deghuna, Enaerto	CH, ELL, WLL	Fruits for human consumption, shade, bee foraging, animal feed , Landscaping and firwood
Grevillea robusta	-	CH	Landscaping, bee foraging, construction, firewood and shade
Haphaene thebaica	Arkobkobai, Garaito, Oma, Ghamba, Weika, Unga	WLL,ELL	Landscaping, fruits for human consumption, construction, animal feed and other value added forestry products.
Jacaranda mimosifolia	Jacaranda	CH	Landscaping, construction, bee foraging and firewood
Juniperus procera	Tsihdi, Nered, Seredo	CH	Landscaping, construction, and firewood
Leucaena leucocephala	Leucina	CH, ELL, WLL	Anima feed, shade and landscaping
Malus domestica	Tufah	CH	Fruits for human consumption
Mangifera indica	Mangus, Manga, Mangusa	CH	Fruits for human consumption, medicinal purpose, firewood, bee foraging
Melia azedarach	Melia, Mim	CH	Firewood, bee foraging, firewood and construction
Moringa oleifera		WLL,ELL	Medicinal purpose, Most parts for human consumption, animal feed (all parts of the plant).

Botanical name	Local name	Suggested zone	Used for
Olea europaea subsp. africana	Awliie, Wegre, Wekhora, Aulaeto	CH	Medicinal purpose, firewood, shade and construction materials
Opuntia ficus-indica	Beles	CH	Fruits for human consumption, animal feed, and life fence, land stabilization
Parkinsonia aculeata	Shewit hagai, Shewina	CH	Bee foraging, life fence and firewood
Phoenix canariensis	Siye, Temer	CH	Landscaping, shade, construction fruits for human consumption
Phoenix dactylifera	Temri, Temer	ELL	Fruits for human consumption, shade and landscaping
Phoenix reclinata	Aguseana	CH	Shade, landscaping
Prosopis chilensis	Temer musa, Sesban	ELL, WLL	Fire wood, fruits for human consumption, land stabilization, landscaping, shading, and bee foraging
Prosopis joliflora	Temer musa, Sesban	ELL, WLL	Fire wood, fruits for human consumption, land stabilization, landscaping, shading, and bee foraging
Prunus persica	Kuk	CH	Fruits for human consumption, shade and landscaping
Psidium guajava	Zeithun, Zeitun, Lila	CH, ELL, WLL	Fruits for human consumption, shade, landscaping and medicinal purpose
Rhamnus prinoides	Ghesho, Geseha	CH	Local beverage
Ricinus communis	Gulii, Gulie, Nakobeles, Intura	CH, ELL, WLL	Bio-fuel
Schinus molle	Berbere-tselim, Etset ferfer	CH	Firewood, medicinal purpose, bee foraging, shade construction and landscaping
Senna siamea (Cassia siamea)	-	ELL, WLL, CH	Shade, constuction, and landscaping
Tamarix aphylla	Ubel, Segeito, Weama, Shilla, Segel	ELL, WLL	Shade, construction and landscaping
Vernonia amygdalina	Grawa	CH	Bee foraging, medicinal purpose
Vitis vinifera	Weini, Enab	CH, ELL, WLL	Fruits for human consumption , shade and landscaping
Washingtonia filifera	-	CH, ELL	Landscaping, shade and firewood
Ziziphus spina-christi	Gaba, Kuslet, Hamburi, Mulgi, Guff, Aseba, Kusurto	CH, ELL, WLL	Medicinal, bee foraging, construction, boat construction, shade, and fruits for human consumption.

Source: Ministry of Agriculture, Asmara

NB. Abbreviation for * CH= Central highland
**ELL= Eastern lowland
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Activities for students:

Activity: Seasonal calendar for school

Ask children to ask their parents and grandparents for their advice on which vegetables and crops should be planted at what time of year. Are there special varieties for early, middle and late season?

Time: To be collated over 2 weeks.
Information could be continually added to over a year.

Purpose: To establish a seasonal calendar for planting and growing vegetables and fruits in the school garden.

What you need:

- Notebooks.
- Pencils.
- Large paper to collate findings (rough copy), and another for seasonal calendar (good copy).

What to do:

1. Students interview people who they know that are experts on fruit and vegetable gardening. This may be a member of the family or a neighbour. They ask questions about when to plant fruit and vegetables and when they can be harvested.
2. Students bring the recorded information back to school and share with the rest of the class.
3. This information is collated onto a large piece of paper.
4. This information is then refined and a calendar is drawn up and decorated of the different kinds of fruit and vegetables that can be grown in that area and when it is best to plant and harvest.
5. Once they have completed their calendars in their groups, display the calendars in the classroom for students to look at as the events in the calendar happen throughout the year.
6. If possible, students can also add or make changes to the calendar throughout the year as they become more familiar with what is happening and when.

Activity: Collect seeds and seed stories from home

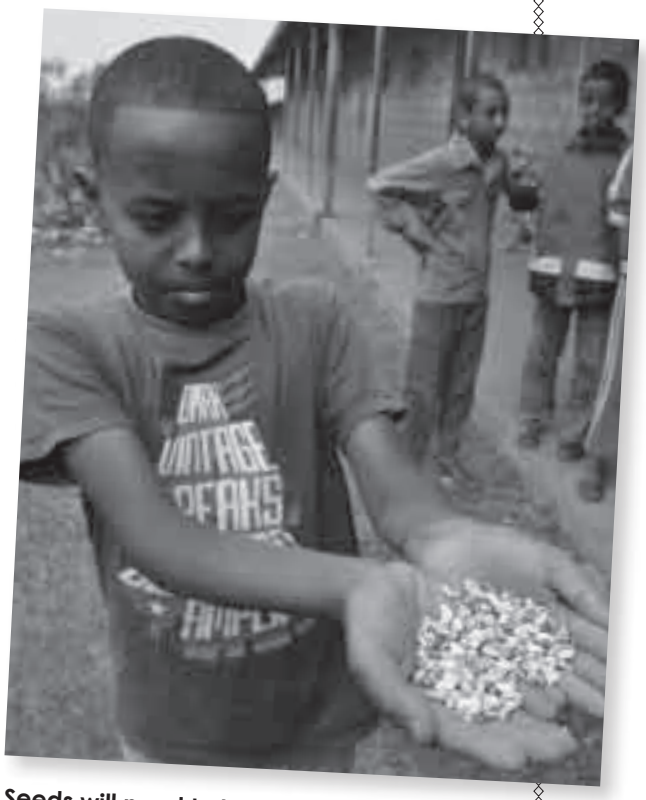
Time: 40 minutes

Purpose:

- To collect seeds for a seed bank at school.
- To collect a background to the seeds.

What you need:

- Seeds
- Container for seeds
- Large paper
- Marker/pen
- Notebooks



Seeds will need to be collected from families of children and local farmers and gardeners for the school food garden

What to do:

1. Students collect seeds from people in their community who they know are keen gardeners, collecting the seeds in uncontaminated containers and keeping each different kind separate.
2. Students note down what the seeds are and where they came from. They add any other interesting information they find out about the seeds.
3. Students share their stories with the rest of the group.
4. Students could write up stories and information.
5. Teacher collect all the stories and create a book on their new seed bank.
6. Seeds are collected, stored in a dry place in the containers with labels. These may be used to plant gardens in appropriate seasons.

Fencing and living fences

Background Information

A school garden must be protected from animals like chickens, goats, sheep, donkeys, cows and rodents. Fencing with bricks, cement or wire mesh can be expensive. If your school is not already fenced, you may want to make a fence around the garden. Even within the school compound a small fence may be useful to clearly mark the food garden area so that children are aware they must be careful of damaging the plants inside this area when they play.

Living fences provide long-lasting fencing at low cost but they take time to get established. A living fence is made up of strong, usually thorny plants that animals do not like to eat and cannot easily get through, although in drought times, even living fences can be eaten by livestock.

It may be a good idea to build a temporary bush fence at the same time as you plant a living fence, or just keep repairing a bush materials fence.

Pictures of living fences

A bush/stick fence at a school.

Dry thorny branches as temporary protection for trees and gardens.

Stone wall

In some areas there, may be a lot of stones available. You can use these to make a wall for the garden. This is heavy work and you may need to involve the PTA and community if it is too big a job for the children. A stone wall can be beautiful and can also form a small windbreak, or used to catch rainwater and divert it to the garden if designed the right way.



Stone and brick walls

Activities for students:

Activity: Building a living fence

Collect different species of plants used for living fences in the area. Plant a small plot of 'living fence plants'. Children should be careful when handling spiky plants.

Time: 2 x 40-minute sessions.

Purpose: To plant a fence using prickly plants to protect a garden or school from animals or wind.

What you need:

- Small prickly plants.
- Toolbox: digging tools.
- Gardening gloves for safety.

What to do:

1. Students collect samples of little cactus or aloe vera. Sometimes plants they have at home may have reproduced and have little plants starting to grow, or else a part of the leaf can be broken off and replanted in soil. The students will need to wear gloves when collecting so as not to hurt themselves. It is also a good idea to transport the

plants in a box to protect the students from any spikes as they carry the plants to school.

2. An area is selected for the living fence.
3. Students plant the plants they have collected in the area where planned. Space the plants apart, considering the size they will grow. If there is a large area to fence, you will need a considerable number of plants.
4. Watch the living fence grow. If there is an urgent need for the fence in the interim, use branches or thorny branches to create a temporary fence.

Extension Idea: Ask the PTA to repair school gates and existing fences if required.

Water harvesting (earthworks)

Background Information

For a garden and trees to grow, they need enough water. For some schools, this will mean having a garden at certain times of the year only, when there is enough rain and water available, or finding other solutions like organising students to carry water from their homes. Through careful planning and structures like bunds and micro basins, we can move water from one area to another or concentrate water into certain areas.

Water can be stored:

- In containers.
- In the ground (the soil is the best place to store water).
- In the plants and trees.

If your school has a rainwater tank with enough water available, you can plan to use this on the food garden. You may want to consider catching some more rainwater for the garden. Even just one drum situated under a roof down pipe close to the garden can make a difference to watering during the rainy season.

Some ideas to do this are presented here:

Rainwater diversion and infiltration

If you study where water moves within the school grounds after heavy rain, you can see if there are simple ways that you can divert some of this water to be absorbed into the ground around the food garden or by the trees. Across Eritrea, there is much knowledge and experience on diverting surface water for agriculture. Some of these methods could be applied in your school garden.

A simple barrel used to collect water for gardens.

Surface water diversion drain in terraces.

Conserving water

Once your food garden is established, being careful with water becomes part of the day-to-day work in the garden. Careful use of limited, available water is very important. Mulching is important to prevent the soil drying out too quickly and losing your valuable water to evaporation.

Watering at the right time of day

It's best to water plants either in the morning or late afternoon. This is to prevent the sun from evaporating the water and giving the water time to be absorbed into the soil and by the plants. If it is very dry and you have very little water, you can pull back the mulch and water onto the ground and then replace the mulch to keep the moisture protected from the sun and heat.

Adding rocks around the plant reduces water evaporation. Grass, branches and twigs can also be used.

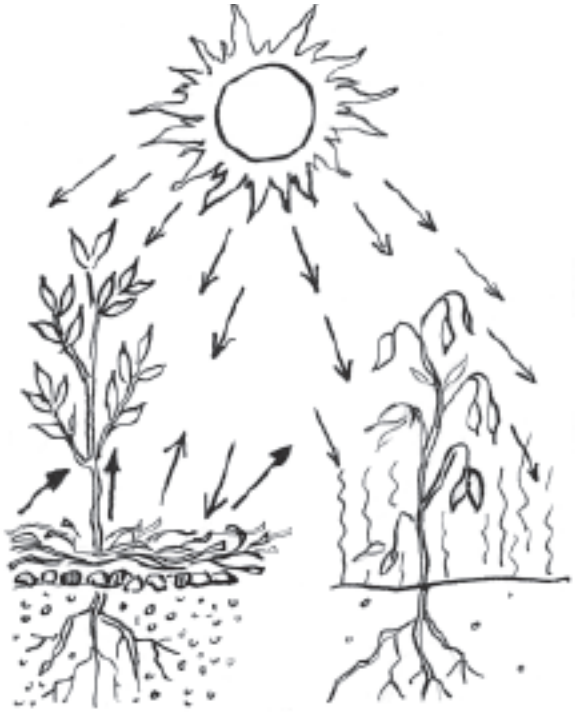
Carrying water from homes

A small garden bed of 1.5m metres will need about 20 litres, three times a week, during dry times of the year. This can be carried by students who can be organised into groups to be responsible for watering different garden beds at different times of the week.

When watering, advise the students not to pour the water too heavily onto the ground or plants. This can damage small seedlings and also compact the soil making it difficult for roots to spread out. The best method is to pour the water so that it falls like rain. This can be done by using a tin or plastic container with holes punched with a nail. Pour water from the bucket or water container through the tin onto the garden.

Generally, it is best to give more water every few days, rather than a small amount of water every day. This encourages the roots of plants to grow deeper, making them stronger and more resistant to dry times. If you give only a very small amount of water, all the roots will remain close to the surface.

This is why flood irrigating often practiced in Eritrea can be a good method to encourage deep root growth.



Mulch diagram: On top of the soil is a layer of leaves, grass and organic matter. Under the mulch are worms feeding on the organic matter. The worms make the soil loose and aerated for plant roots to grow. Mulch keeps moisture in the soil and keep the soil from drying out by the sun. When rain falls it hits the mulch first instead of directly on the soil, reducing erosion.

Farmers understand the importance of deep watering in Eritrea, and where they can they use flood irrigation of their fields.

Students carrying water from home.

What to do if your school has no water

For some schools where there is no water available at all, then there are fewer choices with school gardening. Some ideas would be:

- Children can carry water to the school from their homes. You will need to ask children to consult their families and get commitment from them to the Green Clubs and then it should be possible to keep a garden going.
- Start a rain-fed garden bed (see Chapter 5).
- Start a seed bank (see Appendix B).
- Start a tree nursery using water carried from home by students (trees can then be planted at home in the community) (see Chapter 5).

Activities for students:

Activity: Watering containers

Watering will become a regular activity for the children during the full cycle of your school garden

Time: 40 minutes.

Purpose: To make water containers for watering the school garden.

What you need:

- Watering containers: plastic bottles, buckets, tin cans.

What to do:

1. Each child brings a water container to school and writes their name on it in permanent pen.

Students watering the garden.

Water containers ready for students to assist with watering activities.

2. Use containers, tins and leaves to pour water over and into the garden. See how it falls softly like rain and does not damage the plants. The first time the children water the plants, they can compare watering through this tin to pouring water strongly.
3. Assign beds and watering responsibility to different classes.
4. Students continue to water in morning and evenings, making sure they water under the mulch.

Activity: The importance of ground cover

Time: 40 minutes (1-2 lessons if required).

Purpose:

- To build a model catchment.
- To examine how running water can cause erosion in a catchment.
- To examine how mulch and steepness of slope can affect erosion.

What you need:

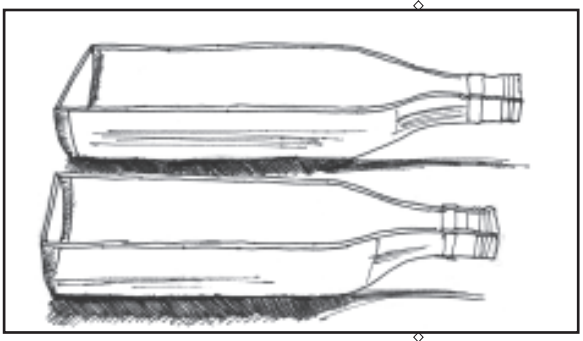
- 2 plastic bottles or cartons (2-litre size) per group of students.
- Toolbox: Scissors.
- Mulch materials (leaves, bark, sawdust, twigs, grass clippings)
- Small plastic containers or bowl.
- Watering can (plastic bottle with small holes in the base).
- Toolbox: Clock with second hand.

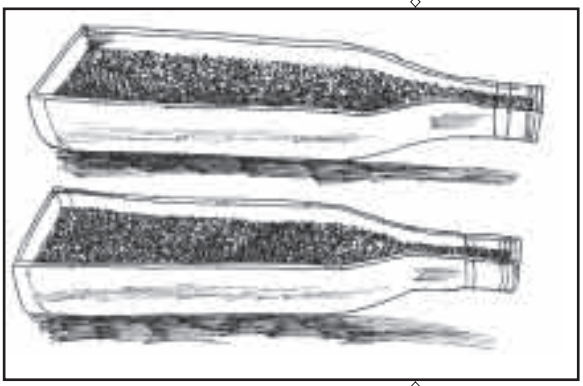
Measuring equipment could be used for quantifying the water, or else class containers with quantities marked on them.

What to do:

1. Beforehand, the teacher requests the students bring a 2 litre plastic bottle or drink carton from home and a small plastic container. Arrange for enough scissors for each group.
2. The teacher introduces the lesson, explaining that this experiment is designed to demonstrate what happens with and without mulch and plant matter on the surface of the ground.
3. The students prepare the drink bottles or cartons. With the pouring side of the drink carton or drink bottle face up, use scissors to cut out the section as shown in illustration.

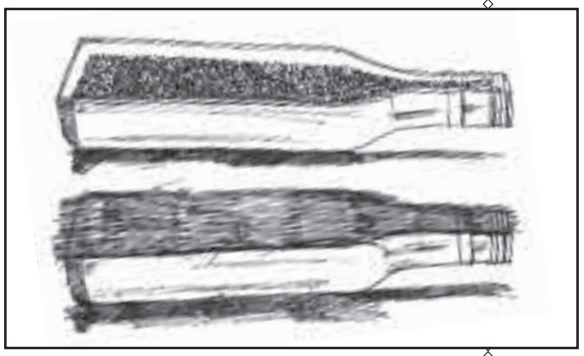
   Teachers' Note: This lesson could be conducted outside or on the veranda, as it involves water and soil.

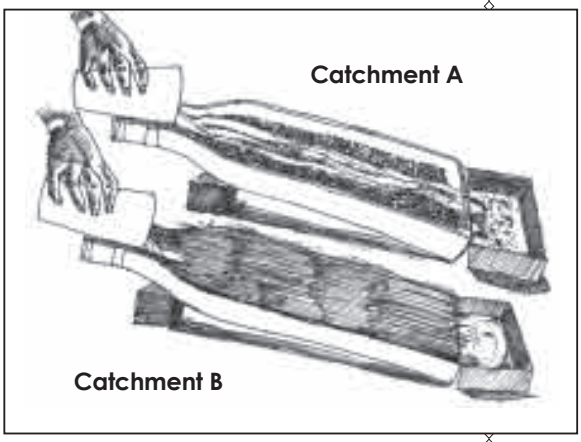




4. The students fill the carton with soil. Make sure there is the same amount of soil in each carton.
5. The students then place a layer of mulch over the soil in one of the cartons.
6. The students incline the two cartons equally to represent the same slope. Place a plastic container at the end to collect run off from the experiment.

   Teacher Note: The students now have two different types of catchments.
7. The students sprinkle the same amount of water over each catchment and measure the time it takes for the water to flow into the container base.





8. Measure the amount of water in the containers. Record the following:
   - The quantity of water.
   - The appearance of water.
   - Content.
   - Quality of water.

	Catchment A	Catchment B
Water at Start		
Water at Finish		
Time taken		

9. Record results in the chart in notebooks.
10. The class discusses their findings. Which catchment is more likely to have soil erosion problems? Brainstorm some ways we can improve the catchment to reduce soil erosion, such as planting trees.

Ideas for extension:

Students could experiment by varying the angles of the slope and observing the effect of the angle on run off in terms of quantity and quality of water in the runoff.

Students could experiment with creating barriers with twigs, mud or stones to divert the run off. This principle can be applied in the school grounds to divert water runoff from concrete paths to garden beds.

Activity: Collecting rainwater

Given the importance of rainwater, it is important that rainwater collection is maximised. This can be done by:

- Adding a gutter to the entire roof area.
- Adding a second tank.
- Setting up communal tanks.

What you need:

- Map of the school
- Notebooks

What to do:

1. In groups, walk around the school and observe and record how rainwater is being collected.
2. Write answers to the following questions:
    - Is there a rainwater tank?
    - Is the rainwater tank covered?
    - Are there over hanging branches above the tank?
    - Is the rainwater tank clean?
    - Is the area surrounding the rainwater tank clean?
    - Are the roof and gutters clean and working?
    - Is the top of the tank clean?
3. From your observations, what are the threats to rainwater?
4. What recommendations would you give to the school to safeguard their rainwater?

Many schools have guttering on their roof and down pipes with rainwater runoff that is not being used. You might want to fill up some 44-gallon drums with rainwater if you can source the drums or containers. If the down pipes are broken or rusted, ask the Director and PTA to assist with the repairs.

Food garden infrastructure

Background Information

Bed layout

Now that you and the students have decided where to locate the garden, you will need to come up with a plan for the garden layout or design. Have the children involved. A school garden can have a design similar to local farmer's fields or it could be a more fun design with beds in circles, rectangles, triangles or other shapes. The advantage of squares and rectangles is that they are easy to layout and easy to enclose with hard edges like bricks. Curved and irregular shapes look more natural.

If the beds are too wide for children to be able to reach the middle, place stepping stones so that they can step on the stones to get to the middle of the beds without stepping on top of plants or compacting the soil.

Pathways and edges

The garden will need paths in between the beds for children, teachers and visitors to work in and appreciate the beautiful school garden.

Pathways can be marked with garden bed edges or borders. These could be made of stone or just raised earth. The paths themselves could be covered in flat stones, gravel or sand – whatever is easily available. Bare earth is also OK, although it can get muddy. If you allow grass to grow on the paths, you will need to be careful it does not grow into the garden beds or steal too much water or nutrients from the garden.

It is a good idea to design some spaces within the garden where groups of students can sit together to listen to a teacher explain an activity or to just relax in the garden. This can be an outdoor classroom.

Ideas for bed layout and garden pathways.

Trees can be used to create cool and shaded outdoor teaching spaces.

Wall of a school building with trellis on it, used to create a small garden.

The edge between pathways and garden beds can be defined with hard materials such as rocks or bricks. These need to be built carefully. They must be able to take the weight of several children without collapsing.

Shade structures

Trellises are structures for plants to climb and provide shade underneath. Climbing plants use less space. Materials for trellises can be sticks and branches, string or rope and bamboo. Plants could also be trellised along school walls. A fence around the garden can also act as a trellis. Trellis can also help to provide shade for school buildings and help to keep them cooler.

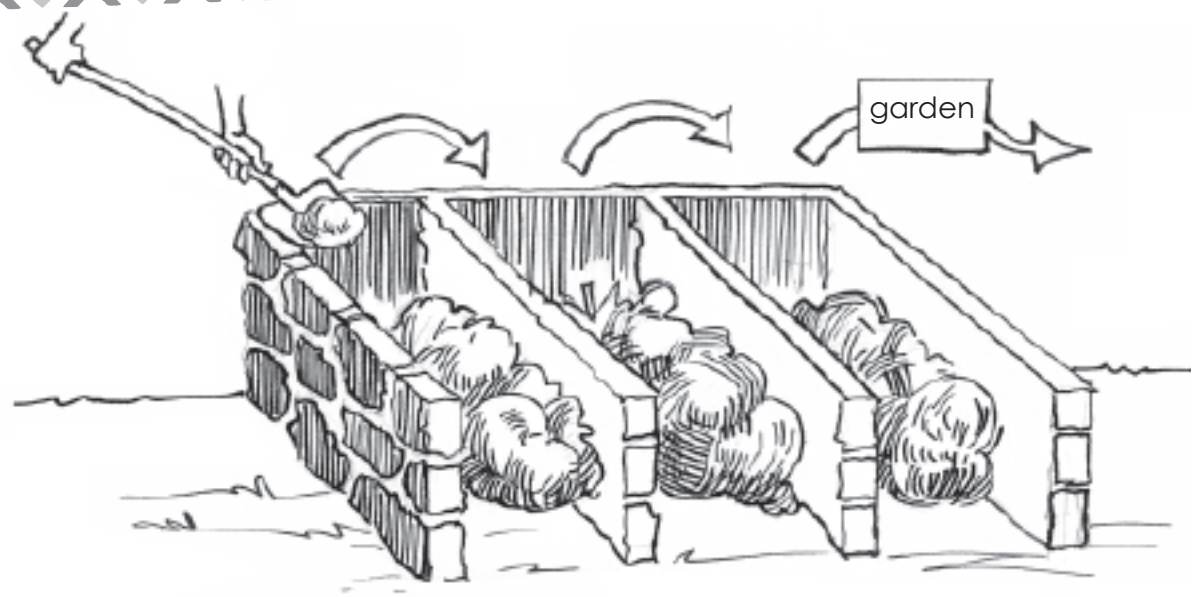
Signage

Put a sign in your garden to recognise all the hard work and beauty! Construct a blackboard that is protected from the weather to tell visitors about the progress of the garden, upcoming projects or garden events.

Designing a compost area

Compost is naturally broken down organic matter such as grass, leaves and food scraps. Compost is used to help enrich the soil.

Prepare an area for making compost. The area should be close to or on one side of the school food garden. But it should also be easily accessible to the front gate of the school as it may be necessary to drive in a truck with loads of organic matter collected outside the school.



Stone walls for a three bin compost area. Compost should be turned and airated at each stage of the decomposting process.

One method of compost making is the '3 bin method'. This requires three fenced areas next to each other. Such fences could be made of stone. Compost is then moved from one bin to the next and then from the third bin to the garden. For more detail, see Appendix C.

Activities for students:

Activity: Marking out garden beds

Time: 40 minutes

Purpose:

To mark out a garden bed and prepare for planting

What you need:

- Toolbox: tape measure or 1 m ruler
- Toolbox: string
- Small sticks

What to do:

1. Mark out an area for your garden beds. For example, if 1m x 1m plots, measure out 1m by placing a stick at the beginning or end of the metre, and do the same for the other four sides. Attach string to the sticks to form a square.
2. Once the garden bed has been marked out, bricks or stones can be placed next to the string to form the walls of the garden bed.
3. Also mark out the pathways. Place stones, bricks or pebbles along the pathways to make a space for people to walk.
4. Add some artwork such as mosaics or a scarecrow to brighten up your garden.

Activity: Name it!

Every time you sow some seeds, don't forget to stick a label in the pot. Many seedlings look the same, so if you don't label them you could end up with the wrong plant in the wrong spot – imagine a giant sunflower growing in a window box.

You will need:

- Large plastic container like a bucket or empty plastic drinking bottle.
- Toolbox: scissors.
- Ruler.
- Ballpoint pen/permanent marker.

What to do:

Steps:

1. Cut down the side of the plastic container or bottle, then carefully cut out the bottom, leaving a long piece of plastic that can be flattened. If you are using a bottle, you will need to cut the top off first.
2. Open the side out and lay it flat.
3. Using the ruler and the pen, draw lines about 2cm (3/4 inch) apart along the width of the plastic side, not the length.
4. Cut along these lines with the scissors.
5. Cut a tapered point at one end to make it easier for your tag to go into the soil in your pot.
6. Now your label is ready to write on.
7. If you used a plastic bottle, writing with a permanent marker will work best. If you used a non-clear plastic, you can use a pen or pencil. Using these should make sure the label does not wash off when you water your seeds.
8. Write on your label information like the name of the plant, where you collected the seeds, and what day you planted them.

Extension Idea:
Construct a blackboard as a sign indicating what plants are in your garden or use to record watering in the garden or to keep track of jobs to be done. You may need to ask for support from the PTA.

Activity: Creating compost

Organic waste comes from animal and plant material. These wastes can be broken down into soil by the action of bacteria and returned to the garden. Much of the waste we throw away is organic waste.

Time: Initial set-up half a day; management and maintenance – ongoing.

Purpose:

- To learn the basic principles of composting.
- Gain practical experience by beginning a real compost heap.

What you need

- A supply of household organic waste.
- Toolbox: Composting poster.
- Machete/bush knife or spade.
- Cardboard boxes.
- Materials for a frame (cardboard boxes or wire, old tyres or wood).

Introduction:

Making compost is a great way to safely get rid of our food and garden wastes without losing the nutrients that are stored in them. Dumping or burning 'green wastes' such as vegetable peelings and off-cuts, grass clippings and leaves is the same as throwing away packets of flour, rice or sugar with some still left in the bag.

Compost is nature's way of breaking down material into usable pieces for plants and animals. Compost not only reduces what is considered waste, it is also a very useful way to recycle organic material to make an environmentally friendly alternative to artificial fertilisers. Using compost instead of having to buy artificial fertilisers can help save you money. By selling compost for use by other gardeners or by providing composting services, you may be able to raise some funds for your school.

What to do:

Before you begin

- Organise for your students to bring a supply of household organic waste (e.g. vegetable scraps) for this activity.
- Read and discuss the Composting Poster and the steps below .
- Select an appropriate site for the compost heap. The site must be convenient, have access to water and be located where it will not attract unwanted pests to your school

Steps:

1. Lay out the materials that have been collected for the heap and ensure that there are also sufficient leaves or dry yard wastes. Examine each material and decide if it is dry yard waste or green vegetable waste. Place these into two piles.

Materials that can and cannot be composted

YES - food scraps, animal manure, grass, branches, ashes, paper, cardboard

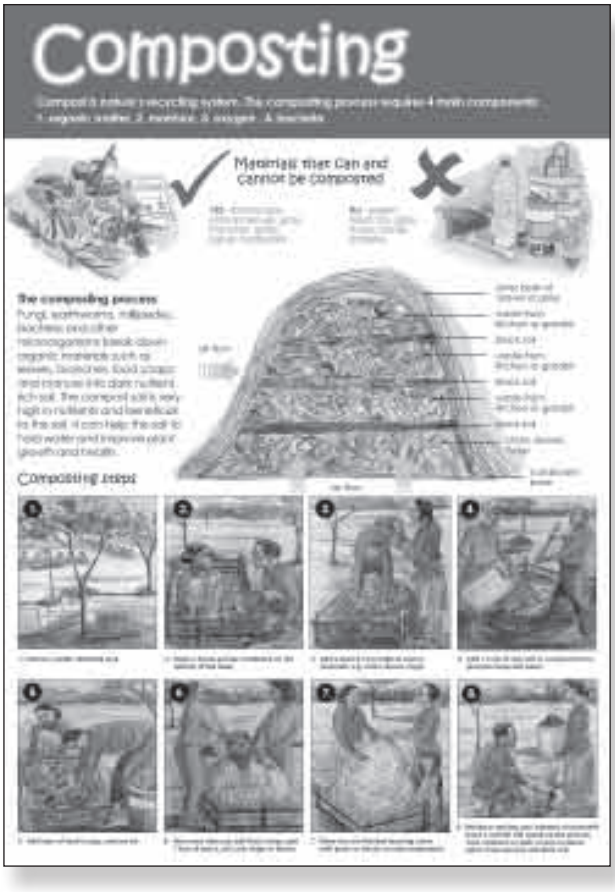
No- plastic, tins, glass, stones, bones, batteries

2. Dispose of any item that should not be placed in a compost heap.
3. Use a machete/bush knife or spade to chop up the coarse leaves and yard waste into small pieces.
4. Lay cardboard boxes underneath the heap. Explain that this will help to protect the groundwater from any liquid that drains or 'leaches' through the compost. Sometimes this can include substances that are not good for the soil.
5. Create a 'frame' to contain the compost heap. This could be made with cardboard boxes or wire, old tyres or wood.
6. Make the compost heap in layers as described in the nine steps on the next page.
7. The compost is ready when the soil looks dark, has a clean smell and doesn't contain any identifiable vegetable scraps.
8. Every two to three weeks, you will need to remove the cover and mix the remaining compost.
9. Add water if the mix is too dry, and replace the cover.
10. It is important to monitor the moisture in the compost heap. If it is too dry, it will compost very slowly, and if it is too wet it will get smelly.

Now that you have the knowledge and skills required to make a compost heap, what will you do with this knowledge and skills? Make a commitment to start compost heaps at home, or conduct a training workshop to show other people in your community how to compost.

Simple steps to make compost

1. Firstly, make a base 30 cm high and 2 m wide with coarse plant material such as small stems. This will ensure good air circulation and drainage.
2. Add a 10 cm layer of material that is difficult to decompose, such as dry grass or coarse leaves.
3. Add a 10 cm layer of material that is easily decomposed, such as fruit and vegetable scraps.
4. Add 2 cm of animal manure or old compost.
5. Add a sprinkling of top soil (soil collected from within 10 cm of the ground surface).
6. Very small amounts of ash can be lightly sprinkled onto these layers to accelerate the process of decomposition.
7. Repeat all these layers, except for the first layer of coarse material, until the heap reaches 1 to 1.5 m high. This can be done over time and may take several weeks.
8. Monitor the moisture level of the compost. It should be damp but not wet. If it is too dry, add water. If it is too wet, remove the cover when it is sunny and replace the cover to protect it from getting waterlogged if it rains.
9. The heap should be covered to protect it against evaporation and heavy rain as this will wash away all the nutrients. Plastic sheets, thatch or flattened cardboard boxes are suitable for this.



Adapted from: Discovering Biodiversity, An Educator's Guide to Exploring Nature's Variety Live & Learn Environmental Education, Vanuatu 2008.

Collecting materials

Background Information

When you are ready to get started with gardening you will need some piles of different organic materials ready for use. It is a good idea to start collecting these materials with help from the children before the time for planting the garden. Teacher and students should be on the lookout for organic materials all the time.

Compost components

This part of the manual explains what to use and what not to use in compost. Almost anything organic can be put in a compost heap. The methods of making a compost heap are described in Appendix C: Preparing the ground – keeping the soil fertile.

Mulch

Mulch is a covering on the soil that is used to stop evaporation and enrich the soil. Materials for mulch include: grass, leaves, torn up paper and bark.

Teaching tips:

Safety with handling of animal manure.

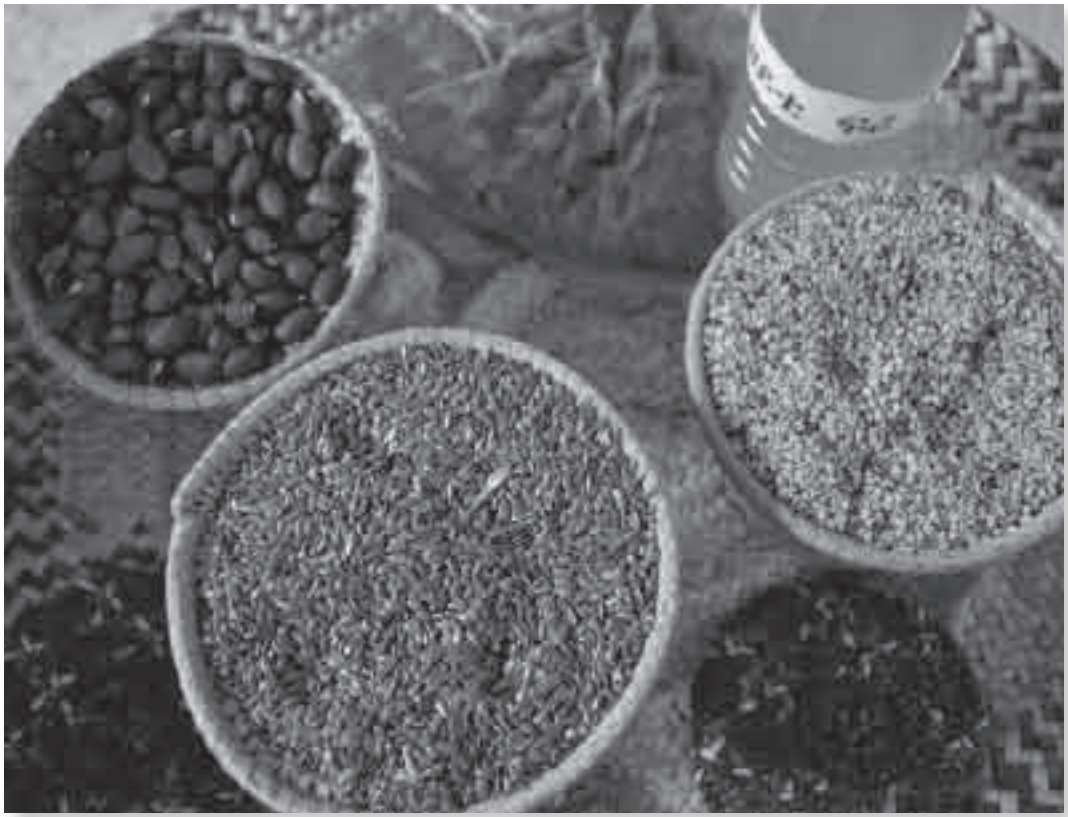
When using animal manure (dung), it is important to practice basic hygiene. Children should wash their hands after handling dung including moving it to the school and digging it into the soil. Animal manure is a great resource for gardening but children need to be shown that they must practice good hygiene. They need to wash their hands after handling it and before eating food or drinking.

Grass, leaves, branches and rocks are suitable for mulch.

Seeds

See Appendix A for more information about planning what plants you want to grow in your garden. But during the lead up to starting a garden, students and teachers should be looking for seeds at home, in the market and in the fields and nature around the school. Children will have more ownership of the school garden if they have collected the seeds themselves from their families and the community. Over time, the school will build up its own seed bank from saving seeds from the garden.

See Appendix B: Seed Saving for more information on collecting and saving seeds.



A variety of seeds from Asmara.

Plant propagation – growing the seeds!

Background Information

Now with your garden area safely fenced, a plan in place, garden beds laid out and materials and seeds collected, you are ready to get started with planting! This section explains how to grow your seeds and prepare for transplanting into the field or garden if required. This is called **plant propagation**.

The joy of sowing seeds and watching them come up should not be denied to children. Some seeds must be planted directly into the ground, as they do not do well when moved as seedlings. These include grains, root crops and legumes such as beans and chickpeas.

Make sure you use good quality seeds. A seed has a better chance of growing if it is fresh and plump, without insect damage. Soon you will be planting the seeds you have produced in your own garden.

Teaching tip:

Look for some fun plants to grow, like sunflowers.

A nursery is needed for smaller seed plants that are a little bit delicate when they are young. Start smaller seeds in a nursery near the classroom and the source of water. Begin this early before the ground is fully ready, so that when you plant out the garden you have some seedlings ready to go.

The collection of seeds and seed saving is covered in more detail in Appendix B.

Seeds for direct planting

- Corn
- Sorghum
- Wheat
- Taff
- Faba Beans
- Chickpea
- Lentils
- Sunflower
- African finger millet
- Millet
- Groundnut
- Sesame

Before planting seeds into the garden it is a good idea to soak them in water for a few hours. This helps the seed to start to grow before it goes into the soil. If seeds have been soaked in water, then they must be planted into moist soil or watered immediately after planting.



Soaking of seeds.

Seeds for the nursery

- Lettuce
- Ball cabbage
- Chinese cabbage
- Tomato
- Eggplant
- Pepper
- Chilli
- Basil
- Cauliflower
- Onions

Soil mixture for nursery/nursery methods

Some seeds will give you better results if you grow them first in a nursery. There are a few main types of nursery:

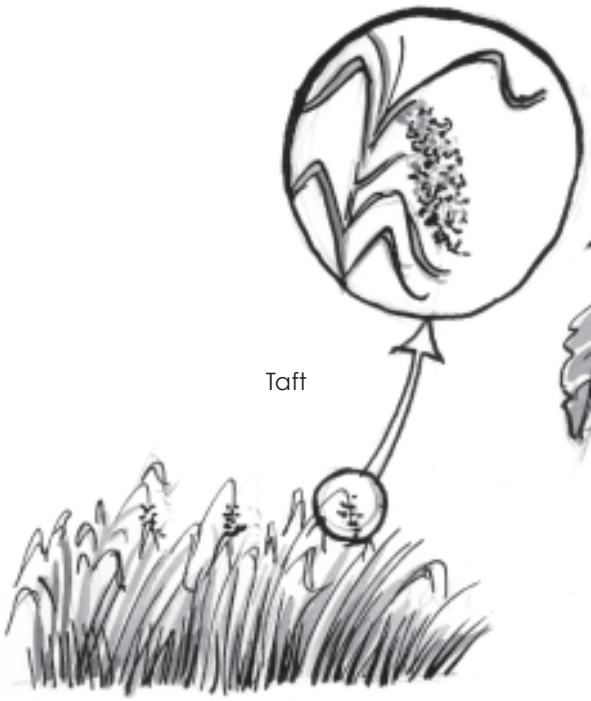
- Boxes or raised-bed nursery.
- Ground nursery – in the garden area.
- Raised seed-bed nursery (used in highlands).
- Sunken seed-bed nursery (used in lowlands).

Raised seed-bed nursery.

Ground nursery.

Container nursery.

Corn

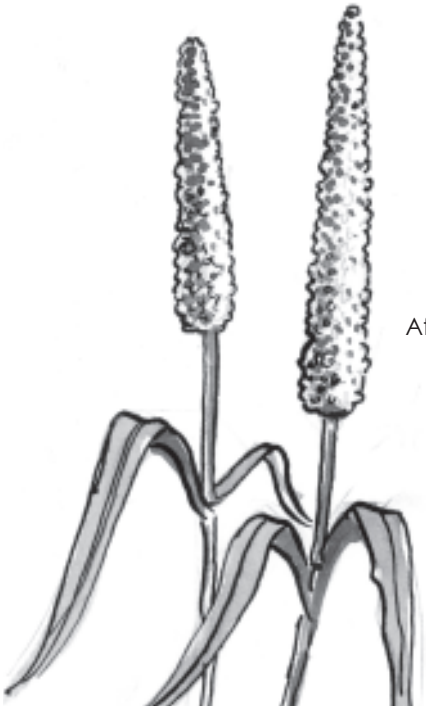


Taft

Sunfllower

Faba Beans

Chickpea



African Finger Millet

Sesame

A raised-bed nursery, or a box nursery, uses a container of some type to hold soil for the seedling to grow inside. This container could be made of wood or from old plastic containers around the village. The nursery should be located in an east–west direction so that it does not get too much morning or afternoon sun.

Soil mixture for germination of seeds

The soil that goes into nursery boxes needs to be soft. An ideal soil is a mixture of a humus-rich soil (from a compost heap for example) and some sandy soil. Nursery soil should be well drained and does not need too much moisture or nutrients. Fill up the nursery area or containers with soft soil.

When seedlings have developed their second set of leaves, then they are ready to be moved to a second nursery area or box. The soil mixture for seedlings that have been pricked can have some more organic matter.

Top dressing with animal manure

To give the seedling a boost before you transplant them to the garden, you can give them a top dressing of animal manure. Animal manure (dung) should be old and well composted before it is used on the nursery. If it is too fresh it can burn the seedlings. Sprinkle the dry dung along the surface of the soil in rows between the seedlings. Put it close to the seedlings, but not touching them. When you water, the nutrients will be absorbed by the seedlings roots and will grow very well.

Shade

A nursery should have some shade. If the soil mixture is rich in humus, it will not dry out so quickly, and so more sun is OK.

Transplanting to the garden

Move the seedlings carefully from the nursery area or nursery container. It's a good idea to leave a ball of soil pressed around the roots of the

Direct planting of seeds.

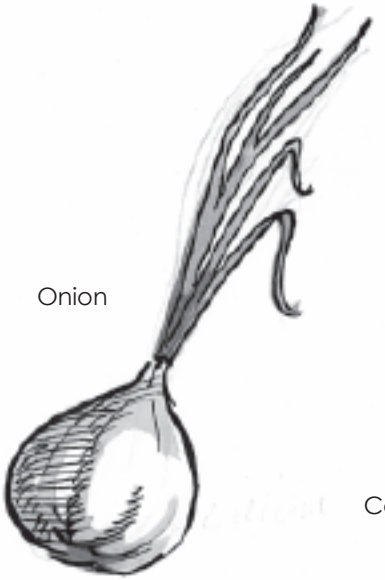
Seedlings in ground nursery.

Seedlings transplanted.

Ball cabbage

Basil

Pepper



Onion

Cauliflower

Chinese cabbage

Tomato

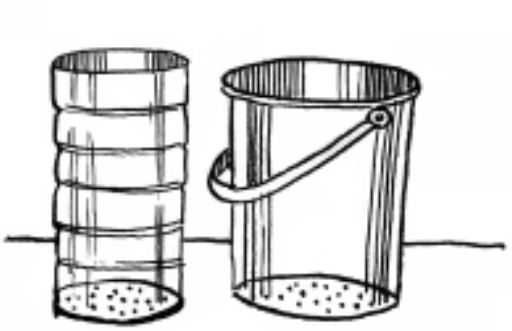
seedling. Make a hole for the seedling, carefully lower it inside and press down the soil around it gently. Water immediately after transplanting.

Direct plant seeds

Some seeds are best sown direct in the soil. Prepare the garden so that the soil is soft. Mix in some compost if required.

Watering

Plants need to be watered as soon as they are transplanted from the nursery into the garden. Nursery beds will need to be watered every day. Seeds should be watered after sowing, and regularly once they have germinated.



Watering cans made by reusing old containers and adding holes.

Steps in transplanting seedlings

Carefully select a seedling and prepare a small hole for it. Be careful not to damage roots.

Bury the seedling and pack soil around its base.

Water well.

Student digging hole.

Putting the seedling in the hole.

Firming soil around the roots.

Activities for students:

Activity: See how seeds germinate

Time: 30 minutes (2-3 weeks for germination).

Purpose: To watch seeds germinate.

What you need:

- Glass or jar
- Paper hand towel or toilet paper
- Seeds, or corn, or beans
- Sawdust or soil

What to do:

1. Line a glass or jar with paper hand towel or toilet paper.
2. Put seeds, corn or beans between the paper and the glass.
3. Fill the inside of the glass with sawdust or soil.
4. Water thoroughly and place the glass in a light place.
5. Through the glass, watch how the seeds germinate from day to day.
6. Draw an image each day of the seed to keep a record of the seed germination.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7

Activity: Planting seeds directly

Time: 40 minutes.

Purpose: To plant seeds directly into the prepared garden bed.

What you need:

- Seeds
- Small tins for holding seeds
- Plant labels
- Toolbox: elastic bands or string
- Watering can

What to do:

1. Before the lesson, count out enough seeds for each student into containers such as small tins. These are also convenient for attaching the plant label with a rubber band.
2. Assign an area of the garden to each child or small group. Make sure

the compost has been mixed into the soil prior to students planting seeds, otherwise they can apply some compost before they plant the seeds.

3. Students mark out the furrows or patches to be planted. The students label where they are going to sow the seeds.
4. Students sow seeds to a depth about twice the size of the seeds. Seed should be sown into soft, fine soil if possible. Larger seeds will be stronger in their **germination** than smaller seeds.
5. Cover the seeds with soil.
6. Water and continue to water each day.

Extension Idea: Making a box or small container garden (good for schools with little space or water)

What to do:

1. Collect containers for small gardens.
2. Make a soil mixture of soft soil mixed with some animal dung.
3. Fill up the bags or containers to the top with soil.
4. Plant seeds or seedlings into containers. For larger containers, place some mulch on the surface of the soil.
5. Water them, being careful that the soil is soaked all the way through.
6. You may want to cover the nursery with a wet hessian bag or cloth to help to keep the seed moist.

Activity: Planting the school garden

Purpose: To establish a school garden.

Time: 30 minutes.

What you need:

- A digging tool
- Gloves (optional)
- Water
- Plants or seeds
- Guards or stakes to protect plants (if required)

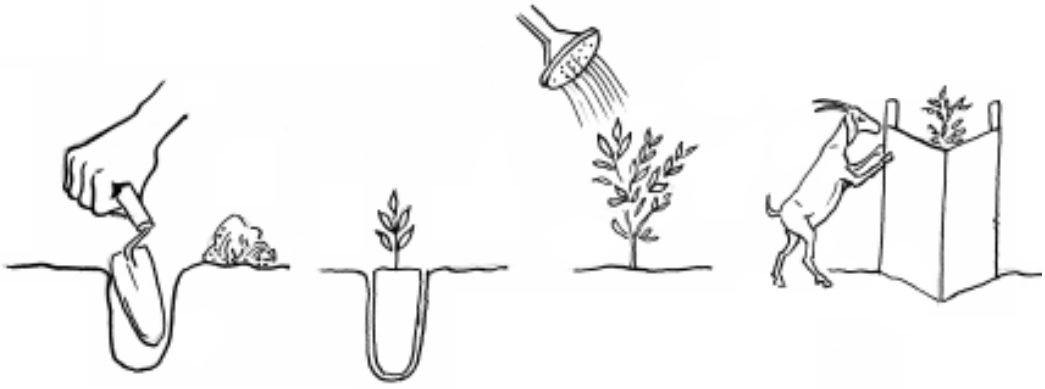
What to do:

1. Select your plant and where you would like to plant it in your garden. Remove any mulch away from the surface so that you can see the soil.
2. With your digging tool, make a hole the same size as the pot of your plant. Make sure that you keep the soil you remove neatly to the side.
3. Carefully remove your plant from the pot, making sure you do not pull on the plant and damage the foliage. Only remove the pot when you are close to your hole, so that you do not have to travel with it unprotected. Place your plant in the hole, making sure the top of the

plant's soil is level with the ground (as pictured below). Use the soil you removed earlier to fill in any gaps around the plant – make sure you don't leave any big air pockets. Think of tucking someone into bed, and gently firm the soil around the stem of the plant.

4. Now you need to give your plant a drink of water. Make sure you cover the mulch back over the plant as well – that will help to reduce moisture evaporation.
5. It may be necessary to guard your plant to protect it from animals, weeds or even humans! If so, place the stakes at even distances around the stem of your plant and carefully cover this with the guard, making sure you protect the foliage of your plant while you are doing it.

You have done an excellent job. Now you need to make sure you look after and maintain your garden for the future.



Activity: How does your garden grow?

Purpose: To observe and record the growth of the plants in the garden over a period of time.

Time: 40 minutes per week

What you need:

- Pen
- Notebook
- Pencil

What to do:

1. A very important part of your school garden project is the ongoing monitoring of your garden. It is vital to keep track of how the garden is going. Your garden will change very quickly and drawings provide a great visual record of your achievements. Record the drawing so it is clear when you return over the years! As part of the monitoring of your garden, you should record:
    - The growth rate of the plants each month (e.g. monitoring height of plants, drawing pictures of the garden).

- The number of healthy plants and how many have died.
- A list of native birds and animals observed.
- Pest plants that have been removed.
- Pest animals that have been sighted

Students can learn much from monitoring and maintaining the school garden.

2. Collate and graph the average growth of each type of plant.
3. Draw a picture of your garden, to compare with the picture you drew at the beginning of the program. Make sure you draw from the same perspective to make the best comparison.
4. Create a 'plant progress' timeline.
5. Keep a close eye on the size of your plants. Once the leaves are growing strongly in and above the guard, it's time to remove the guard and let the plants spread even further.

Natural pest management

Background Information

When insect pests or diseases attack plants growing in your school garden, some teachers might think that they should turn to using agriculture chemicals to control the problem. We strongly discourage this in a school garden. Food grown with agriculture biocides is dangerous for children. Avoid using any agriculture pesticides, herbicides or fungicides in a school food garden.

Teaching tip:

Dangers of pesticides

Explain how synthetic pest management chemicals can:

- kill wildlife
- get into streams and pollute the water, making it unsafe for drinking
- remain on the plant and cause health problems for families eating the plant.

Pests and diseases can be used as a learning experience for children. If the garden has diversity, many times pest and disease problems will sort themselves out over time. Many pest and disease problems may be a sign of lack of soil fertility or unhealthy plants. By addressing the plant's health – feeding it with more compost or preventing it from drying out with mulch – you may strengthen it enough to resist pest and disease attack.

Children can be encouraged to learn about a balanced ecosystem and how 'pests' are eaten by 'predators'. In a mixed garden, there will be a balanced mix of pests and predators like wasps, lizards, lady birds and small insect eating and pollinating birds.

The basic strategies for natural pest management are:

- Diversity – mixed planting, rotational planting, intercropping etc.
- Seasonality – planting the right thing at the right time.
- Keeping the plants healthy – good nutrition from a healthy soil.
- Encouraging predator insects for a balanced agro ecosystem.
- Understanding pest cycles.
- Natural pest control – bio or botanical pesticides (e.g. neem, custard apple leaves, chilli etc).

Diversity – mixed planting, rotational planting, intercropping etc

Growing lots of plants of the same type, at the same time, in one area is called a **monoculture**. Monocultures encourage pest problems because pest numbers build up, as the insects see a lot of food! A **polyculture** is where a number of different plants are mixed together. Generally mixed planting will result in less pest and disease problems.

Crop rotation is very important to prevent the build up of pest and disease in the soil. Crop rotation involves planting different plants after each other. Generally, one of the cycles will be a legume plant, which can add nitrogen.

Seasonality – planting the right thing at the right time

Always plant in the best season or conditions that suit the crop to grow. It's also important to not plant the same crop over and over in the same area of land.

Keep the plants healthy – good nutrition

A healthy soil means that plants will grow to be healthy and will be more resistant to pests. A soil rich in humus, which comes from using mulch, compost and dung, discourages plant diseases. The first step when trying to understand why a plant is sick is to look at the condition of the soil.

Mulching the garden helps:

- Plants grow stronger as the mulch breaks down to become food (nutrients) for our plants.
- Stops the hot sun drying out our soil.
- Provides more food for plants.
- Reduces the spread of fungal disease that can be transmitted from soil to plants.

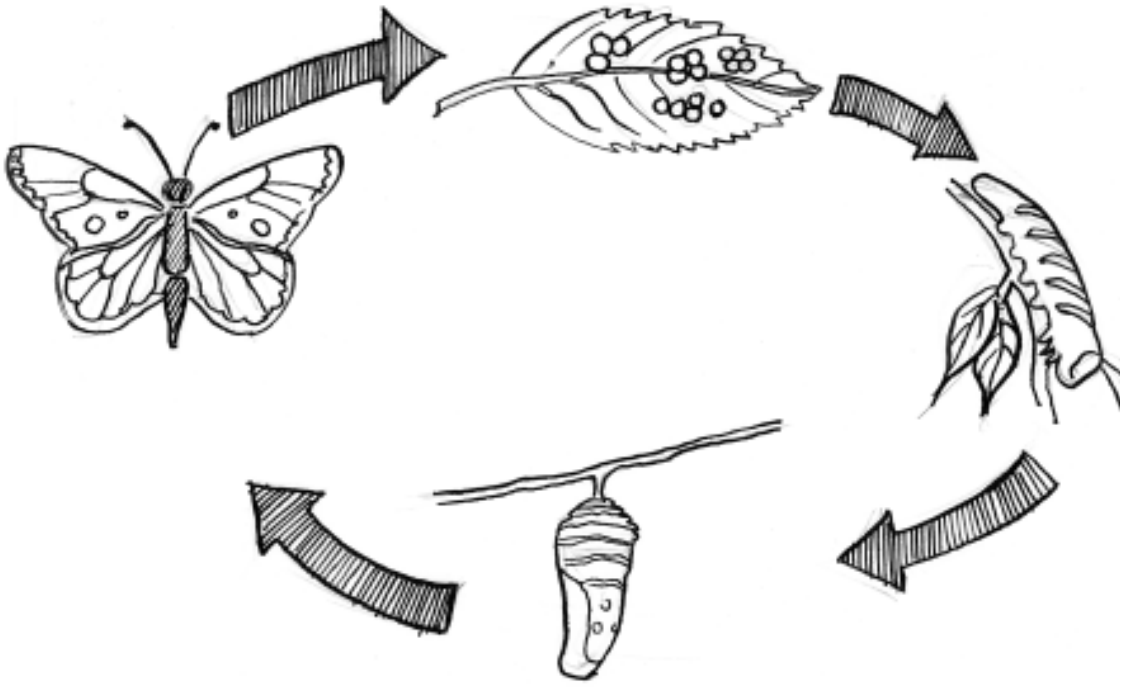
Organic manures are organic materials added to the garden soil. They increase life in the soil and reduce plant diseases. They help to make more food available to your plants. Ash can be useful to add to the soil to control certain diseases.

Predator insects/agro ecosystem

Pests can be controlled by their natural enemies, or predators. Growing a variety of flowering plants –like marigold – will attract insect predators into the garden. These beneficial insects feed on the pest insects.

Pest life cycles

It's good for children to observe the life cycles of insects and understand how they go through different stages. Children can collect insects in the garden and raise them in small jars with mesh lids and feed them with leaves to watch them transform and reproduce.



Life cycle of an insect.

Repellent plants

Some plants have a strong smell either from the leaves and flowers or the roots. These plants can repel or confuse insect pests. Some of these repellent plants are attractive to some predator insects such as wasps. These predators are good to encourage in the garden as they will help to reduce the population of plant eating insects. It's always good to have a lot of flowering plants in your school garden as they attract pollinators like bees.

Grow plants with a strong smell near your vegetables to repel insect pests, including:

- onion
- garlic
- mint
- sweet basil

- oregano
- marigold

Many medicinal plants also have a strong smell and for this reason they may be good to plant in your school garden as repellent plants as well as for their use as herbal medicine. See the book on medicinal plants in the Toolbox.

A book on some herbal medicine plants is included in your school kit.

There will be much more knowledge about these and other plants within your community. It is fun, interesting and useful for children to learn about the properties and use of these plants. Be careful not to introduce plants that might be poisonous.

Attracting birds, butterflies and predators

Some plants attract birds, butterflies and predator insects. These are good to add to the garden. Have you noticed any of these plants in your area?

Mixed planting- rows of tomatoes mixed with rows of onions, a plant that insects don't like.

Photos of plants that are good companions in a food garden in the highlands.

Handpicking

Handpick pests when you see them in the garden. If this is done regularly, it can reduce pest population and bring the problem under control. This can be fun for children to collect insects.

Hand picking or removal of insect pests.

Natural pest management – bio pesticides (e.g. neem, custard apple leaves, chilli)

As a last step, if none of the other methods are working, you can experiment with botanical sprays. Botanical sprays, sometime called plant-based pesticides, can kill or repel certain insect pests. They are made by producing a liquid spray from crushed leaves and fruits of certain plants mixed with water. Sometimes a little bit of soap is added to help the mixture stick to the plant leaves. Generally, strong-smelling plants have potential use as botanical sprays. Some of the plants known to work in home gardens are chilli, neem, annona leaves and ashes.

Activities for students:

Activity: Invertebrates in action – the good, the bad and the ugly

Time: 2 x 40 minutes

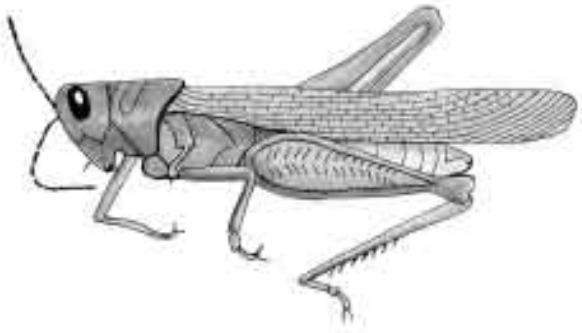
Purpose: To learn about a number of invertebrate species found in agricultural areas and their roles (both positive and negative) in the environment.

What you need:

- Pens
- Notebooks
- Large paper
- Markers
- Coloured pencils
- 6 invertebrate cards (name of invertebrate on a card, teacher to make)

What to do:

1. Students are divided into six groups. A different card is given to each group.
2. Students have 10-15 minutes to prepare a 5-minute presentation of the insect on their card. Students can do this by preparing a poster, a play, a song, a dance or a formal talk.
3. Once the presentations are over, the class can discuss:
    - Which insect did you think was the best, the worst and the ugliest?
    - Why are invertebrates so important?
    - How would these species affect food production?
    - What sort of invertebrates can be found in the garden or the schoolyard?
    - What would be their importance?



Activity: Identify insect pests and predator insects

Time: 40 minutes

Purpose:

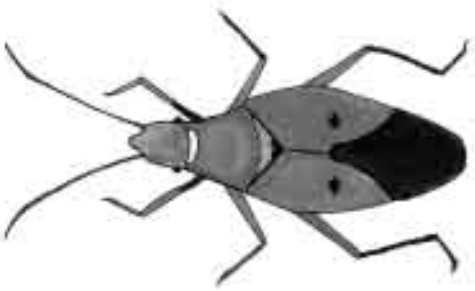
- To learn to describe a number of insect pests occurring in the garden.
- To learn to appreciate some insects found in the garden are beneficial.

What you need:

- Small containers of plastic or glass with lids.
- Toolbox: Insect identification cards, for students to use in the garden.

What to do:

1. Ask the group about the types of insects that are pests in their gardens:
   - The names of the insects.
   - What plants they eat.
   - What part of the plant they attack (leaf, stem, roots).
   - What times of the year they are found.
   - What they look like (ask participants to draw a picture of the insect on the board or on flip chart paper, or to draw a picture on the ground; ask them to show how long the insect is).
2. Take the group for a walk through the school garden and identify as many of the insects as possible; this makes sure everyone knows the insects and what they look like. Point out, or have the participants point out, any damage to leaves, stems or roots caused by the insects; identify which insects have caused the damage. Walk across the garden, collecting insects as you go and making notes for identification. Collect and count pests and predators on each plant.
3. Break into small groups to discuss the insects and the plants they eat; groups report back on what they know. Summarise why it is important to be able to identify insect pests.



Activity: Making botanical sprays

Botanical sprays can be used as a last option if all other methods fail to control or reduce the pest problem. Botanical sprays are generally more effective for soft-bodied insects like slugs rather than hard-bodied insects like beetles.

Purpose: To control or reduce insect pests in the garden.

What you need:

- Garlic
- Vegetable oil
- Soap
- Warm water
- Plastic or glass container

What to do:

Garlic Spray (effective against snails, aphids, white butterfly, caterpillars).

1. Soak 90g chopped garlic in 2 teaspoons vegetable oil for 48 hours.
2. Dissolve 30g grated pure soap in 600ml warm water.
3. Add to garlic.
4. Filter well and store in a sealed plastic or glass container.
5. Dilute using 1 part solution to 99 parts water to begin with, and strengthen if necessary.
6. Spray onto affected plants.

Extension Ideas:

- **Neem** – leaves and fruits.
- **Chilli** – for caterpillars and red spider mites. Mix 2 cups of ground chilli with two cups of water. Strain and use immediately.

Cooking from the garden

Background Information

Cooking and eating food harvested from the school garden can be a fun experience. This will depend on how the school garden is organised and how much produce is available.

Some schools may prefer to sell the produce from the garden and use it for prizes for the green club students.

Activities for students:

Activity: Cooking from the garden

Time: 2 x 40 minutes as well as some homework.

Purpose: to collate a recipe book using plants that can be grown in the school vegetable garden.

What you need:

- Notebook
- Pencils
- Good copy paper

What to do:

1. Discuss recipes with students. Written recipes include ingredients and a description of how to make up the recipe.
2. For homework, set the students the task of choosing a favourite recipe from home that includes the vegetables or fruits in their vegetable garden.
3. The students share their recipes.
4. A recipe book is collated that includes all the students' recipes. Decorate and publish the book on good copy paper.

Extension Ideas: Consider making tomato sauce, or pickling other vegetables such as zucchini. Olive trees grow well in Eritrean soils and climate. The olives that grow can be bottled.

Growing trees for food and the environment

'When we chop down a tree for firewood, we have the ability to destroy 40 years of growth of that tree in just half an hour. But we cannot replace that tree in half an hour.'
(Redaegzy Gebremedhin, RAM Farms)

Planting trees is very important for the environment that we live in and depend on. Trees perform many functions, such as protecting the soil from erosion, building soil fertility, increasing infiltration of water into the ground, providing habitat for many animals, shade and various useful materials for people, including food, fibres, medicines, building materials and fuel for cooking.

In Eritrea, much of the natural tree cover has been removed in recent history. This has been done through clearing for firewood and building and by grazing animals that prevent the regrowth of new trees and forests. This causes serious problems such as increasing soil erosion, loss of biodiversity and loss of water infiltration. Due to deforestation, our mountains have lost their capacity to store water. Trees assist rain to penetrate the soil and therefore increase water storage. Deforestation is contributing the the expansion of deserts.

Schools can lead the way in showing children methods of how to re establish tree cover and biodiversity. We suggest you do this in the same way as in the food gardens and in the same way as it is done in nature – with a mixture of **species** or types of trees.

This chapter explains how to establish a mixed 'mini forest' of useful trees in your school. This may involve adding trees to the existing plantations or starting to plant trees in bare areas of the school. For many schools in drier

parts of Eritrea, it may be more realistic to start with a mixed-tree plot rather than a garden. Use the same planning ideas as discussed earlier in this book.

The parts of this chapter are:

- Learning from the forest
- School as useful tree biodiversity collection
- Collecting seeds for a mini forest
- Growing trees in a school nursery
- Planting trees

Learning from the forest

Background Information

Trees naturally grow in a forest or woodland – that is where they come from. There is a lot that we can learn from the forest.

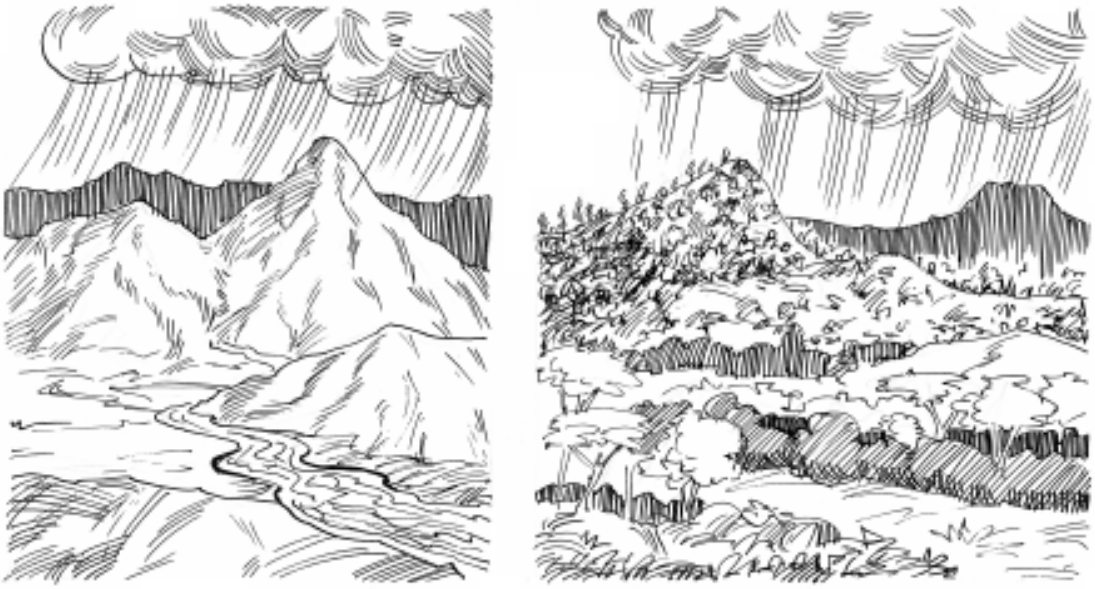
Forests and woodlands are rich in biodiversity. They have many different types of trees, shrubs, small plants and grasses. They also contain many insects, birds and animals. In an old forest, the soil is usually quite rich. This is because organic matter builds up in a forest and the soil remains covered and protected by plants like grasses and mulch. While there are many different insects and animals in a forest, it is rare to see one species or insect, animal or plant take over. Widespread pest and disease problems are rare. This is because the **ecosystem** is in balance.

Eritrea had many types of forest and woodland in the past. These include:

- Highland forest
- Mixed woodlands
- Bush or shrub vegetation
- Grasslands to wooded grasslands
- Riverine forest
- Mangrove

Within these forests, are many different kinds of trees. Many are useful to people. All of these trees have important roles in the environment and in their ecosystem. It's important to replant these indigenous trees of Eritrea. They are well adapted to our environment. Our indigenous trees are a great resource for Eritrea.

What type of forest would your school and community have originally been covered with? Are there remnants of this forest in your sub zoba or zoba that you could visit?



The importance of tree cover in water absorption and avoiding erosion

What is desertification?

Desertification happens when land that has been able to support people gradually turns into desert. It is a process that occurs in dry and fragile ecosystems. It affects topsoil, earth, ground water reserves, surface runoff, animals, plants and humans. Desertification causes soils to erode and disappear. There is less water. The number of plants and animals that can live on the land is reduced. This makes it harder for farmers to make a living and results in more poverty.

Combating desertification in Eritrea

Eritrea, as part of the sub-Saharan world, is directly exposed to desertification and it is because of many natural and human causes. These include climatic conditions, deforestation, over-grazing, over-cultivation, soil erosion and decline of soil fertility. The cultivated cropland of Eritrea is approximately 23% and it is the key resource that needs to be protected from desertification or land degradation. According to the country assessment report on sustainable development, the annual net rate of soil loss from the croplands of Eritrea is estimated at 12 tons/ha and the crop yields are declining at an average rate of about 0.5 percent /annum owing to soil loss only.

Much of the country's land is composed of terrains and steep slopes. These features make the land very vulnerable to excessive land degradation. But records indicate that about 30 percent of the country's land mass was covered by forest a century ago. This percentage is now dramatically lowered to less than one percent. The main causes for this catastrophe include the long struggle for independence, overpopulation leading to overuse of trees for different purposes and clearing of forests for agriculture, as well as unfavourable climatic conditions.

Photo courtesy of Ministry of Agriculture

Soil erosion in Eritrea

The people of Eritrea are making great efforts and significant strides to address land degradation and broader UNCCD (UN Convention to Combat Desertification)-related issues. Recognising the seriousness of land degradation, Eritrea signed and ratified the UNCCD in 1994 and 1996 respectively. The National Action Plan was finalised in 2002 through a wider stakeholder participation including government institutions and concerned civil society organisations such as Non-government Organisations and Country Based Organsiations. The finalisation of the NAP is one of the major achievements, as the NAP is seen as the key operational tool for transforming the provision of the Convention to concrete actions and measures to combat land degradation/desertification. A Road Map for NAP implementation was formulated in 2001.

The Government is addressing land degradation by building dams and by national tree planting programs.

What can be done about desertification?

There are a number of steps which can be taken to reduce desertification:

- Improve soil fertility – the fragile soil need to be built up with organic material. The cheapest and most effective way to do this is with compost. In the Green Club Guidelines, there is information on making compost.
- Reduce the effect of wind – wind blows away fragile soil. You can reduce the effect of the wind by terracing and by planting trees that act as a wind break.
- Reduce water erosion – although Eritrea is a dry country, the rains, when they come, are often very heavy. Because the topsoil is loose, the sudden rush of water can cause erosion. Your Green Club Guide gives practical activities for reducing erosion.
- Plant trees – planting trees, or reforestation, is one of the best things you can do to reduce desertification.
- Eliminate over-grazing – reducing the number of animals grazing in an area will help plants to establish. This helps in reducing erosion.

Activities for students:

Activity: Field trip to a forest or other natural environment in your local area.

Time: All day or ½ a day if the forest is nearby.

Purpose:

- To explore and experience a natural environment.
- To provide an authentic learning opportunity.
- To develop an awareness of local natural environment.

What you need:

- Notebooks.
- Pencils.
- Toolbox: Bird identification cards.
- Toolbox: Insect identification cards.
- Toolbox: binoculars.
- Ask students to wear long pants and shoes.
- Toolbox: magnifying glasses.

What to do:

Before the field trip

1. Organise with other subject teachers to conduct a field trip that has cross-curricular learning opportunities such as gathering data and field investigations, as you may need to take the students all day in order to travel to and from a forest or other site.
2. Consider transport to and from – there may be a local bus or parents with transport that can help out.
3. Pack the equipment needed. If all day, students may bring some water to drink or something to eat. The class may fundraise to cover any costs of the field trip.
4. Prepare the students for the field trip by brainstorming in class beforehand a list of things they expect to see at the field trip site.
5. Ask students to draw up the observation tables in their books. See page 92 for examples of these.

During the field trip

6. As well as gathering data on the physical conditions, signs of human impact and what animals and plants are present, the children can have a little time to wander and explore.
7. Organise students into groups to investigate one topic from the following suggestions. It is also possible to organise different groups to carry out different investigations.

For example:

- Group 1: Record birds observed.
- Group 2: Record animals found.
- Group 3: Record physical conditions.
- Group 4: Record plants found.
- Group 5: Record signs of human impact.

The students can record the information in the tables in their school books. Examples of the tables are on page 92.

Make sure when you are making field notes, you record the following:

- The name of the animal or plant observed
- Date
- Area
- Other details

Suggested activities while on your field trip include:

Bird watching

- Wear colours that blend in with the environment.
- Move quietly and gently in small groups.
- Avoid making sudden noises.
- Try not to move when the bird is calling.

To identify a bird, look for:

- What it is doing.
- Proportions, e.g. long or short legs, large or small head compared to body, angle of tail and body.
- Size – compare it to a bird you know, e.g. is it the same size as a crow?
- Shape of the beak.
- Colours and patterns – position on the body.
- With large groups of birds. make an estimate of the number.

Other ideas for bird watching activities:

- Record the excursion through art, written accounts or photography.
- Invite an expert to accompany the excursion to identify forest flora and fauna.
- Visit the area during different times of the year and record any changes.
- Try to use your data to make observations about the ecosystem. Store your findings (such as on a chart), to be added to next year, in order to build up a complete picture of your chosen area.

Observation table 1: Describing the Physical Environment

Record information about the physical environment in the observation table in your school books. An example of an observation table is on page 94.

Observation table 2: Plant and animal identification

Take time to quietly observe the plant and animal life present. See if the students can identify the plants and animals. An example of an identification table is on page 95.

- Plants
- Invertebrates
- Mammals
- Birds
- Reptiles
- Amphibians

Students can use magnifying glasses and containers to have a closer look at the animals and plants. Make sure these animals and plants are returned to their original place before you leave.

After the field trip

7. On returning from the field investigations, students should first complete their various observation tables and field notes.
8. Each group takes it in turn to report on the things they found out.
9. Students could then write up their investigations as a factual recount or a report.

Observation table: 1

Describing the physical environment

Ask students to draw these tables in their school book.
While outside, students should investigate and record their findings.

Living things		Non-living things	
Plants present	Animals present	Human structures	Litter

Observation table: 2

Plant and Animal identification sheet

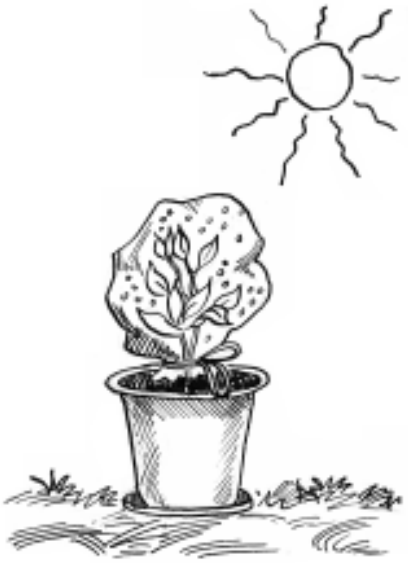
Ask students to draw these tables in their school book.
Record information about the plants and animals you observe using descriptions and illustrations.

Name and drawing of animal	Number observed	Description of habitat	Food source
Plants			
Invertebrates			
Mammals			
Birds			
Reptiles			
Amphibians			

Activity: Transpiration exercise – plastic bag around branch of tree or plant

Time: 40 minutes (continue experiment overnight).

Purpose: To show how the water absorbed by the roots of plants is given off as water vapour by the leaves.



What you need:

- Toolbox: clear plastic bag or clear plastic sheet
- Pot plant
- Water

What to do:

1. Water a potted plant.
2. Put a plastic bag over the pot plant and place it in the sun.
3. Soon afterwards, you will find small drops of water on the inside of the bag.
4. Discuss the water cycle and draw the connection between the experiment and transpiration in the water cycle.

Activity: Evaporation exercise

Time: 40 minutes (continue experiment overnight).

Purpose: To show how leaves are responsible for the water absorbed by plants.

What you need:

- Three bottles.
- Three branches – one with many leaves, one with a few leaves, one with no leaves.
- Water.

What to do:

1. Put equal amounts of water in each of the three bottles.
2. Place one of each of the branches into each bottle.
3. Leave the branches in the bottle for a few days.
4. After a few days, measure the water in each bottle.
5. Discuss with students which bottle had the lowest water level and ask why?
6. Make the connection with the water cycle and how water transpires through the leaves on the plants.

Activity: Replanting in your area

What you need:

- Seeds.
- Seedlings.
- 'Tips for growing seeds' – see next page.
- Large container
- Smaller containers – cut-off plastic bottles or drink cans.

What to do:

Before you begin

1. You will need to have a source of seedlings or cuttings of native plants and trees to plant.
2. The class may need to start a plant nursery or collect cuttings prior to the planting day.
3. See 'Tips for growing seeds' on the next page.
4. The time required for this will vary depending on what seeds you have put in and how fast they grow.
5. It is important that the site you choose for planting is protected. Consider what or who might ruin your planting. Small trees and shrubs are easily killed by people walking or driving over them. Seek an appropriate agreement with your community if your area is accessed by others.
6. Also consider roaming domestic animals and whether or not they are likely to eat your young plants after you have planted them. Your re-planting could be on your school grounds or in a nearby area in your community.
7. Select and prepare your site. Many sites will be infested with weeds and these will need to be cleared and monitored so they do not take over the area, and so your plants have space and light to grow. If possible, do not clear back to bare ground, and be very selective about what you remove – don't take out any native plants, only the weeds. Prepare the area no more than one week before your planting day.
8. Get support and help, if possible, from your local community
9. Plant the seedlings and cuttings with enough space between them so that they can grow (consider how they grow in the wild).
10. When planting, remember to give some water to each plant. Your plants may also need to be watered occasionally in the first few months.
11. Have students monitor how dry the soil is and water accordingly.
12. If necessary, rope or fence off the area and stake the plants.
13. Check the plants regularly and give them water when needed.

14. When the planting has been successful (i.e. you can see significant growth), invite the community members who helped you to a picnic near the area to say thank you and to celebrate your re-planting area.

Teaching tips for growing local seeds

1. Before you start your re-planting project, you might like to spend some time collecting seeds.
2. Your surrounding community and home garden is a good source of seeds. These local plants can obviously survive in the local conditions (soil, climate etc.) and, therefore, will require less maintenance and have more chance of survival.
3. In the months or weeks leading up to your re-planting project, keep a look out for plants that are producing seeds. Try to make sure the seeds are mature before you pick them, and when you are storing, try to keep them dry. An old envelope is a good thing to store seeds in; you can easily write the name of the plant and the date you collected the seeds on the envelope. If you are unsure of which plants grow well in your local area, ask parents or other older community members.
4. Once you have the seeds you want, you are ready to start growing them!

Tips for students

1. Fill seed containers (old ice cream, butter or egg containers work well) with a light mix of soil and sand. Push down the soil mix firmly and gently.
2. The mix should be about 1 cm from the top of the container. Water the mix.
3. Sow the seed. For fine seed, mix with fine sand and lightly sprinkle to spread seed evenly over the mix. Medium and large seeds can be sown by hand, spreading evenly and pressing seeds down into the mix.
4. Cover the seed with a thin layer of soil mix. Try hard to spread the soil evenly. A good guide is to cover the seeds with soil mix to a depth two to three times the size of the seed.
5. Water with a fine spray.
6. Write labels for each container, with plant name (common and local language) and sowing date.
7. Place seed containers in a sheltered, warm, well-ventilated area and water regularly, especially on hot days.

Transplanting (pricking out)

1. When seedlings have developed four leaves (two pairs of leaves), they are generally ready to be planted out into small individual pots. For this you, will need a pencil-sized stick to help remove the seedlings from the tray.
2. Fill the new pots (cut-off plastic bottles, or milk tins will all work well) almost to the top with fresh soil mix. Make sure you put a few small holes in the bottom of the containers so that water can drain out.
3. Make a hole in the mix large enough for the seedling root system.
4. Gently remove the seedling from the tray with the stick, holding on to the leaves, not the stem.
5. Try to disturb the roots as little as possible.
6. Place into the new pot, keeping the roots straight with your stick.
7. Push the mix around the plant firmly and water thoroughly.
8. Label the plant with its common name and local language name if you know it, and the date of planting.
9. Place in a partly shaded, sheltered spot and water regularly.
10. After a few weeks, move the plants gradually into a more exposed spot where they get some sun and rain to help them become strong before you plant them in the ground.
11. For trees, you might need to wait a few months until the plants will be ready to transplant into the ground.

Schools as useful tree biodiversity collection

Background Information

> "I like planting trees because they are beautiful for the environment, food for animals and humans and make the air good."
>
> Yodit Misgna, student of Green Club

Trees have disappeared from our mountain, plains and farmlands due to our need to use these trees and forests – for fuel wood, for building materials, for medicine and for grazing for animals. In the past we could rely on natural forests to provide these needs. But now it is necessary to plant trees to provide these needs for our and future generations.

The natural forests of Eritrea can be classified into 6 main categories. They are:

- Highland Forests: These are composed of a mixture of coniferous species (Juniperus procera) and broad-leaved species (Olea africana) and other associated species.
- Mixed woodlands of Acacia and associated species occurring mainly in the southern part of the Western Lowlands, but also in restricted areas elsewhere in the country.
- Bush or Shrub vegetation, which is dominant cover in Eritrea.
- Grassland to Wooded Grassland, which occurs in many parts of the country.
- Riverine Forests composed especially of tamarinds (Tamarix apphylla) and doum palm (Hyphanae thabaica), which are common in the Western Lowlands and are frequent in the Eastern Lowlands.
- Mangroves occurring in many spots along the coast and concentrated mainly around the port of Assab and between Tio and the port of Massawa.

Many of our indigenous trees are becoming rare and **endangered**. On page 14, we explained the importance of agriculture biodiversity. One important part of this biodiversity is made up of agriculture trees.

How does a forest grow back? It can happen through the role of pioneer trees, enclosures and removal of grazing animals.

Photo courtesy of Ministry of Agriculture

Forest in Eritrea.

Trees can provide many functions in a school, e.g. shade for play areas, shade for cooling of buildings, timber for construction, sticks for cleaning teeth, or fruits and nuts to eat. Many schools have already started planting some trees such as eucalyptus and acacia. This manual recommends you work with the children to diversify these small plantations. Add in more indigenous trees and useful trees to make a mini forest or woodland at your school.

Planting out swales – protection and nurse trees (fodder and firewood)

In preparation for tree planting in the school, it may be necessary to do some earthworks to collect rainwater to help the trees to grow and survive. This is heavy work that may need support from the PTA and community.

This can take the form of water diversions/collection and mini catchments for each tree.

There are many traditional methods of collecting water and diverting it to fields and plants.

Contour swales/bunding (groundwater infiltration for tree establishment)

Pioneer species/ecological succession

Certain species of trees have a special role in preparing the soil and environment for the development of forest. These are usually faster-growing and very hardy trees that can grow and survive in difficult environments and conditions. These are called pioneer species. Generally, they produce a lot of organic material or biomass and create conditions for other, more long lived species to grow. In Eritrea, there are many natural and introduced pioneer species.

Multi-function trees

There are many useful species of trees in Eritrea. Their uses include:

- Firewood and fuel
- Charcoal
- Timber and furniture
- Poles and posts
- Beehives
- Tools and tool handles
- Farm implements
- Carvings/utensils and walking sticks
- Fruit, food and nut
- Vegetables
- Seasoning and flavouring
- Drink or soup
- Oil and edible gums
- Jam and syrup
- Medicine
- Fodder
- Bee forage
- Shade
- Ornamental
- Mulch
- Nitrogen fixation
- Soil conservation and improvement
- River bank and sand stabilisation
- Windbreak
- Fibre, weaving and rope
- Thatch and roofing material and mats
- Resin, gums and latex
- Tannin and dye
- Veterinary medicine
- Toxin or insecticide
- Cosmetic, perfume or soap
- Live fence and dry fencing
- Ceremonial and boundary marking
- Smoke bath
- Brooms
- Toothbrushes

Teaching tip:

A book on medicinal plants is included in the Toolbox.

Legume trees

Just like in the garden, legumes are also important in the forest and plantation. There are many legume trees in the different ecological zones of Eritrea.

Legume trees can be planted around the school and used for coppicing to provide organic matter for the school garden. One example is a system of alley cropping/pruning of legume trees planted on edges of gardens.

Bee forage exercise

Look at the flowering trees calendar. Discuss and see if you can make a calendar of trees to be in flower all year for your area. How can you bring all these flowering trees into your school?

Teaching tip:

Trees for fuel wood.

82% of household fuel is coming from trees, which results in wide-scale clearing of trees in forests and in agriculture and grazing lands. What are the alternatives? Consider using a solar stove. It is a stove with solar panels that use the energy from the sun to cook food.

Activities for students:

Activity: Understanding the roles and uses of trees

Time: 40 minutes

Purpose: To investigate and record the uses of trees.

What you need:

- Paper or notebook
- Pencils
- Chart with the headings:
  - Foods from trees
  - Furniture from trees
  - Buildings from trees
  - Paper things from trees
  - Other things made from trees
  - Artwork made from trees

What to do:

1. Ask students to consider the classroom, school, home and community and think of things that are made from trees.
2. Students draw six squares on a sheet of paper or a notebook, writing one of each of the headings on the chart in each box.
3. Under each of the headings, the students draw or write the name of something they can think of that comes from trees e.g. food.
4. Students share their ideas with the rest of the class.

Extension Ideas:

- National Greening Day: collect seeds from fruit trees, nut tree, native trees, pioneer species and legume trees. Prepare an area to plant the trees. Organise students in the school, the PTA and other members of the community to plant the seeds. Continue to water the seeds.
- Create and area for natural regeneration.
- Start a rain fed garden.

Growing trees in the nursery

Background Information

Many high schools and some elementary schools have been getting some very good trees from the Ministry of Agriculture nurseries. Schools can also grow their own trees in a small school nursery. This is a good experience for children to learn how to take a seed of a tree, plant it in a nursery, later plant it in the school grounds and watch it grow over the years they attend school. This is an important skill and learning experience that has the potential to change how children see their environment and how they can influence it. It's important and fun for children to learn how to collect seeds from living trees and in their environment around them – from fruits and from the trees in their villages and towns.

To grow trees in a nursery, you will need:

- A germination bed.
- Containers such as plastic poly bags or old tins (they need drainage holes in the bottom).
- Some skills for germination of seed including soaking and scarification.
- A good soft soil mixture.

Mixing soil for a tree nursery.

At first, you should provide shade for the nursery.

Once they germinate, you can raise up the shade structure using bush sticks as shown.

Mixing soil for a tree nursery

Plant seeds directly into the filled tree bags or containers, 2-3 seeds in each. If they all germinate, you can move them to other poly bags.

At first, you should provide shade for the nursery. An idea of how to do this is shown in the picture below with dry grass placed on top of the bags until the seeds start to germinate.

Water the trees daily. When the trees have grown for a while, you can remove the shade but keep the trees, for example, in a shady area under a tree.

Before the trees are moved out into the field it is good to 'harden them up', which means exposing them to more sunlight and, later, less watering so that they will be able to cope with the change of being out in the field.

Trees ready to move to an area for hardening up.

Planting out

Background Information

Trees should be planted out into the field at the beginning of the rain season. You may need to continue to do some hand watering of the trees during the dry season while the trees are young and still establishing.

Preparation for tree planting involves digging holes and water-harvesting trenches, micro basins and bunds as described in other parts of this book.

Trees should be planted early or late in the day. Don't forget to remind children to plant the trees with their roots pointed down! They should carefully remove the container or poly bag and hold the root ball and soil together in their hands so that the soil does not fall off the tree roots.

Tree-planting preparation work. In Eritrea, it is common to dig a small basin for the tree, allowing the basin to fill with water when it rains.

The steps in using mother trees:

1. plant your seedling with another fast growing tree next to it.

2. The fast growing tree or mother tree, will shelter and protect your young tree while it grows.

3. When the mother tree dies, it can become mulch for your original plant.

Mother trees

In some cases, it is good to plant a pioneer tree next to a longer-lasting tree. We call this a 'mother tree'. The mother tree will help to protect and provide organic matter for the important tree to grow. Mother trees can include many of the strong, thorny legumes common in Eritrea. Over time, the mother tree can be pruned back and eventually removed when the important tree is well established.

Mulching

Trees can be mulched for the same benefits as described in Appendix C.

Mulch helps to prevent the soil from drying out and also feeds the soil micro-organisms, which will make the soil softer and more fertile for the tree to grow.

A well mulched fruit tree at the Ministry of Agriculture research station near Asmara.

Leaves for mulching a newly planted tree.

Mulching a newly planted tree with stones.

If you do not have organic mulch, you can use stones. This will still help to retain moisture for the tree and protect the soil worms and micro-organisms from sun and wind.

Old plastic bottles with 4 small holes are buried with the newly planted tree.

Buried plastic containers for slow release of water to trees and plants

In a dry climate we need to be very careful how we use water. One method is to use buried plastic containers or water bottles for watering the garden. The containers can be filled with water and then the water will slowly seep into the soil. The containers have four small holes pricked into them on each side near the bottom. These are then buried in the ground around the tree up to the level of the screw-on lid. Water is then poured into the container where it is released slowly to the tree.

Another experiment would be to use clay containers, if they are locally available. The clay needs to be unfired clay or water will not go through it.

This method can be used in a food garden or with a fruit tree.

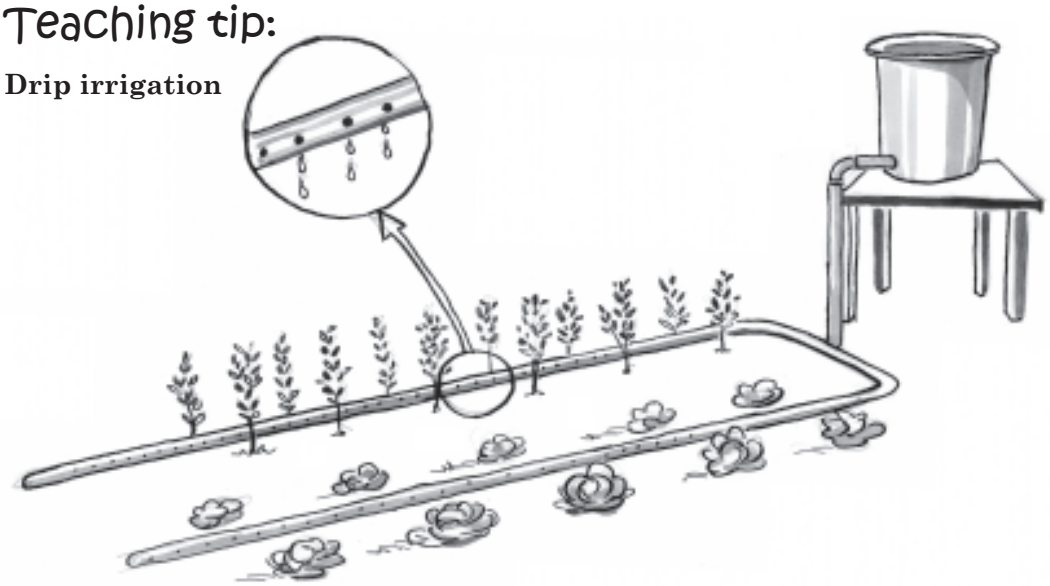
Watering and care

We suggest that trees be watered once a week during the dry season. This can be done by giving responsibility for trees to individual children or groups of children.

It is good to identify areas in the school where there is more water, moisture and protection from wind. This could be a good place for more sensitive fruit and nut trees.

Teaching tip:

Drip irrigation



Activities for students:

Activity: Burying plastic bottles for watering

Time: 40 minutes

Purpose: To prepare plastic bottles and bury them next to trees in the school to provide slow watering close to the roots.

1. Put holes in the plastic bottle.

2. Dig a hole deep enough to plant the tree and 4 bottles around the tree.

3. Fill in the soil around the bottles.

4. Stamp down the soil around the bottles firmly.

What you need:

- Toolbox: scissors
- Plastic bottles
- Water
- Toolbox: digging tools

What to do:

1. Collect plastic bottles.
2. Each student pricks four small holes on the bottom of the containers. The students make each of the holes on the sides of the bottles near to the bottom.
3. These bottles are then buried in the ground around the tree up to the level of the screw on lid.
4. Water is then poured into the container where it is released slowly to the roots of the tree.
5. The bottle needs to be regularly filled up to feed water to the plants.

5. Use half of another plastic bottle as a funnel, to pour water into the submerged bottles. Remember to screw the lids back on the bottles! These bottles will slowly drip water to your plants without evaporation.

5 Working with the community

Tree planting projects can extend into the community.

This section of the book contains some extra ideas if your school wishes to take food gardening to wider community involvement. Most of these activities will involve planting with the PTA.

In some cases, schools without adequate water may choose to engage with the community directly through their Green Clubs instead of working within the school grounds.

This chapter includes the following ideas for working with the community:

- Home-based gardening and tree planting activities.
- Collecting local varieties of crops and trees.
- Finding out about traditional classification of soils.
- Creating an enclosure area for natural regeneration.
- Livestock.
- Holding a diversity fair.
- Starting a rain-fed garden bed – inside or outside the school.
- Starting a medicine garden.

Starting home gardens/nutrition gardens

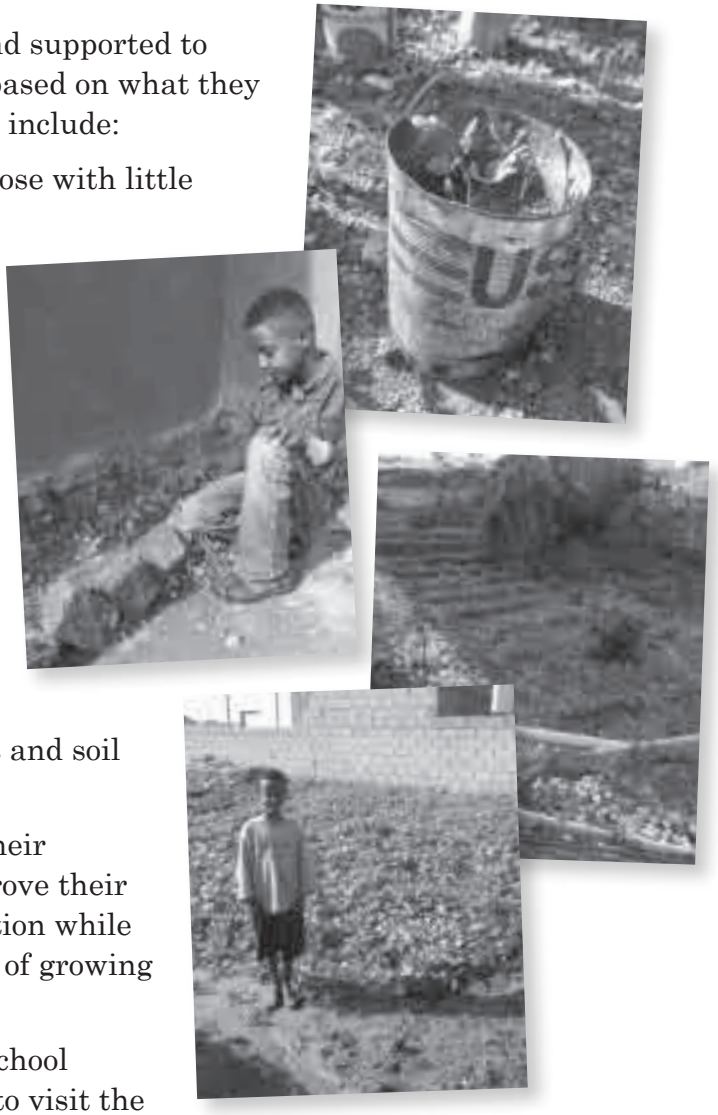
Background Information

Children should be encouraged and supported to start their own gardens at home based on what they have learned at school. This could include:

- Small container gardens for those with little space.
- Door-step gardens with greens.
- A larger home garden plot using all the steps outlined in this Green Clubs book.

Schools can help the children by:

- Providing seeds and seedlings.
- Providing practical skills training in things like compost and soil improvement.
- Encouraging parents to help their children make gardens to improve their nutrition and their own education while learning about the importance of growing food.
- Bringing families to visit the school garden and holding field days to visit the children's gardens at home.



Home gardens can use just a little space, even in an old tin!

Planting trees grown at school

Children should be encouraged to take home some of the trees grown at the school nursery and plant them around their homes or in other parts of the community. For a school without an area suitable for planting trees, all the trees could be given to students to plant at home.

The same steps as outlined in the relevant Appendix C should be followed in preparing trees for planting and preparing water catchments and care of the trees for their first few years. More fruit and other useful trees in the community will make a positive contribution to food security, nutrition and the environment and provide a wonderful experience for the children to give something back to their families from their school education while they are still at school.

Schools can help the children by:

- Providing seeds and seedlings of useful trees – especially fruit and nut trees.
- Providing practical skills training on growing and looking after trees.
- Encouraging parents to help their children make gardens to improve their nutrition and their own education while learning about the importance of growing food.
- Bringing families to visit the school mini forest and holding field days to visit the children's trees at home.

Start a community seed bank

Background Information

Community seed banks preserve local varieties of seeds for future use to ensure that we don't lose species of flowers, fruits and vegetables. They also can help to restore crops after a severe drought, disease or insect infestation. Farmers and home gardeners can benefit greatly from a good seed bank. It saves them from having to repurchase seed at a high cost when a crop fails.

One suggestion for a school seeking to engage more with the local community in agriculture and food security would be to establish a classroom community seed bank. Local seeds would be collected by students and stored carefully in the seed bank, with seed handed out to local farmers for periodic multiplication and subsequent return to the seed bank.

What to do:

1. Talk to gardeners, farmers and people that can help you collect and organise seeds for your school seed bank. The experienced farmer and gardener can tell you that this is a year-round job. Preserving seeds for future use takes a lot of work. But you can start small at the school. Remember this is also a learning experience for the students.

2. Ask children to collect seeds, including tubers and cuttings from their families and relatives. Ask the children to find out the best time to collect seeds, and to tell you what you need from which plants and the best way to clean and dry the seeds.
3. Clean and dry the seeds. Spread the seeds in the sun.
4. Label and store the seeds. You should keep them in moisture-proof containers with some wood ash or charcoal in a cloth bag inside the container. This helps absorb any moisture that gets into the container. Store the seeds in a cool, dark space. For the children, it is nice if they can see the seed bank somewhere in the classroom.
5. Check your seeds often. You may need to replace the ash or charcoal in the containers. What you need to do depends on the kind of seed and the climate. Talk to experienced growers to get some good insight on how long you can keep the seed for.
6. Share seeds with students and ask their families to regrow them and use them to restock the seed bank. Farmers and students should be advised to plant them carefully, not too close to another variety of the same plant. You don't want to cross-pollinate or mix two kinds of the same plant.

For more information on seed saving, refer to Appendix B.

Have a diversity fair with the local community

Background Information

Seed is a central part of a farmer's life. For centuries, Eritrea's farmers have selected seed from their crops for the next season. Their knowledge has been accumulated over generations, and nobody is in a better position than they are to choose seed that is adapted to their particular conditions. Normally, farmers obtain the seeds they need from various sources. Some of the seed is selected from grain they produce themselves, some is bought from (or exchanged with) neighbouring families and some is purchased seed, produced by seed companies and bought in shops or from agriculture extension officers.

Crop diversity – the practice of using many varieties – is a way of 'insuring' against climatic uncertainties. For example, one variety may be better adapted to drought while another may produce a better yield when there is better rainfall. By using various types of seed, farmers reduce the risk of losing their entire harvest.

One method that the school could get involved in is to organise a Diversity Fair or Seed Fairs to encourage the community to look after their local varieties, sharing them and at the same time helping the children to understand and value this precious local resource.

What is Diversity Fair?

A diversity fair is a fair specialising in seed and is normally organised at local or village level.

The objectives of diversity fairs include:

- To create opportunities for seed exchanges or to arrange future exchanges.
- To create awareness among farmers, agriculture extension officers and zoba planners, and officials of the diversity of local seeds and of planting materials and their current status (i.e. is it well preserved, or is it disappearing?).
- To enable local extensionists and farmer seed experts who do not normally meet to exchange knowledge and experiences on the old and new crops that they grow.

- To create working contacts between farmers, extensionists and researchers that will continue to exist and develop independent of outside facilitators.
- To enable disaster-affected farmers to access crops/varieties in quantities of their choice.
- To instil confidence among farmers through a healthy and productive competition.
- To create market linkages.
- To create social interaction.

Activities for students:

Activity: Conducting a Diversity Fair

Preparation

A Diversity Fair can be organised at either a village or sub-zoba level and all preparations should be coordinated at the local level. The most significant of these preparations are taking stock of the available seed, determining and agreeing on the judging criteria, selecting judges, sharing determined judging criteria with the community, food arrangements.

A Diversity Fair could be held at the school as venue. The date and timing of the fair takes into consideration local beliefs and events. It should also be held at the right time of the local cropping calendar, which normally should be after harvesting and before the rains.

Determining the judging criteria

The judging criteria may include the extent of crop and variety diversity, crop (produce) and seed quality, quality of presentation, exhibitor's knowledge of displayed crops and varieties, crop and variety origin, variety suitability to local conditions, history of performance under local or similar conditions and the display itself.

Selecting Judges

Judges are selected from among the community itself with representation from all the participating groups including women, men and young people. Some independent representatives or agriculture extension workers may also support the judges.

Competition Participants

The community decides who can exhibit – individuals, farmer groups or villages. If the seed fair is being held at the village level, then individual or group exhibitions are recommended, however, if it is a ward seed fair,

the village exhibitions should suffice due to space constraints; this will speed up the judging process.

Seed Exchanges

The main purpose of a seed fair is to promote local seed exchanges. It is, however, important to keep a track of the exchanges to be able to monitor how much seed is exchanged locally and if the fair is held regularly to see how the range of varieties changes over time. Monitoring will help identify the origin of all the seeds exchanged, and will help to maintain linkages and farmer seed networks.

In addition to the seed that is on display, exhibitors may bring larger quantities of the same varieties to the samples for sale on a cash basis or for exchanges with other farmers.

Seed Fair Prizes

Seed fair prizes can either be cash or farm inputs such as seed packs, implements (such as ploughs) and wheelbarrows. These can be sourced through community contributions, cash and material donations from government or local business people.

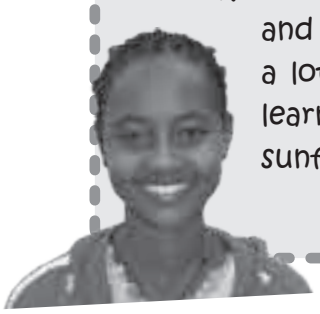
Medicine garden

You could start a medicine garden with the local community. The garden could be in the school or in an agreed location in the community. Children could help to collect and grow in a pot local medicine plants – herbs and trees. Involve local healers and specialists in traditional medicine to share their knowledge with the children and the community.

A book on medicinal plants is included in the Toolbox.

Appendix A

Deciding what to plant – planting for good diet



> "When we plant here, some people can take a seedling and plant at home. The club is good for me, I learn a lot. Green club has had a big role in my life; I learn to grow chilli, tomato, passion fruit and sunflowers."
>
> Winta G/Tsadik

Background Information

What is a good diet?

In order for our bodies to grow well and stay healthy, we need to eat the right mixture of foods. As most foods are grown in the soil, there is a very strong relationship between our soil, what we eat and our health. It is often said that 'We are what we eat'.

The 2005 Health Survey of Eritrea found that 34% of children are chronically malnourished and 40% are underweight. How could a school garden and trees help?

In a school garden, we can help children to understand the concept of nutrition and how they can help to get good nutrition from the soil.

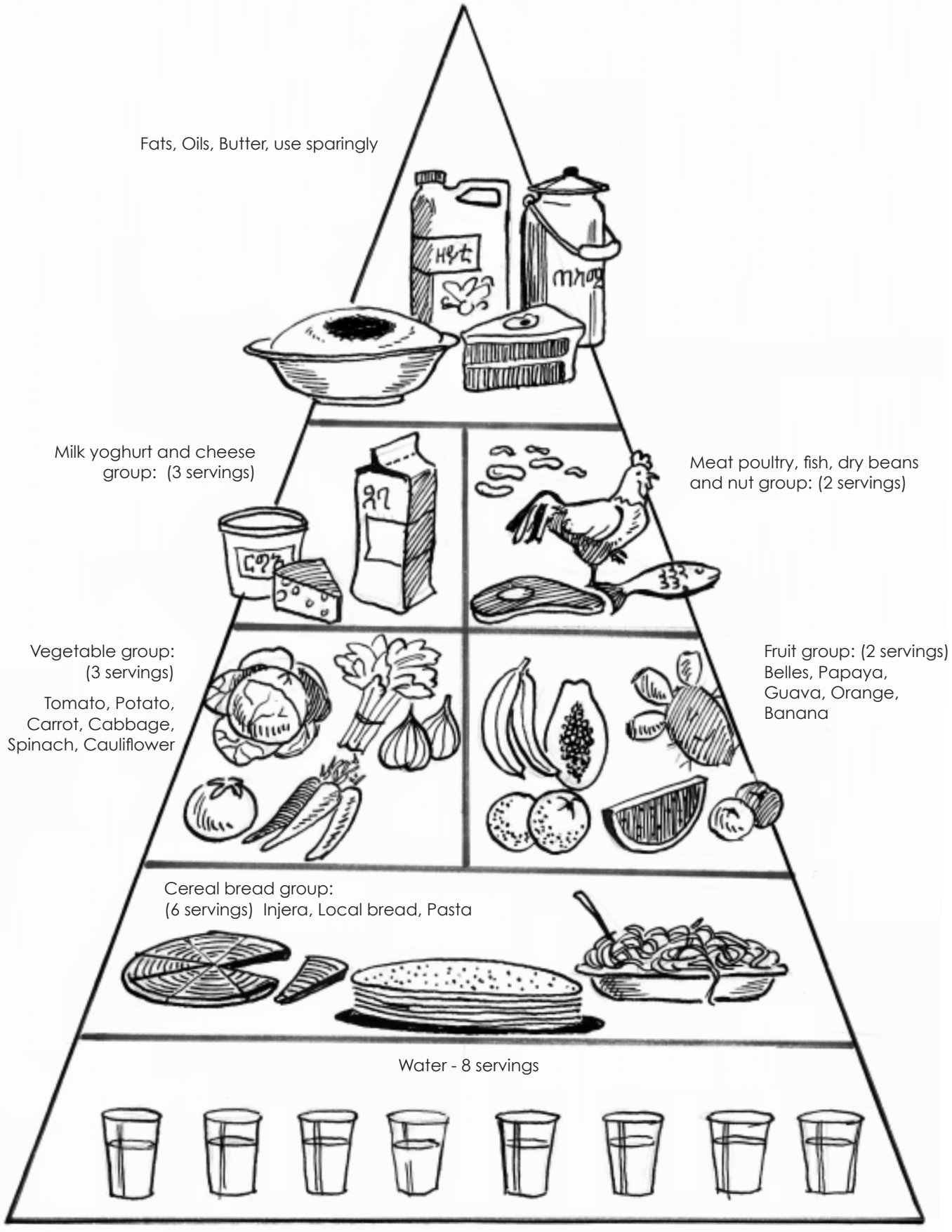
A balanced diet is made up of staple foods composed of carbohydrates, mixed with protective or vitamin rich foods and protein foods.

It is difficult to grow staple foods in a small school garden, as they require larger areas of land. But both protein and protective foods can be easily grown. Protein foods include chickpeas, green beans, and lentils. Protective foods in a school garden can include green vegetables, pumpkin, tomato, eggplant and fruits such as papaya and mango.

You might want to divide the garden beds into the three food groups for the children to learn about these groups of plants and how they are important to mix together for good health and nutrition. If your area has a particular nutrition problem – for example a deficiency in Vitamin A – then you could have a focus on this in your school garden, but planting different Vitamin A-rich plants such as leafy greens and orange-fleshed fruits.

Food pyramid

You should center your diet around the foods at the base of the food pyramid, and eat less of the foods at the top.



Source: UNICEF

Planting for food security

Some food plants are:

- Drought resistant.
- Live for a long time.
- Have medicinal or nutritional values.
- Are not used commonly but have important value in times of famine – emergency foods.

It is good to include some of these plants in your school garden. This helps children to learn about them, and to think about the need to plant more of them in the community to help to improve food security in hard times.

You could invite some of the older people in the community to the school to share their experiences with foods that can be used in times of drought, disaster, war and other hardship. The children might want to start a collection of these plants in one corner of the school garden or compound.

Collecting seed for the garden

With this list in mind, you can start to collect seeds for planting. When you have seeds ready and the garden beds are ready to go, you can start to plant either directly in the garden or into the nursery beds.

Preparing seeds for children to plant can take time. For a class-sowing activity, it is best to make the steps clear to the children beforehand. Children might pour a whole packet of seeds onto one spot.

Some tree seeds such as acacia and other tree legumes have a hard seed coat. These may need individual **scarifying** – rubbing on concrete or nicking with a knife.

Labelling seeds

Have the children write a label for their seeds before they sow them. This can be done by writing with a soft pencil, such as a 3B or 6B, on white-plastic labels made from old containers. The reason we don't use felt-tip pens is that we have found them to be unreliable – the sun fades them or the rain washes off the writing. What other ideas do you have to use for labels?

Write the plant's variety name, such as 'Asmara Lettuce', the child's name and the date. Recording the date allows you to see how long plants take to come up and grow.

Planting of Vegetables in School Gardening

The following vegetables are recommended to be planted in school gardens, based on their nutritional content.

	Type of vegetable	Units	Iron per/100g
1	Spinach	mg	3.57
2	Sun flower	mg	3.45
3	Tomato	mg	2.98
4	Lettuce	mg	0.86
5	Sweet Potato	mg	0.72
6	Broccoli	mg	0.68
N.B. The recommended daily allowance for Iron is 10-18 mg			
	Type of vegetable	Units	Vitamin A per/100g
1	Carrot /Row	mcg	838
2	Sweet Potato	mcg	787
3	Spinach	mcg	524
4	Lettuce	mcg	370
5	Broccoli	mcg	77
N.B. The recommended daily allowance for Vitamin A is 1000mcg			
	Type of vegetable	Units	Zinc per gram
	Avocado	mg	0.64
	Broccoli	mg	0.45
	Pumpkin	mg	0.23
	Sweet potato	mg	0.20
	Spinach	mg	0.18
N.B. The recommended daily allowance for Zinc is 15 mg.			

Source: UNICEF

- The above listed vegetable foods are high in iron and vitamin A but also contain other nutrients in small amounts.
- The **Moringa Tree contains most of the requirements needed for a balanced diet. The tr**ees have been used to combat malnutrition, especially among children and nursing mothers. 25 grams of Moringa Leaf Powder will give a child the following recommended *daily allowances*: Protein 42%, Calcium 125%, Magnesium 61%, Potassium 41%, Iron 71%, Vitamin A 272%, and Vitamin C 22%.

  This means moringa tree covers above amounts of a child's daily requirements. For instance, in 25g of moringa leaf there are more than the child's daily needs of calcium and vitamin A.

Appendix B:

Seed saving

Collecting seeds - silver rose going to seed

Background Information

When children observe the full life cycle of the plants, it brings them closer to nature and provides a life-long lesson. They gain an idea of how plants in the wild reproduce from watching what happens when plants flower, go to seed and self-seed.

For the last 10,000 years, farmers and gardeners have saved their seeds for planting. Even now, 80 per cent of seeds sown around the world are home-saved. In Eritrea farmers save seeds of sorghum, teff, finger millet, wheat, chickpea, faba beans, lentils and more.

Allow space in the garden beds for some plants to flower. Select the best plants for seed and remove the worst, making sure you label your selections so they are not picked by the children.

Collect seeds at maturity and clean them up so they can be stored for re-sowing. If you have enough seeds, sprinkle them around the garden to see when they come up again.

Dryness is important when storing seeds. Seeds need to be as dry as possible before storing them in an airtight container.

Producing and collecting your own seeds will save money. It will also ensure a garden that the children will be even more proud of next year. Local farmers will be proud to see their children and young people growing their traditional varieties in the school garden.

Pollination

Pollination occurs in plants when pollen from the male parts of the flower is deposited on the female parts. Fertilisation occurs when the pollen grain reaches the ovum.

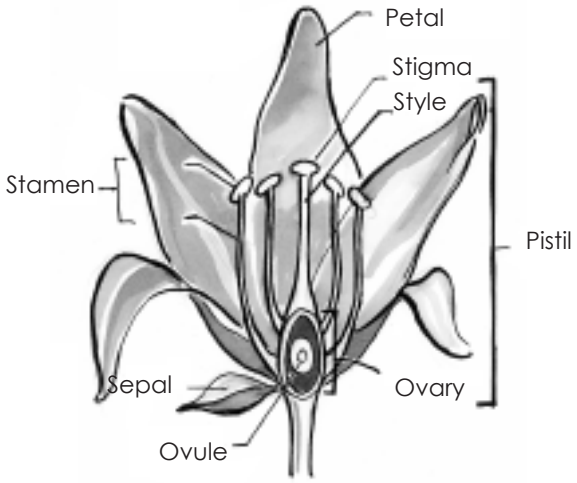
In most of our vegetables, herbs and flowers, the male and female parts are in the same flower. These are called complete flowers. Exceptions to this are:

- The Cucurbitaceae family (pumpkins, melons, cucumbers, etc.) and corn where the male and female parts are on the same plant but in different flowers – called **monoecious**.

- Papaya, where the male flowers are on one plant and the female are on another – called **dioecious**.

Self-pollinating plants

In some complete flowers, self-pollination occurs. Lettuce, tomato, capsicum, chickpeas and beans have the female part so close to the male that the slightest breeze, even from a passing insect, causes the pollen to drop onto the receptive stigma (female part). It is easy to keep the seeds of more than one variety of a self-pollinating plant in the same garden, as they will not cross.



Cross-pollinating plants

Other types of complete flowers and all monoecious and dioecious flowers require cross-pollination. They need an external agent, such as an insect or the wind, to transport the pollen onto the female parts and thus create fertile seeds. Most vegetables, except those mentioned above, are cross-pollinating. This means if more than one variety of a vegetable is flowering in the garden at once, they may cross which means the original variety will change. All the same, seeing two different varieties cross, such as red corn and yellow corn, may be of interest to the children.

If you want to keep the varieties pure, use one of the following techniques:

- Isolate varieties. Grow two cross-pollinating varieties 500m or more apart. This is how far most insects will fly, though bees will fly up to 4 kilometres.
- Isolate varieties in time. Suitable for crops where all the plants flower simultaneously, such as corn and sunflower. Each will shed pollen at a different time.
- Cage different varieties. Put cages made of fly wire, or nylon netting such as mosquito netting, over flower stalks of different varieties of the same species.

Selecting best seeds

You will have to decide which are the most suitable plants to keep for seeds. Keep the best and eat the rest. Allow the most healthy, largest plants to run to flower and seed. Select the best seeds from the best fruits, the best seed head or best pods.

Roguing out off-types

You must also remove unwanted individual plants. This is called roguing and involves taking out any plants with undesirable characteristics before

flowering time. This ensures that the pollen of any unwanted off-types – or plants that are not true-to-type – does not fertilise the flowers of the plants you have chosen for seed.

You may need to carry out roguing at several stages, say taking out the slow growers when the plants are young, the diseased plants when they are full size and the early bolters (see below) as they send up the flowering stalk.

Characteristics to favour

Choose individual plants that perform well under stress, such as a plant that has done well in extreme weather or that has resisted disease or insect attack.

With crops that send up a flower stalk after their edible stage, such as lettuce, silver beet and cabbage, it is important to choose plants that are slow to grow seeds. Select plants that remain in a prolonged leaf stage, rather than plants that send up a flower stalk early in the season. Otherwise, you will be selecting for early bolting in future generations.

With plants that give a number of successive crops, such as green beans, leave the best bushes or vines to produce seeds and eat the rest.

With soft fruits, like tomato, capsicum, rock melon and watermelon, you have the opportunity to select for the best tasting ones.

Marking plants reserved for seeds

Mark the plants you and the children have selected by tying a bright ribbon or string to them so everyone knows they are special.

Dry seed heads of sunflower.

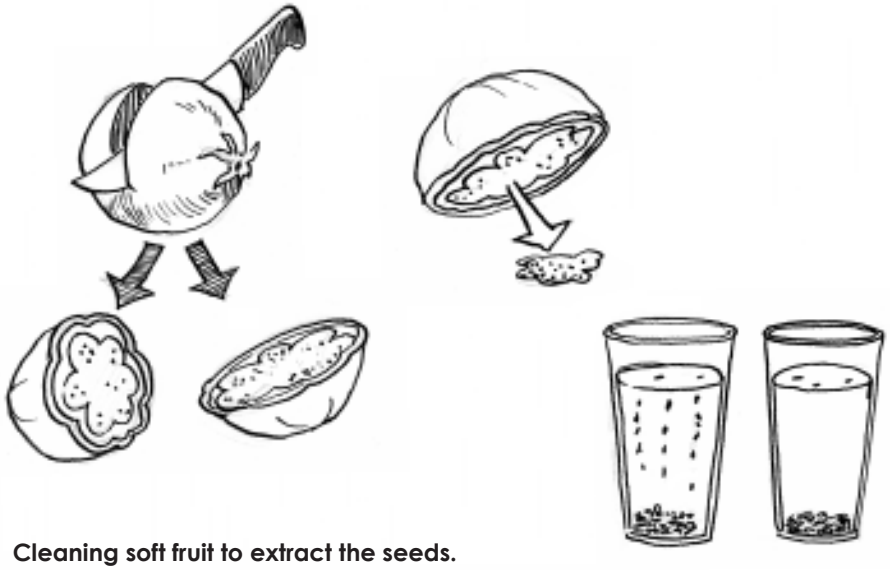
Collecting seeds

The best time of day for seed collection is about 10am, when the dew has evaporated. Collect in dry, wind-free conditions.

Seed heads

For plants with seed heads, pick off the ripe seed heads one by one or ease the entire plant from soil and remove dirt gently. If seeds are not all fully mature, leave them on the whole stem to complete their maturation.

With seeds that shatter (seeds fall to the ground when ripe), such as lettuces, carrots, parsnips and onions, collect the seeds individually as they ripen.



Cleaning soft fruit to extract the seeds.

Seeds in fruits

Fruits such as tomatoes and eggplant are best picked when they are overripe. Fruits that have seeds in their cavity, such as pumpkins and capsicums, are picked a little riper than for the table and left for a couple of weeks to ensure the seeds are fully mature.

Those fruits that are normally eaten immature, such as zucchini, cucumber, okra and sweet corn, will have to stay on the bush or vine until they are full-sized and mature. Cucumbers can even grow to a metre in length, as can zucchinis. Leave the fruit on the vine until they are fully mature, for example, a cucumber will go brown and a zucchini quite yellow when their seeds have had time to mature inside.

Where the seeds are the part eaten, like maize, broad beans, peas and sunflowers, make sure the seeds are fully mature and dry on the plant. The most common mistake made by beginners is to pick seeds too immature. They simply will not be viable – that is, they will not come up when sown.

Cleaning soft fruits

Scoop seeds from ripe fruits out of the flesh into a large container of water. Rub them to clean off bits of flesh, tip off water and refill several times until clean. Pass through a sieve and spread on a plate to dry.

Cleaning seed heads

Strip as many dry and dead leaves from the lower part of the plant as possible, without disturbing seed heads. Rub the seed heads together or on a sieve to remove the seeds.

Separate seed from debris by sieving and winnowing. Use sieves or screens of different gauges to separate the seeds from the chaff.

Winnow with a flat basket or plate either by blowing on the seeds or tossing them up and allowing a gentle breeze to take away the chaff. What is the traditional method of winnowing seeds in your area?

Cleaning pods

Peas and beans are easy enough to remove from pods. Place tougher pods and capsules in a strong bag and either flail firmly with a stick or have the children stomp over them. Avoid using too much force as seeds can crack.

Final selection

Select the best of the seeds, rejecting small misshapen or mouldy ones. This is particularly relevant for pumpkins, beans, peas and corn.

Dry seeds after cleaning

Dry seeds in labelled bags in an airy spot, out of the sun, for a week or two before storage. It's a good idea to write the name of the variety and the month it was harvested.

Storing seeds

Seeds are alive but dormant, so try and keep them that way by providing cool, dark and dry conditions. If you want to store seeds in the classroom, try to put them in a spot where the temperature does not fluctuate, as they will last longer with a constant temperature.

The most critical factor in storage is dryness. Seeds are hygroscopic, meaning they absorb moisture. If they are exposed to moisture, fungus and insects can attack them. They have to be kept sealed from the air.

Put dry seeds into jars, keeping the airspace to a minimum. Use a desiccant such as dry rice, ash or charcoal, which also helps to stop weevils, and then seal them up.

An airtight and water resistant container makes a good place for seed storage.

Botanicals are sometimes used in storage as insect repellents. These include well-dried cinnamon sticks, seeds of fenugreek and black pepper or leaves of eucalyptus or neem.

Don't keep seeds for too long.

Vegetable seeds last for one to ten years, but their viability and vigour (ability to grow fast) deteriorate over time. It is best to grow them within two years. Send excess seeds with the children to plant at home.

Rituals can be followed. In one school, the year sixes grow sunflowers and each year pass on the seeds to the next year sixes to grow.

Appendix C:

Preparing the ground – keeping the soil fertile

Background Information

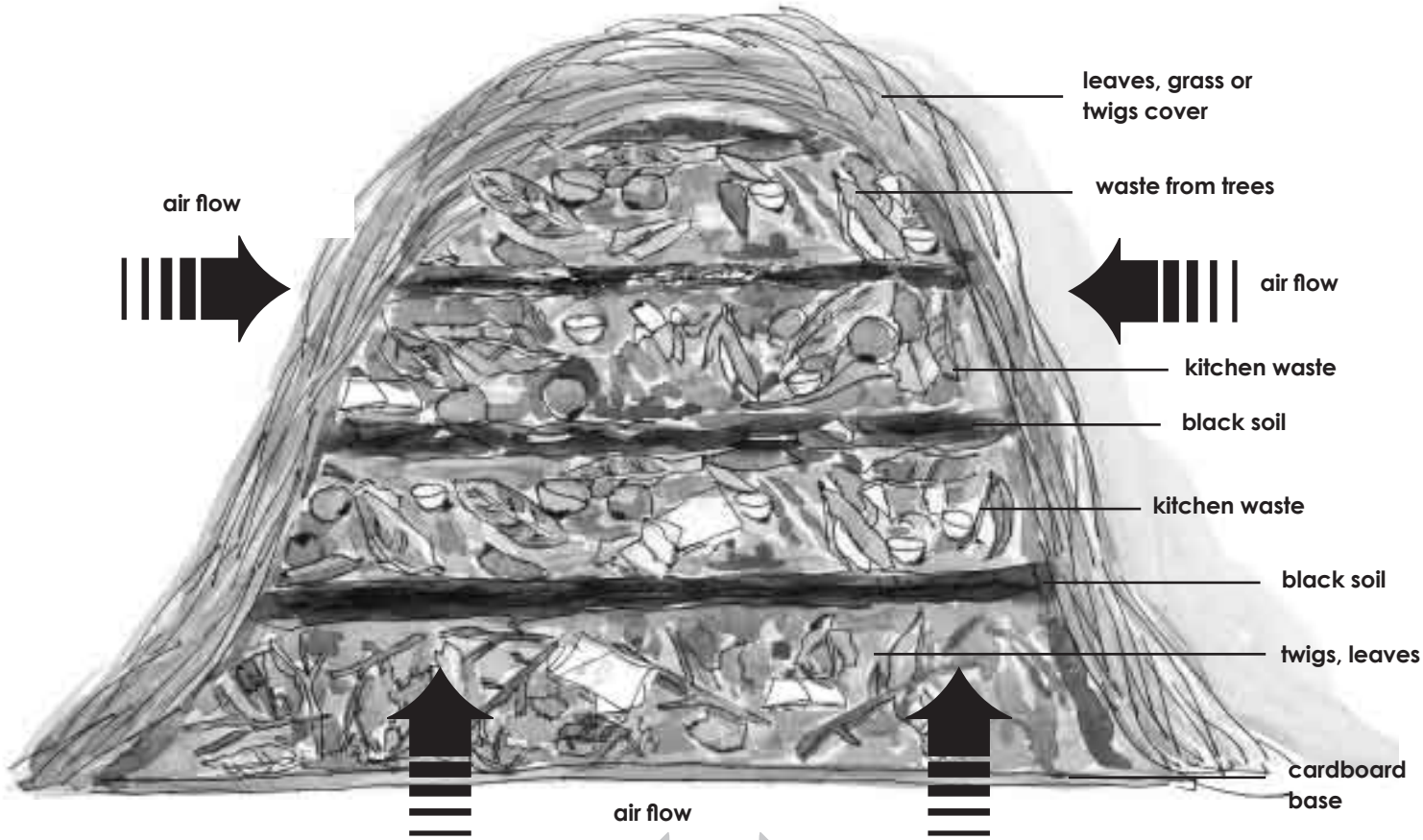
On a regular basis, you will need to add organic matter to the soil to keep it fertile. This can be done by:

- Compost.
- Mulching.
- Animal manure.

These are covered in this section.

Making compost

Compost is made by building up layers of different organic materials in a pile. Moisture is also needed. Moisture, oxygen and organic matter provide food for micro-organisms to grow and flourish. These micro-organisms break down the organic matter into humus.



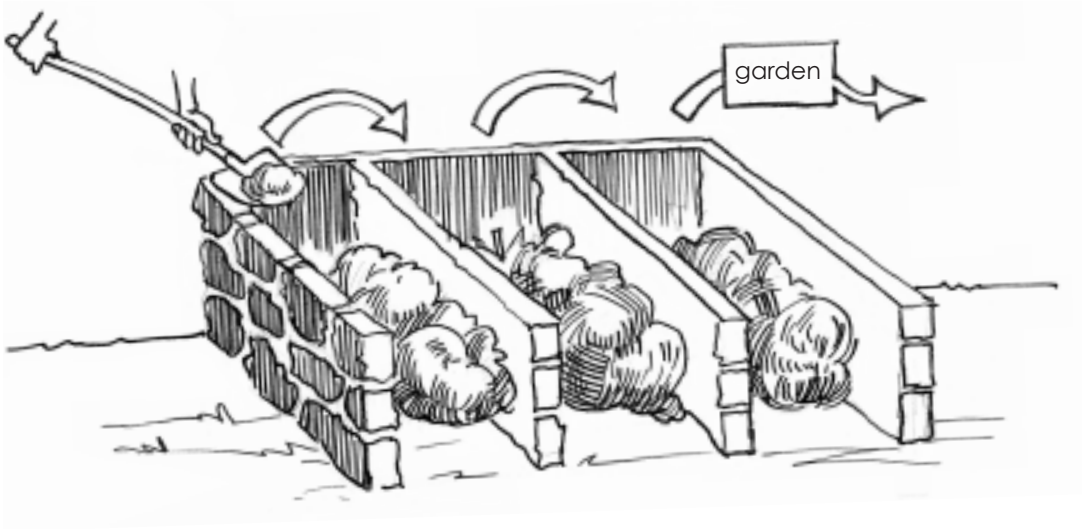


Diagram of rotational composting method

Rotational compost heaps

If you want to produce compost quickly, then the 3-bin rotational method is a good approach. You can provide additional oxygen for micro-organisms in the heap by turning the compost every week. By the third turn, the compost should be ready to use in the garden.

A good compost heap will get warm and generate heat.

It can be good to have a fenced compost area to prevent animals from disturbing the compost. A good method is to include a compost section within the fenced food garden area of the school.

Static compost heaps

This is a heap that is made in one place, and then left to break down and rot on its own. This is still an effective method, but it will take longer than a rotational heap. This type of compost heap could be made above ground or buried in a big hole in the ground.

Mulching – living mulch

Mulch is usually made up of a layer of organic matter such as leaves, branches and even cardboard or paper on the surface of the soil. Mulch is good because is protects the soil from sun, wind and rain. It also provides food for worms and other micro-organisms in the soil.

Glossary

Acidic soils - Are chemically unbalanced soils with a low pH.

Alkaline soils - Are chemically unbalanced soils with a high pH.

Agro forestry - Agro forestry is the commercial farming of trees.

Biodiversity - Biodiversity is the number and variety of organisms found in an area.

Companion planting - This is the practice of planting one plant close to another because of the benefits it gives to its 'companion' plant. An example is planting garlic near other vegetables because it deters insects.

Compost - Organic matter which is broken down naturally.

Ecosystem - An ecosystem is an inter-related and inter-dependent community of living members together with the environment in which they are found.

Endangered - An endangered plant or animal is one that is in danger of becoming extinct.

Germination - Germination is the process in which a seed develops a stem and root.

Grey water - Waste water from washing dishes, clothes and people.

Inter-planting - The practise of planting alternating species of plants.

Legume - A special type of plant with the abililty to put nitrogen into the soil.

Micro-nutrients - Minerals which are found in tiny amounts in soil and which are essential for plant growth.

Microclimate - A micro-climate is the climate of a small specific place within an area, as contrasted to the climate of the whole area.

Mini-forest - A small forest that you might grow in your school.

Monoculture - Monoculture is the culture of a single crop on a farm, or across a large area.

Mulch - Covering put around plants to reduce water loss by evaporation. Suitable materials are leaves, grass and rocks.

Organic gardening - Gardening without the use of artificial fertilisers or pesticides.

Pollinators - Assist in the process of pollination by helping in the transfer of pollen for example bees.

Polyculture - A polyculture is agriculture using multiple crops in the same areas, in a way that is similar to natural ecosystems.

Roguing - Removing those plants from which you do not want to breed.

Stacking - The practise of growing plants under other plants, e.g. growing cabbages between corn plants.

Trellis - A frame for growing climbing plants.

Vitamin A - Vitamin A is a vitamin that is essential for growth.

Wetland - A low area where the land is saturated with water.

Overview of the Resources

The Environmental Education Curriculum Companions for elementary schools provide practical examples of how Environmental Education can be integrated across the subject areas of:

- English
- Science

Social Studies

A manual has been developed to provide teachers with practical ideas for extra-curricular activities, including suggested activities for Green Clubs and Health Clubs.

A resource has also been developed to support the School Directors, School Staff and PTA about ways in which they can contribute to ensuring their school operates as a sustainable school environment.

There are additional resources provided in the Toolbox which includes posters, information cards and reference materials.