

Resource Material for Homestead Food Gardeners

Chapter 2: Handouts (English)

Handout 1 Farmer Experimentation

1. Farmer Experimentation



In farming, we will face new problems all the time and we need to try different ways of solving them. We may also want to try out new ideas. We need to try these new ideas without taking risks and without making more problems or difficulties for ourselves. We can do this by experimenting.

An experiment is a test to see if an idea or a solution works. When we have worked out what our problem is and the causes of this problem, we can come up with ideas or solutions to this problem. We can then do an experiment to see if our ideas really do work. We do the experiment on a small scale at first, in case the experiment does not work, and the whole crop is ruined.

Here is an example of Mrs Ngobese from KwaHlongwa (Umzumbe, South Africa). She decided to experiment with methods of controlling aphids on her cabbage crop. She heard of two things she could try. The first was to put ash on the leaves of her cabbages, and the other was to spray chilli-soap on her cabbages. These were solutions to aphid control that she could try by herself, without spending a lot of money.

Mrs Ngobese took a small piece of her garden (1/10th) as the experimental plot. She divided the plot into 3 sections and marked them out very carefully.

	Ash	Control	Chilli-soap
	1	2	3

1. On the first section she sprinkled ash on her cabbages.
2. On the second section she did a control. This means she did not try out one of her solutions here because she was trying to see if her solutions really worked. In other words, she wanted to make sure that the solution was better than doing nothing
3. On the third section she sprayed a chilli-soap solution.

Then she monitored and looked at her experiment. Every week she checked her cabbages and wrote down how many aphids the cabbages had. She did this so that she could remember exactly what happened, and at the end she could decide which method was better.

Here are her results:

Week	1 Ash	2 Control	3 Chilli-soap
1, 2 and 3	No aphids	No aphids	No aphids
4	Sprinkled ash when aphids appeared	Aphids appeared; about 10 on each plant. Only some plants have aphids	Sprayed chilli-soap when aphids appeared
5	Still some aphids, about 5 per plant	Now aphids on all the leaves; about 100 per plant	Aphids seem to have disappeared
6	More aphids. Aphids appearing on plants that did not have them before. Sprinkled ash again	Aphids on the plants that did not have aphids before	More aphids. Aphids appearing on plants that did not have them
7	Fewer aphids. Some plants free of aphids. Hot weather, leaves look scorched. Was it the ash?	Aphid infestation now on all the plants. Hot weather, no scorching	Fewer aphids, some plants free of aphids. Hot weather, no scorching
8	The scorched/burnt leaves have been pulled off and plants are still growing - few aphids	Plants not growing well. Aphids seem to move from here onto the ash and chilli-soap plots.	Few aphids, but increasing
9	Aphids increased slowly after heavy rain. Did not use more	Decided to pull out the control plants, as they were not growing and they were	Aphids increased rapidly after heavy rain. Sprayed

	ash	infesting the other two plots	again.
10	Some aphids on all plants, but not too many		Very few aphids. Plants are starting to head
11	Suddenly more aphids. Difficult to use ash with plants now heading, but did try to sprinkle some		More aphids. Plants are starting to head. Sprayed again.
12	Harvest		Harvest
RESULTS	Some aphids, heads now have ash on them and some do not look that good.	No heads. Plants destroyed by aphids	Very few aphids on plants, good heads on them.

She thought that another way of checking to see whether her experiment had worked was to weigh some cabbages at the end of the experiment. She weighed 10 cabbages from each section.

Her results have been recorded in the table below.

	Ash	Control	Chilli-soap
Cabbage Number	Weight per cabbage	Weight per cabbage	Weight per cabbage
1	0.85kg	-	0.75kg
2	0.56kg	-	0.82kg
3	0.55kg	-	0.59kg
4	0.81kg	-	0.62kg
5	0.33kg	-	0.86kg
6	0.76kg	-	0.88kg
7	0.54kg	-	0.45kg
8	0.59kg	-	0.73kg
9	0.62kg	-	0.55kg
10	0.88kg	-	0.65kg
TOTAL	6.49kg	0	6.90kg

At the end she wrote down what she thought about each method: Which way of controlling aphids worked best for her. This was her final outcome. From this experiment Mrs Ngobese knows which method of aphid control works best for her. In future, she will use this method on all of her cabbages, not just a few of them.

Ash	Control	Chilli-soap
<p>What do I think:</p> <p>There is still some ash on the cabbage heads, as some ash got into the folds of the leaves. I think that the ash might have scorched the cabbage leaves. Also the ash gets washed off in the rain, and I have to apply it again.</p>	<p>What do I think:</p> <p>There were so many aphids that I had to take out all the cabbages in the control section, and so they cannot be weighed. I think they would not even have formed heads. Using ash or chilli-soap is definitely better than doing nothing at all.</p>	<p>What do I think:</p> <p>The cabbages from this plot look the best and weigh the most. I had to spray the solution every two weeks, especially if it had rained. Chilli-soap seems to kill the aphids, which is good because then they cannot go on to other plants. I will use chilli-soap in future.</p>

Let's think more about what Mrs Ngobese did. You can use her example to plan experiments in your garden.

Experimentation



We will use this picture to help you with your experiments. Whenever you see this picture, it will be time to think about how you can **experiment** in your garden to get better results.

In doing her experiment, Mrs Ngobese asked herself some questions, and then answered them

1. **First of all, she asked what her problem was.** The answer is that she had aphids on her cabbages and she thought this was bad.
2. **What is a solution to this problem?** Mrs Ngobese thought one solution was to sprinkle ash on her cabbages, and another solution was to spray her cabbages with chilli-soap mixture.
3. **Why will this solution solve the problem?** Mrs Ngobese thought that these solutions would get rid of the aphids
4. **How will I test this solution?** Mrs Ngobese put ash on some cabbages, and chilli-soap on other cabbages, and did nothing at all on the rest of her

experimentation plot. She then counted the number of aphids.

5. **How will I check my results?** What will I look for? Mrs Ngobese checked the number of aphids on her cabbages every week, and she wrote down what she found. She found that her control plot had many, many aphids and that with ash and chilli-soap she could reduce the number of aphids, as long as she applied this every two weeks.
6. **How else will I check my results?** What will I measure? Mrs Ngobese weighed 10 cabbages from each section at the end of the experiment at harvest time. She found that the 10 cabbages with ash treatment weighed 6.49 kilograms and the 10 cabbages with chilli-soap treatment weighed 6.9kg. This means the cabbages treated with chilli-soap weighed more. She did not keep her control cabbages to weigh.
7. **How will I measure the results or outcomes?** The cabbages with the fewest aphids or the cabbages that weigh the most will be the best.
8. **How will I compare my experiment to my usual way of farming?** Mrs Ngobese's usual way of farming was to do nothing about aphids, like she did on her control section. From this experiment, she has seen that both ash and chilli-soap mixture reduces the number of aphids on her plants. She has seen that she needs to re-apply both, especially when it rains. Now she thinks that chilli-soap mixture is the best way of controlling aphids on her cabbages.

In the following table you will find the questions for planning your experiments, and space to write your answers.

Small scale experimentation plan	
1. What is the problem?	
2. What is a solution to this problem?	
3. Why will this solution solve the problem?	
4. How will I test this solution?	

5. How will I check my results? What will I look for?	
6. How else will I check my results? What will I measure?	
7. How will I measure the results or outcomes?	
8. How will I compare my experiment to my usual way of farming?	

When doing experiments it is important that you can measure your results, and judge whether the experiment has worked or not. If you try too many things at once, without thinking about how you can measure the results, you might not know which solution has worked. This is what happened in the following story:

What happens when we try several remedies at once?

If things go well/badly, how will we know what caused the outcome?



THE BACKACHE

One day an old woman had a backache...

Ah! I can't stand this backache!



Everyone had a suggestion...

Go and see a doctor...



Go and see an inyanga...



You can fix it with some herb tea...



I'm going to see the doctor.



As she came out of the doctor's office, she met the inyanga...



How wonderful to see you, Baba Mkhize... I have a backache!

Do you want me to cure you?



The same thing would have happened to Mrs Ngobese if she had sprinkled ash and sprayed the chilli soap mixture on her cabbages at the same time. She would not have known which method was better at controlling aphids.

One good thing about doing experiments is that you can share your knowledge with your friends and neighbours, and this might help them. If they do experiments, they can also share their knowledge with you, so that you do not have to do the experiment yourself. In this way your community can decide what is best practice, and everyone can use that method of farming.

Resource Material for Homestead Food Gardeners

Chapter 3: Handouts (English)

- Handout 1 Living and eating well
- Handout 2 The 10 food-based dietary guidelines
- Handout 3 What did we eat today?
- Handout 4 Planting Plan

1. Living and Eating Well



What is nutrition?

We all need to eat. Our bodies need food to stay alive, for energy and to grow and recover from illness. The food that we eat is used by our bodies in many different ways. Different parts of the food are used for different things like giving us energy and helping us to get better.

We need to eat lots of different and healthy foods so that our bodies get all the things that they need. If we eat well we have a better chance of feeling good and living a better life.

It is best for babies to drink breast milk only. Babies get all the things that their bodies need from their mothers' milk.

Children need to eat vegetables and fruit to keep them healthy.

They also need to eat foods that will help them to grow like egg, cheese, meat, peanut butter, beans, lentils and soya. Small children need to eat five times a day.

Adults need to eat lots of different kinds of food to keep their bodies functioning well. It is most important to do this if you are sick or if you are pregnant.

How can we eat well to be in Good Health?

To eat well means to eat lots of different kinds of food so that our bodies get all the good things that they need. This does not mean that you need to buy expensive food. By thinking carefully about what you eat, and what you prepare for your family, and choosing food well you can eat in a healthy affordable way.

There are three main types of food:

Go foods, grow foods and glow foods.

You should eat things from each of these types of food every day. You should also drink about eight glasses of water every day.

Good Energy/ Go Foods:

Sweet potato



Boiled, baked or mashed potato

Brown or white rice

Sorghum



Macaroni, spaghetti or other noodles

Bread



Dried beans and peas

Oatmeal



Cereal



Bananas



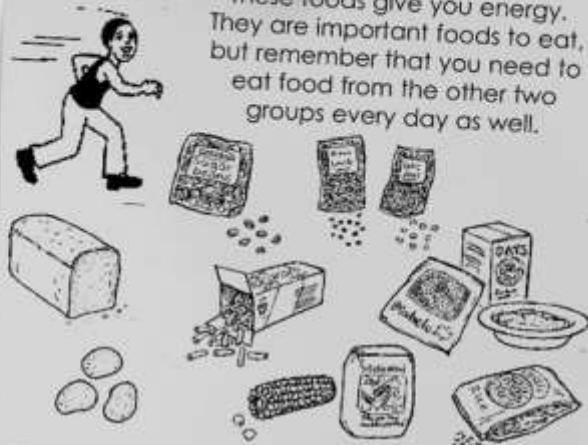
Avocados

Try to have a fruit or vegetable with each of these meals. It is also good to add beans, meat, chicken or fish if you can.



Go Foods

These foods give you energy. They are important foods to eat, but remember that you need to eat food from the other two groups every day as well.



Grow Foods

These foods help you to grow well. They help to build your body and to make it strong.



Glow Foods

These foods keep the body healthy. They have lots of vitamins and minerals which your body needs to stay well.





Food safety tip

Always wash your hands with soap and water before you touch food, and after using the toilet. Wash both sides of your hands for a long time – count to 15 while you wash!

Cover any wounds or sores that you have when you are preparing food.

Good grow foods

These are the foods that contain a lot of protein. These foods help to maintain your body and muscles. They also help to prevent infections. It is important to eat some grow foods every day, especially if you are ill. Children need extra protein because they are growing. So do pregnant women.

Below is a list of some grow foods:

Beans

peas

soyabeans

groundnuts

chicken

chicken livers

fish

meat

eggs

cheese

maas (sour milk)

peanut-butter

nuts

sunflower seeds



Eggs are especially good for children and pregnant women, as they contain protein, vitamins, fat and calcium.

Children can also eat beans or peas every day.

It is good for children to eat small meals more often.

A meal of brown rice and beans is more nutritious than meat! Brown rice is the same as white rice, except that the husks have not been removed. This means that it contains much more proteins, minerals and vitamins than white rice.

Good glow foods

The foods that help to fight infections are glow foods. These are foods with lots of vitamins and minerals. You need to eat lots of different kinds of glow foods as they all have different good things in them.

Below is a list of good glow foods:

oranges

grapefruit

grapes

bananas

granadilla

yellow peaches

apricots

apples

pears

lemons

pineapple

spinach

tomatoes



potatoes

broccoli

pumpkin leaves

carrots

green beans

peas

mealies

beetroot

avocado

samp

moroho

rapa



Remember to wash the fruit and vegetables well in clean water before you eat them..

Dark green leafy vegetables and yellow fruits and vegetables are very important for children. Children and pregnant women should eat some of these foods every day.

Selection and Preparation of Food

Drink lots of water

You need at least 8 glasses a day. You may not think that you need much water. But you can try and experiment on yourself. For three days drink 8 glasses of water. This does not include cups of tea and coffee. After those three days, how do you feel? Do you have more energy and do you feel good?



Food Safety Tip:
Water from a tap is safe. If you get your water from a river or a well you must boil the water or add 1 teaspoon of bleach to every 25 litres of water before you drink it. Store your water in a clean covered container.



Eat each day:

❖ **Grow foods – three of the following:**

One cup of beans or peas (plus one tablespoon of uncooked sunflower oil); two eggs; a large piece of meat, chicken or fish; one tablespoon of sunflower seeds; nuts such as almonds or brazil nuts; one cup of milk or maas (sour milk); a big piece of cheese.

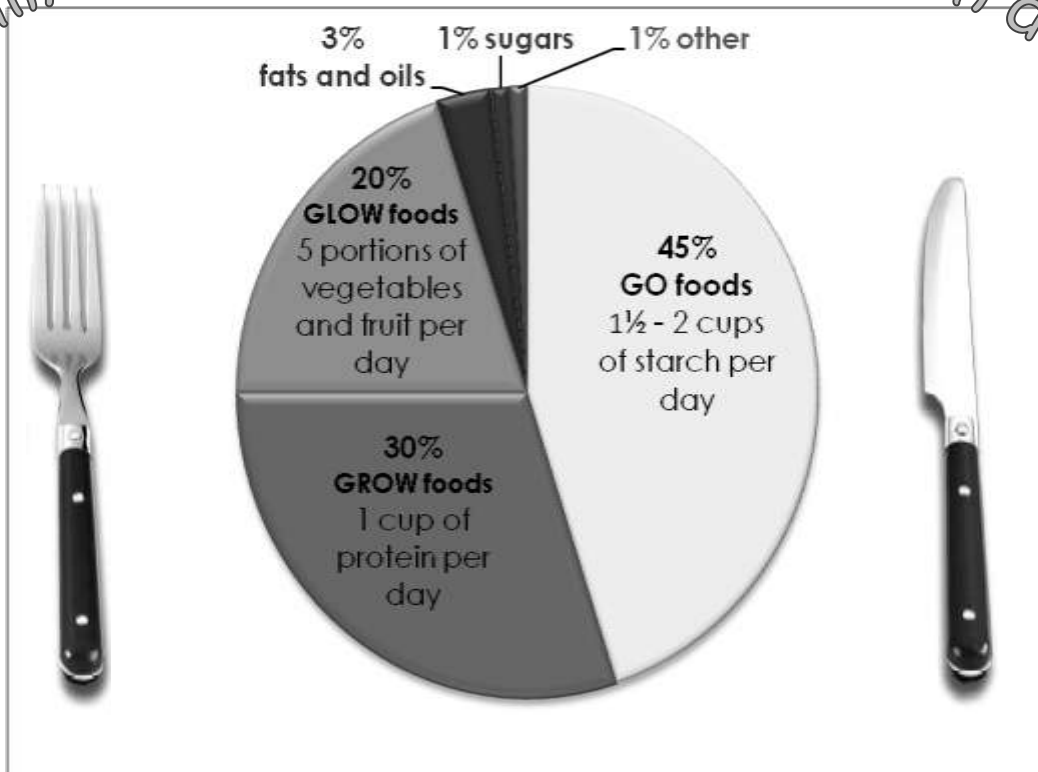
❖ **Glow foods**

Three whole fruits and one and a half cups of vegetables. Eat more vegetables if you do not have fruit.

❖ **Go foods – any or all of the following:**

Bread; half a cup of pasta, rice (preferably brown rice), potato, maize; a cup of cereal such as oats or sorghum porridge or maize meal.

On my plate – what I should eat each day:



Some common traditional foods

ngekoe	beans and sorghum/mabele leaves
likhetso	unpeeled pumpkin portions with seeds
lepu	young pumpkins with pumpkin leaves
lithotsi	roast, cooked pumpkin seeds
lehala	lesheleshele – maize or sorghum porridge made with milk
Legebekoana, ujeqe	steamed wheat bread
Motoho	fermented maize/sorghum porridge
Likhobe, isinjela nkobe	maize/maize with peas/maize with beans
setampo tša koro	whole wheat
mabele a tša batsoeng	half opened sorghum, ground and cooked to make buns

Make sure you keep the goodness in ...

Fresh fruit and vegetables have lots of vitamins and minerals in them. But these vitamins and minerals can disappear very quickly if you are not careful about how the food is prepared and cooked. Here are some tips to help you keep the goodness in:

- ❖ Eat raw fruit and vegetables whenever it is possible.
- ❖ Eat as much of the fruit or vegetable as possible – including the skin.
- ❖ Most of the vitamins are in the outside parts of the fruit and vegetables. Try not to peel.
- ❖ Try to buy and eat fruit and vegetables as fresh as possible.
- ❖ Cook the vegetables in big pieces. Small pieces will lose more vitamins.
- ❖ It is best to steam vegetables.
- ❖ Cook vegetables very slowly over a low heat until they are just cooked.
- ❖ Use the vegetable cooking water to cook other foods in or to make soup or gravy.
- ❖ Eat the vegetables as soon as they are cooked.

Food safety tip

You must eat meat on the day that you buy it if you cannot keep it in a fridge. You can only keep meat in the fridge for two days. After two days it must be frozen.

Cook all types of meat well. Don't ever eat raw eggs, meat, chicken or fish. Don't use eggs that are cracked.

Herbs, spices and medicinal plants

- ❖ Spices, especially sweet spices like cinnamon, can help to make food taste better. You can buy cinnamon sticks which you add to food while it is cooking.
- ❖ Eating parsley after you have eaten will help to freshen your mouth and it is good for you. It's easy to grow at home too.
- ❖ Ginger helps if you are feeling nauseous and for colds. You can make a ginger tea.
- ❖ Garlic helps to fight infections. Make a tea or add garlic while you are cooking.
- ❖ Thyme helps with digestion. You can add thyme leaves to food.
- ❖ Other good herbs to eat are sweet basil, coriander, oregano and fennel. They are all easy to grow and can be added to your food.



What to eat when you are sick

Often when you feel sick the last thing on your mind is eating, but it is very important to eat well when you are sick. Good eating will help you to:

- ❖ Keep up your body weight and strength.
- ❖ Fight the infection.
- ❖ Take in enough vitamins and minerals to get better.

If you do not eat well when you are sick, it will take longer for you to get better.

What happens to your body when you get sick?

When your body is trying to fight off an illness it has to work harder than usual. This means that you need to take in more good food than usual for your body to have enough energy, vitamins and minerals to cope.

When you feel sick though, you may:

- ❖ feel too tired to prepare food and to eat,
- ❖ find that the medicine you are taking might make food taste strange.
- ❖ have nausea, vomiting or diarrhoea which make it difficult to eat.
- ❖ have sores in your mouth which make it difficult to eat.

Even though it is difficult, you should try to eat well when you are sick.

The best way to eat well when you are sick is to:

- ❖ Have small meals often.
- ❖ Make sure you get extra energy.

Fever and night sweats

Fever is the natural way your body will fight an infection. Fevers are actually good because the heat destroys the germs. But you need to be careful that the fever does not become too high, as this can cause damage as well. Make sure that you drink lots of water. Eat lots of glow foods and grow foods to get back your strength.

Stomach problems

A very common kind of stomach problem is diarrhoea. Diarrhoea is very dangerous because our bodies lose a lot of the water we need. It is especially dangerous for babies, children and people who are sick.

What causes diarrhoea?


- ❖ Drinking dirty water
- ❖ Not washing hands well before eating and after using the toilet
- ❖ Not washing fruit and vegetables and cooking utensils well.
- ❖ Some medicines
- ❖ Infections in the stomach
- ❖ Stress
- ❖ Food that is rotten or bad
- ❖ Some types of food cause stomach problems in people whose bodies cannot cope with that food.

**Why is it important to eat well if you have diarrhoea?**

Diarrhoea can cause weight loss. The body loses too much water and salt and becomes weak. It is very important to drink a lot of fluids when you have diarrhoea. Eat more after you have diarrhoea. A baby with diarrhoea should be fed often.


Water is important


If you have diarrhoea you should drink about 3 litres of fluid during the day and the night. It is best to drink something with salt and sugar in it.






A good drink to have is to add ½ teaspoon salt and 8 teaspoons of sugar to 1 litre of water.

You can also have fruit juices and soups that will help replace the water as well as some of the other things your body has lost.






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8 level spoons of sugar
½ teaspoon salt
1 litre of water

Good foods for diarrhoea

- ❖ Eat soft, mashed, moist foods like soft fruit and vegetables, porridge and stews.
- ❖ Peel and cook vegetables and fruit.
- ❖ Eat warm food.
- ❖ Eat small meals often throughout the day.
- ❖ Drink diluted fruit juice
- ❖ Soups
- ❖ Unripe Banana, Mangoes, Orange, Grapefruit
- ❖ Potato, Pumpkin, Tomato, Carrots
- ❖ White rice
- ❖ Mealie meal
- ❖ White bread
- ❖ Pasta (macaroni)



Some foods can make diarrhoea worse. Avoid cereals like bran flakes, raw vegetables, fruit and vegetables with the skin on, spicy foods with chillies or curry powder, dried fruit or fruits with small seeds like berries, tea and coffee. You can also try and have less milk, milk powder and milk drinks and see if it helps.



Nausea and vomiting

- ❖ If the medicine you are taking causes nausea try to take it at a time when it will not affect meals.
- ❖ Eat small amounts of food often throughout the day. Even if you eat a small amount of food it might help to settle your stomach.

- ❖ Try eating cold food.
- ❖ Some people find fried foods, fatty food and cheese difficult to digest. Try cutting out one food at a time and seeing if it makes a difference.
- ❖ Don't eat beans. Eat only small amounts of onions, green peppers, broccoli, and cauliflower.
- ❖ Only use a small amount of margarine or oil when you are cooking.
- ❖ Try dry foods like toast, biscuits or dry cereals.
- ❖ Avoid food that has a strong smell. Sometimes the smell of food can make you feel sick.

Good food to help with nausea and vomiting

Nausea:

Lemon juice in hot water or soda water
 Rooibos tea with sugar and lemon
 Puddings and custards
 Rice or pasta
 Boiled eggs
 Diluted fruit juice
 Bananas
 Boiled chicken
 Baked or mashed potatoes
 Toast
 Well cooked vegetables



Vomiting:

Water
 Soups
 Soft foods like bananas, pumpkin and avocado



Mouth problems

Sometimes we don't eat well because of sores in our mouths, or because food tastes different or strange. You might not enjoy your meals as much as you used to, or find it too painful to eat. If this happens you don't eat enough to give you energy and to help fight infection.

What can I do about it?

Taste change

Cinnamon Tea

Make a tea with ¼ teaspoon of powdered (ground) cinnamon in a cup of boiling water.

Garlic Tea

Make a tea with 2 chopped cloves of garlic in a cup of boiling water. Use this to rinse your mouth.

Lemon Tea

Add the juice of a lemon to ½ cup of boiling water. You can add sugar, and try to drink it when it is very hot.

- ❖ Try rinsing your mouth with ½ tsp bicarbonate of soda dissolved in a cup of warm water before you eat, or with lemon added to water.
- ❖ Food should be warm, not too hot or too cold.
- ❖ Eat foods that you like. Experiment with new foods and spices until you find foods that you like.
- ❖ If red meat tastes bitter, try chicken, fish and eggs.



Dry mouth

- ❖ Rinse your mouth with salted warm water, or lemon water.
- ❖ Drink lots of water between meals to keep your mouth moist.
- ❖ Don't eat dry, rough and crumbly foods. Eat soft, mashed, moist foods like avocados, pumpkin, bananas, soups, minced food or food with sauces and gravies.
- ❖ Don't eat sugar. It will make your mouth drier.

Mouth sores

- ❖ Eat soft, mashed, moist foods like avocados, pumpkin, bananas, soups, minced food or food with sauces and gravies.
- ❖ Use a straw to drink liquids, and a cup to drink porridge and soups.
- ❖ Drink soups, vegetable and fruit juice.



Good food for sore mouths

- ❖ Try soft, smooth foods like soup and mashed potatoes.
- ❖ Minced meat
- ❖ Pasta dishes like macaroni and cheese
- ❖ Soups
- ❖ Custard



Foods to avoid

- ❖ Spicy food like chillies and curries.
- ❖ Sour food like tomatoes, oranges and pineapple
- ❖ Food and drinks that is too hot or too cold

- ❖ Foods that need to be chewed a lot like raw vegetables, or food that sticks like peanut butter.
- ❖ If you have thrush cut down on sweet food, sugar and bread.

Eating well to gain weight

Why do we lose weight?

There are many reasons why someone can lose weight. If you do not eat enough food you will lose weight. Sometimes people don't really feel like eating. We say that they have a poor appetite. This can happen if you are very tired or you feel depressed or sick. It can also happen if eating is difficult because of things like nausea or sores in the mouth.



You might also lose weight because you are sick with infections, diarrhoea, nausea or vomiting. When you are sick your body does not take in the goodness that it needs from food very well. At the same time, it needs more of this goodness to get well again.

Tips for gaining weight and increasing appetite

- Try to eat 5 or 6 small meals every day even if you don't feel like eating.
- Try lots of different foods until you find those that you like.
- Exercise will improve your appetite. Try to have a short walk before a meal.
- Don't eat lots of fried food or fatty meats.
- Add flavour to food to make it look and taste interesting. Try things like lemon juice, and sweet spices like cinnamon. Or add herbs like parsley, thyme, oregano and sweet basil.
- Try rinsing your mouth out with bicarbonate of soda or lemon juice in water before you eat to help the food taste better.



Examples of good foods for weight gain

- ❖ Eat more samp, rice, brown bread, oats, potatoes and bananas.
- ❖ Eat chicken, fish, eggs, meat, beans and soya as often as possible.
- ❖ Eat snacks like fruit, carrots, maas and peanut butter or jam sandwiches between meals.

The most important ways to gain weight are:

- ❖ Stop diarrhoea
- ❖ Treat any infections you might have
- ❖ Make sure that you are eating enough of the right things

How to improve what we eat at home

Here are some ideas to add 'weight gain food' to things you eat at home.

- ❖ Add sugar or jam to your porridge
- ❖ Put a teaspoon of margarine into your porridge.
- ❖ Cook beans and mix in with rice. Add a teaspoon of margarine as well.
- ❖ Add margarine or oil to potatoes.
- ❖ Add meat or chicken whenever you can. Even a small amount in soups and gravies is good.
- ❖ Eat beans with pap, sorghum and samp.
- ❖ Add a teaspoon of dry milk powder to any porridge, soup or stew.

**Living well by growing your own food**

One of the ways to make sure you always have plenty of cheap, fresh food available at home is to grow your own vegetables.




What can I grow?

You can grow nearly all kinds of vegetables and herbs.

These vegetables and herbs are all good for you and are easy to grow:

carrots	thyme
cabbage	sweet basil
spinach	fennel
onions	coriander
garlic	beetroot
potatoes	cauliflower
tomatoes	kale
broccoli	rape
pumpkin	mustard greens
mealies	turnips
beans	leeks
parsley	peas



Remember that you should be eating some of these foods every day. It is easier to make sure you do this if you can pick the vegetables from your garden, rather than buy them from the shops!

If you have enough space you can also plant some fruit trees.

2. The Ten Food based Dietary Guidelines

1. Enjoy a variety of foods

- ❖ Eat different foods from different food groups
- ❖ Give attention to methods of preparation
- ❖ Address low micronutrient and low energy intake
- ❖ Address chronic diseases of lifestyle.

Eat 20 - 30 different foods in a week

2. Be active

- ❖ Do 30 minutes of moderate to vigorous activity on most days. This protects against chronic diseases such as hypertension, diabetes, heart disease and cancer.

Do 30 minutes of exercise on most days

3. Make starchy foods the basis of most meals

- ❖ Consume cereals and root vegetables in unprocessed or minimally processed form (high in fibre). This will also contain some micro-nutrients, fat and protein.
- ❖ Amounts of around 260gram/day are recommended for adult women and 325 gram/day for adult men. This should be at least 55% of one's total energy intake.

Eat at least 50 gram/adult/day of starch

4. Eat plenty of vegetables and fruit every day

- ❖ Eat citrus, onions, garlic, carrots and tomatoes (high in vitamin C and A) and crucifers (cabbage, kale, broccoli, cauliflower).
- ❖ Consume dark green and orange vegetables.
- ❖ A minimum of 5 portions or 400gram/adult/day is recommended

Eat 2 fruits and 5 vegetables every day

5. More legumes for better overall health

- ❖ Eat dry beans, peas, lentils and soy regularly

- ❖ Grain legumes are beans, lentils, cowpeas, chickpeas, peas etc.
- ❖ Oil seeds are soya and peanuts for example.
- ❖ This provides good quality protein, carbohydrates, fibre, vitamins and minerals.

Eat 100-200gram of legumes /adult/day. This is 0.5 to 1 cup.

6. Food from animals can be eaten every day

- ❖ This includes meat, fish, chicken, milk and eggs.
- ❖ Besides protein this contributes towards intake of calcium, iron, zinc and omega-3 fatty acids.
- ❖ Eat low fat meats and use fats sparingly in preparation.
- ❖ Add small amounts to a plant based diet.

Take 400-500ml of dairy/day (milk, yogurt, maas, cheese...)

Eat 4 eggs/week

Eat 2-3 servings of fish per week

OR

Do not have more than 560 grams of meat (chicken and red meat) per week

7. Eat fats sparingly

- ❖ Lower the fat intake from meat and non dairy creamers.

8. Eat salt sparingly






- ❖ High salt intake can lead to hypertension. For hypertension eating a diet high in vegetables and fruits, with low fat dairy products for 8 weeks will significantly reduce blood pressure.

Sprinkle, don't shake

9. Water, the neglected nutrient

Drink at least 2 litres of water per day

10. If you drink alcohol, drink sensibly.

			What did we eat today?																			
			Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday	
			Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant	Small kids	Adults	Sick/old/ pregnant
GO foods (starch)	maize, potato, sweet potato	1.5-2 cups/day																				
																						
																						
GROW foods (protein)	eggs, milk, maas chicken, red meat, fish peanuts, beans, peas	1 cup/day																				
																						
GLOW foods (vegetables and fruit)	carrots, ground sweet potato, pumpkin, kharcho, okra, etc.	5 portions/day																				
																						
	cabbage, onions, green beans, lettuce, beetroot	5 portions/day																				
																						
Fats and oils: sunflower oil, butter, margarine, animal fat																						
Sugar in tea and porridge softdrinks such as Coke and SweetAid; biscuits, sweets																						

we draw a circle around food
we got from our garden

[illegible]

Resource Material for Homestead Food Gardeners

Chapter 4: Handouts (English)

Handout 1	Mixed Cropping
Handout 2	Crop Rotation
Handout 3	Pest and Disease Management
Handout 4	Wind and Frost Protection
Handout 5	Seed Saving
Handout 6	Growing Fruit Trees
Handout 7	Tower Gardens
Handout 8	Grafting Fruit Trees
Handout 9	Vegetative Propagation – Cuttings
Handout 10	Fruit and Vegetable Processing

1. Mixed cropping

We want to create as much diversity in our gardens as possible. Diversity ensures a natural balance in the garden. This includes creating a living soil, using water efficiently and minimising pest and disease attack on crops.

Mixed cropping involves planting various crops together in one plot. Plants can either be inter-planted at the same time or crops can be rotated. This means that different crops are planted in the same place at different times. Using both inter-planting and crop rotation in your garden is a good idea.

Inter planting

When planting a number of different crops together we need to consider the following:

- ❖ **Nutrient consumption:** We mix crops together that consume different amounts of nutrients. Some plants are heavy feeders and need a lot of nutrients. Other plants are light feeders and some even add nitrogen to the soil. A good example is the traditional practise of planting maize and beans together. Maize is a heavy feeder, while beans are light feeders as well as fixing nitrogen in the soil.
- ❖ **Root depth:** Plant deep and shallow rooted plants together to ensure that they do not compete for nutrients and water. A good example is planting maize and pumpkins together. Maize is an upright plant that has a deep rooting system and pumpkin is a creeping plant with a shallow rooting system. They do not compete for space either below or above the ground.
- ❖ **Insect repellent plants:** There are some crops which have a unique smell that repels some kinds of insects. For example, onion has a specific smell that butterflies dislike. If onions are inter planted with cabbage, this will reduce the attack from insects (worms). Combinations like onion and cabbage are called companion plants. Companion planting is an effective pest prevention measure.
- ❖ **Timing:** Some crops have a longer life cycle than others. It is possible to plant crops that mature quickly in-between crops that take longer to mature. In this way one crop can be harvested while the other crop is still growing and competition is reduced. An example is planting radish, mustard spinach and potatoes together. Radish matures quickly and is harvested within 6 weeks of planting. The leaves of the mustard spinach are harvested for 2-3 months. This reduces competition with the potato plants that are now growing large. Potatoes are harvested after 3.5-4 months. A combination such as this also includes that aspect of rooting depth, nutrient consumption and insect repellent properties.
- ❖ **Shade tolerance:** This becomes important when tall crops and perennial plants are also grown in the garden. These include fruit trees. Some crops such as comfrey, lettuce and strawberries are shade tolerant.

More examples of inter-cropping in a vegetable garden

In the beds

Plant carrots and onions together: Carrots protect against onion fly and onions protect against carrot fly. Carrots root more deeply than onions and are harvested earlier; giving the onions the space they need to mature.

Plant cauliflower or cabbage, lettuce, fennel and onion together: This combination gives complete control of aphids and diamondback moth (shown on the right) on the cauliflower. It takes into account nutrient consumption, rooting depth, insect repellent properties (onion and fennel), timing and shade tolerance.



Plant tomatoes, onion or garlic and carrots together: This combines insect repellent properties, nutrient consumption, rooting depth, timing and disease control. Tomato plants are scattered so that they do not touch each other, which reduces the incidence of early and late blight.

Plant swiss chard (spinach) and beans together: this combination takes into account nutrient consumption, rooting depth and disease control on the chard. Planting the chard in alternate rows with beans reduces the incidence of bacterial spot on the chard.

Many different combinations are possible. Below are two more examples:



Left: Swiss chard inter-planted with fennel and garlic chives

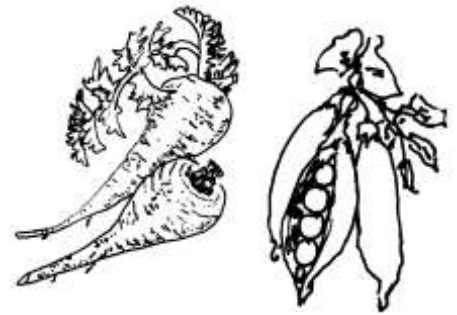
Right: A bed with onions, cabbage, lettuce and swiss chard planted together.

There are a number of crops that grow well together and some that do not. When

planting a bed, use the diagrams below to choose combinations of crops that suite each other.

Some plants which grow well together:

Beetroot	-	onions
Carrots	-	peas, lettuce, onions, tomatoes
Onions	-	beetroot, strawberries, tomatoes, lettuce
Eggplant	-	beans
Cabbage	-	potatoes, beetroot, onions
Green Peppers	-	all vegetables
Lettuce	-	carrots, radishes, strawberries, cucumbers
Pumpkin	-	mealies
Swiss Chard	-	strawberries
Tomatoes	-	onions, carrots
Mealies	-	peanuts, peas, beans, cucumber, pumpkins, potatoes
Sunflowers	-	cucumbers
Beans	-	potatoes, carrots, cabbage



vegetables

Plants that do not grow well together:

These are some plants which do not grow well together. Try to avoid putting them in the same beds. Try and experiment for yourself.

Beetroot	-	pole beans
Onion	-	peas and beans
Cabbage	-	strawberries
Pumpkin	-	potatoes
Tomatoes	-	potatoes and cabbage
Beans	-	onions
Sunflowers	-	potatoes



Advantages and disadvantages of inter-planting

ADVANTAGES of inter-planting	DISADVANTAGES of inter-planting
Efficient use of space below and above ground	Looks “untidy”
Reduces and avoids pest and disease build-up in the soil and in the garden	Can make harvesting of crops more time-consuming
Reduces weeds. Covers the soil and uses nutrients in an effective manner. Building of a healthy, living soil is possible.	Weeding can be more time consuming initially, as crops may be scattered, rather than being planted in rows
Plants support each other in a synergistic relationship that protects against pest and disease attack and increases vigour and growth	Some shading may occur if plants are not spaced well
Efficient use of water	Some plants may be over or under watered depending on their life cycle. For example, some plants may be seeding while others are still growing.

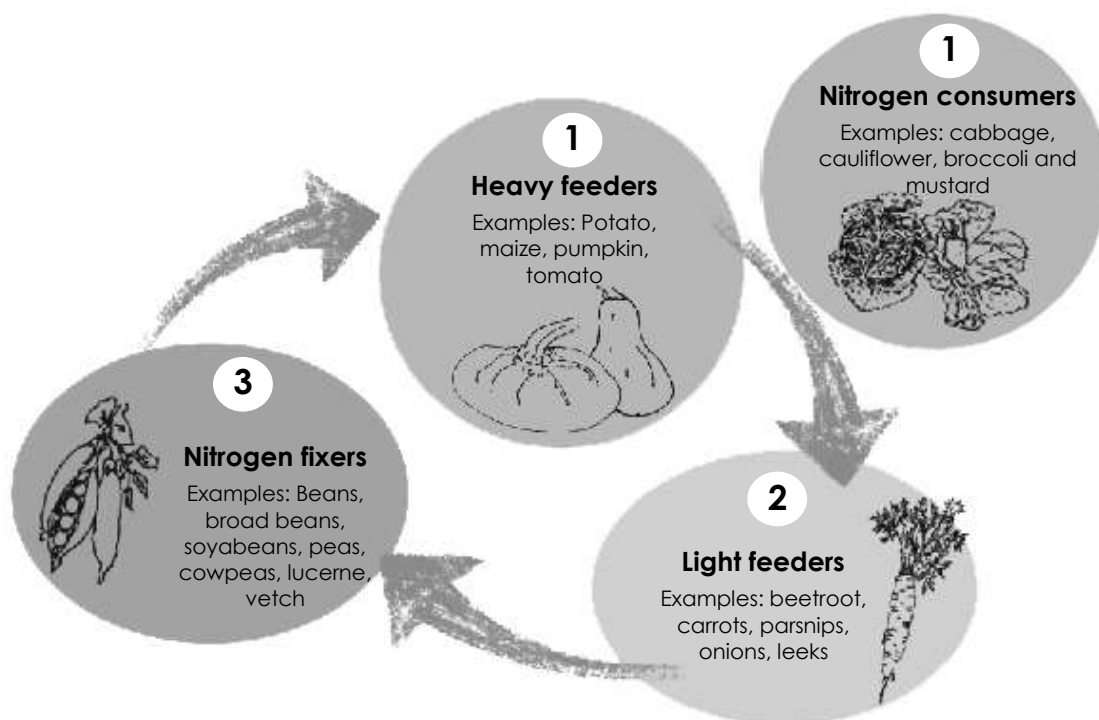
2. Crop Rotation

Here you do not plant the same crop in the same place year after year, but you make sure that a different crop is planted in each space. This is a good idea because:

- ❖ It prevents or stops the accumulation of insects and diseases. If the same crop is planted some insects and diseases will become more every year!
- ❖ Different crops use different nutrients or plant food stored in the soil. In this way you do not overuse some of the plant foods, while not using others.
- ❖ The soil can be covered all year round.
- ❖ Some crops add nutrients or nitrogen to the soil. Examples are beans, peas, broad beans, soya beans, peanuts, cowpeas, lucerne and clover.
- ❖ It prevents the soil from building up bad or negative reactions to specific plants. An example here is nematodes on tomatoes and swiss chard. Nematodes are very small worms that we can not see with our eyes. They live in the soil and feed on the roots of your plants.
- ❖ There is no build up of specific weeds.

There are a number of different crop rotation systems that can be used.

Below is an example of a system that is easy to use and remember.

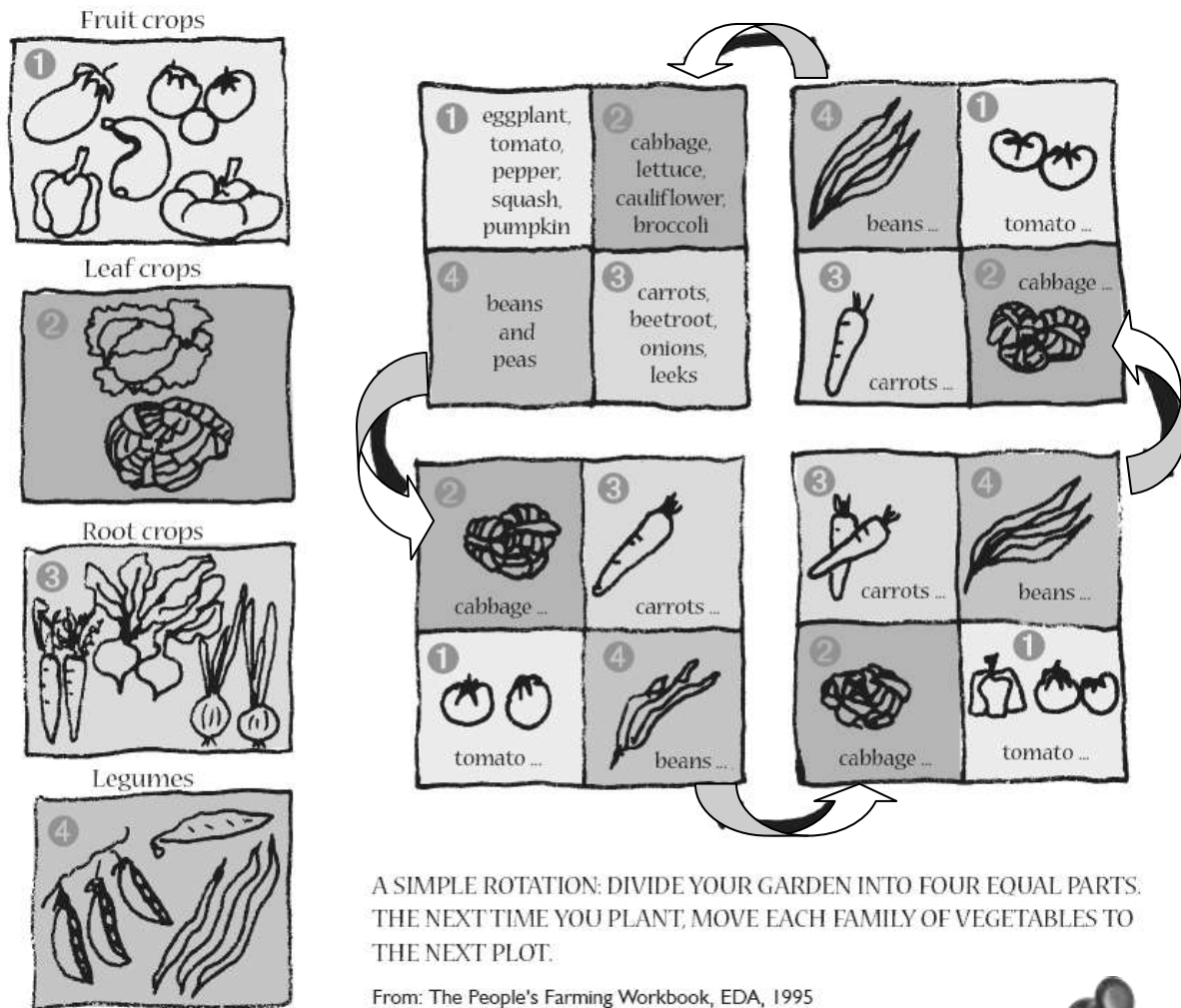


In the first season after applying compost and or manure heavy feeders or nitrogen consumers are planted. In the second season light feeders are planted and in the third season legumes are planted. This is followed by another application of compost

or manure and the cycle is repeated.

In trench beds, where the organic matter is decaying slowly in the soil, you may want to start with legumes, move on to heavy feeders or nitrogen consumers and then move on to light feeders. This is because during the decaying process plant nutrients will take a while to become available for use by plants. The legumes can fix most of their own nitrogen and are thus a better starting point.

An alternative system is presented below:



Prepare the land or bed well. Put a lot of compost or manure in your bed (4 full spades/ square meter). Then, start by planting a fruiting crop. These plants need the most food. Leaf crops need less and can follow fruit crops. Then root crops can follow leaf crops without much addition of plant food. Root crops like fertile soil, but do not like fresh manure or compost. It has to be well rotted. Then, nitrogen fixers can follow, with addition of little or no plant food. Then you need to prepare the land well again. Start once more with fruiting crops.

Preparing the bed well:

This would mean trenching, or double digging or addition of a lot of compost/manure forked into the top 40cm of soil. You will need at least 4 full spades for every square meter.

A general recommendation is to place 30 tons of compost to a hectare of land. This comes to about one half of a wheelbarrow load for every square meter (which is about the same as 4 full spades!)

Advantages and disadvantages of crop rotation

ADVANTAGES of crop rotation	DISADVANTAGES of crop rotation
<ul style="list-style-type: none">• No build up of pest and diseases• Soil nutrients are used effectively• Soil moisture is used effectively• A healthy living soil can be built up over time	<ul style="list-style-type: none">• Without a plan, either drawn or written on paper, it is difficult to remember which crop is to follow• It can be tricky to decide which rotation to follow when inter-planting is also used

3. Pest and disease management



Above is a picture showing some of the useful insects, predators and animals in your garden. All these creatures are our friends and help to control pests

Diversity is good

- ❖ Work with nature and copy the natural ways in which plants grow. Insects and "weeds" are a part of nature. We can learn to encourage those insects and plants that help us in the garden. Ladybirds, praying mantis, lacewings, wasps, frogs, lizards and birds all eat the insect pests that harm our gardens. They are called predators. If you leave them in your garden, they will help you!
- ❖ We have talked of planting different vegetables together (companion planting) and of rotation. It is also possible to mix vegetables with other plants- strong smelling plants that deter pests and attract predators

In the picture above, nasturtiums and peppermint are planted with the vegetables.

Below are some strong smelling plants that you can grow with your vegetables

Pyrethrum and Feverfew

These plants belong to the *Chrysanthemum* family. They have small white flowers, which are also very decorative in the garden and contain a poison for insects. They can be planted as borders along your beds, or dotted throughout your garden.



You can buy seeds for these plants. Write to the following address:

Mahlathini Organics, PO Box 807, Richmond, 3780, KZN, South Africa.



Marigolds (*Tagetes spp*)

These plants can be used in the same way as pyrethrum. They have the added advantage of deterring nematodes (tiny worms that attack the roots of plants) in the soil.



Different kinds of nematodes



Fennel

Fennel is a great plant for attracting wasps. Wasps lay their eggs in caterpillars and can kill many of them in one day!



Wasp

Wormwood (*Artemisia affra*)

These plants grow as large bushes and should be placed at the edges of your beds, or given their own space to grow. A tea made from the leaves is also a good medicine for fevers and colds.

Khakibos and blackjacks

These weeds are useful to deter pests. Keep a few in the garden!

An inter-crop of cauliflowers, lettuce, fennel and onion can give complete control of aphids and diamondback moth. This means you will have no attacks!!!



Diamond back moth and its larvae

Grow strong, healthy plants

Pests and diseases do not attack healthy plants.

- ❖ Fertile soil, fed each year with compost and manure will produce healthy plants.
- ❖ Make sure that your plants are not short of water.
- ❖ Select the best plants at harvest time from which to collect seeds.
- ❖ Use strong, healthy seeds and seedlings. If your plants do not have a good start, they will not get better later! Rather start again.

- ❖ Plant the vegetables in the correct season. Early planting of some crops can protect them from the worst attacks. Examples are stalk borer in maize and blight in potatoes.
- ❖ Mulch!
- ❖ When you are weeding, do not let the rubbish lie around your garden. The smell attracts pests. The best liquid manures are made from weeds. Otherwise, place the weeds on your compost pile.

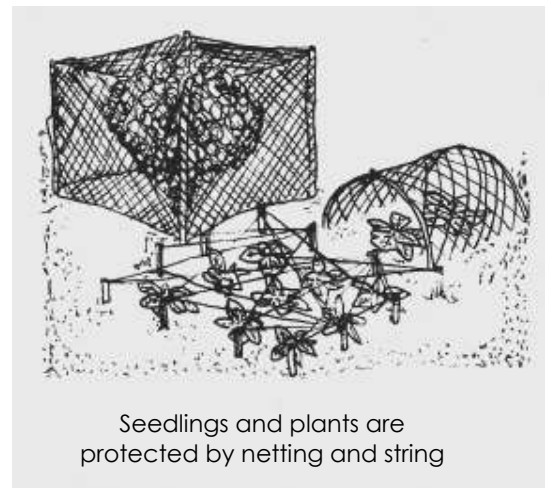
If prevention does not totally succeed in a pest and disease free crop, then there are a number of ways in which to control these problems.

Physical controls

Birds

Birds can be kept away from your crops in the following ways:

- ❖ Use 4 sticks and some netting to make a cage
- ❖ Cover seedlings with netting or wire stretched across a hoop
- ❖ Or make a mesh of string wound around wooden pegs.
- ❖ Scare crows still work well, as long as you move them quite often. The birds will get used to them after a while



Cutworms

These are fat brown or grey worms that live just under the surface of the soil and cut the stems of small plants as they are feeding.

- ❖ Cutworms can be collected in the early morning by digging with your finger in the soil, around the small plants that have been cut. The worm can be removed and fed to your chickens or destroyed.
- ❖ Collars can be made for the seedlings. These are placed around the seedlings when they are planted. Be sure to press the collar quite deep into the soil (at least 3 cm, which is the width of 2 fingers), otherwise the worms will burrow underneath the collar. Collars can be made from stiff paper, cardboard or rings of plastic cut from bottles.



Cutworm and moth

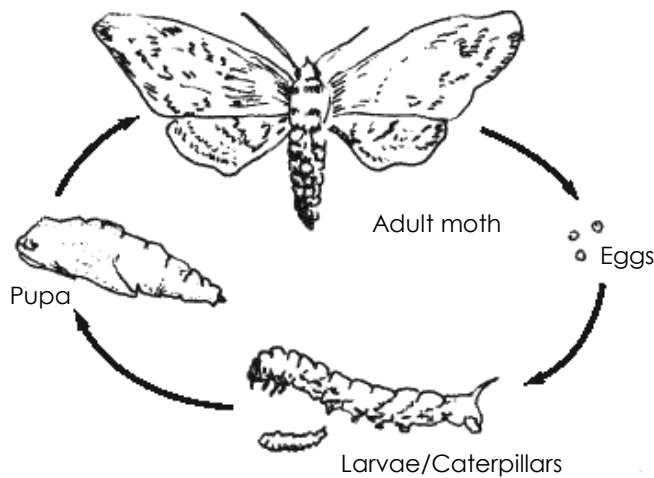


Cutworm collar around seedlings

From: Production without Destruction, 1995

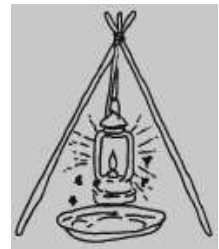
Many worms/caterpillars have the following life cycle:

A moth lays eggs, which hatch into larvae/worms/ caterpillars. They feed on the plants. They then turn into pupae, which do not feed. The pupae turn into moths, which do not feed, but lay eggs. And so on.



Life cycle of some insects

From: Production without Destruction, 1995

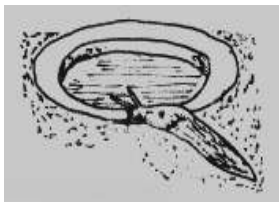


Light trap for moths and other insects

It is possible to attract many different kinds of moths with light traps. These are put out at night. Using a light trap will reduce the egg laying of many different moths.

Snails and slugs

From: The Complete Book of Self Sufficiency



Dish set in the ground with fermented liquid, to attract slugs and snails

- ❖ They can be picked off by hand and placed in a bucket of water, or feed them to your chickens. They will love to eat them.
- ❖ A saucer or shallow dish with beer or any fermenting liquid can be placed so that the rim is level with the ground. Slugs and snails will be attracted to this liquid. Here they will either fall in, or they can be collected and fed to your chickens, or destroyed.

Snail



Herb and plant teas

Many different plant mixtures can be used to control insects and diseases. These remedies should only be used if all the other methods fail. The main advantage of natural remedies is that they are cheap. They can be prepared at home.



Controlling pests and diseases

General points for making plant sprays

- ❖ Soap (green bar soap only!) can be added to the mixture to make the spray stick to the plants and insects. Do not use liquid soap or soap powder.
- ❖ The mixtures can be filtered through thin cloth to remove the bits of plant material. They can be applied using a homemade brush from grass or twigs.
- ❖ These sprays act as contact poisons. So make sure you cover the insects or disease symptoms well.
- ❖ Some sprays can burn the plants if they are too strong. First test your spray on a few plants.
- ❖ The best time to spray against insects is in the late afternoon.
- ❖ The sprays are washed off in rain and have to be re-applied.

IMPORTANT:

These sprays are still poisons. Make sure that children cannot reach your preparations. If you boil up your mixtures, use an old pot no longer used for cooking. Wear gloves if you can!



Below is a listing of some of the plants, how the remedy is prepared and what it is used for:

Aloe

Any kind of aloe can be used.

- Crush the leaves in water (1:5). This means that you use 5 times as much water as you sue leaf material. Filter this mixture through a fine cloth and use the liquid as a spray OR
- Dry the leaves and grind them into a powder. This can be dusted onto plants and also onto seeds for storage.

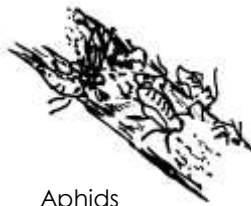


Control:

Ants, aphids, termites, grasshoppers



Ants



Aphids



Termite



Grasshopper

Amaranthus

Extract the juice from 1kg of leaves (1 kg is about one plastic shopping bag full of leaves). This can be done by cutting the leaves and then pounding them with a stone. Then mix this juice with 3 litres of soapy water and spray.



Control:

Various spotty diseases caused by fungi such as leaf spot and blight.

Wormwood (Lengana/ Umhlonyane)

Cut up the leaves into water (1:4) and stand for 2-7 days before using. Add some soap to the mixture.

Control:

Insects in general and snails.

Snail



Blackjack

Cover a cupful of seeds with water and boil for 10 minutes, or let it stand overnight. Add 1 litre of soapy water and spray.

Control:

Insects in general; aphids, ants, beetles, caterpillar, cutworms, mites, termites and whitefly.

Mites



Whitefly



Termite



Chilli

- ❖ Chop up one cupful of hot red chillies.
(Be really careful not to rub your eyes!)
- ❖ Add 2 litres of water.
- ❖ Either leave this to stand in the water for 2-3 days or boil for 15 minutes.
- ❖ Add half a cup of soap shavings and mix until this has dissolved.
- ❖ Filter the solution to remove the pieces of chilli.
- ❖ During dry weather, apply once a week.



Caterpillar



This mixture can burn the leaves of plants if it is too strong!

Control:

Caterpillars, aphids and ants.

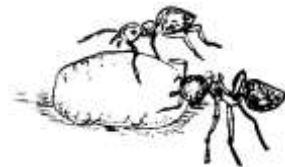
Garlic and onion



Crush 3 big bulbs of garlic (or 1-2 onions) and soak them in 2 spoons of cooking oil or paraffin for 2 days. Filter and mix with 1 litre of soapy water. Dilute this mixture 1:10 with water and use as a spray.

Control:

Insects in general: aphids, mites, wireworms, termites and ants. Diseases such as leaf spot, blight and damping off. Examples are bean rust and tomato blight.



Ants



Aphids



Termite

Marigolds

Use the whole plant. Take 2-4 plants and crush the leaves, roots and flowers. Pour on 1 litre of boiling water and soak for one day. Then add 1 litre of cold soapy water and spray this on your plants. The coarse plant materials remaining behind can be used as mulch around your plants.

Control:

Insects in general: ants, aphids, beetles, stalk borer.

Disease in general: leafspot and blight (early blight and late blight).



Tobacco

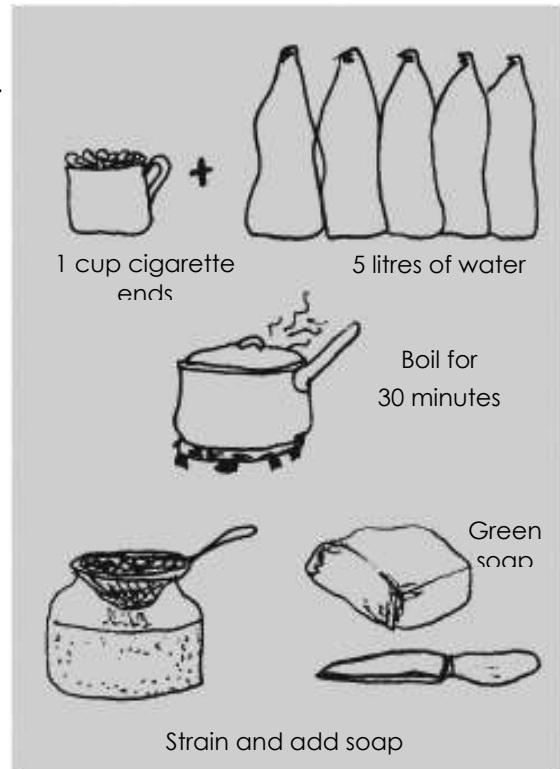
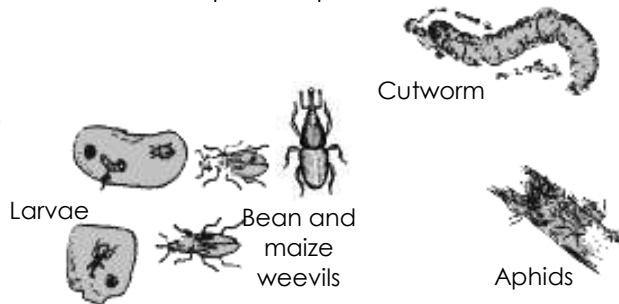


WARNING: Tobacco is very poisonous to all insects and to people. Be very careful with these preparations.

- ❖ Take 2 handfuls of dry leaves or cigarette ends. This is the same as one cup full.
- ❖ Add 5 litres of water and boil for 30 minutes. Filter. Then add soap, mix and let your remedy cool. Apply once a week.

Control:

Cutworms, caterpillars, aphids, flies and weevils.



Organic remedies

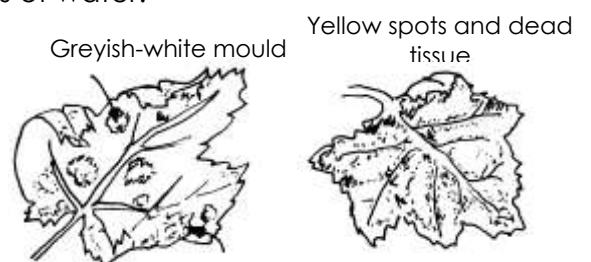
These remedies are made from organic materials, not from plants. Some examples are given below:

Wood ash

- ❖ Mix one heaped spoon of wood ash in 1 litre of soapy water. Leave it overnight. Spray against insects in general.
- ❖ Mix one heaped spoon of wood ash in 1 litre of soapy water. Mix in one cup of sour milk and add 3 litres of water.

Control: Mildew on plants and most insects. Also snails, slugs, and cutworm

- ❖ Spread the wood ash in a circle around the base of your plants and water it into the soil a bit.



POWDERY MILDEW:
Fine, white floury powder mostly on the upper surface

Flour

Mix one big spoon of flour into 1 litre of water. Brush this on the underside of leaves where mites and aphids are. Apply in the morning of a sunny day.

Control:

mites, caterpillars and aphids.



Milk

Spray a mixture of 1 litre of milk and 10 litres of water to control spider mites and diseases such as mildew on pumpkins, blight on tomatoes and potatoes and mosaic virus on peppers. Do this every 10 days.

Liquid manures/compost teas

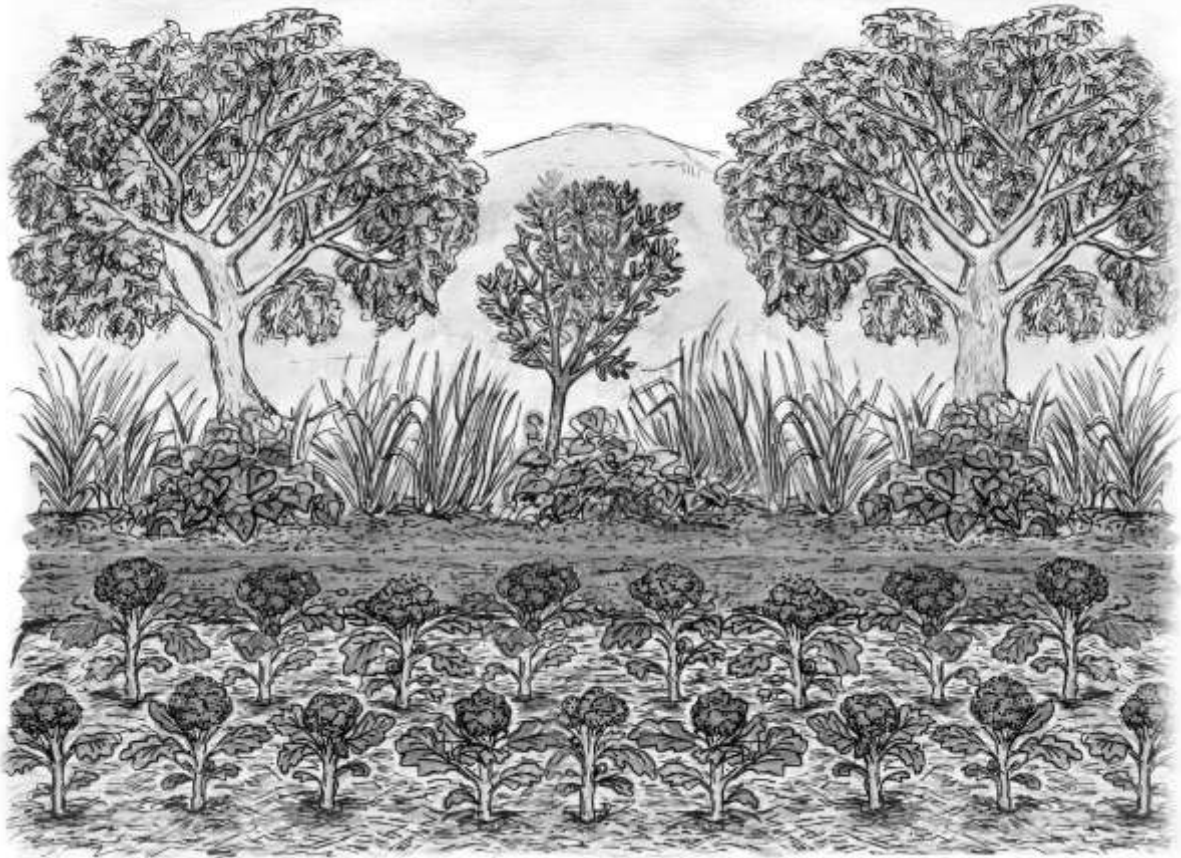
See Chapter 6, Handout 3; Brews for Plant Nutrition. This explains how to make liquid manures.

- ❖ Mix one spade full of compost or manure in 10 litres of water.
- ❖ Let this mixture stand for 10-14 days.
- ❖ Dilute animal manures 1:4. Use compost tea as is.
- ❖ Spray these onto your plants every 7-10 days.

Control:

Generally protects against insect and disease attacks. Can repel aphids, caterpillars, grasshoppers, beetles, mites and cutworms.

4. Wind and frost protection



Shelter belts or rows of different plants and trees grown together can protect your garden from wind and frost. A windbreak/shelterbelt is a physical barrier that we place across the path of the wind. It serves to slow the wind down and to make the negative effects of heat, cold and dust less. Above is an example of such a shelter belt that contains fodder species for livestock; the plants grown in these rows can all be used as feed for goats, cattle, sheep and chickens!! Shown here are cow peas climbing up the trees, napier fodder (grass), pigeon pea (the small tree) and Acacia karroo. These plants are also good for improving your soil fertility. The leaves of all these plants can be used as mulch. The leaves can also be included as green material in compost. They can be used in the making of trench and keyhole beds.

Wind protection

The movement of air is important to plants. It prevents diseases caused by too much moisture/wetness and lack of air. It also helps to spread pollen (which is necessary for fruit production on some trees and plants) and helps plants to seed themselves.

Wind can affect your plants in negative ways:

- ❖ Strong winds can blow over or break your crops and trees
- ❖ Dry winds cause the soil and plants to dry out.
- ❖ Very hot or cold winds can destroy crops.
- ❖ Dust carried by the wind scratches plants like sandpaper.
- ❖ Wind can also cause soil erosion, especially in the dry months. Your topsoil can be blown away by the wind, leaving you with the less fertile subsoil.

Where to place a windbreak

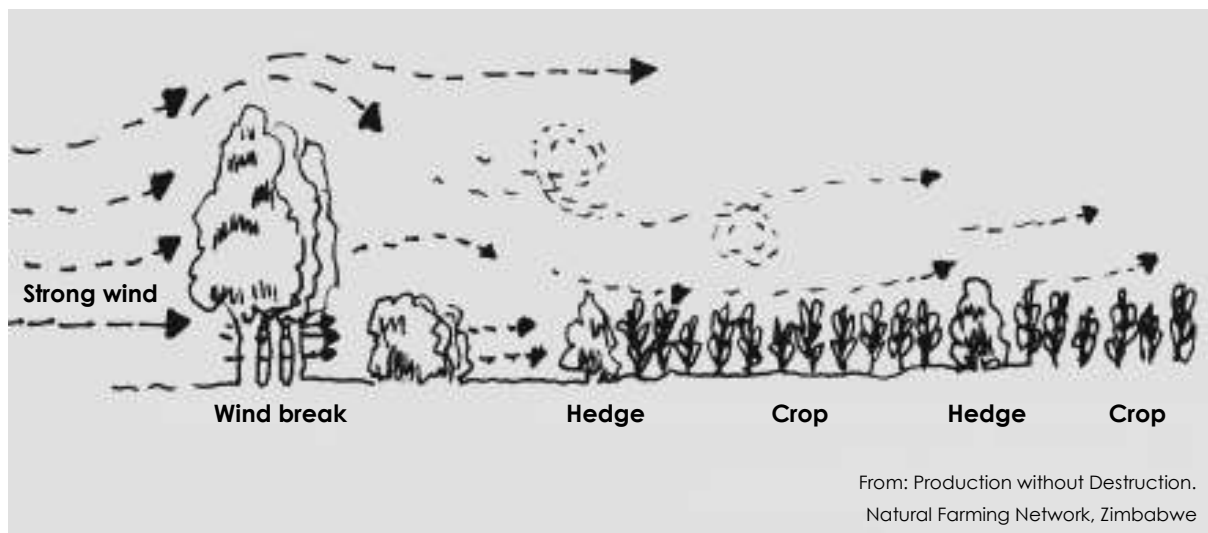
Windbreaks are planted across the path of the main hot, cold and dry winds in your area. Windbreaks are good around homesteads. They can also be planted along roads and paths and also as boundaries around your fields and gardens.

Some extra advantages of windbreaks

- ❖ Can provide firewood
- ❖ Can provide fruit
- ❖ Can be thorny for protection
- ❖ Can provide fodder for animals
- ❖ Can provide medicine

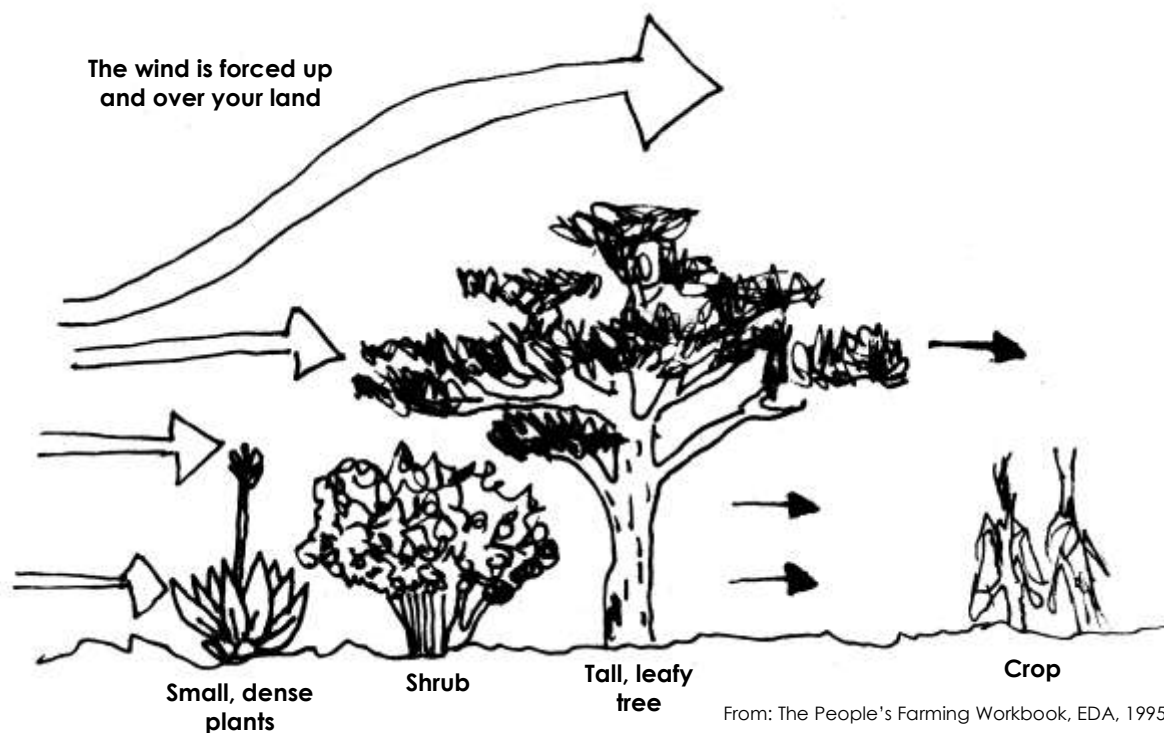
How to make a windbreak

It consists of rows of trees and shrubs, usually of various kinds and heights. They are planted as a semi-solid barrier. This means that some air can still move through the windbreak, but it will be slowed down. The best windbreaks consist of at least three rows of shrubs and trees of different heights.



The trees and shrubs can also be planted in 1 or 2 rows. If you can, make sure that branches and leaves still grow close to the ground. With tall trees only, the lower branches die back over time. The wind will then "tunnel" past these bare stems and damage your crops. The shorter shrubs and plants can be planted on the side the wind is coming from as well.

Here are some examples of plants, shrubs and trees that you can use!



Small plants	Shrubs	Trees
<ul style="list-style-type: none"> ❖ Aloes ❖ Comfrey ❖ Wormwood ❖ Herbs such as rosemary, thyme, lavender, etc. ❖ Marigolds ❖ Fennel ❖ Runner beans ❖ Vines such as grapes and passion fruit 	<ul style="list-style-type: none"> ❖ Napier fodder ❖ Pigeon pea ❖ Buddleja or Sagewood ❖ Halleria or Tree Fuchsia ❖ Dovyalis or Kei-Apple ❖ Carrissa or Num-Num ❖ Euclea or Blue Guarri 	<ul style="list-style-type: none"> ❖ Casuarina or Beefwood ❖ Acacia or Sweet thorn ❖ Mulberry

More about some of the suggested small plants, shrubs and trees

Aloe

These are good for protection as they often are thorny. They also provide some protection against fire, as the leaves are fleshy and hold a lot of water. They can be used for medicine. A good kind to use is Aloe maculata. This is a low growing aloe with white speckles on the leaves. The gel in the leaves is very good as a medicine for constipation and contains a trace element known as selenium. Selenium is a very important supplement for your immune system.

The aloe often grown around homesteads, *Aloe striatula*, which has long, thin leaves, can be a bit invasive.



Marigolds and Fennel

These are small strong smelling plants that help to protect your garden from insect attack. The white umbrella-like flowers of fennel help to attract insects (predatory wasps) that eat the pests in your garden (worms and aphids). Marigolds can be used to make a poison that will kill small worms (nematodes) in your soil.



Napier fodder

This is a tough, hardy fodder grass that can be used for hay and silage. It is also good for mulching. It grows fast. It is propagated by taking small rooted clumps from a "mother" plant. It is also possible to lay the canes/grass stems in shallow furrows. These will grow from the nodes/notches in the stem. In cold areas the plants will die back in winter (the dry leaves remain as a windbreak). They will re-shoot in spring.



Buddleja salvifolia; Sagewood; Lelothwane

These are tough, fast growing, evergreen shrubs. This means they do not lose their leaves in winter. They are frost resistant. They will need to be protected when young, but are robust when older. The flowers attract birds and bees. The leaves can be used as tea or as a medicine for eye complaints.



Halleria lucida; Tree fuchsia; Lebetsa

This is a shrub, but can also grow into a small tree. It grows up to about 3-10metres high. It has multiple stems that can be cut for firewood, garden stakes and fencing. It has tubular orange/red flowers that attract birds and bees. The fruit is edible.



Euclea crispa; Blue guarri; Mhlakolo, Motsoetla

This is a shrub or bushy evergreen tree that grows between 1 and 5 metres high. It has small, black pea-like berries that are edible. It grows wild in some places.



Carissa bispinosa; Num-num

This is a branched, spiny evergreen shrub. The leaves are small,

shiny and thick. Fruit are small oblong red berries that are good to eat and for making jams.



Cajanus cajan; Pigeon Pea

This is a small tree that is native to Africa. It fixes nitrogen in the soil and has deep roots. It can be used for firewood. It is frost tolerant, but needs to be protected when young. The young leaves can be eaten as spinach and the seeds are eaten as beans or "dahl". The leaves are also good fodder for animals; especially cattle and goats.



Dovyalis caffra; Kei Apple

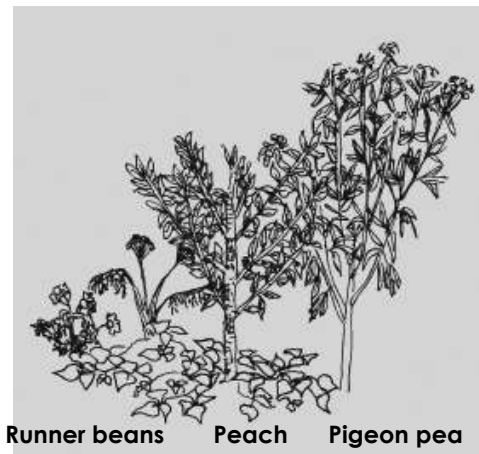
This is a very thorny small tree with fleshy leaves. It makes a good protective hedge. It grows a bit slowly. It is resistant to drought and frost. It needs to be protected from frost when young. The fruit is good to eat and can be made into jams and jellies. The flesh needs to be washed off the seed before planting.



Mulberry

These are large deciduous trees. This means they lose their leaves in winter. The leaves are good animal fodder. The small black berries are very sweet and can also be used for making jam. Mulberries are easy to grow from cuttings. They can be pruned and these branches can be used for fences, stakes and firewood.

It is possible to plant fruit trees together with some of the trees and plants mentioned here. This helps to protect your fruit from pest attack and wind and frost damage. On the right is an example of a peach tree planted with runner beans, marigolds, fennel and Pigeon Peas. Different combinations of plants can be used.



Runner beans Peach Pigeon pea



Casuarina Cunningham; Beefwood

This tree originally comes from Asia and Australia. It is a large shady tree with leaves that look like pine needles. It grows very fast and can grow in poor soil. It provides good timber and firewood. It can be planted easily from seed. It is moderately frost resistant and should be protected when young.

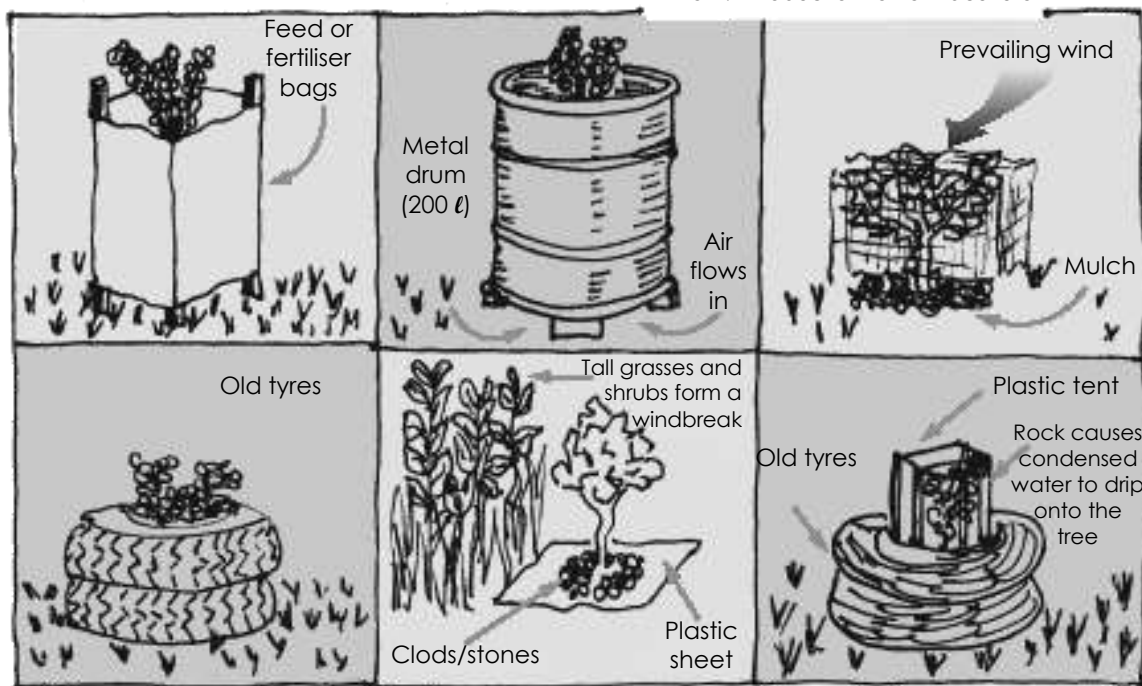


Acacia karroo; Sweet Thorn

These are very hardy, fast growing, very thorny trees. They are frost and drought resistant. They fix nitrogen into the soil. The tree provides good firewood. Leaves, flowers and pods are good animal fodder.

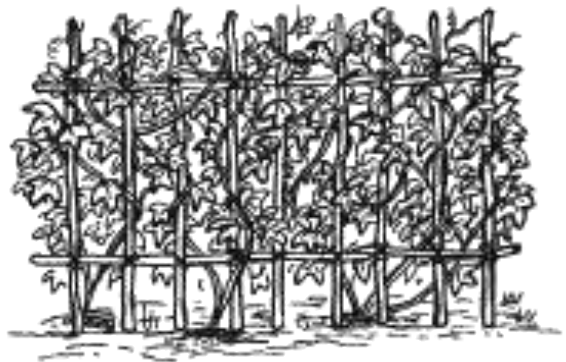
It may be difficult to find some of the plants described above. They will also need some water when they are young and some protection against frost. Below are some examples of how you can protect individual trees and plants in your windbreak.

From: Introduction to Permaculture



You can also use other materials as small windbreaks around your garden:

- ❖ A fence made of many thin sticks can help. You can use old maize stalks or even black jack stalks.
- ❖ It is also possible to grow vines or creepers on a fence to give more protection. It may be difficult to find vines that are highly resistant to frost. Passion fruit or granadilla can take some frost. This is called frost tolerant. It means that if you are expecting very heavy frost and your vine/plant is still young it will need some protection from the frost. Later, when the plant is older and stronger it will be able to tolerate the frost better. Other vines are deciduous. This means they will lose their



leaves in winter. They can still offer some protection.

Examples are: Grapes, Kiwi fruit and climbing beans such as lima beans, seven year beans and red runner beans.

- ❖ Bundles of thatch grass or maize stalks can be tied to the fence, across the path of the main winds.
- ❖ Animal feed sacks or plastic orange pockets can be sown together and sown onto the fence to provide a screen.

Experimentation



You need to decide how much you need a windbreak and what it should be made from. Growing rows of plants and trees will take a few years, but it is the best kind of windbreak. It can also provide fruit, food for animals and firewood.

But perhaps you only need a windbreak for your seedlings or a small part of your garden.

You may want to experiment by using a temporary windbreak, like animal feed sacks sown onto a fence. If you do this, it will be hard to have a control for your experiment, because there will be nothing that you can compare your experiment with. But you may be able to see some differences between having a windbreak and not having one.

Questions to think about:

- ❖ Do your plants seem healthier because they have not been bent and damaged by wind?
- ❖ Do you have to water less because the wind has not taken so much moisture from the soil?
- ❖ Do you think you have put your windbreak in the right place? Is it in the path of the wind? Should it be closer or further away from your garden?
- ❖ What have been the advantages and disadvantages of a windbreak? You may want to make a list. But remember, some advantages might be hard to see at first. Maybe you are watering your plants less, or there is less soil erosion. (Mulching is also a good way of stopping soil erosion.) Other advantages of growing a windbreak are wood for stakes or firewood, fruit and natural pest repellents that you get from them.
- ❖ What will you make your windbreak from? If you are going to use plants and trees, which ones will be best? Which ones can you get hold of easily? When they are fully grown, will they give rows of protection to stop the wind getting through, like in the picture on page 1? Think about how tall each will grow and whether it will loose its leaves in winter or not. Will the wind be able to get through? You need to plan your windbreak carefully.

Frost protection

Frost is like cold water, as it flows downhill and collects in the lowest points. This freezing air is usually less than 1m (the length of a spade) deep. It is coldest closest to the ground.

Early frosts are usually only ground frosts. That means that the temperature only goes below freezing at ground level, but not at, say, 30 cm (the width of a spade) above ground, so only tiny seedlings will be damaged. Fully grown plants like peas, especially if staked, will survive. But later frosts will be air frosts, which means that the temperature drops below freezing at even 1,5 metres above the ground, thus affecting all crops. These are the killer frosts and are usually seen as coating everything with a crust of ice instead of dew.

Crops damaged or killed by frost	Crops affected by frost	Crops that can withstand Frost	
tomatoes green beans peppers sweet potatoes chillies pumpkins	leaves of potatoes (but not the plant, which can re-grow) young peas (the flowers and pods)	spinach swiss chard some mustards carrots beetroot lettuce onions	broad beans cabbage kale turnips garlic leeks

Dealing with frost

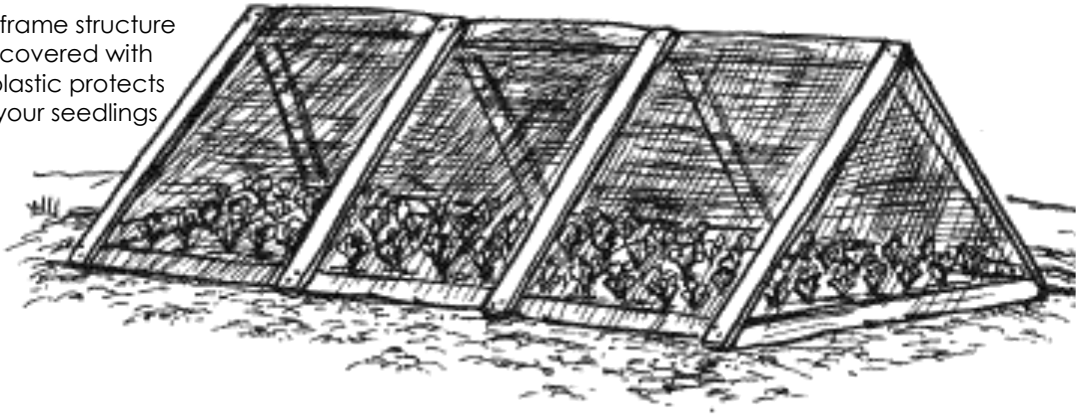
The only real way to deal with both kinds of frost is to protect your plants. There are a number of ways you can do this. All of them will need you to plan in advance. Some may even need you to design your garden in a different way.

1. *Covering your sensitive crops*

For the early frosts, you can cover your sensitive young plants with anything you can find which will act like a thin blanket. You can use grass, newspaper weighed down with stones, or old onion and orange pockets tied together. You can also use old livestock feed bags. It is possible to buy frost cover from your local nursery or Co-operative. This "cloth" is not very expensive and works very well. It can just be draped over your beds and pegged down using clothes' pegs. Make sure to put this "blanket" over your plants in the late afternoon.

It is also possible to cover your crops with structures made from greenhouse plastic or netting, placed over a wooden frame. This will protect your crops also from the severe winter frosts. One can buy shade cloth or special netting to deter frost from a garden centre or agricultural cooperative. This however is quite expensive.

A frame structure covered with plastic protects your seedlings

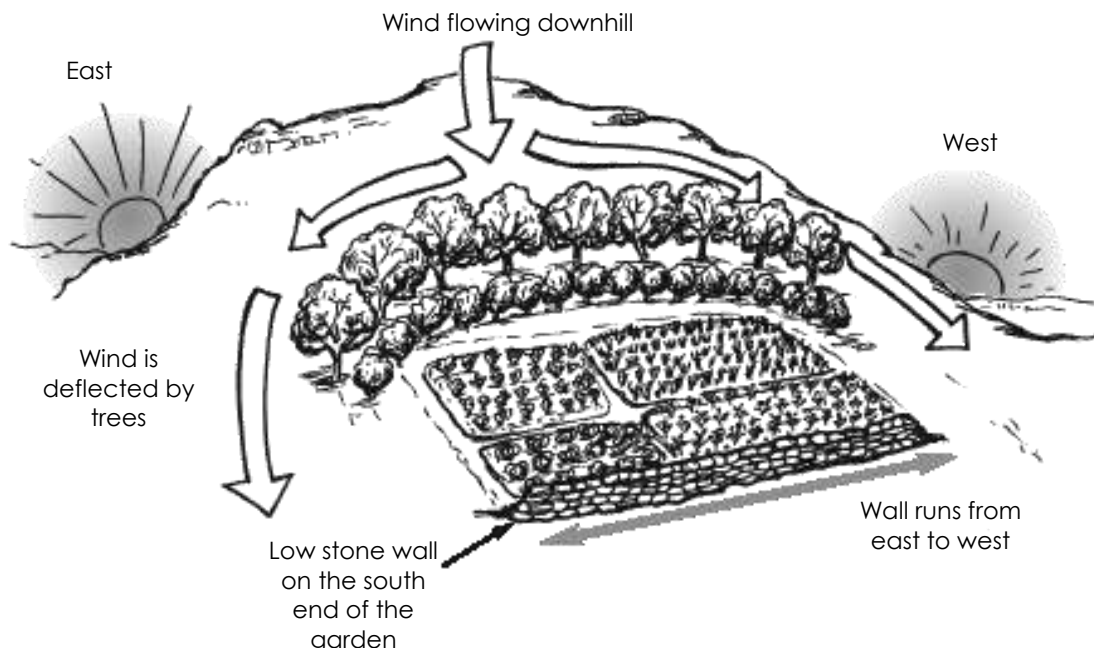


2. *Siting/placing your garden*

The best place to have a garden is on the top part of a north facing slope. It will get the most sun and will not be so cold at night as land at the bottom of a slope.

If your land is on a slope, put plants which may be affected by frost at the top of the slope.

A low wall of stones, built roughly east-west across your garden and on its southern edge will catch the sun during the day and warm up. It will then act like a stove at night giving off the day's heat.

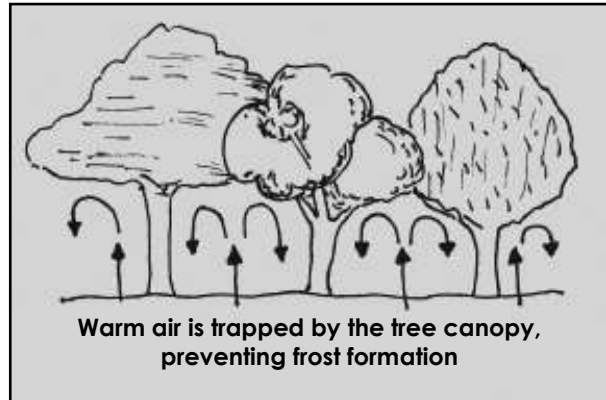


3. *Hotbeds*

These will help in autumn and into winter. Put soil back on top of a trench full of rotting weeds, grass and manure and then plant on top of that, keeping the whole bed well watered.

4. **Trees and bushes**

Trees and bushes help to prevent frost by trapping the heat as it is lost from the ground. They will also radiate some heat into the air at night.



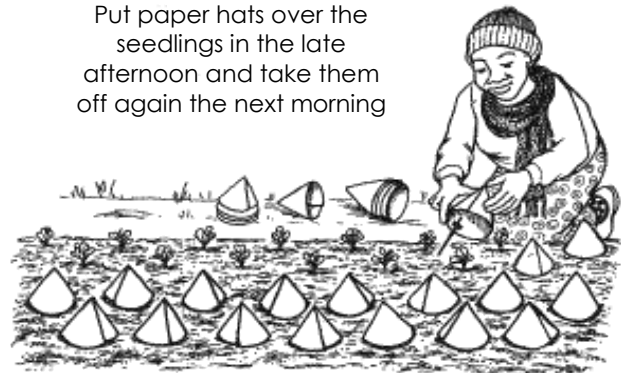
5. **Movement of water and air**

If there is a lot of water on and around your plants, it is sometimes less likely that frost will form. You can try watering your plants well, late in the afternoon. This will sometimes reduce the amount of frost formed on your beds and plants.

You can also make little conical hats from paper for each seedling. This involves quite a lot of work, but may be worthwhile in protecting sensitive plants and seedlings.

Then, it can also help to water the frozen plants in the morning early, before the sun comes up and heats up the environment. This reduces the damage to plants that have been frosted.

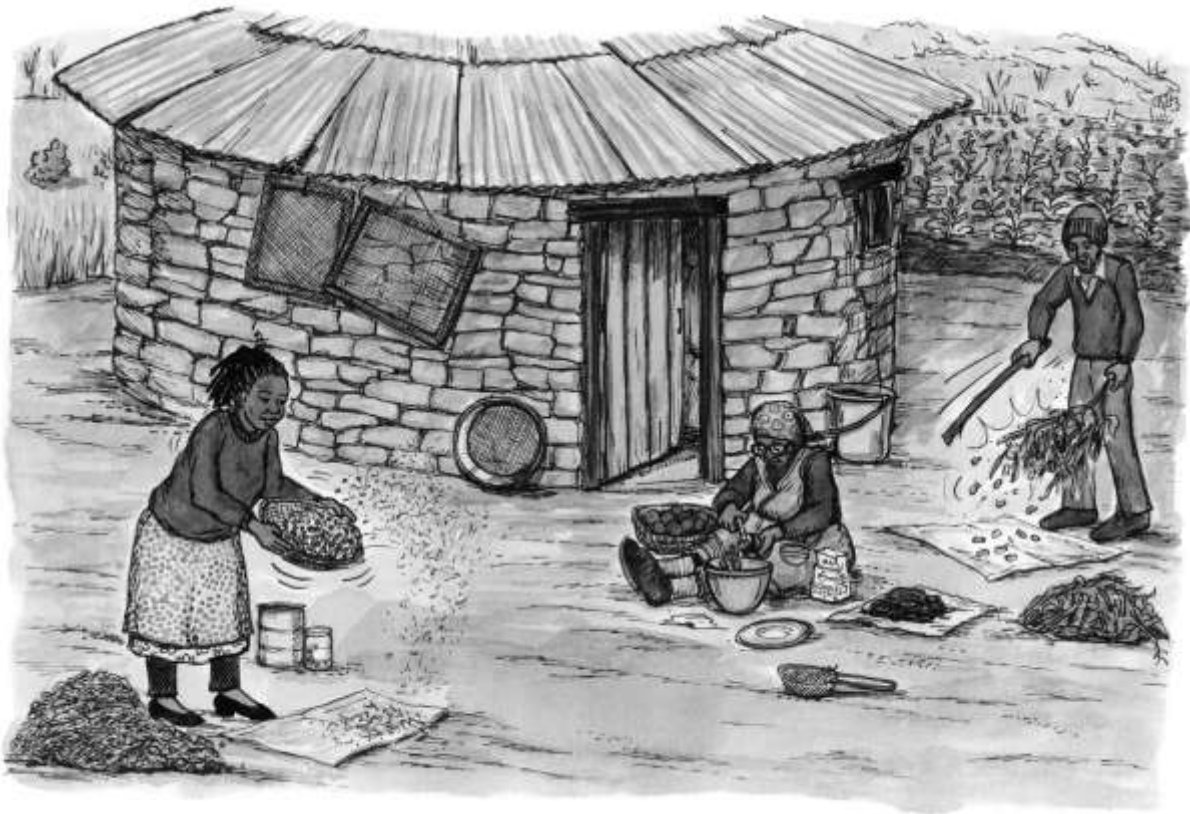
Put paper hats over the seedlings in the late afternoon and take them off again the next morning



Some people make fires in their gardens at night. The movement of the air reduces the settling of frost on plants.

If you have a nice big rock that faces the sun, you can use this as a "heater" for a small seedling bed. Make the small bed in front of the rock. Make a small structure of wattle sticks around your bed. Then drape some clear plastic over your structure. It is easy to get large pieces of plastic from furniture shops in the area. This will create a small "greenhouse" for your seedlings. It will be much warmer inside the structure than outside.

5. Seed saving



Keeping your own seed is central to your independence as a farmer. You can choose which crops you like and which varieties or types of crop. You do not need to go to the shop to buy seed.

There are still many varieties of seed that farmers keep or that you can buy from a shop that you will be able to keep for yourself once you have grown the crop.

Growing from seed to seed involves germinating seeds, transplanting seedlings and looking after selected healthy plants until they mature, so that their seeds can be collected and stored for the following year.

Plants adapt to the environment they are grown in and produce seeds that carry those adaptations, producing healthier plants better able to cope with the local environment.

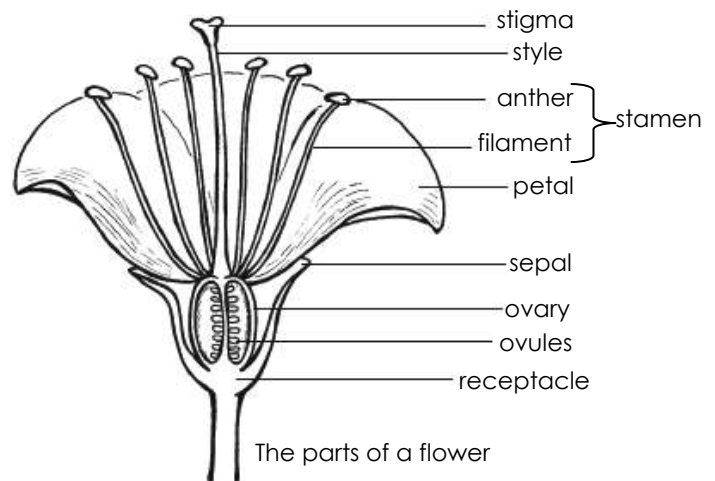
Pollination

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

In some vegetables, herbs and flowers, the male and female part is in the same flower. These are called **complete flowers**.

Exceptions are:

- ❖ The cucurbits such as pumpkins, melons, gourds and cucumber and maize. Here the male and female parts are on different flowers, but on the same plant.
- ❖ Asparagus and papaya. Here male flowers are on one plant and the female flowers on another.



‘Open pollinated’ vs ‘Hybrid’ crops:

Originally all crops were open pollinated. Many plants propagate themselves like humans do. Pollen from the male parts of flowers needs to reach the female parts of the flower. This pollination usually occurs through wind or insects of various kinds: mostly bees.

Hybrid crops have been cross pollinated by humans in a controlled environment. These are crops that will NOT NORMALLY CROSS. This means that you cannot keep seed from a hybrid plant. The seed will either be sterile, or will produce many surprises. The plants grown from hybrid seed will not look like their parents and often are not very strong.

You know that a packet of seed contains hybrid seed when it has a sign on it that says:



Self Pollination

Here, pollen is transferred from the male to the female part of **the same flower**.

Crops that self-pollinate are: tomatoes, lettuce, capsicum (green pepper) and okra. Beans and peas self-pollinate even before the flower has opened.

Generally, plants that self-pollinate can be grown quite close together without them crossing with each other. It is still a good idea however to separate different varieties of the same plant (e.g. different varieties of lettuce) from each other, as some crossing can still occur.

Self pollinated crops:

Green beans, dry beans, cow peas, peanuts, peas, tomato, lettuce and capsicum (green pepper)



Cross Pollination

Here, pollen is transferred from one flower to another on the same plant, or to the flower of another plant of the same type. Cross pollinated plants produce more varied offspring that are better able to cope with a changing environment.

Cross pollination occurs when the pollen is carried between flowers by the wind, bees, other insects, birds and bats. Honey bees are by far the most important pollinators.

Pumpkins are an example. If you have two different types of pumpkin, planted close together. They will cross with each other. The seed that is produced will grow and produce a plant with a fruit that is a mixture of the two types of pumpkin you have grown. This happens with all cross pollinated crops.

Cross pollinated crops:

Brinjal (eggplant), cabbage, carrot, chilli, kale, leeks, maize, mustard greens, onions, spinach (swiss chard)



Pollinators

Bees are the best pollinators of vegetables. As they fly around and

collect the nectar (sweet juice) from the flowers of plants, pollen collects on the sticky hairs on their legs. When they visit the next flower some of this pollen is rubbed off and cross pollination occurs.

Insect pollinated crops:

Brinjal (eggplant), cabbage, carrot, chilli, green pepper, kale, leeks, mustard greens, onions, spinach (swiss chard)



Many grains (such as sorghum and maize), grasses (such as Napier fodder and sweet reed or imfe) and trees are dependent on the wind for pollination. Pollen picked up by the wind can travel vary far (many kilometres) on air currents before coming to a rest.

Wind pollinated crops:

Beetroot, spinach (swiss chard), amaranthus (imbuya)



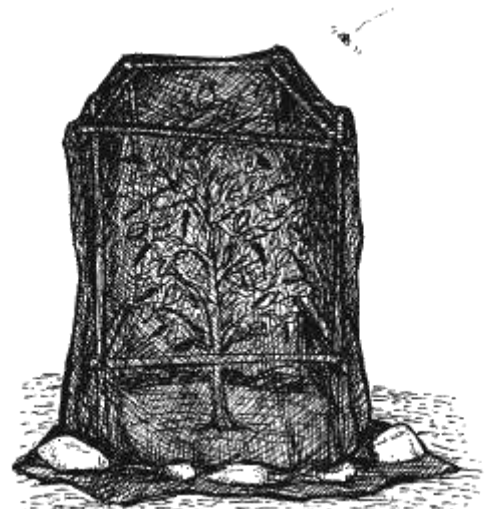
Keeping them pure

Any **insect** or **wind pollinated** plant will need to be isolated from other varieties to stop them from crossing with each other. Below are four techniques you can try to achieve purity:

Grow them apart: Grow two varieties that cross pollinate at least 500 m or more apart. This is how far most insects fly, although bees can fly up to 4 km. Obstacles that deflect wind or insects such as hedges, buildings and ridges can greatly reduce cross pollination.

Isolate them in time: This is possible for crops where all the plants flower at the same time, such as maize and sunflowers. Crossing can be avoided by growing early, mid- and late season varieties that shed their pollen at different times.

Cage them: Caging is needed for species that



Caging of a chilli plant

flower over a long period of time, such as cabbages and chillies. Put cages made of fly or nylon netting over the flower stalks of the different varieties to exclude all insects. Pollinate by hand.

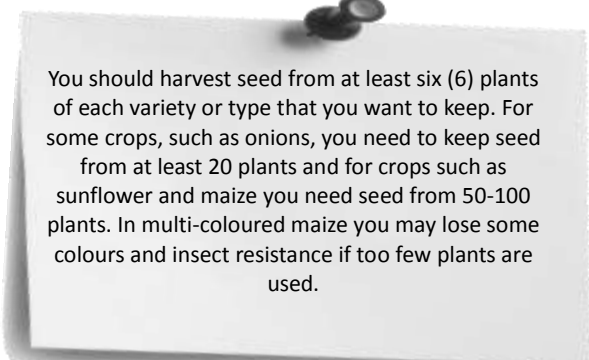
Cage them on alternate days: This can be used instead of hand pollinating varieties that are flowering at the same time. Cage one variety while insects pollinate the second variety. Then cage the second variety while insects pollinate the first one. Once they have been pollinated, both varieties should be caged until flowering has stopped.

Selecting and collecting seed

How long does it take?

Annuals:

These plants produce their crop and seed within one year and then die. This takes 6-9 months. Examples are tomatoes.



You should harvest seed from at least six (6) plants of each variety or type that you want to keep. For some crops, such as onions, you need to keep seed from at least 20 plants and for crops such as sunflower and maize you need seed from 50-100 plants. In multi-coloured maize you may lose some colours and insect resistance if too few plants are used.

Biennials:

These plants grow during the first warm period, slow down through a period of cold weather, and flower and seed during the second warm period. Most biennials originate from the colder European climates where winters are severe and there is not enough time for a plant to produce seed in one warm season. This takes around 18 months. Examples are cabbage, cauliflower, carrots, parsnips, turnips and radishes.

Perennials:

These plants continue to grow, are permanent and survive from year to year. Few vegetables fall within this group. Examples are fruit trees and herbs such as comfrey, rosemary and thyme.

Criteria for selecting seed

- ❖ The seeds should possess the same quality as the variety that was planted. If you planted a long, purple brinjal, collect seed from a long purple fruit. If the fruit looks different, the seed will also be different.

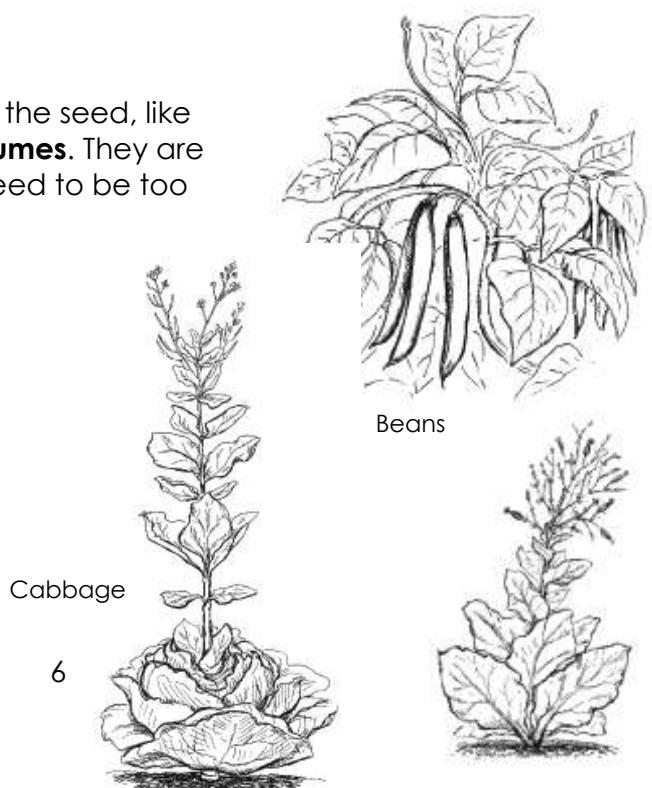
- ❖ Take out plants with undesirable characteristics before they start flowering. Examples are slow growers, sick/diseased plants or ones that bolt (start seeding) too early.
- ❖ Harvest seed only from strong, good looking plants.
- ❖ Harvest seeds from plants that perform well under stress such as extreme weather conditions and plants that resist disease or insect attack.
- ❖ Harvest seed only from healthy plants; if the leaves or fruit have rotten spots or a mottled appearance, do not use seeds from these plants. These diseases are carried in the seed and will appear next time.
- ❖ Do not harvest seed from plants that have bolted. Bolting is when the plant goes to seed much quicker than it normally should. It could be due to stress, such as hot and dry conditions, but is also in-built. So if you take seed from plants that have bolted you are selecting for a plant that bolts, or goes to seed very easily. This is important for crops such as mustard spinach and lettuce where you are looking for a prolonged leaf stage.
- ❖ Harvest the seed when it is ready. Immature seed will usually not germinate as it has not fully formed. Over-mature seed tend to go rotten before you plant them.
- ❖ Do not harvest seed that has been damaged by insects or in any other way. They can only germinate if they are whole.
- ❖ Do not harvest seed that have diseases, such as brown blotches or mould growing on them.

How to know where to find the seed?

Seed heads

Some plants carry pods which contain the seed, like beans and peas. These are called **legumes**. They are mostly self pollinating, so you do not need to be too careful in separating different varieties.

Leafy crops like lettuce and swiss chard will send out stalks from the middle of the plant. The flowers and seeds will be produced on these stalks.

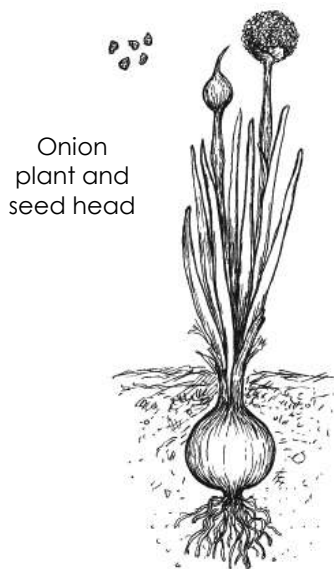
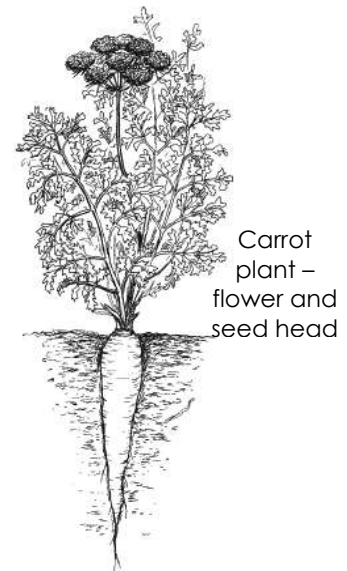


Brassicas (the cabbage family) will first make a head, or compact leaves. Examples are cabbage, cauliflower, broccoli, kohlrabi, kale, chinese cabbage and mustard spinach. Then, in the next warm season, a flower stalk will grow out and seed pods will be produced on these. This can take up to 18 months.

Lettuce

The cabbage family requires bees or other insects to carry pollen between plants. You need as many plants as possible to collect seed from (at least 6, but up to 20). One plant on its own will produce hardly any seed. Brassicas can cross with any member of the family. A cabbage can cross with a cauliflower or a broccoli or chinese cabbage!!! It is important to isolate different members of the cabbage family to obtain seed.

Root crops like carrots: With this type of root crop, the bulb will start to go woody and harder and send out a long stem on which flowers and seed will develop. This will take about 9 months. Wasps and flies carry pollen from one "umbel" to another or from one plant to another. Other crops in the **Umbelliferae** family (umbrella shaped flowers), behave in a similar way. Examples are celery, parsley, fennel and parsnips.



Root crops like onions: With this type of root crop, the flowering stalk develops in the second warm season, as the crop is biennial. This stalk is leafless, hard and hollow, and can grow very tall.

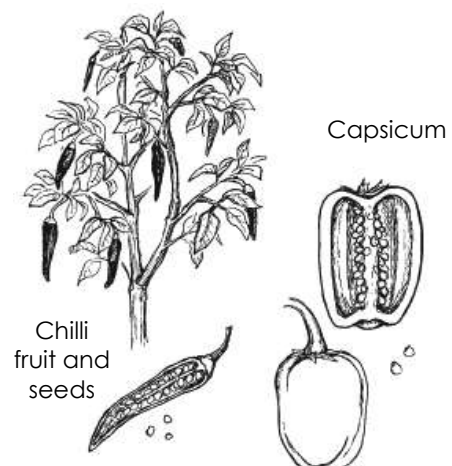
Other plants in this family (**Amaryllidaceae**) are leeks, shallots, garlic, spring onions, chives and garlic chives. These plants are pollinated mostly by bees. Pollination occurs between the little flowers on the same flower ball and between flowers from one plant to another. Seed from at least 20 plants needs to be kept to keep the variety strong. Seeds don't all ripen at the same time and they need to be harvested as they become ready, as they tend to shatter and are blown away by the wind.

Leave these seeds on the plant to dry. For those plants where the seed heads shatter and scatter seeds, you will need to collect them as they dry, rather than waiting until all the seeds are ready. Examples are lettuce, carrots, parsnips and onions.

Seeds in fruit

Fruit is produced only after the fertilisation of the ovules has taken place. These ovules develop to produce the seeds inside the fruit.

❖ **Fruit** is picked when it is slightly over-ripe.



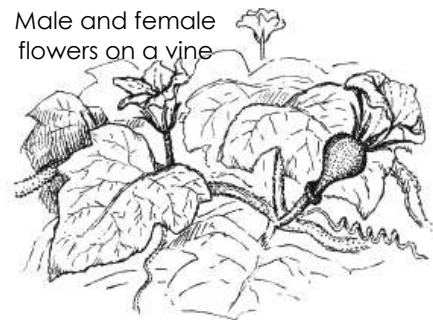
Examples are tomatoes, chillies, capsicums (green peppers), gooseberries and brinjals.

Tomatoes and capsicums are self pollinating. The other plants in the Solanaceae family like chillies and brinjals are cross pollinating. If you are growing more than one variety of chilli, they need to be isolated from each other. Otherwise you may get some HOT surprises!

Pumpkins, melons, gourds and squashes are picked when over-ripe and then left for a few more weeks for the seed to mature further. There are many different kinds of pumpkin and melons. All different kinds of pumpkins will cross with each other, but they will not cross with melons, cucumbers or marrows which are all in the same family (Cucurbitaceae). In this family there is crossing in each species, but not between them. A cucumber for example will not cross with a pumpkin.



In this family, plants have both male and female flowers. The male flowers grow on long thin stems and open before the female flowers, which grow on a short stem and have a small swelling at the base.



- ❖ Cucumbers and marrows are left on the plants until they are fully mature; cucumbers will go brown and marrows will go yellow (and VERY big!).

Seeds that are eaten

Examples here are maize, beans, peas and sunflowers. These are left on the plants until they are mature and dry.

How to know when your seed is ready?

- ❖ The fruit has a **hollow sound** and/or is **disconnected** from the branch. *Examples:* pumpkins, cucumbers. For these fruits it also helps to leave the seed inside the fruit for several weeks after picking.
- ❖ **Colour, size and shape** of fruit. *Examples:* tomato and chillis (red), aubergines (purple or yellow). Green peppers need to be left until they go red. They are immature when green!!!
- ❖ **Shattering** of pods. *Examples:* beans, peas, cowpeas.
- ❖ **Dryness.** *Examples:* carrots, coriander, lettuce, swiss chard, cabbage (seed head goes brown and dry).

Cleaning seed

Winnowing

Chaff and stems need to be removed from seed, as they can hide insects that can attack your stored seeds.

- ❖ Seeds and chaff are tossed into the air and the chaff is wafted away with a gentle breeze. Elongated flat baskets work well.
- ❖ Or put the seeds in a bowl and shake them until the debris floats to the top. Gently blow the chaff away.
- ❖ Large quantities of podded seeds (peas, beans) can be placed in a sack and the seeds separated by stomping on the sack or beating it with a stick. The dried empty pods can then be winnowed out.



Wet cleaning

This is used for plants that **carry their seeds in moist flesh or fruit** such as tomatoes, melons, pumpkin and cucumbers.

- ❖ Scoop the seeds out into a large container of water and rub vigorously. Pour off the water and place seeds on a flat surface to dry.
- ❖ Ferment the seeds of tomatoes and cucumbers. These seeds are encased in the flesh of the fruit and have a slippery jelly around them. This jelly needs to be removed before the seed will germinate. It also rids the seeds of unwanted seed-borne diseases.

Method:

Place the seed in a container. Cover with water. Add one to two tablespoons of sugar and stir until it is dissolved.



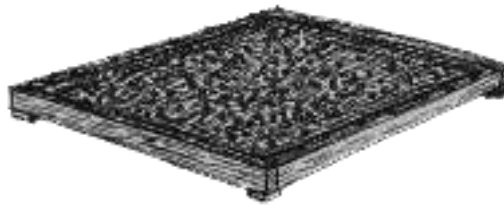
Now leave this mixture for 3-5 days (NOT LONGER!!!). or crust will form showing that the fermentation has occurred and the jelly has dissolved.

Rinse the seeds with large amounts of water.



A foam

Spread them out to dry in a cool place and store in an airtight container like a glass jar.



Drying seed

Large seeds need longer to dry than smaller seeds. A simple test for large seeds (such as beans) is to try to bite one of the seeds. If no impression is made on the seed (tooth marks) it is ready.

- ❖ You need to dry seeds away from the sun in a dry and breezy, airy place.
- ❖ In wet or cold weather, place seed on screens for fly netting and place them high up on racks in a warm room, such as the kitchen.
- ❖ Hang up small quantities in paper bags in a breezy spot.
- ❖ Lay larger quantities on screens or hang them up in hessian sacks. Do not use plastic bags.

Storing seed

The length of time that seed can be stored depends on:

- ❖ The seed type;
- ❖ The quality of the seed; and
- ❖ The storage conditions.



Storage conditions

Darkness

Find a way to keep the seeds in darkness. Use paper bags, dark coloured plastic and galls jars and place them in cupboards. DO NOT place the seeds on a shelf in clear glass jars.

Most seed can be stored for a period of 3-5 years and remain viable. **Viability** is the ability of the seed to germinate. Your seed may look perfect, but if it is not viable, it will not grow!

Moisture

Even if the seeds are dry, if you store them in a damp environment they will absorb that moisture/water. This seriously affects how long your seeds will be viable. Mostly we can only dry our seeds in the air. Do not dry them in the sun, but in a shady place where the air can move (ventilated). When the weather is very wet with a lot of rain and mist, it will be difficult to dry seeds, especially the larger ones, like beans and peas.

The life of seed doubles when the moisture content is lowered by 1%.

Temperature

Seeds last longer in cold, but not freezing conditions. Choose a cold place such as near a river, under trees, under the ground or inside a clay jar.

If you store your seed in hot, light (sunny) and wet conditions they will lose their viability very quickly. You may even not be able to plant them in the following season. They like cool, dark and dry conditions to germinate.

The life of a seed doubles when the storage temperature is lowered by 5°C.

Pests

Storage weevils, fungi and bacteria shorten the life of seeds.



- ❖ Weevils begin to multiply when the moisture content gets high enough (10% or more). The eggs are laid inside the seed, under the seed coat, and the insects hatch from there.
- ❖ Storage fungi/ moulds begin to grow when the moisture content is high enough (around 13% or more) and bacteria start growing around (20% moisture). Mostly we cannot measure the moisture content of our seed. All we can do is keep our seed as dry as possible.

Store your seeds in dry, clean, airtight glass jars or other airtight containers. AND LABEL THEM – Give them names!! By next year you will not remember what it was.

Materials that stop the growth of pests can be used:

- ❖ **Dry ash:** this absorbs moisture inside the container and also prevents the growth and increase of weevils. Add ½ kilogram ash to 1 kilogram seed.
- ❖ **Lime:** can be used in the same way as dry ash. Mix 15 teaspoons (50 grams) with every kilogram of seed.
- ❖ **Cooking oil:** mix cooking oil with your seeds to prevent increase of weevils. Use only 1 teaspoon of oil for every kilogram of seeds.
- ❖ **Dried and powdered leaves of different aromatic plants:** weevils are sensitive to aromatic or strong smelling plants. Try the following:
 - CHILLI: mix 4-6 teaspoons of chilli powder with 1 kilogram of seed.
 - WORMWOOD (MHLONYANE): Dry and crush the leaves and mix with seed. Use 4-6 teaspoons for every kilogram of seed.
 - ALOE: As above.

7. Tower Gardens

What are tower gardens?

Tower gardens are small upright gardens that can be watered using gray water. These gardens are good for older people or people who are ill, as you do not need to bend down a lot and they can be made anywhere close to a home.

What is gray water?

Gray water refers to the water that has already been used for domestic purposes; such as washing of dishes and clothes. Because of the normal shortage of water, it is essential to save water. This water can be re-used for gardening purposes.

Making the most of gray water

In many cases, water has to be carried from the nearest stand-pipe in plastic containers not for the purpose of gardening, but for cooking and washing. This water can be re-used for growing vegetables successfully. Tower gardens offer a way of saving water, because you can use your gray water for gardening.

Vegetables are grown in a column of soil that fills a bag. They are planted in holes cut in the sides of the bag itself and, each day, the available gray water is poured into the bag.

Vegetables can grow successfully with soapy water! You can clear the soapy water out of the system by pouring two buckets of clean water into the column once a week.

This is lazy gardening

One of the main attractions of tower gardens is that little labour or attention is required and this appeals to all busy gardeners. Once people have become familiar with the towers, they prefer to position them right at the back door so that it is easy to pour the wastewater into the tower.

It is difficult to predict how much water is required, only time can tell. If water forms a puddle around the bottom of the tower, it is an indication that too much water is being applied and the obvious answer is to make a second tower!

Making up the tower

The way in which the tower works is simple:

- ❖ The **upright poles** can be made from branches or fencing standards. Where crops such as tomatoes are planted in the top layer of soil, extensions can be wired on to provide trellising.
- ❖ The selection **of the cloth** that forms the sides of the tower is critical.
 - Nylon gunny bags can last about two years;
 - Sacking, as shown in the photograph on the right can only **last the season**;
 - Black plastic sheets deteriorate rapidly in the sunlight;
 - Shade netting is much more durable; but it is important to use nylon string or fishing line to join up the ends of the shade netting to form cylinder, as shown in the diagram at the bottom.



A picture of a tower garden being constructed. Poles here are made from branches, and the tower is made from shade cloth.



- ❖ The **soil** is contained by the shade cloth "skin" and surrounds a central stone packed drain/ column.

The **soil mix** provides fertility and retains water:

- Mixtures of six parts of soil, four parts of manure and two parts of wood ash are satisfactory.
- The soil should be damp but not too wet when you are packing the tower.
- The water must be distributed evenly throughout the soil mass and will not

penetrate any compacted areas.

The **stone column** in the middle of the tower controls the flow of **water** so that the soil in the tower is kept moist.

- ❖ Carefully pack flat stones, or building rubble.
- ❖ If it is possible, use smallish round stones, provided they are evenly packed, so that even water distribution is achieved.



Participants in Potshini are busy filling up the stone column in the middle. Note the small white bucket (bottomless) that help to provide a rigid structure for the placing of the stones.

What vegetables can be grown?

- ❖ Leafy crops:
The towers are ideal for leafy crops, typically various varieties of *spinach* are

planted through the holes in the side of the shade net cylinder. Ideally the holes should not be one above the other but should be staggered diagonally, providing more space for root development.

❖ Tomatoes and onions:

Tomatoes and *onions* can be planted in the top layer and, if crops require trellising, this can be provided by extending the vertical uprights and joining them with wire or string. Where possible, companion crops should be grown to facilitate biological control of disease and pests. *Garlic* and *onions* are useful in this regard.

An unexpected benefit is the way in which the vegetables **thrive in severe heat wave conditions** which have proven to be too much for conventionally planted gardens. The reason for this is not quite clear. It may be the free air circulation, lower soil temperature or the better moisture status of the soil.

It is not claimed that towers will be able to provide all the food a family needs but the contribution made to nutrition and eating pleasure is very considerable.



Participants in Potshini are planting spinach into the sides of the newly prepared tower garden. Tomatoes and onions will be planted in the top

Materials needed



bucket, with the bottom cut out
(10 liter, with vertical sides,
about 300 mm diameter)

shade cloth
(3.0m x 1,3m)



**fishing line or
nylon string**
(1,5m)

soil mixture:

6 wheelbarrows **soil**

4 wheelbarrows **manure**

2 wheelbarrows **wood ash**



Instructions

Step 1:

Choose a flat piece of ground (1m x 1m), as close to the kitchen as possible, but make sure that goats and chickens won't be able to get to your Tower Garden.



Step 2:

Plant the 4 wooden poles to form the four corners of the Tower.

Step 3:

Wrap the cloth around the poles and sew the ends together with fishing line or nylon string (something that won't rot away, letting the Tower collapse).

Step 4:

Roll the top edge of the cloth down and out of the way before filling the Tower.



Step 5:

Using a spade, mix the soil, manure and ash very well, then mix in some water to make it slightly damp (not too wet!), so that you can place the soil mixture without compacting it.

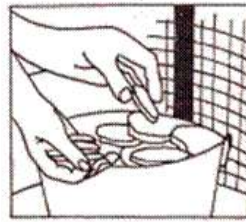


Step 6:

Fill the first 30cm (one ruler height) of the Tower with the soil mixture.

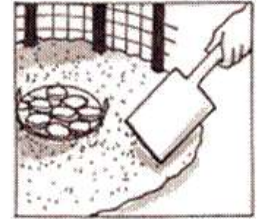
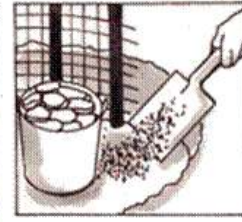
Step 7:

Place the bottomless bucket in the centre of the Tower, on top of the first layer of soil.



Step 8:

Pack flat stones carefully in the bucket, in such a way that water poured into the top would run through nice and slowly. This gives water time to seep sideways into the soil to the plant roots.



Step 9:

Fill the next layer of soil in the Tower around the bucket and up to its rim. Take care not to compact the soil while placing it.

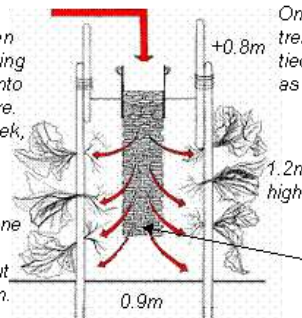


Step 10:

-Pull the bucket out partially, leaving the stones in position.
-Pack the next layer of stones into the bucket and then the next layer of soil, again to the rim of the bucket.

Repeat until the Tower is at waist height (about 1.2m high). Plant seedlings into small holes made in the cloth, staggered around the sides of the Tower; and taller-growing crops on the top surface of the Tower.

Water the Tower Garden daily by pouring grey water onto the stone core.
Once a week, pour two buckets of clean water down the stone core to flush soapiness out of the system.



Once the taller crops need trellising, extensions can be tied onto the upright poles, as necessary.

Use your Tower Garden continuously to prevent it drying out and becoming unusable!

The porous core of flat stones starts 30cm above ground level

8. Grafting Fruit Trees

What is grafting?

Wild fruit trees grow in many different soils and climates and have very strong roots, but their fruit is not very big or tasty. Other trees that are not so strong may

bear good, tasty fruit. To obtain a tree with both strong roots and good fruit the roots of the wild tree are joined to the branches of the tree with tasty fruit. The process is called **grafting**; this is done by cutting the stem just above the roots of a wild tree and binding a branch that has been cut from a good fruit bearing tree. The two trees grow together to form a single tree.

Fruit trees that you buy from a nursery are usually grafted. Gardeners can graft their own trees at home to create varieties that provide the type of fruit they desire – perhaps even with different kinds of fruit on the same tree!

Guidelines for Successful Grafting

- ❖ Use clean sharp tools to make your cuts – sterilize your knife between cuts with a 10% bleach solution (1 teaspoon bleach mixed with 9 teaspoons water)
- ❖ Once you've made cuts, work quickly so that the wood won't dry out.
- ❖ Don't touch the exposed wood.
- ❖ Make sure your rootstock and scion are compatible. You can ask a nursery or just experiment. Generally you can graft apples to apples, pears to pears, grapes to grapes, stone fruits to stone fruits (peaches, apricots), and citrus to citrus (orange, lemon).
- ❖ Grow rootstock in rich deep soil with full sun and wind protection if necessary. Water regularly.
- ❖ Don't get discouraged as you're learning how to graft! Do several different graftings in case some don't take. Practice makes perfect!

Important terms

A **scion** is the branch that you graft on to another tree. You cut scions from a tree with desirable fruit.

A **rootstock** is the root portion that forms the base of a grafting. To graft a fruit tree you attach a scion to a rootstock. You choose rootstock from healthy trees that grow well in your area.

Benefits of grafting

Some of the benefits grafting can bring to the experimental gardener include:

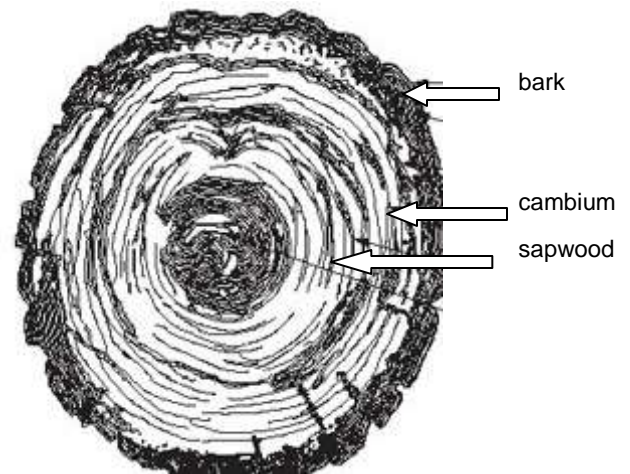
- ❖ You can create trees such as an apple tree with two cultivars that can pollinate each other.
- ❖ You can choose a rootstock that gives a nice size tree with good pest and disease resistance and high productivity and graft it with a tree that makes

the large, flavorful fruit you desire.

- ❖ You get fruit sooner. The top branch (scion) is grafted onto a plant (rootstock) with well-established roots. This means that the roots can feed the scion well, so you have a head start of at least a year.

How to graft

There are many different methods of grafting. The key in all the methods is to make sure the cambium layer in both the scion and rootstock come into contact so that they will grow together. The cambium, a thin layer found just under the bark, is the actively growing part of the stem.



First you must prepare in advance

Two years before you plan to graft (June/July):

Take cuttings (see box below) from trees you want to use as rootstock and plant in a container or bed.

One year before you plan to graft (August or September):

Plant the 1-year old rootstock in the ground where you want the tree to grow. Care for it throughout the year, rubbing off buds as they form. Keep watering and adding manure/compost in adequate (but not excessive) amounts. Let rootstock develop until it's approximately 46 cm tall before grafting onto it.

(Alternatively, you can graft directly on to an existing tree. In this case, water and care for the tree in the year preceding grafting.)



The following June/July:

Take scion cuttings. (Remember, these come from the tree which has the fruit you want your rootstock to produce).

When cutting your scion, choose strong straight branches. (Remember, they will form the trunk of your new tree). Cut 23-25 cm (a bit longer than a hand width) pieces about 4cm below a bud. Make

How to do cuttings

- ❖ Cut from a good, productive tree
- ❖ Use a sharp knife/razor to cut pieces of stem as thick as a pencil.
- ❖ Choose stems with buds.
- ❖ Cut top section off so you're left with pieces with 4 buds.
- ❖ Cut top end at an angle and bottom end straight across.



sure the width at the bottom (where you cut) is the same as the width of the rootstock (ideally 1 cm). Cut off any wood at the top that isn't completely hard. Cut several scions. Bundle scions with a tie, wrap in a dry plastic bag, label, and store them in a cool, dark place.

Now you' re ready to graft

The following August or September:

1. Just before the buds break in early spring, cut off the top of the rootstock so it stands 15-30 cm (one hand) above the soil line. Prune all branches to be flush with the stem. (If grafting onto an existing tree, just prune back a bit).

2. Cut back the rootstock to where the scion is to be grafted. Make a sloping cut.



3. Prepare the scion: Make a top cut just above a bud about 4 buds from the base. Make a cut at the base of scion at the same angle as the rootstock cut.



4. Make a shallow cut into the rootstock from 1/3 down the sloping cut.



5. Make a shallow cut into the scion from 1/3 up the sloping cut.



6. Slip the scion into the rootstock so that they interlock.



7. Bind the union with tape. Dab the top of scion with wax and cover tape with wax if possible.
8. After 2 months or so – after a strong callus has formed and buds on the scion are developing, remove the tape. Cut off any rootstock growth – rubbing off any buds and cutting any suckers that arise from the soil.



9. Vegetative Propagation - Cuttings

Plants can be grown from seed or from parts of the parent plant. The advantage of using the parent plant is that the offspring will have the same features as the parent in terms of growth and fruit.

Only some types of plants and trees can be grown directly from the parent plant (vegetative propagation). There are different methods of vegetative propagation – in this handout we will discuss how to grow a tree from a cutting.

Cuttings

Cuttings are plant pieces, usually stems and branches that can grow new roots. Cuttings can be taken from deciduous trees (which lose their leaves in winter) such as peaches, plums, figs and mulberries. They can also be taken from other plants such as herbs and sweet potatoes.

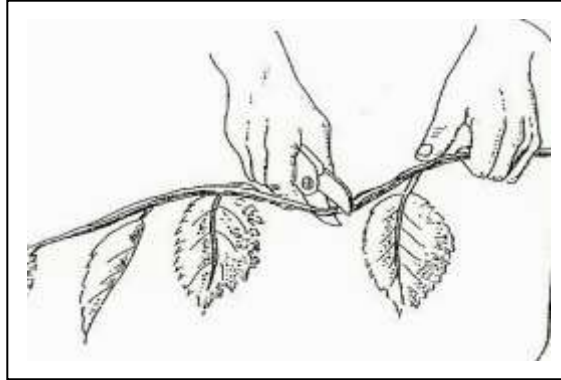
Cuttings should not be taken when plants are stressed for example if they are very hot or cold or during drought. Shoots that are producing flowers or fruit should not be used for cuttings. Generally there are two kinds of cuttings:

Softwood Cuttings	Hardwood Cuttings
These are “green” cuttings taken from new growth during the season.	These are older, woodier shoots from the previous seasons’ growth.
Cuttings are usually taken early in spring.	For deciduous trees: cuttings should be taken in the dormant period before buds sprout (winter). For evergreen trees: cuttings should be taken just before a time of rapid growth. (This is difficult to judge so you need to experiment).
Remove all but the top few leaves.	These cuttings have no leaves and usually tips should be removed. In general, use a relatively young shoot with many nodes.

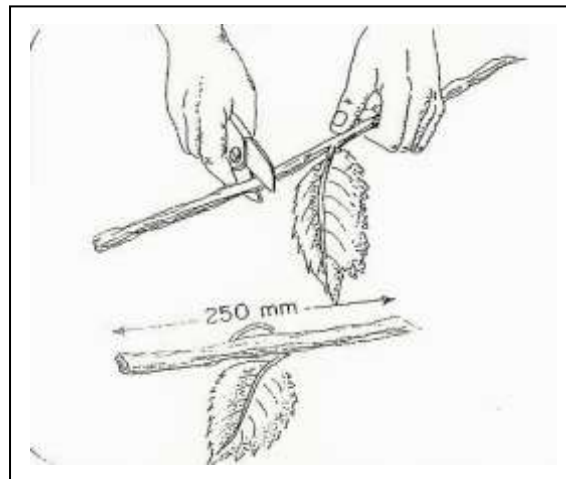
How to take a cutting

- ❖ Cut just below a leaf node or bud.
- ❖ Make sure that the cutting has at least 5 nodes on it, reasonably close together.

Use lateral and basal branches rather than water sprouts so that the new tree will grow upright with long sections between nodes. The cutting should be about as thick as a pencil.



- ❖ Cut the stem to a length of 25-30 cm. The bottom of the cutting is made at an angle just below a node. The top of the cutting is made at an angle just above a node.



- ❖ The cutting needs to be placed in well-drained soil (preferably sand) with at least two of the nodes covered. **Make sure your cutting is the right way up!!!** The sand must be kept moist at all times and protected from wind and heat.
- ❖ If you can get some hormone rooting powder, dip the bottom of the cutting in this before planting in order to help the stem form roots.



10. Fruit and Vegetable Processing

When you have an abundance of tomatoes, peaches, or any other fruit or vegetable in your garden it's nice to know how to preserve them so that you can use them all before they pass their prime. By learning how to dry your produce or preserve it in a jam or relish, you can ensure that none of your hard work in the garden will be wasted. Also, if you are interested in making an income from your garden, you may find that by processing your produce first you can make even more than if you sell it fresh.

Food Hygiene

It's important to practice good hygiene in food processing to avoid food poisoning. Wash your hands thoroughly before handling food and after using the toilet or handling kitchen waste (especially raw meat). Ensure that cutting boards, knives, jars, and bowls have all been properly cleaned. Make sure the water you are using to clean your kitchen equipment and fruits or vegetables is clean. If not, boil it for 10 minutes or add a bit of bleach (1 : 50 mixture).



Drying Fruits and Vegetables

- Some vegetables need to be blanched before being dried. This means they are dropped into boiling water for a certain amount of time.
- Drying requires a warm temperature, low humidity and a flow of air.
- Drying is a slow process and can take from 6 hours to 5 days. Drying time is influenced by the moisture content of the vegetable or fruit as well as the method of drying used.
- Always use fresh healthy produce to ensure a good quality dried product.

Methods of Drying

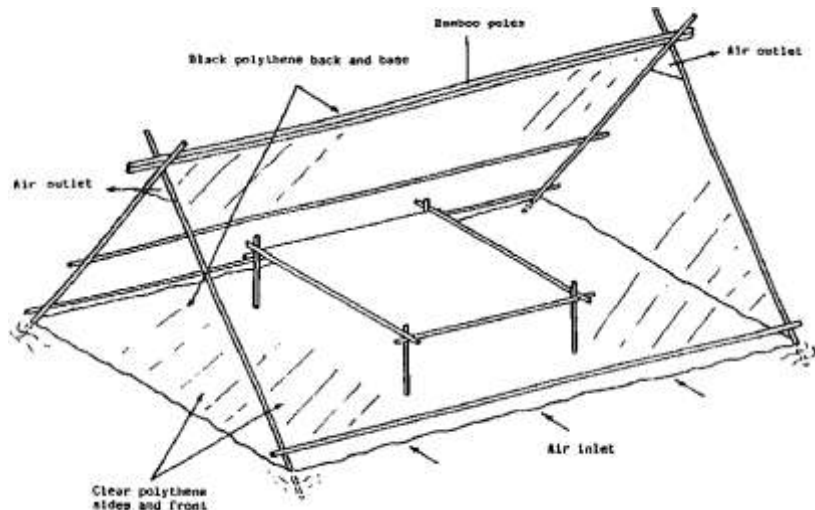
Sun Drying: Produce is placed on drying racks, covered with netting to prevent contamination from insects and dust, and placed in direct sun or shade.

Drying time: 3-5 days



Disadvantages	Advantages
Produce must be removed when weather changes (wind or rain). If produce isn't protected, produce may be contaminated with dirt.	Drying frames are cheap and easy to make.

Tent Drying: Produce is placed in a wooden frame, covered with plastic and placed in direct sunlight. Drying time: 3-5 days



Disadvantages	Advantages
Requires some supplies and labour to construct.	Protects crops from rain and wind.

Oven Drying: Produce is placed on oven racks and baked at 140° C. Drying time: 8 hours or more

Disadvantages	Advantages
Very expensive and should therefore only be used as experimentation.	Very fast drying time.

The Drying Process

Cleaning

- Use only good quality, ripe produce
- Clean all working surfaces, containers, and equipment. Use a solution of 1 part bleach to 50 parts water (20L water + 400ml bleach)
- Use fresh cleaning solution every day.
- **Do not break the skin of the produce during this process!!**
- Place produce in a clean container after washing.
- Stops ripening
- Prevents change in flavour

- Enables produce to rehydrate better

Peeling

- Peeling should not take place in the space where raw produce is washed.
- Peel carefully to remove as little flesh as possible.
- Dispose of peels immediately.

Cutting and slicing

- The type of produce determines the thickness of the slice.
- Thick slices take longer to dry.
- Thin slices stick to drying trays.
- If you intend to sell, make sure all slices are the same thickness.



What does blanching do?

- Destroys enzymes and thus sets the colour
- Shortens the drying time

The following should be blanched before bottling:

- All greens should be blanched about 5 minutes to reduce the bulk.
- In order to prevent loss of the milk, maize should be blanched on the cob until it is firm to the touch and until the milk does not ooze out when it is pricked with a fork.
- Beets, carrots and parsnips should be blanched until the skins will slip off easily.

Blanching (necessary for vegetables and recommended for fruits as well)

- Boil just enough water to cover the produce.
- Place cut produce in a steamer basket.
- Immerse in boiling water (required time varies).
- Remove from boiling water and drain with a sieve.

Keeping the colour

- Now place vegetables into a bath of warm water into which the juice of one lemon has been squeezed
- Allow to cool for about 10 minutes, before removing the vegetables and draining them.

- This will ensure that vegetables do not lose their colour or become discoloured during drying.

Loading the tray

- Drying trays must be brushed clean and washed beforehand.
- Load trays while slicing -- produce must be placed close, but not overlap.
- Trays should be placed on a level area out of the wind either directly in the sun or in the shade.

Drying

- If moisture forms on the inside of your Tent Dryer, open the door slightly.
- If possible, place the tray/dryer inside overnight to protect from dew.

Packaging and Storage

- Proper packaging and storage prevents moisture from re-entering.
- Pack carefully to avoid bruising.
- Packaging needs to be done immediately after totally dry.
- Keep your eye on the container for the first 7 days: stirring daily and removing any mouldy or damaged pieces.
- Store in airtight glass jars, boxes, or metal cans with tight fitting lids or sealed in plastic bags.
- Store in small quantities to avoid major losses due to mould.
- Store only one type of food in each container.
- Glass containers should be kept in a dark environment.
- Containers must be marked with the date.
- Store in a cool, dry, and clean area.
- Product can be stored 1-2 years, depending on the type of food.

A high quality product will be properly dried with no mould. It should have a good colour, but some browning is normal. It should taste like the fresh produce. Dried vegetables must be dry and brittle.

How to dry pumpkin leaves:

Select fresh, tender leaves
Peel off the hairy outer skin
Wash in clean water
Steam blanch for 3 to 5 min
Place on trays ready for drying
Test for dryness: crumble easily



How to dry carrots:

Choose crisp, tender carrots without woodiness
Steam until cooked through but not mushy
Remove whiskers, tails and crowns
Cut into rings (2-3 mm) or shred
Arrange on trays for drying
Test for dryness: slices very tough, but can be bent.



Sauces, Relishes, and Jams

Selection and preparation

- Select firm produce of good quality.
- Do not use mouldy or diseased fruit – the heat will kill potential spoilage organisms, but will not remove the off-flavour that the mould may cause.

Washing

- Wash thoroughly (even if you will remove skin) to remove dust, dirt, and mould spores.
- Wash small quantities at a time under cold running water.



Choosing bottles

- Bottles must not have any cracks.
- Metal lids should not be bent or rusted and should fit securely.
- Clean bottles by washing with soap and rinsing in clean water.

Sterilizing bottles

- Place bottles in a saucepan filled with water.
- Bring to boil and continue boiling for 15 minutes.
- Use tongs to lift the bottles out, pouring out the water.
- Spoons and lids must also be sterilized in boiling water for 10-15 minutes.

Filling bottles

- Fill bottles while food is still sufficiently hot ($\pm 80-85^{\circ}\text{C}$).
- Ensure you leave 1-2 cm at the top.
- Release bubbles by inserting a knife between the bottle and the food.
- Clean the rim with a clean dampened paper towel.
- Seal bottle, but not too tight.

Warm water bath

- To ensure a longer shelf-life, give bottles a warm water bath for 10-15 minutes.
- Use a large saucepan with a tight-fitting lid, which is deep enough to ensure that the water will be 5cm above bottles during the entire process. Refill water

bath during sterilization if necessary.

- Preheat water to 82°C. Place bottles one at a time on a false bottom (like a flat rock inside the pot) and cover with warm water. Bring water to boil and continue boiling for 10-15 minutes. Start timing only once water is boiling.
- **It is important to leave a 20mm space on top when filling the bottles to prevent content boiling over during sterilization.**

Cooling of bottles

- Remove bottles from the saucepan and place on a rack, towel, or newspapers, allowing a 3cm space between the bottles.
- Allow to cool to room temperature for 12-24 hours.
- Check lids to ensure that they are sealed.

Reprocessing of unsealed bottles

- If lids did not seal, check the lid for tiny cracks or scratches. Replace if necessary. Then repeat warm water bath within 24 hours.

Labelling and storage

- Label with product name and date.
- Store in clean, cool, dark place.

Identifying and handling spoiled bottled food.

- **Do not taste food that is suspect.**
- Check for dried food on rim of bottle, rising bubbles, or unnatural colour.
- When opening the bottle check for unnatural odours and cotton-like mould.
- Discard of all contaminated food and containers.

Recipes

Tomato Relish

1 large onion	800 g chopped ripe tomatoes
1 granny smith apple: cored and chopped	250 ml vinegar
160 g sultanas	83 ml fresh orange juice
¼ teaspoon mixed spices	1 whole clove
¼ teaspoon chilli powder	

Place all ingredients in a large saucepan.

Bring to boil.

Turn off heat and simmer for 1 hour, stirring frequently. Remove from heat.

Sterilize bottles for 15 minutes. Pour hot relish into sterilized bottles and seal.

Tomato Chutney

1 kg tomatoes	500 ml vinegar
12.5 ml mustard powder	2 ml red pepper
½ clove garlic	300 ml brown sugar
12.5 ml ginger	125 ml sultanas
2 onions	

Dip tomatoes into boiling water and peel. Cut into pieces. Place all the ingredients in a saucepan and boil slowly, stirring occasionally with wooden spoon, until soft and thick. Pour into sterilized bottles and seal.

Piccalilli Relish

2,75 kg prepared vegetables (Enough vegetables to fit into one big pot. You can use cucumber or cabbage, marrow or carrots, small onions, cauliflower, beans)

3 pints (6 cups) white vinegar

6 teaspoons dry mustard powder

2 teaspoons ginger

250 g sugar (1 cup)

37.5 g plain flour (1/3 cup)

4 teaspoons turmeric

Brine (Very salty water. To make add approx. ½ cup salt to 1.5 litres of cold water)

Clean and prepare vegetables (peel, cut into 2 cm cubes, slice onions, break cauliflower into florets, cut beans into 2 cm lengths). Immerse the vegetables in brine and leave overnight.

Spice the vinegar with mustard and ginger and add sugar. Heat slowly until the sugar has melted.

Rinse and drain the vegetables thoroughly. Put them in a pot and add the hot vinegar syrup. Simmer for 20 minutes.

Lift the vegetables out with a slotted spoon and pack into jars. Don't overfill.

Mix the flour and turmeric to form a smooth paste using a bit of vinegar. Stir this into the hot syrup. Boil for two minutes, then pour over the vegetables and seal.

Curry Cabbage Atjar

2 cabbages

4 onions

500 g white sugar

30 ml corn starch (or flour)

15 ml curry powder

15 ml mustard powder

7 ml salt

625 ml white vinegar

Chop cabbage finely. Peel onions and chop finely. Cook cabbage and onions in a little water until soft. Drain well.

Mix sugar, corn starch, curry powder, mustard powder and salt.

Make into a paste with a bit of the vinegar.

Add remaining vinegar, heat until boils. Cook for 5 minutes.

Add cabbage mixture and let it cook through well.

Pack into jars and seal while hot.

Resource Material for Homestead Food Gardeners

Chapter 5: Handouts (English)

- Handout 1 Saving and Using Water
- Handout 2 Homestead Irrigation Techniques
- Handout 3 Tank Maintenance and Safety
- Handout 4 Watering the garden: How much, how often?

5.1 Saving and using water



Other than getting water from taps, boreholes, springs, streams or rivers, we can also harvest rainwater to meet our household water needs. If we live in areas with little rain, or long periods without rain, it is important that we harvest rainwater and reuse our water whenever possible. By harvesting and reusing water, we have more water over a longer period of time.

With **rainwater harvesting**, we collect the water falling on and running across our yard. One of the main attractions of harvesting rainwater in the yard is that it falls where it is needed – which reduces the time and effort needed to get the water to the garden. We get more water to soak into our soil, so that the soil gets wet deep down and can sustain plants for much longer. Additionally, we can store water in containers and/or tanks for later use.

Another source of water for household use is **greywater**. This is water that has been used in the home for washing dishes, doing laundry or bathing. This water can be re-used in the garden. You may add ash from a wood fire to the greywater and leave it overnight to settle out the soap and impurities before it is used to water your plants. You should rotate where you irrigate your garden with greywater so that each part of your garden gets clean water as well as greywater.

Rainwater harvesting can happen in a number of different ways, usually in this order:

- ❖ We can **catch** the water where it falls and **slow it down** so that it doesn't wash

away everything in its path

- ❖ We can **channel** water to where it is needed
- ❖ We can **store** water either in the soil or in tanks or containers

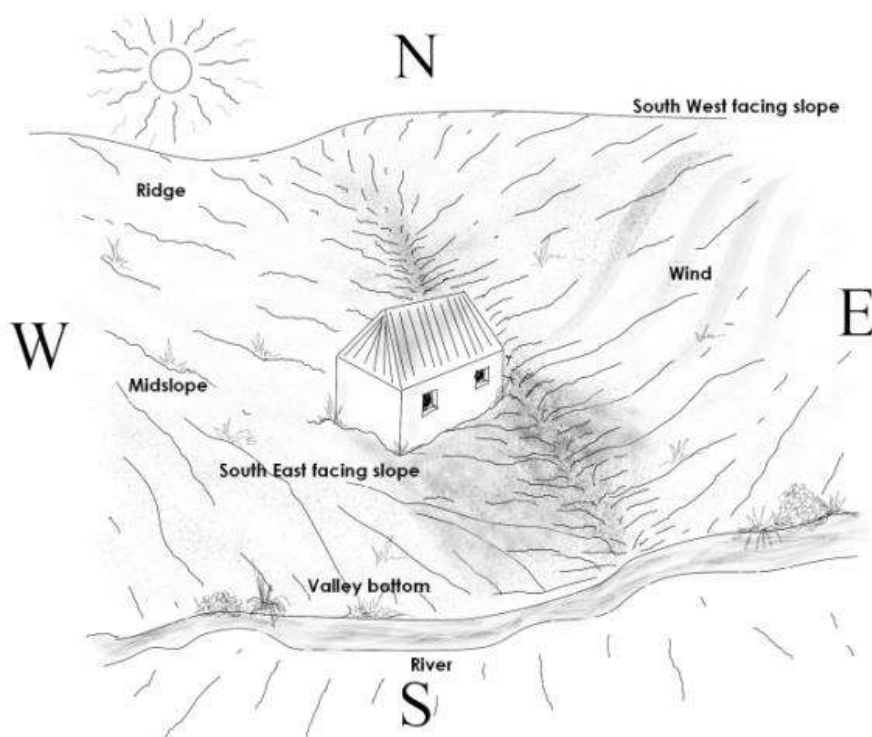
Collecting water where it falls

The first step in rainwater harvesting is to catch water and slow it down to give it time to sink into the ground. This is done through proper garden layout as well as through constructing earthworks such as bunds/earthbanks, swales and tied ridges.

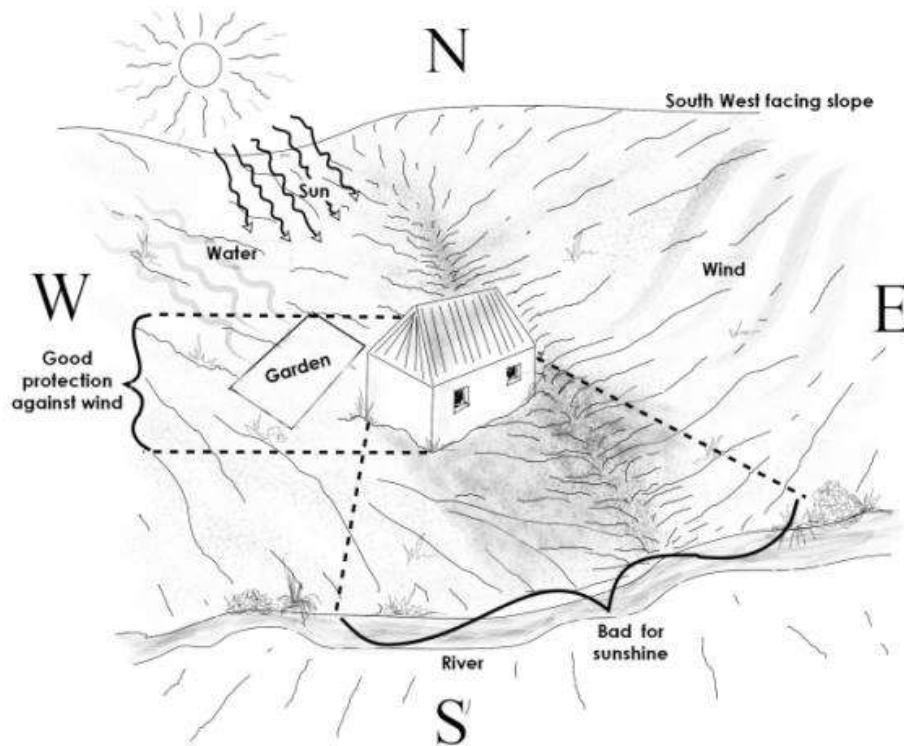
Garden Layout

When designing your garden layout you should consider elements such as wind, run-off and sun position in order to maximize the amount of moisture retained in your garden. Below are some examples of how you can collect water where it falls in your garden and keep the moisture in the soil.

- ❖ Protect your garden from wind. In windy areas, plants and soil left unprotected will dry out.
- ❖ If your garden is on a slope, make your beds across the slope. This will catch the water and stop it from running down your beds and off your land. Notice where the water runs through the yard during rainstorms.
- ❖ Plan your beds so that full-grown plants get maximum sun exposure, while seedlings are protected from too much sun.



Where would be a good location for the garden?



This garden location is good because it's not too high on the ridge (so not too exposed to wind) and not too close to the valley bottom (so less tendency for frost). Since the house is on a south-facing slope (which tends to be colder as the sunshine cannot warm it as effectively as slopes that face north), this gardener must make the most of the available sunshine. The farmer will divert run-off from the natural drainage route. The house will provide some wind protection for the garden.

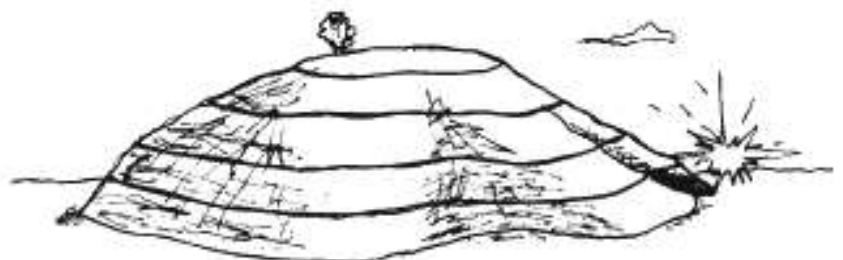
- ❖ Add organic matter to the soil. Soil with more organic matter incorporated into it retains more water for longer. Deep trench beds are an excellent way to enable garden plots to retain more water for a longer period of time.
- ❖ Add mulch to garden beds to help retain moisture in the soil. Mulching also protects your soil from crusting.
- ❖ Keep the soil covered with growing plants. Use ground covers, bushes and trees.

Bunds / Earthbanks

Bunds (also known as earthbanks) are laid out across a slope, along a contour line. A contour is a line or a series of points that runs straight across a slope. Everything along the line is level.

How to mark out a contour line

You can use an A-frame to mark out the level points along a contour.



Contour lines drawn on a picture of a hill to show the areas that are level

Materials:

2 poles, each about 3 metres long
 1 pole, about 2 metres long
 String and wire
 A small stone

An A-frame is easy to use and build!

**How to build an A-frame:**

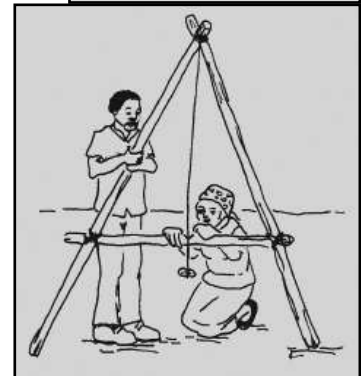
- 1 Take two poles of the same length and tie them together at one end, using string or wire.



- 2 Then, tie the third pole across, between the two other poles, about 1 metre from the bottom.



- 3 Now tie a piece of string onto the frame at the top. Attach the stone onto the end of the string. When you hold the frame up, the stone should hang just below the cross pole/bottom pole. Hold the A-frame upright on a level piece of ground/floor. Mark the place where the string hangs across the bottom pole. This should be close to the middle of the pole.

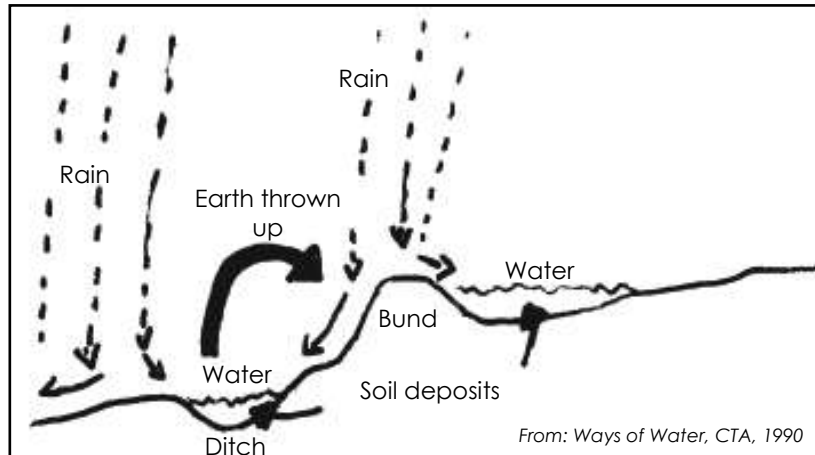
**How to use an A-frame:**

- 4 Find two level points on the left-hand side of the area where you are trying to establish the contour. Mark the two points with pegs. Now pivot the A-frame on its right leg, swinging the left leg around. Find the level for this leg by moving it until the string with the stone attached is at the marked mid-point. Continue moving the frame in this manner.

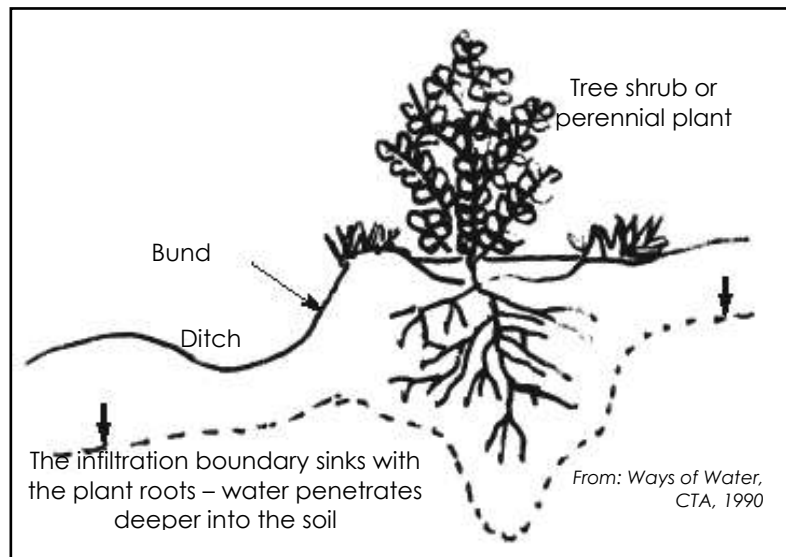


From: Farmer-to-Farmer Handbook, FSG, 1996

Build a **bund** by digging a ditch across the slope, along a contour line. Place the soil from the ditch above the ditch. Dig the ditch about 30 cm deep (the width of a spade) and 30 cm wide. Rainwater will accumulate above the bund and in the ditch. This water will sink into the ground instead of running off your land. As soil is washed down the slope and accumulates behind the bank, a small flat terrace/area will be formed over time.

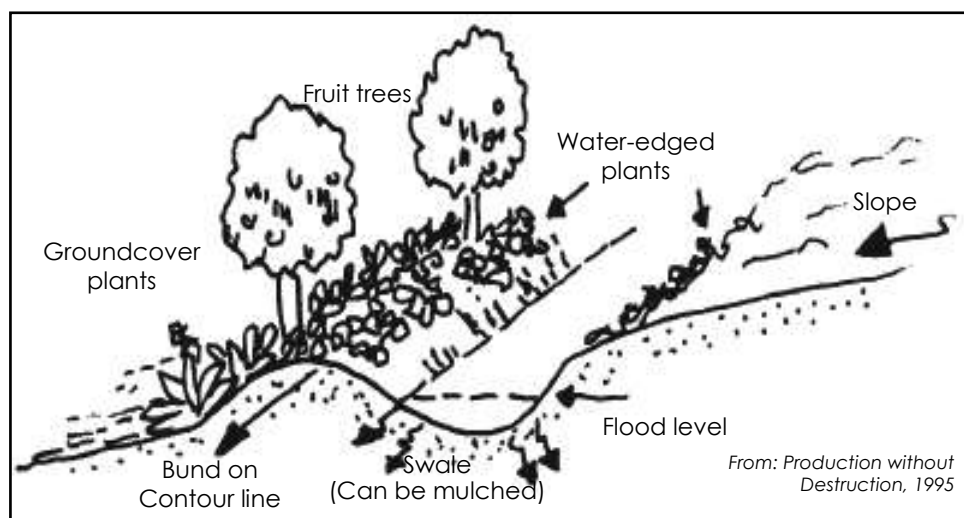


Plant long-living or perennial plants along these banks. This helps to hold the soil on the bank. It also provides your bushes and trees with water. This is a good place to plant fruit trees and medicinal plants. The ditches will fill up with soil over time and need to be cleared out when this happens.



Swales

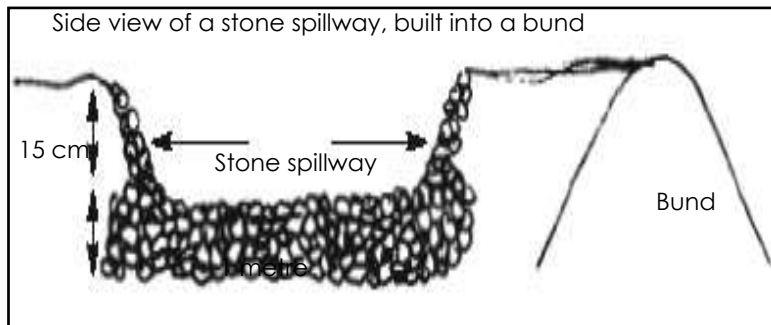
Swales are very similar to bunds/earthbanks built along a contour line. The difference is that the earth is piled *below* the ditch rather than above. This is a very good way to concentrate water on the land. In this way, you can double the amount of water in your soil.



Swales do not lead to terracing as the first method does. The banks are planted with

water-loving and long-living plants. The swales fill up with soil over time and need to be cleared out when this happens.

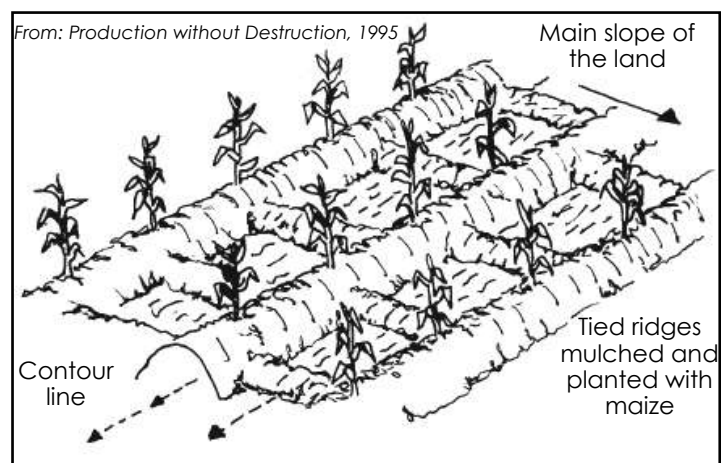
Bunds and swales must be built high enough so that water never flows over the top of the bank. If there is a danger of this, spillways need to be built into the banks (see diagram below). These will lead the excess water down the slope in a safe way.



Tied ridges

These bunds have small ridges or cross walls that help the water penetrate into the soil where it falls. The ridges also ensure that the water in the ditches won't become "streams" in heavy rain. This reduces the danger that the ditches will overflow and cause erosion.

Build the ridges about half as high as the bunds. Once the ridges are made, they are left intact. You may need to lift crumbled soil back onto the ridges and rebuild some of them from time to time.

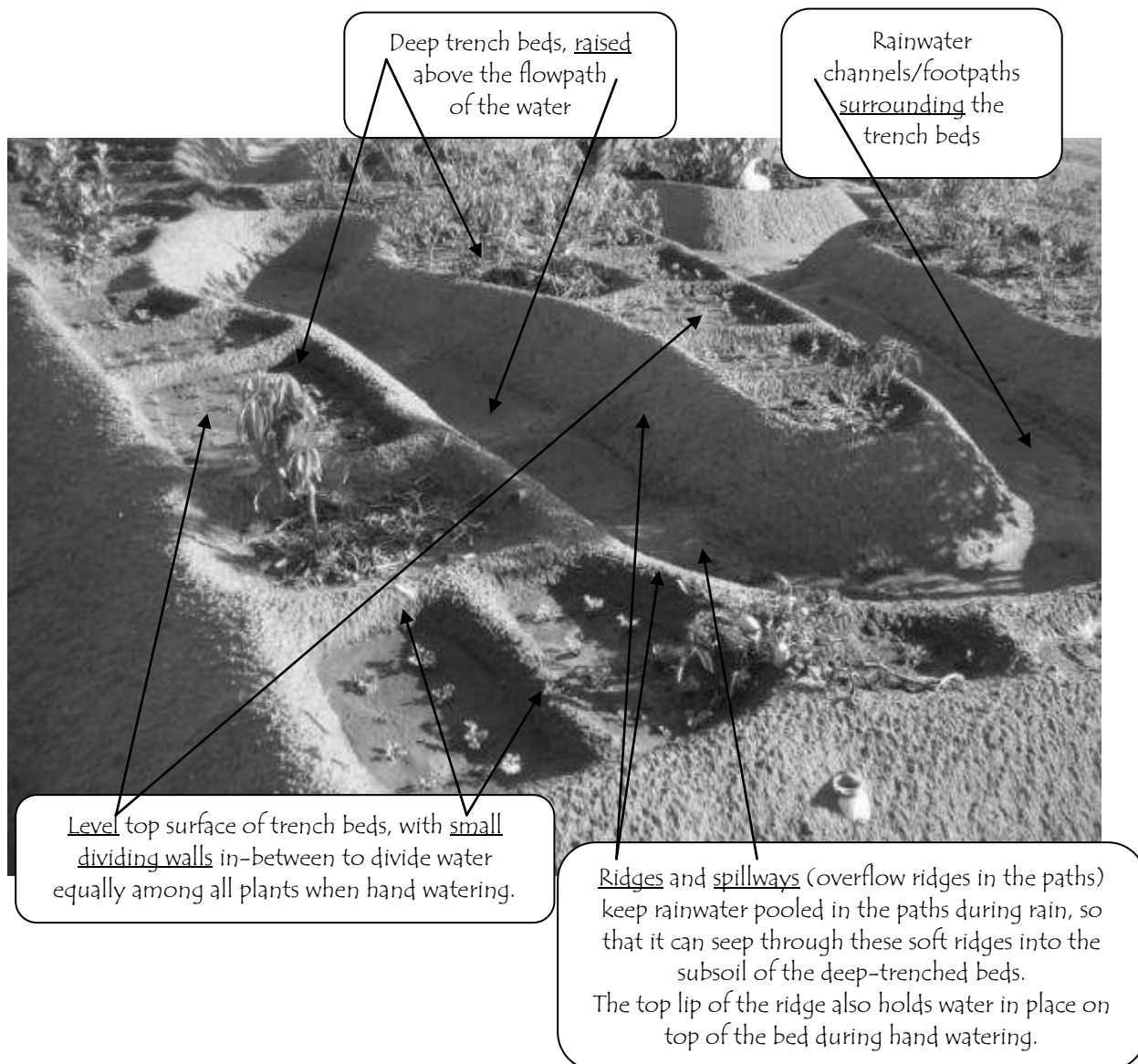


Channelling water to where it is needed

MaTshepo Khumbane has a beautiful working system of "turning run-off into run-on" at her homestead in Limpopo. Her system – the result of years of experimentation requiring no pipes or tanks – is described below:

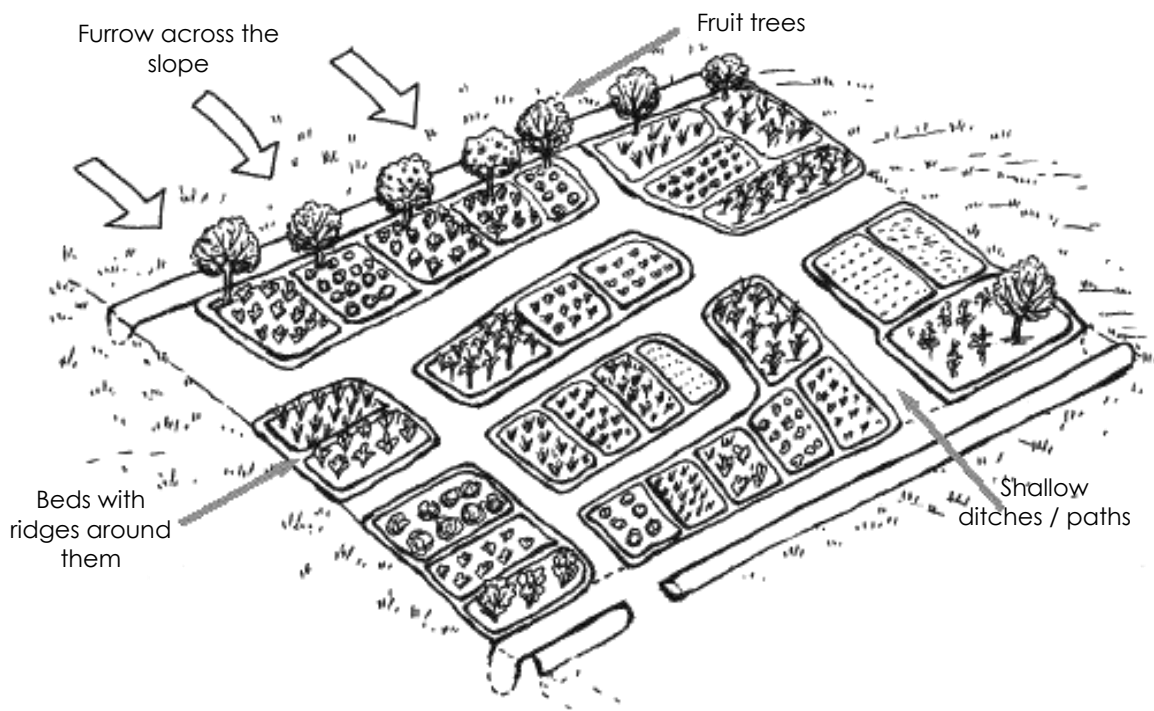
- ❖ A trench or furrow is dug across the slope to catch rainwater.

- ❖ Below the furrow the vegetable beds are dug 1 metre deep. They are filled with organic matter – grass, leaves, manure and ash – and mixed with soil. The beds are fertile and absorb and hold water.
- ❖ The beds are edged with ridges. Some are reinforced with small stones to stop the soil from being washed away. This ridging keeps the water on the bed when you irrigate.
- ❖ Between the beds, a network of shallow ditches/channels connects the furrow above the beds with ditches/channels lower down. The water flows along these channels. The channels are also the footpaths to get to the beds.
- ❖ Fruit trees are planted on the lower side of the furrow, so that their deep roots can benefit from the extra water.



Important points to remember when channelling water:

- ❖ Notice where the water runs through the yard during rainstorms. This will always be from higher-lying areas to lower-lying areas. The steeper the slopes in the garden, the faster the water will run. The best way to understand how the water flows in your garden is to walk your land in the rain!
- ❖ Plan how to take control of the water (slow it down) and channel it to where it is needed (in the garden beds and/or in dams or storage tanks).
- ❖ Lay out long, level garden beds along the contour (i.e. across the slope) to more easily intercept and spread out the water along each bed.

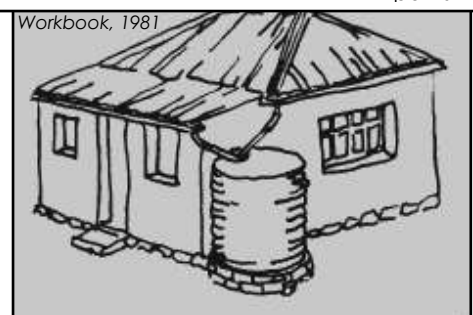
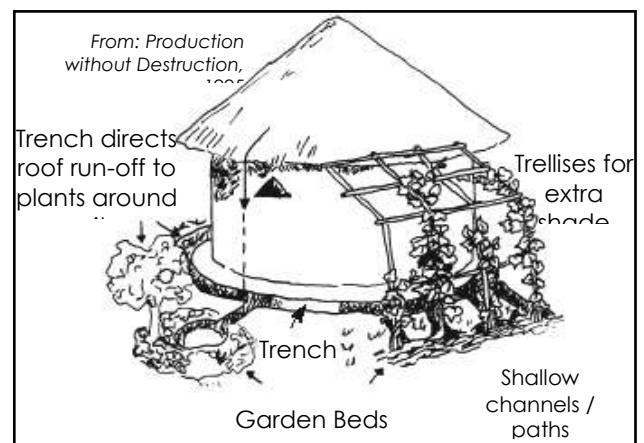


Storing water

❖ Aboveground

A good surface for collecting run off water is the roof of your house.

- It is possible to dig a ditch around the house where the rain pours off the roof. Water is led along this ditch to garden beds.
- It is also possible to put a gutter on your roof. This can lead the water straight into a storage tank. It is much easier to do this with a metal

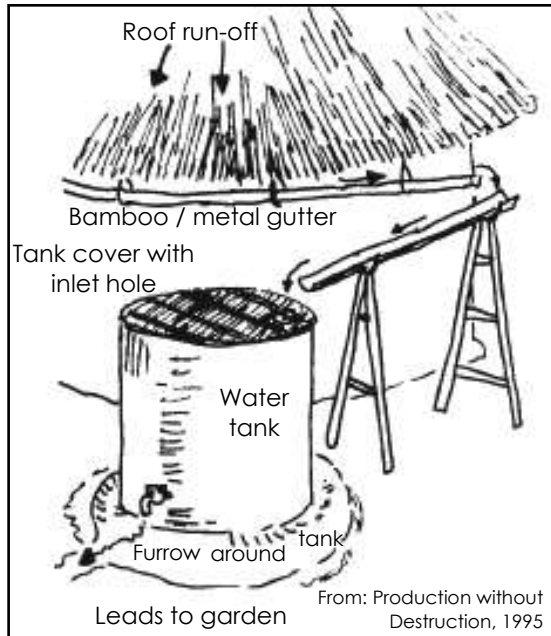


Water is channelled by gutters to the storage tank

or tile roof. Water collected from your roof is good drinking water. With a thatched or grass roof, hanging gutters can be made from bamboo or metal. This water is usually too dirty for drinking.

You may want to catch the first bit of rainfall after a long dry period in a different container and use it in the garden. This water is likely to contain a lot of dirt.

You can build a tank that will hold enough water to be able to water a small vegetable garden throughout the



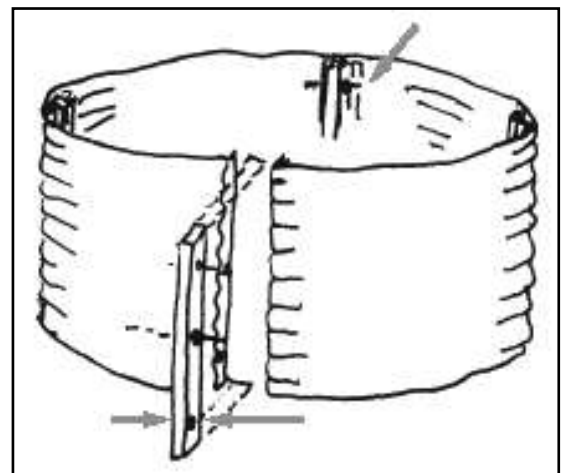
dry periods. It is a good idea to find someone who is an experienced builder to assist you in building your roof tank.

Roof tanks can be made from cement with wire reinforcement (ferrocement), plastic, or stone.



Gutters can even work on thatch! Water is

Collecting run-off from a thatched roof into a ferro-cement tank

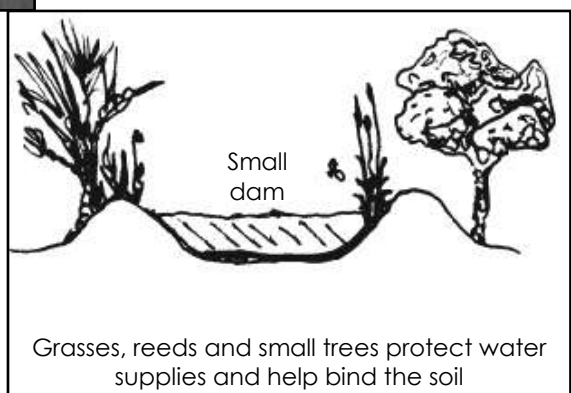


Formwork to build a ferro-cement tank



Roof tank built from stone and cement

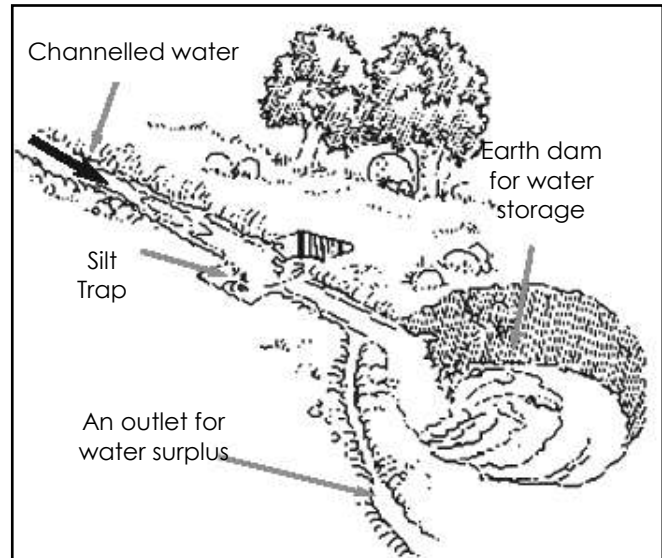
Dams or ponds can be dug into the soil and



Grasses, reeds and small trees protect water supplies and help bind the soil

filled from a stream or gully or with rainwater. Dams generally do not hold water for very long. Dams can be lined with plastic or cement to increase their water holding ability. You can decrease the amount of water that evaporates into the air by digging a deep dam with a small surface. A shallow dam with a large surface loses a lot of water through evaporation. You can also surround your dam with windbreaks.

The main reason for building floors and walls in the dams is to stop the water from leaking out. In some places the soil has enough clay to seal the dam after a while and no structure or water-proofing is needed. In other places the soil may cave in when it gets too wet and the dam may leak.

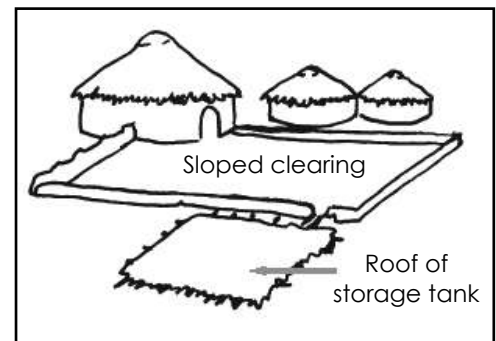


❖ Underground storage

- Underground Tanks

You can collect rainwater from a flat surface, such as a large rock, or the clearing in front of your house, by building a low wall along the rock or clearing and making it slope down towards an underground tank.

Underground water storage can be made large enough to hold all the water you will need in your garden. There are various ways of building underground tanks:



- ❖ Cement lined/Ferro-cement tanks
- ❖ Geo-fabric lined tanks
- ❖ Masonry (Bricks/stone and mortar) tanks

Cement lined/Ferro-cement

Reinforcing mesh can be placed along the walls and floor and can then be plastered with cement. An experienced builder is needed; otherwise your tank is likely to leak.

Mrs. Mamotepane built an improved

Water runs into these tanks from the ground. It is possible to gather run-off water from any surface such as your roof, a road, paved areas around your home, ditches, swales and even the veld.

These tanks may be made large enough to store enough water for the whole dry season

These tanks can be cheaper and easier to build than large tanks above the ground.



The cement lined tank

homestead tank that she lined with cement. There were 3 workers from the village involved. A builder showed them how it is done and then left them to do the work under his supervision. It took about 14 days to build. Only cement and chicken wire were used. The hole was dug and covered with the wire on the inside. Then it was covered with cement. The sand used for making the cement was fetched in an ox cart from the river.

The tank is almost square (5 metres long and 4 metres wide) and about 2 metres deep.

The inlet to the tank is made of cement. This is a very good idea and helps to keep the tank strong.



The inlet made of cement

The dam is fenced to keep children and animals away. A 1 000 litre header tank was placed on a structure high above the ground (about 2.5 metres). This helps for the water to flow down into the pipes and taps in the garden. A foot pump is used to pump water into this tank.



A part of the garden and the seedling nursery

Mrs. Mamotepane says that as the water is now close by, she can concentrate on other work. She can also produce a lot more vegetables. She grows and sells vegetables and seedlings for a living. She sells at the schools and to hawkers that come to her home to buy. Mrs. Mamopetane also processes surplus vegetables by bottling and making jams.

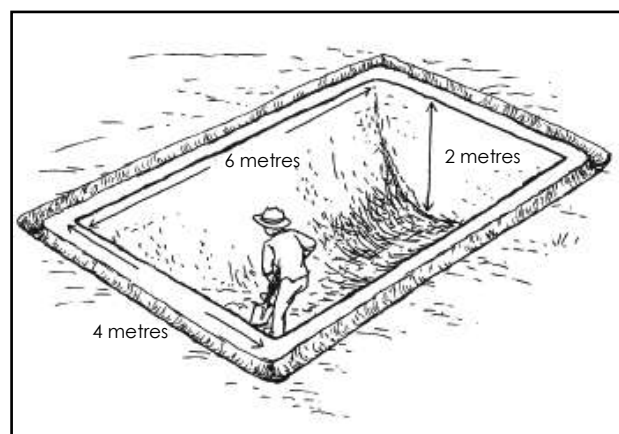


Mme Mamopetane with a bottle of senoane or melon jam and the seed that she also sells to make an income

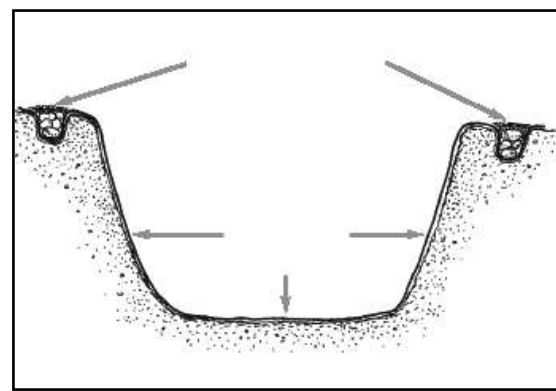
Geo-fabric lined tanks

This tank holds 48 000 litres of water. It is inexpensive to build. The most labour is required for actually digging the pit.

Dig a pit 6 metres long, 4 metres wide and 2 metres deep. There is a slight slope on the inner walls. This means that they are not dug straight down, but at a slight angle. When the pit is dug, stamp the soil inside the pit down, so that it is firm and smooth.



Dig a trench about 30 cm deep around the outside of the pit. This will anchor the



geofabric liner.

Lay the geofabric inside the pit and the anchor trench. Make sure there is about 1 metre of the fabric in the anchor trench. Now cover the fabric in the trench with stones and soil. This will make sure the fabric does not slip down into the tank. You will need about 90 square metres of fabric to line this size pit.

Now the fabric is painted with a bitumen type sealant. The sealant needs to stay flexible or stretchy at low temperatures. Otherwise the sealant will crack as the water gets cold. You will need about 210 litres of sealant.

Names and contact details of suppliers:

Geofabric:

Kaytech factory in Johannesburg

Phone: 011 - 452 5310

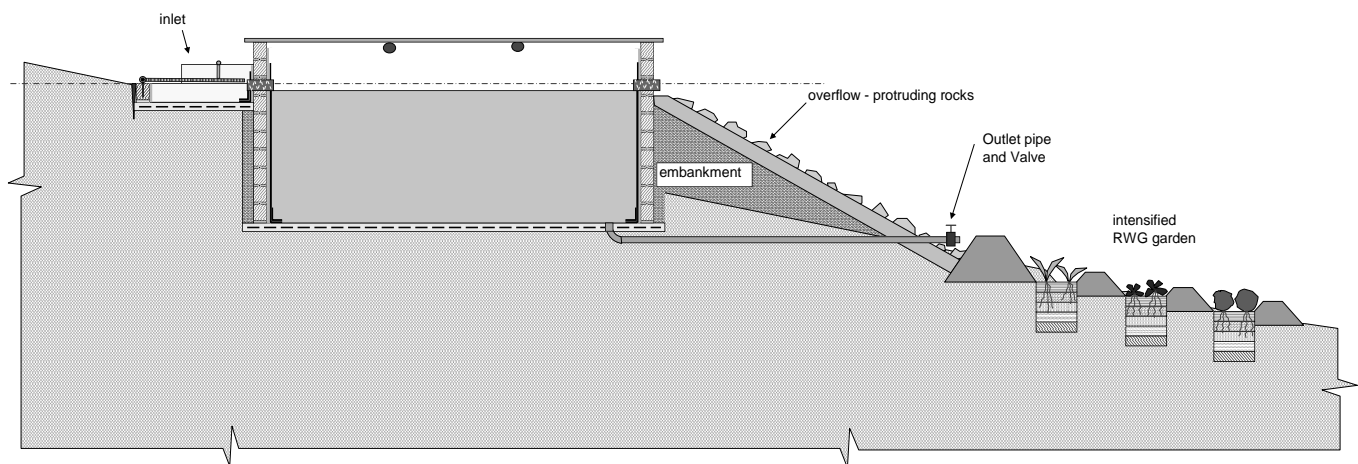
Sealant:

Tosas; Spartan factory in Johannesburg

Phone: 011 - 902 1905

Masonry Tanks

Masonry tanks are made using bricks or stone with mortar.



Cross-section of a masonry tank



These tanks need to be designed and constructed by people who know how to do this. They can easily leak, if not constructed well. Mostly, tanks such as these have been built with support from Government and implementing agents, as they can be expensive to construct.

Table: Recommended size, shape and elevation

❖ **Standard size: 30 000 litre**

– This provides enough water for year-round vegetable and fruit production of 100-200m² in the yard (when combined with run-on RWH).

❖ **Shape: Round** [walls: cylindrical; floor: flat]

– A round shape is geometrically stronger, and less prone to cracking and leaking than square or rectangular tanks. A flat floor helps the household to leave a few centimetres of water to protect the floor and wall/floor joint from drying out and cracking.

❖ **Elevation: Underground**

– Tanks are built underground to catch both roof run-off AND surface run-off. In sloping areas, half-buried dams can still catch those all-important large quantities of surface run-off.

2. Homestead irrigation techniques



There are three parts to good water management at your homestead.

- ❖ The first part is to catch as much rainwater as you can.
- ❖ The second part is to get the water to the crops.
- ❖ And the third part is to store and use the water you have as well as possible.

In this handout we discuss more ways to get water to our crops and how to irrigate in a way that uses water as wisely and efficiently as possible.

GETTING THE WATER TO THE CROPS

Mechanical Pumps

These pumps use human energy to power them, rather than fuel or electricity. There are hand and foot operated pumps.

Foot / Treadle pumps

Foot pump

The foot pump has been designed specifically for low cost and reliable operation in remote areas. The frame is small, robust and portable. It is capable of pumping water for small-scale irrigation and household water supply.

How the pumping works:

The pump is not very compact, but is very robust and is easy to maintain with locally available materials. It weighs around 22 kilograms.



Two cylinders push the water through the pump.

There is an inlet (32 mm) and outlet pipe (25 mm) and two cylinders with leather bushes that push the water through.



Filter on inlet hose

A filter needs to be attached to the end of the inlet hose. The pump cannot tolerate silt.

The total pumping height is around 14 metres. This is the sum of the suction depth below the pump and the pressure head above the pump. The maximum suction depth is around 7 metres. The pump then lifts water through the outlet to a height of 7-10 metres. The volume of water pumped is between 0.4 litres per second to 1.5 litres/ second, depending on the height. A fitting can be added so that watering is possible straight from the pipe.

Suppliers:

This ApproTEC foot pump is produced in Kenya. At the moment they can be sourced in South Africa:

Contact: Chris Stimie, Rural Integrated Engineering

Tel: 082 469 4535 or 012- 842 4106 Email: dir@rieng.co.za

Or directly: ApproTEC/ Kickstart, Nairobi; PO Box 64142, 00620.

Tel: +254-(0)-20-787 380 / 787 381. Email: aprotec@aprotec.org.

USING WATER WISELY

There are many ways to conserve water. Ideas include:

- ❖ Use mulching (dried grass or leaves) to cover the soil and keep the water in the soil. Stones can also conserve water as the stones act as mulching on the edges of the bed.
- ❖ Add organic matter to the soil.
- ❖ Plant along the contours or make terraces. Terraces are useful when your land is very steep, or your soil is shallow and you need to build up your beds or soil.
- ❖ Use ditches and swales to channel and catch water, so that it can seep into the soil and not be lost.
- ❖ Protect you garden from the drying effects of wind.
- ❖ If you have really sandy soils, lay plastic or feed bags at the bottom of your trench before building up your bed. This will help to keep the water in your bed.
- ❖ Use greywater wisely.

We will now focus on two ways of **applying water** in ways that conserve water, time and labour: drip irrigation and keyhole beds.

Drip irrigation

Drip irrigation is a method of applying water directly to the roots of plants, which saves a lot of water. Drip irrigation is good at reducing both direct evaporation as well as evaporation from the soil surface. Water is applied evenly and with deep penetration. However, be warned! Drip irrigation can be very bad on coarse sandy soils where water



This bed is built up and mulched with stones to conserve moisture.



This garden is built on a very rocky slope. All the beds have been built up as terraces. Both soil and water are beautifully conserved.

Greywater is water that has been used in the home for washing dishes, doing laundry or bathing. This water can be re-used in the garden. You may add ash from a wood fire to the greywater and leave it overnight to settle out the soap and impurities before it is used to water your plants. You should rotate where you irrigate your garden with greywater so that each part of your garden gets clean water as well as greywater.

Advantages of drip irrigation:

- ❖ Water is applied directly to the roots of plants and can infiltrate deeply into the soil.
- ❖ It saves time and labour.
- ❖ It can also save water, but this depends on how you use the system.

runs straight down without spreading sideways in the soil to reach the plant roots.

Drip systems need careful management because the drippers can easily become blocked without the gardener noticing it. Also, gardeners often find it hard to believe that the plants get enough water, because there could be just a small wet patch on the soil surface. More than with any other type of irrigation, with drip systems it is important to take a spade and dig to see where the water goes. Do this as often as you need to until you know your system well, and how it reacts on your soils.

Generally, with drip irrigation systems, plants are watered once a day, every day. At the beginning of the season, this ensures that the soil stays wet as deep as possible. Later in the season the bigger plants can use the water that has been stored in the soil (as well as the little water that is provided every day).

Drip irrigation kits

Drip irrigation kits are pre-designed and usually come with the pipes already cut into specific lengths and the drippers placed in the pipes. There are many different kinds of kits. One of the common designs for drip irrigation kits is known as **Netafin**.

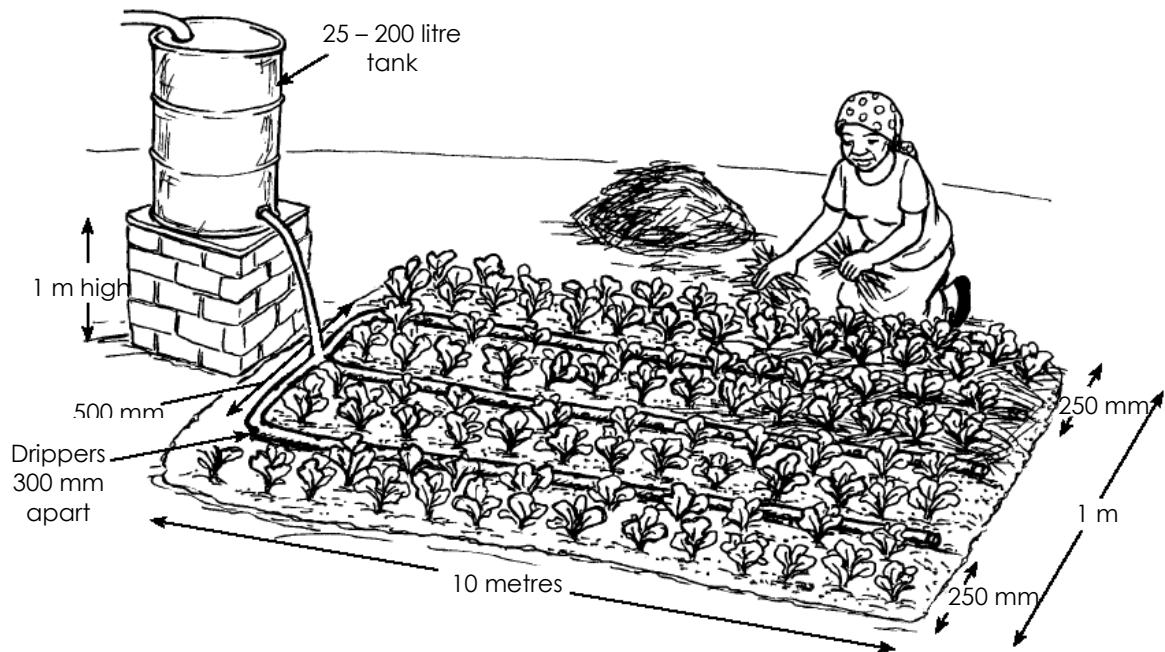
The Netafin system has a 200 litre drum with a filter attached and enough dripper lines to cover 200 square meters of garden. 100 square meters can be watered at a time. The dripper lines have been specially made. The drippers themselves are inside the pipe and are spaced 30 centimetres/ 300 millimetres apart.



Mr. Mokethi shows his 200 litre drum with the filter attached. The dripper lines lie next to the drum.

After experimenting with the Netafin drip irrigation system for six months, Mr. Mokethi says, *"This system saves me time. It also saves water, as the water now goes directly to the roots."*

He removes the whole system at night and replaces it every morning to irrigate. He places the system on two flat rocks to make it slightly higher than the beds. Mr. Mokethi spaces his plants so that each one will be next to a dripper. He does not use this system for row crops like carrots, but for individual plants like cabbage.



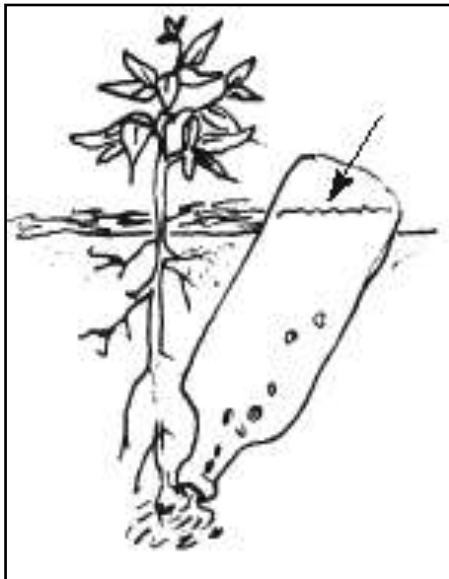
Important points

- ❖ The drum should be placed on a surface/platform about 1 metre (one spade length) above the garden.
- ❖ The garden/area should be completely flat. If the area is not flat, the amount of water from each dripper will be different. The distribution of water will not be equal.
- ❖ The drip irrigation system cannot be left out on frosty nights because the pipes may burst if ice forms inside.
- ❖ The drip irrigation system may be used with greywater.
- ❖ When drippers remain blocked, pipes must be replaced. Replacement parts are easy to find in shops.

Variations on drip irrigation

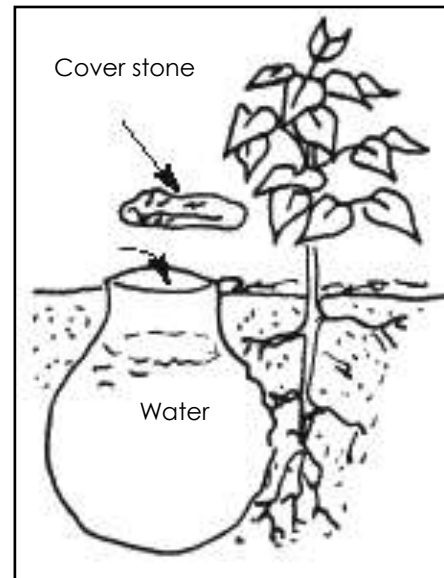
Drip systems cost money and a food insecure family may not be able to afford the replacement costs. Below are a few methods of making your own variations on the standard drip system

Buried vessels



Water can drip slowly from an upside-down bottle

From: *Production without Destruction*, 1995



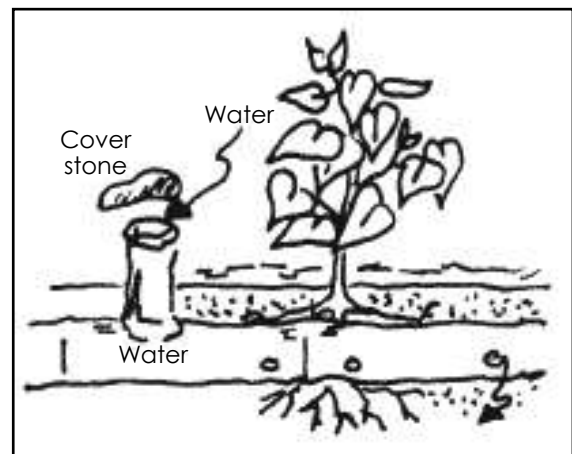
Water can seep through an unglazed clay pot to plant roots.

Water

Buried pipes

You can also use a plastic pipe with slits/holes drilled or burned into the pipe. The pipe is laid on top of the ground and the whole bed (including the pipe) is covered with a good layer of mulch.

Water can be poured straight into the opening of the underground pipe or water can be led from a tap or storage tank. You can use greywater as long as there are no bits in the water that will clog up the slits in your pipe.



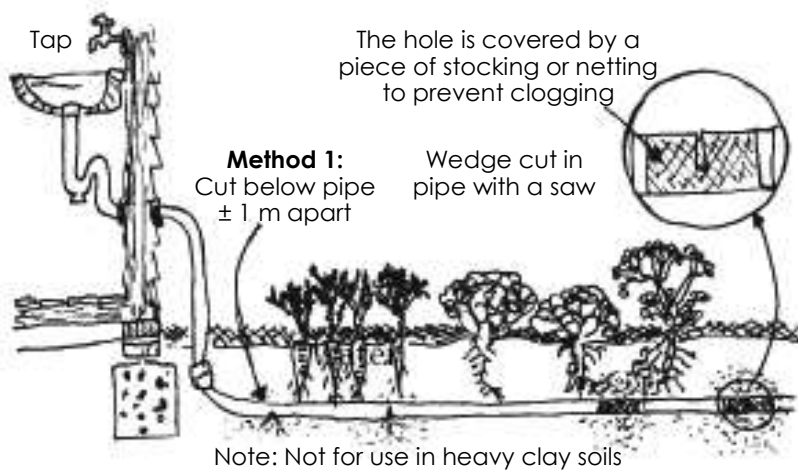
From: *Production without Destruction*, 1995

- ❖ The holes in the pipe should be about 20-25 cm apart. The one end of the pipe is closed with a plug. The other end is attached to a pipe leading to a large water storage container or tap.
- ❖ If water is coming from a container, it must be at least 1 metre above the

From: *Introduction to Permaculture*

Method 2:

Cut on top of pipe
± 1 m apart

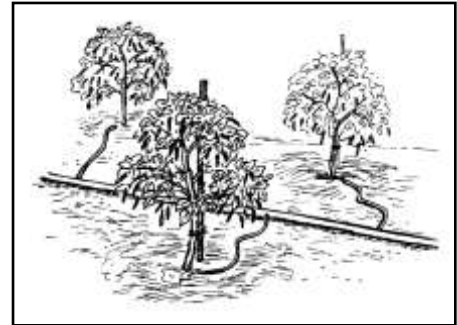


ground. The vegetable beds must be as level as possible.

- ❖ If you use this method, you will need less than half the amount of water to wet the whole bed than you would use if you were pouring or spraying the water onto the bed.

Spaghetti lines

Spaghetti line systems consist of small pipes connected to a larger main line aboveground. Spaghetti lines are easy to unblock – you just suck on the opening of the spaghetti pipe. The beds must be quite level and the pipes and spaghetti lines also need to be at the same height. Height differences give differences in the amount of water coming out of the end of each spaghetti line.



Spaghetti line systems consist of small pipes connected to a larger main line.

- ❖ Use any tank that can be easily found – from 25-200 litres. The system is designed to use 25 litres a day. If your tank holds 50 litres you can fill it and irrigate every second day. If your tank holds 200 litres, you should be able to irrigate once a week only. This however depends on the climate, your soil and the size of your plants. Seedlings will need less water more often.
- ❖ Place this tank above the bed, which is made to be 1 metre wide and 10 metres long. It is long and narrow to make it easy to work in.
- ❖ Use normal black plastic piping (15 mm) to make a main line from the tank to the garden. Make three lines – each should be 10 metres long and 500 millimetres apart.
- ❖ Make small holes in the pipe 300 mm apart and fit the thin spaghetti lines into these holes. You will need 93 of these.
- ❖ Plants are spaced to have one spaghetti line for each plant.

This system irrigates an area of 15 square metres. It uses around 25 litres of water in 5 minutes. It provides about 260 millilitres of water per spaghetti line dripper per day.

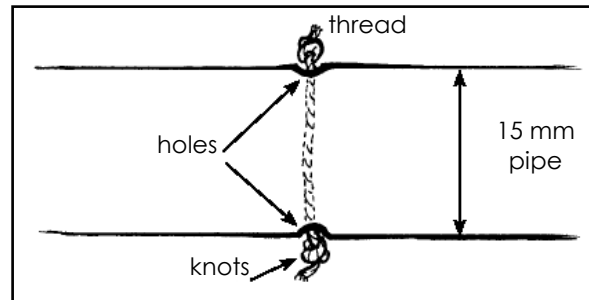
Sponge lines and string lines

Sponge lines and string lines are controlled flood systems of drip irrigation that are good for row crops such as carrots, onions, turnips and peas. For sponge line systems, holes are punched in the irrigation pipe (usually 15-20 mm black plastic piping) using a heated nail or binding wire. The holes should be about 2.5 mm in size. Small pieces of sponge are forced into these holes. Water then trickles out of the holes.

String line systems are similar to sponge lines, except that you use string instead of sponge.

To make a string line system:

- ❖ Make a series of paired holes on opposite sides of the pipe. There will be two holes across from each other at each dripping point.
- ❖ Thread a piece of string through these holes and tie knots on both ends. This thread can be jiggled if the hole becomes blocked and also makes sure the water trickles out, rather than pouring out too fast.



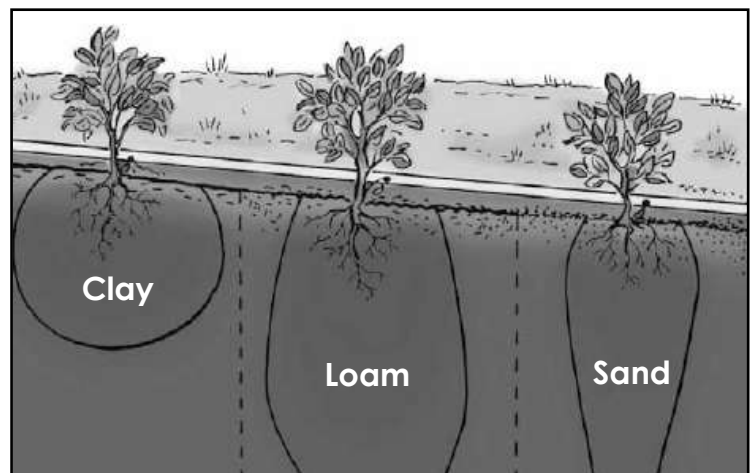
An advantage of sponge line and string line systems is that the holes in the pipe can be made any distance apart, depending on need. A disadvantage is that it is difficult to control the amount of water that comes out of the holes. Another disadvantage for sponge lines is that the small pieces of sponge need to be replaced each year.

Each drip irrigation system has been designed to work in a specific way. You can use one of the systems explained above or you can design your own. A few keys to remember when you use drip irrigation are:

- ❖ Make level planting beds and furrows
- ❖ Make sure your drippers are never clogged
- ❖ Space sprayers so that their sprays overlap enough to create equal watering across the whole area.

A note on distribution

Distribution is how the water moves into and inside the soil. This depends on the kind of soil and the kind of irrigation or dripper. To the right are pictures of how the water may move in different kinds of soil:



- ❖ Above ground, on top of the soil, you will see little circles of wetness, which may be close together or more spread out and further apart.
- ❖ Underground the circles of wetness may flow into each other.
- ❖ You will need to check what is happening under the ground to know what the water is actually doing. You can press a stick or a rod into the ground as far as it will easily go – close to the drippers and then further away – to get an idea of how even the distribution of water is.
- ❖ There may be some dry patches inside the soil, which is why it is more difficult to

use drip irrigation with row crops. People usually put one plant next to a dripper.

- ❖ How fast the water comes out of the small hole or dripper will also change how the water moves. The systems that use large holes in the pipes, like the sponge and thread systems are more like a controlled flood irrigation system than a dripping system as the water pours out, rather than drips.

The secret to good irrigation is to check what is happening in the soil! Take the time!!!

BED DESIGN FOR WATER CONSERVATION

It is possible to design your garden and beds in a way that will use as little water as possible and also to save as much water as is possible.

Keyhole beds

Meet Mr. and Mrs. Matlole, a retrenched miner and his wife growing vegetables for home and for sale. They plant their vegetables in keyhole beds, which are raised beds made of stone that require less water than regular beds. Additionally, you can use greywater in keyhole beds because the ash in the soil filters out the soap in greywater.



Mr. and Mrs. Matlole and one of their keyhole beds

Where do I build a keyhole bed?

Find a sunny place, close to the door of the house on any base rock, compacted soil or hard clay.

Advantages of keyhole beds:

- ❖ The garden can provide fresh vegetables all year-round under all conditions
- ❖ Greywater can be used to irrigate
- ❖ It can be built on top of hard clay or rock.

What do I need?

- ❖ Good dark soil
- ❖ Rocks, manure, wood ash, dried grass, leaves, yard sweepings and any plant wastes
- ❖ Black wattle or other sticks or netting

How do I build a keyhole bed?



Where the centre of the garden will be, build a tall basket of sticks; 40 cm x 40 cm round and 1.5 metres high.

Begin to fill the basket with composting material such as wood ash, grass and manure. Pack it in

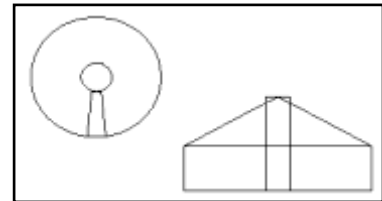
quite firmly.

Now measure out from the basket, one arm's length, all around in a circle. This is where the rock wall will go. It will be about 1.5 – 2 metres in diameter. This diameter is measured from one side of the bed to the other. Build a wall about 1 metre high with an entrance to the basket. This entrance should be about 60 cm wide.



Completed keyhole bed
(from D. Hall and V. Gibberd for LRAP)

Fill up the inside of the circle as you go, making alternate layers of soil-manure, soil-ash, soil-plant wastes, soil-manure and so on until you reach the top. The soil should reach from the top of the wall to the top of the basket in a gentle slope. Do not make it flat. Seen from the top it looks like a keyhole; from the side it looks like a house.



Top-view and side-view of
keyhole bed



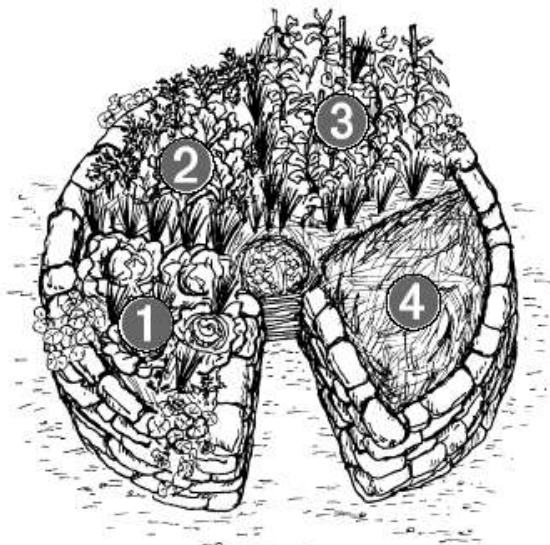
A keyhole bed built on hard clay
(from d.hall and v.gibberd, for lrapp)

The soil must then be covered with a thick mulch of dried grass and leaves and must always be covered like this. The basket must have a cover of grass on top of the manure.

Rotating crops in keyhole beds

It is a good idea to grow different crops in different places each season. Divide the garden into 4 sections.

The first section is for leafy crops (except spinach).



Crop rotation in a keyhole bed

The second section is for root crops and spinach.

The third is for peas and legumes in winter or potatoes, egg plants, tomatoes, peppers and chillies in summer. These need extra wood ash in the soil to give a good crop

The fourth section has 2kg of lime dug into it and is covered with a thick layer of manure and mulch. This section rests for 1-2 months before the manure is dug in. Now the leafy crops are planted here.

Every time you plant, you move the crops around to the next place.

Plant onions among all the crops. Plant herbs and strong smelling plants such as chives, nasturtiums and marigolds around the edges of the garden.

Sowing seed in keyhole beds

To sow seed, pull the mulch aside, leaving a line of soil exposed. Here, you make a furrow and put your seeds in. Cover with earth and pat it down a little. Water the seeds and then cover the line with mulch again. As soon as you see the seeds coming up reduce the mulch so that enough sun shines on the seedlings. Always leave a light cover of mulch, so that the soil does not dry out.

Watering keyhole beds

- ❖ Greywater from the home is poured into the basket. You can pour it underneath the mulch in the basket. From here it spreads into the rest of the bed.
- ❖ The next time you water with greywater, move the mulch aside and pour the water along the root line. Then replace the



mulch.

- ❖ It is best to water early in the morning or evening, not in the heat of the day.

Watering the garden: How much, how often?

One of the most common wasteful irrigation practices is to spread a small quantity of water across the whole garden once or twice a day or every day or two. It is understandable that people tend to do this, because they reason that 'at least all the plants will get a little bit of water'. Most of this water simply evaporates out of the topsoil without doing much good at all. Shallow watering also promotes shallow root systems and our plants become water stressed, or wilt, easily. We should rather try to apply more water at a time and water less often. We can try to apply more water every second day and see how that goes. For more mature crops, such as fully grown spinach or half grown cabbages, we can even water well once a week!

Deep watering

If plants receive regular deep waterings, they develop deep, strong roots, meaning that they can produce large, strong stems, leaves and fruit. If they get just a little water on the soil surface most of the time, the roots will be shallow and the plants will have very little resistance to dry periods.

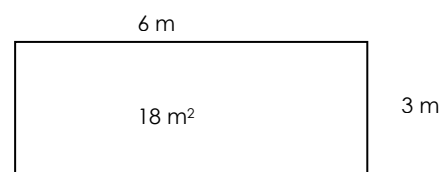
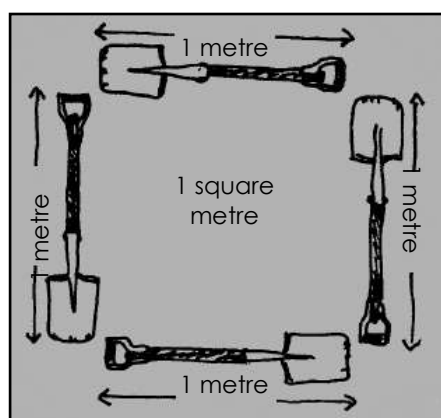
Rather than giving our gardens a small amount of water every day or two, a much better approach would be to divide the garden into imaginary 'blocks' or 'sections', and to provide a good deep watering to each section every four to seven days. This allows the water to seep deep into the soil and less of it will be lost to evaporation.

Beware: deep watering can also be overdone. If the water seeps down too deep, the plant roots can reach it. However, this is a less common mistake than watering too little and too frequently.

We use deep watering, because we want to draw the roots of our plants down into the ground. Deeper in the soil the water is distributed more evenly and the soil is not subject to fast drying and wetting cycles that are dependent on watering and evaporation. Thus, applying MORE water, LESS OFTEN is crucial.

As a general rule of thumb, vegetables require around 20mm of irrigation a week. This means that you need to apply 20 litres of water to every square meter square of garden bed.

How much water would you need to apply, to this garden below



Did you know that plants can also suffer if there is too much water around their roots all the time? If the soil is water logged, the roots don't get enough air. Plants need well-drained soils to prevent the roots from rotting and dying.

which is 18m^2 in size? (answer $20 \times 18 = 360\text{l}$)

20mm/week is a good assumption to start our planning on, but of course, our plants would not need exactly the same quantity of water week after week!

- When it rains, they need less irrigation.
- When the plants are still very small, they need less water, but just like human babies, they need it more often. Human babies drink every two or three hours after birth; your seeds/seedlings must never dry out, so check them several times a day in the beginning.
- When plants are making fruit, like nursing mothers, they need extra food and water!
- This often coincides with peak season, when all the plants need extra water because it is extra hot. In cooler periods, plants would need less.
- Towards the end of their life, like older people, plants need less.
- The plants in your garden will be at different growth stages, and of different types – all having their own level water needs from week to week.

20mm/week is equivalent to 20litres/week which is a 20-litre bucket on 1m^2 .

For drip irrigation systems 20litres/ 1m^2 equates to about 340 ml of water/dripper/week.

How can one know how deep the water has gone?

The simplest method is to push a steel peg into the soil a few hours after watering the bed, when the water has had time to infiltrate properly into the soil. The peg goes in quite easily until it reaches the dry soil below, which gives you a good idea of how deep the water had gone down. Combine this with knowledge about the typical rooting depth of the crop, and it becomes easier to strike a balance between over- and under-watering. If you measure rain in a rain gauge, you will measure this in millimetres. 1mm of rain is equivalent to 1litre of water on m^2 of soil.

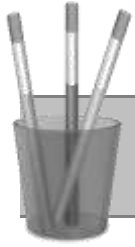


Here a steel rod is being pushed into the ground next to a drip line. The wet circles of irrigation can be seen. In the next picture the rod has been taken out of the ground to show soil that is uniformly wet to 30cm below the surface.

Golden rules of watering

Day-to-day, how and when you irrigate your plants has a big influence on how much water you use in the end. Here are a few golden rules:

- ❖ Start the growing season with your soil thoroughly wet to at least one meter deep – especially for the dry season crop when there will be very little rain for a few months. At first, the young roots won't reach this water, but the water will stay there and the plants will draw on it later in the season when they may need more than you can give. Wetness in these deeper soil layers also encourages your plant to develop deep roots, which makes it stronger and more resistant to drought.
- ❖ Deep wetting, once a week. In very hot periods you can shorten this to once every three days, but give enough water to make sure that it will seep deep into the ground, and not all just evaporate out of the top 10-15cm of your soil. You can also mulch to help reduce evaporation losses. But NEVER give shallow daily wettings to mature plants. Other than evaporation losses, you are also encouraging your plants to make only very shallow roots.
- ❖ Try to give soft, fine showerings rather than big hard drops (which will compact your soil), or gentle flows rather than rapidly running water (which will wash out your soil and expose the plant roots).
- ❖ Distribute water evenly across the planting bed. If all the plants get equal amounts of water, you will be getting the most 'crop per drop'. With uneven water sharing between the plants, those plants that get too much water, use too much 'drop'; while those that get too little water, will give you too little 'crop'.
- ❖ Measure! Monitor! Keep a record of how much water you are giving; how much rain you are getting; and how the level changes in your rainwater tank(s). Every year you will get better at stretching your water to get the most 'crop per drop'. Always dig the day after you have given water to see how deep the wetness goes. Do these until you have developed a feel for how your soil reacts to irrigation and rain; and check again whenever you are uncertain whether the deeper soil layers are beginning to dry out.



Activity 1

How much water does the garden need?

Aim

To develop useful 'Rules of Thumb' on how many buckets per week your food garden needs, and how much water you can get from rain.

Instructions

1. Make sure you understand these two rules of thumb, and REMEMBER THEM.

Rainfall:

If 1mm rain has fallen, then 1 litre has fallen on every area of 1m x 1m.

The rule of thumb is: Every 1mm of rain gives 1 litre per m².

Watering the garden:

In most areas, a garden needs about 20mm per week.

To give 20mm per week, we need to give one 20 litre bucket of water per week for every 1m x 1m area of garden beds.

The rule of thumb is: One 20 litre bucket per week for every m² of garden beds.

2. Now use your rule of thumb to work out how many buckets per week a garden with 10 planting beds of 1m x 6m would need.
3. How many buckets is that per day if the gardener waters 6 days per week?
4. Should the gardener try to divide these buckets evenly between all the beds every day?

Answers:

2. 60 buckets (20 litre size) per week.
3. 10 buckets per day, which is the same as one 200 litre drum per day.
4. No, definitely not! Every bed would just get a thin sprinkling and will dry out again almost immediately – all the hard work and precious water to waste. Much better: divide the garden into six parts and water one part per day, moving on to the next part the following day. In very hot periods, water one-third of the garden per day and increase the number of buckets per day if necessary.

How big is your garden? (Remember to just consider the beds. You don't need to include the paths in your measurement)	How many litres per week do you need to water your garden?	How many 20 litre buckets per week does your garden require?
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10 m ²	200 litres per week	10 buckets per week
20 m ²	400 litres per week	20 buckets per week
30 m ²	600 litres per week	30 buckets per week
40 m ²	800 litres per week	40 buckets per week
50 m ²	1000 litres per week	50 buckets per week
60 m ²	1200 litres per week	60 buckets per week



Activity 2: Estimating garden water needs

Aim

To make an estimate of the water needs of a typical food garden according to the rainfall area.

Average water needs for vegetables in different rainfall areas per 10m² deep trenched garden beds

Types of crops	Summer rainfall area		Winter rainfall area	
	Summer	Winter	Summer	Winter
Spinach (High demand)	2 800 ℓ	3 900 ℓ	6 600 ℓ	900 ℓ
Mixed (Medium demand)	2 500 ℓ	2 900 ℓ	5 400 ℓ	1 000 ℓ
Cabbage (Low demand)	1 000 ℓ	1 900 ℓ	2 600 ℓ	200 ℓ

Instructions

Using table above, work out how much water your 60m² garden would need for your summer crops, and for your winter crops in your area.

Managing stored water

It's a good idea to start the dry season with a full rainwater tank and with a full soil profile. Our strategies differ for dry and wet seasons.

Irrigation strategy in the dry season

This would be **winter**, in most parts of South Africa. There is no rain, and thus no crops. Or, in some parts, there is some rain, but not enough to see crops through to harvest, so crops may grow well initially, but die before we can benefit from them.

Dry season strategy: START FULL, END EMPTY

1. Start the dry season with the trench beds thoroughly wet, and the water tank full. You will try to use as much water from the tank as you need to get through the winter, and should end the dry season with the tank nearly empty.
2. If you are worried that your water may run out before the end of the season, plant a smaller portion of your garden in the dry season.
3. Decide how many days per week you will irrigate your garden. Divide the garden in equal parts to be watered every day (e.g. if you are planning to irrigate five days per week, divide the garden into five parts).
4. IRRIGATE ONE PART OF THE GARDEN PER DAY, do not try to give a little bit of water to every bed in the garden every day. (The exception is for seeds and seedlings, which need a small sprinkling once or twice a day until their roots are strong and deep enough to cope with less frequent watering).
5. Keep an eye on how much water remains in the tank, and how long before the next rain is expected. Write this down every day, so that next winter you can try to benefit from this year's experience.
6. If it looks as if your water will run short, decide which crops are most valuable to you, and keep them going with the water you have left. It is better to lose a few beds than to harvest hardly anything from all your beds. Keep in mind that some types of plants need less water than others; e.g. cabbage uses less water than spinach. So in a crisis you may decide to save fewer spinach plants and more cabbage plants.

Irrigation strategy in the wet season (Points 2-5 above also apply here)

This would be **summer** in most parts of South Africa. Some years there is an abundance of rain, but some years can be very dry. A very difficult problem is when there are long dry stretches in an otherwise good rainy year, and this is where stored water will help you to save your plants. It is hard to predict when to expect a good or bad rainy year, therefore we have to plan for the worst, or 'almost the worst'.

Wet season strategy: START EMPTY, END FULL

1. If you can wet your beds thoroughly at planting, this is always a good strategy. Your rainwater tank will be nearly empty if you have made good use of it during the dry season, but should fill up quickly with the first few rainstorms.

2. You will then need to balance your irrigation with the amount of rain that has fallen, so that you do not irrigate unnecessarily. Remember the calculations in the sections above
3. During really hot dry weather you will need to irrigate more, but by now your tanks should be full and you can empty it dealing with these "dry spells" so that it can re-fill. The assumption is that your tank should be able to fill up at least twice during the summer season and should be full for the start of the winter season.



Left: An underground tank holding around 30 00l of water and
Right: A plastic roof tank 'jo-jo' that holds about 5 000l of water

3. Tank Maintenance and Safety



Both underground and aboveground rainwater harvesting tanks are a big investment in your homestead. It's important that you take responsibility for your tanks and ensure proper maintenance, cleaning, safety, and protection from fire. If you care for your tanks properly, they'll provide water for your garden for several decades.

Roof Tanks

Roof tanks must be cleaned out at least once a year. All the tanks have been fitted with ladders, so it is easy to climb in and out.

You should place a pile of stones or concrete under the tap in order to reduce splash erosion and to avoid having a muddy mess in your yard. You may want to keep a container under the overflow...every drop of water counts! Lead any excess water away so that you won't have standing water next to the house. Uncovered standing water offers a breeding ground for mosquitoes and various diseases.



Stones help to decrease splash erosion

Gutters

Gutters should be attached as close to the roof as possible to ensure that most rainwater runs off the roof into the gutters without splashing out or dripping straight to the ground. If gutters become loose over time, you may need to tighten the wires holding the gutters in place. It is advisable to remove gutters if you expect heavy snow because the weight of the snow may permanently bend them.



Gutters should be placed as close to the roofline as possible so that most rainwater will go into the tank.

Gutters must be checked for leaks occasionally. Leaks can be fixed with silicon. You can buy silicon for around R20 at your local "Spares" shop or hardware store. You should clean out your gutters as needed in order to keep the water in your roof tanks relatively clean. During the rainy season it is advisable to clean out your gutters once a month.

Underground Tanks

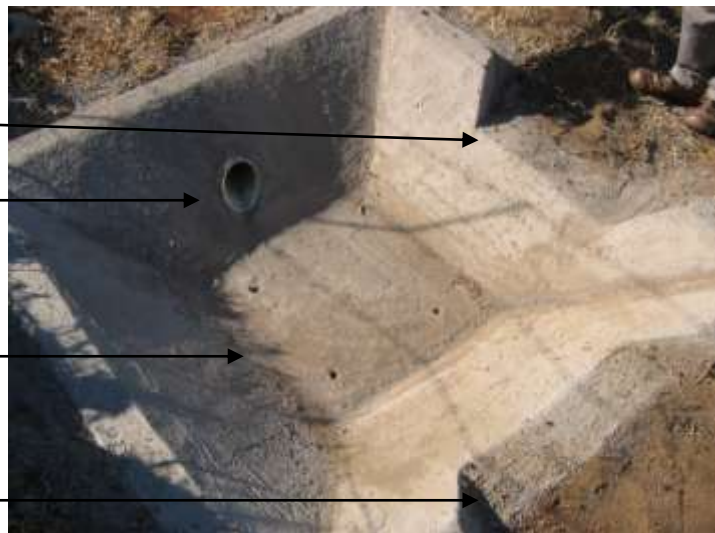
Your underground rainwater harvesting tanks are a unique design using plastic tanks. A silt trap leads water to your underground rainwater harvesting tank. Remember, water that enters your underground rainwater harvesting tanks is not fit for drinking.

Overflow directs water away once the tank is full

Inlet pipe leading to tank

Silt collects in the bottom so that it doesn't enter the tanks.

Inflow directs runoff into silt trap



Silt trap leading to underground rainwater harvesting tank also serves as an overflow.

Clean your silt trap after each storm with a flat-edge spade. Check regularly that the trenches leading to your inlet are still shaped properly to direct water towards the silt trap. Also, after each storm you should clean debris out of the metal strainer inside the pipe leading to your tank.



You should clean debris out of the strainer in your silt trap after each storm

It's very important to protect your underground tanks from cattle. If cattle graze the area around your tanks, place a fence around the tanks or pile thorny bushes as a barrier around the tanks. If a large bull steps on one of your tanks, he may cause serious damage!

It's also important to protect your tanks from fire. It is advisable to cut the grass around your tank, leaving a border of *bare ground* for at least 3 metres around the tanks. You may consider doing a wider firebreak if your tanks are in a vulnerable position.



This was a storage area at a JoJo factory. Notice the circles where the tanks once stood.

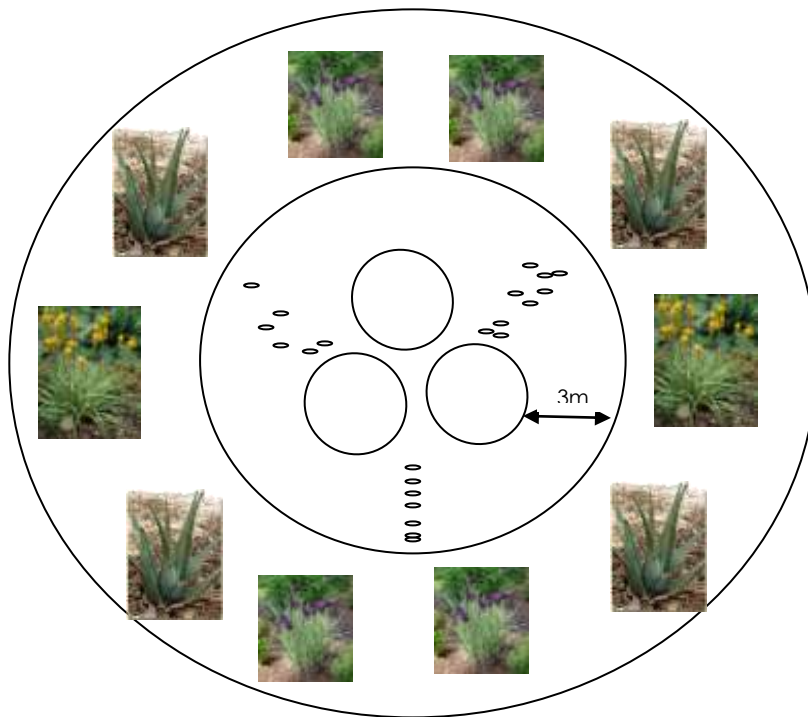
Remove the silt from the bottom of your underground tanks annually. Be careful not to damage the non-return valve placed near the bottom of the tank below the tank door!

Your tanks all come with a lock and key so that you can ensure the safety of curious children who may try to open the tanks. Since you will very seldom need to unlock the tanks, it is advisable to protect the lock from rusting. You can do this by greasing it with vegetable oil, wrapping it in plastic, or placing a small bit of prestik over the keyhole.



Be careful not to damage the non-return valve at the bottom of your tanks when you are cleaning them.

Depending on the layout of your yard, you may consider adding swales or stone lines around your tank in order to prevent soil erosion where you have carefully shaped the land. This will mean less work for you in the long run because you won't have to spend as much time reshaping the slopes around your tanks. Remember, it's important to direct the water around the tanks away so that you won't have standing water directly above your tanks.



In this yard, the tanks are surrounded by 3 metres of bare ground for fire protection. Three stone lines help to keep the soil around the tanks shaped to move water away. In the outer circle, aloes, irises, and bulbinella also help to retain the shape of the land as well as add extra fire protection.

Hand Pump

Your underground tanks have been fitted with a pipe pump that is powered by hand. This unique design offers a simple way to pump the water from each of the JoJos into a watering can.

It's important to keep the black pipes leading to the JoJos plugged so that no debris enters the tank. Emphasize with your children the importance of not putting any sticks in the tank because rubbish will become stuck inside and seriously damage your pump.

Notice the muddy mess in this picture. To avoid this splash erosion, place a pile of stones where the water will hit the ground. This will also help to maintain the shape of the soil around your tank.



Ntate Tladi shows how to use the pipe pump.

Watering the garden: How much, how often?

One of the most common wasteful irrigation practices is to spread a small quantity of water across the whole garden once or twice a day or every day or two. It is understandable that people do this, because they think that "at least all the plants will get a little bit of water." This kind of shallow watering is actually very wasteful, because most of the water simply evaporates out of the topsoil without doing much good at all. Shallow watering also promotes shallow root systems, which means our plants will wilt easily. Instead we should apply *more* water at a time and water *less* often. We can try to apply more water every second day and see how that goes. For more mature crops, such as full grown spinach or half grown cabbages, we can even water deeply once a week!

Deep watering

We all know that plants cannot grow without water. If plants receive regular deep waterings, they develop deep, strong roots, meaning that they can produce large, strong stems, leaves and fruit. If they get just a little water on the soil surface most of the time, the roots will be shallow and the plants will have very little resistance to dry periods.

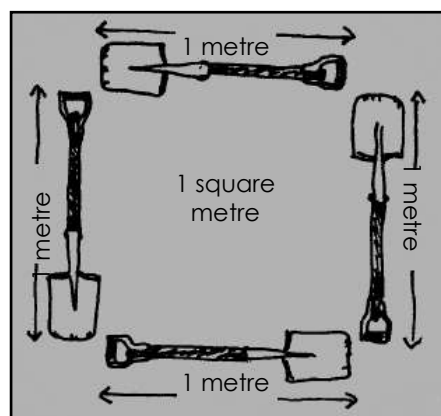
To do deep watering, divide the garden into imaginary sections and provide a good deep watering to each section every four to seven days. This allows the water to soak deep into the soil and less of it will be lost to evaporation.



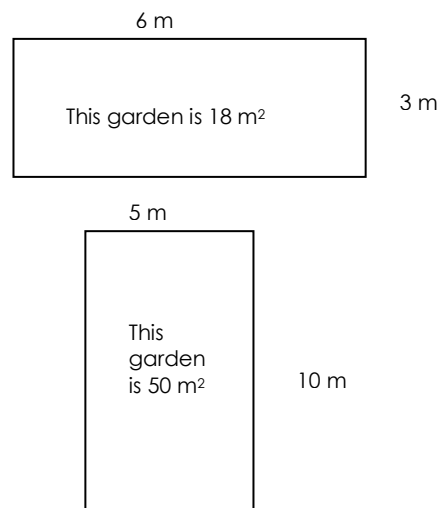
Beware: deep watering can also be overdone. If the water seeps down too deep, the plant roots can't reach it. However, this is a less common mistake than watering too little and too frequently.

We use deep watering because we want to draw the roots of our plants down into the ground. Applying **MORE** water, **LESS** OFTEN is crucial.

As a rule of thumb, vegetables require around 20mm of irrigation a week. This means that you need to apply 20 litres of water to every square meter square of garden bed.



Did you know that plants can also suffer if there is too much water around their roots all the time? If the soil is water logged, the roots don't get enough air. Plants need well-drained soils to prevent the roots from rotting.



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- When plants are making fruit, like nursing mothers, they need extra food and water!
- Plants need extra water because when it is extra hot. In cooler periods, plants need less.
- Towards the end of their life, like older people, plants need less water.
- The plants in your garden will be different types and sizes, so they all have their own water needs each week.

20mm/week is equivalent to
20litres/week which is a 20-litre
bucket on 1m².

For drip irrigation systems
20litres/1m² equates to about 340
ml of water/dripper/week.

How deep has the water gone?

The simplest method is to push a steel peg into the soil a few hours after watering the bed, when the water has had time to infiltrate properly into the soil. The peg goes in quite easily until it reaches the dry soil below, which gives you a good idea of how deep the water had gone down. Combine this with knowledge about the typical rooting depth of the crop, and you can decide if you have given enough water. If you measure rain in a rain gauge, you will measure this in millimetres. 1mm of rain is equivalent to 1litre of water on 1 m² of soil.

Golden rules of watering

Day-to-day, how and when you irrigate your plants has a big influence on how much water you use in the end. Here are a few golden rules:

- ❖ Start the growing season with your soil thoroughly wet to at least one meter deep – especially for the dry season crops when there will be very little rain for a few months. At first, the young roots won't reach this water, but the water will stay there and the plants will draw on it later in the season when they may need more than you can give.
- ❖ Provide your plants with a one deep watering each week. In very hot periods you can shorten this to once every three days, but give enough water to make sure that it will soak deep into the ground, and not just evaporate out of the top 10-15cm of your soil. You can also mulch to help reduce evaporation losses. But NEVER give shallow daily wettings to mature plants.
- ❖ Try to give soft, fine showerings rather than big hard drops (which will compact your soil), or gentle flows rather than rapidly running water (which will wash out your soil and expose the plant roots).
- ❖ Distribute water evenly across the planting bed. If all the plants get equal amounts of water, you will be getting the most 'crop per drop'. With uneven water sharing between the plants, those plants that get too much water, use

too much 'drop'; while those that get too little water, will give you too little 'crop'.

- ❖ **Measure! Monitor!** Keep a record of how much water you are giving; how much rain you are getting; and how the level changes in your rainwater tank(s). Every year you will get better at stretching your water to get the most 'crop per drop'. Always dig the day after you have watered to see how deep the wetness goes. Do these until you have developed a good understanding of how your soil reacts to irrigation and rain; and check again whenever you are uncertain whether the deeper soil layers are beginning to dry out.



Activity 1

How much water does the garden need?

Aim

To develop useful 'Rules of Thumb' on how many buckets per week your food garden needs, and how much water you can get from rain.

Instructions

1. Make sure you understand these two rules of thumb, and REMEMBER THEM.

Rainfall:

If 1mm rain has fallen, then 1 litre has fallen on every area of 1m x 1m.

The rule of thumb is: Every 1mm of rain gives 1 litre per m².

Watering the garden:

In most areas, a garden needs about 20mm per week.

To give 20mm per week, we need to give one 20 litre bucket of water per week for every 1m x 1m area of garden beds.

The rule of thumb is: One 20 litre bucket per week for every m² of garden beds.

2. Now use your rules of thumb to work out how many buckets per week a garden with 10 planting beds of 1m x 6m would need.
3. How many buckets is that per day if the gardener waters 6 days per week?
4. Should the gardener try to divide these buckets evenly between all the beds every day?

Answers:

2. 60 buckets (20 litre size) per week.
3. 10 buckets per day, which is the same as one 200 litre drum per day.
4. No, definitely not! Every bed would just get a thin sprinkling and will dry out again almost immediately – all the hard work and precious water to waste. Much better: divide the

garden into six parts and water one part per day, moving on to the next part the following day. In very hot periods, water one-third of the garden per day and increase the number of buckets per day if necessary.

How big is your garden? (Remember to just consider the beds. You don't need to include the paths in your measurement)	How many litres per week do you need to water your garden?	How many 20 litre buckets per week does your garden require?
10 m ²	200 litres per week	10 buckets per week
20 m ²	400 litres per week	20 buckets per week
30 m ²	600 litres per week	30 buckets per week
40 m ²	800 litres per week	40 buckets per week
50 m ²	1000 litres per week	50 buckets per week
60 m ²	1200 litres per week	60 buckets per week

Managing stored water

It's a good idea to start the dry season with a full rainwater tank and with water deep in your soil. Our strategies differ for dry and wet seasons.

Irrigation strategy in the dry season

In winter when there is no rain, there are few crops. Sometimes there is some rain, but not enough to see crops through to harvest, so crops may grow well at first, but die before we can eat them.

Dry season strategy: START FULL AND END EMPTY

1. Start the dry season with the trench beds thoroughly wet and the water tank full. You will try to use as much water from the tank as you need to get through the winter, and should end the dry season with the tank nearly empty.
2. If you are worried that your water may run out before the end of the season, plant a smaller portion of your garden in the dry season.
3. Decide how many days per week you will irrigate your garden. Divide the garden in equal parts to be watered every day (e.g. if you are planning to irrigate five days per week, divide the garden into five parts).
4. IRRIGATE ONE PART OF THE GARDEN PER DAY, do not try to give a little bit of water to every bed in the garden every day. (The exception is for seeds and seedlings, which need a small sprinkling once or twice a day until their roots are strong and deep enough to cope with less frequent watering).
5. Watch how much water is in your tank, and estimate how long before the next rain is expected. Write this down every day, so that next winter you can try to benefit from this year's experience.
6. If it looks as if your water will run short, decide which crops are most valuable to you, and keep them going with the water you have left. It is better to lose a few

beds than to harvest hardly anything from all your beds. Keep in mind that some types of plants need less water than others; e.g. cabbage needs less water than spinach. So in a crisis you may decide to save fewer spinach plants and more cabbage plants.

Irrigation strategy in the wet season

In summer there is usually an abundance of rain, but some years can be very dry. A very difficult problem is when there are long dry stretches in an otherwise good rainy year, and this is where stored water will help you to save your plants. It is hard to predict when to expect a good or bad rainy year, so we have to plan for the worst.

Wet season strategy: START EMPTY AND END FULL

1. (Points 2-5 above also apply here)
2. If possible, wet your beds thoroughly at planting. Your rainwater tank will be nearly empty if you have made good use of it during the dry season, but it should fill up quickly with the first few rainstorms.
3. Balance your irrigation with the amount of rain that has fallen, so that you do not irrigate unnecessarily. Remember the calculations in the activity above.
4. During really hot dry weather you will need to irrigate more, but by now your tank should be full and you can empty it dealing with these dry spells so that it can re-fill. Your tank should be able to fill up at least twice during the summer season and should be full for the start of the winter season.

Resource Material for Homestead Food Gardeners

Chapter 6: Handouts (English)

- Handout 1 Improving your soil
- Handout 2 Mulching
- Handout 3 Brews for plant nutrition
- Handout 4 How to make a trench bed
- Handout 5 Seedling production

1. Improving your soil

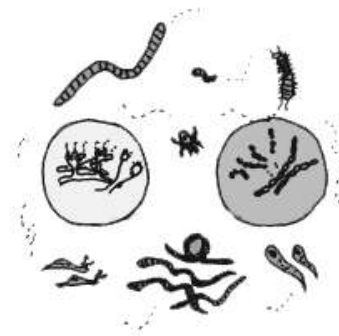


The living soil

Healthy soil is living soil. It contains many living organisms. It is deep, loose, easy to dig and full of air and water.

Living soil is a mixture of many things:

- ❖ Bits of sand, silt and clay, which are types of soil;
- ❖ Bits of organic matter, like leaves, grass, manure;
- ❖ Inorganic matter, like rocks and silica;
- ❖ Minerals such as potassium;
- ❖ Air and water;
- ❖ Micro-organisms: These are tiny bugs or creatures that are too small to see and live in the soil. They make the soil fertile by eating organic matter and changing it into rich plant food or humus. Small creatures like earthworms, other worms and beetles also live in the soil.



From: Lessons from Nature

Soil types

Soil is made through the breaking up of the basic elements or minerals of the earth. These are initially found in the form of rocks. Over a very long time, these rocks are broken down into small particles through rain, wind and sun and mixed with air and water. This becomes soil that can support plants and micro-organisms to grow. Like people, plants cannot live and grow without water, air and food.

All soils are a mixture of sand, silt and clay. The difference in the amount of sand, silt and clay will determine how the soil holds water. Examples of types of soil are sandy, sandy loam, loam, clay loam and clay.

Sand makes the soil loose.

Silt is very fine sand. It holds water and plant food better than rough sand, but it is easily washed out of the soil.

Clay is the sticky part of the soil that holds it together. It holds water like a sponge.

The best soils are called loams and they are an equal mixture of sand, silt and clay.

Characteristics of soils:

Sandy soil	
Good things about this type of soil	Bad things about this type of soil
<ul style="list-style-type: none"> ❖ It is easy to dig and work with ❖ It warms up quickly in spring after winter ❖ It is good for root crops ❖ Water and air can get into the soil easily 	<ul style="list-style-type: none"> ❖ It gets dry quickly ❖ It does not keep much fertility ❖ It does not hold water well
Loam soil (Mixture of sand and clay)	
Good things about this type of soil	Bad things about this type of soil
<ul style="list-style-type: none"> ❖ Holds water well ❖ Best for root growth ❖ Contains organic matter, like 	<ul style="list-style-type: none"> ❖ This soil can be hard when dry
Clay soil	
Good things about this type of soil	Bad things about this type of soil
<ul style="list-style-type: none"> ❖ Holds water well and for a long time ❖ Holds fertility well and for a long time 	<ul style="list-style-type: none"> ❖ Hard to work; heavy ❖ Slow to warm up in spring ❖ Sticky when wet ❖ Hard when dry

How to tell your soil type


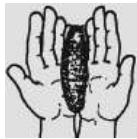



You can tell how much sand, silt or clay is in your soil by how it feels. Wet some soil and roll it into a ball between your hands. Then roll this little ball into a sausage. You can tell what kind of soil it is by looking at the table below.


It is important to know which soil type you have. This will give you some ideas about what you need to do to make your soil crumbly and loose. Crumbly and loose soil holds the most water and the most air, which is what plants need to grow.

To make your soil more crumbly (whether it is sandy, loam or clay) you need to keep adding lots of manure, compost and mulch. Never walk on the planted areas, especially if they are wet.

Sandy soil needs to be given organic matter to increase its ability to hold water and plant food. Clay soil needs to be given organic matter to increase its ability to hold air in the soil and to release the plant foods that are there.

All types of soil need organic matter to increase their fertility, or plant food.

What soil looks like	What soil feels like	When rolled into a sausage		The soil is
Very sandy	Very rough	Cannot be rolled into a sausage		Very sandy
Quite sandy	Rough	Can be rolled into a sausage but it cannot bend		Sandy
Half sandy & half smooth	Rough	Sausage can bend a little		Sandy loam
Mostly smooth	A little sandy, quite smooth but not sticky	Sausage can bend about half way around		Loam or silt loam
Mostly smooth	A little sand quite smooth and sticky	Sausage can be bent more than half way round		Clay loam or sandy clay

Smooth	Smooth and sticky	Sausage can bend into a ring		Clay
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Soil fertility

All living things are composed of the basic elements of the earth. Plants consist mainly of hydrogen, oxygen, carbon, nitrogen, phosphorus, potassium and smaller quantities of magnesium, sulphur and calcium as well as many other elements in very small amounts (these are called trace elements).

Plants need three main kinds of food:

- ❖ **Nitrogen (N)** – for healthy leaf and stem growth;
- ❖ **Phosphorus (P)** – for healthy roots and fruit formation;
- ❖ **Potassium (K)** – for general health and healthy flowers and fruit.

The capital letters in brackets (N, P, and K) are called the chemical symbols. If you buy fertiliser or other chemicals, they may use these letters instead of writing out the name in full.

All three of these foods are found in good compost or manure. You can also increase the amount of these foods in the soil by mulching with leguminous leaves like beans, peas, pigeon peas and Acacia (thorn tree leaves) or comfrey, using liquid manures, earthworm castings and effective micro-organisms. You will need to make the earthworm castings and effective microorganism brews and add them to your soil.

These are different ways of improving fertility that you will need to be shown.

Nitrogen

How do you know if your soil needs more nitrogen?

You will know your plants need nitrogen when the leaves are turning yellowish, instead of a strong bright green.

How can you add nitrogen to your soil?

This element is found in most manures (cattle, sheep, pig, goat, chicken and rabbit). There is more nitrogen in chicken and goat manure. These must be dried before

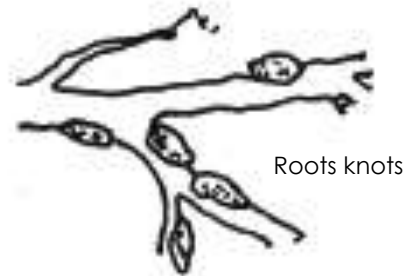


Nodules on the roots that fix nitrogen

being used in the garden. Otherwise they can be too strong and 'burn' the plants.

Nitrogen is also found in legumes

These are plants that form nodules or little knots on their roots. These nodules 'fix' nitrogen from the air, so that the plant can take it up through its roots. There are microorganisms (bacteria) in the roots that help to 'fix' the nitrogen. After the roots of the plant die the nitrogen is released into the soil and can be used by surrounding plants.



The bacteria in the root knots binds free nitrogen from air in the soil and release nitrogen after the plant dies

Examples of legumes that we often grow:

- ❖ Ground nuts
- ❖ Cow-peas
- ❖ Beans (including soya beans)
- ❖ Peas

There are less common crops and also many long living plants and small trees that also fix nitrogen. Some examples are chickpeas, mung beans, lentils, pigeon peas and tree lucerne. Some legumes are grown only as green manures, and are not used for food. These include lucerne, clover, hairy vetch and lupins. These give a lot more nitrogen to the soil than our food plants, because we dig them into the soil when they are still green. This is why we call them green manures. We can also plant our food crops in between these legumes.

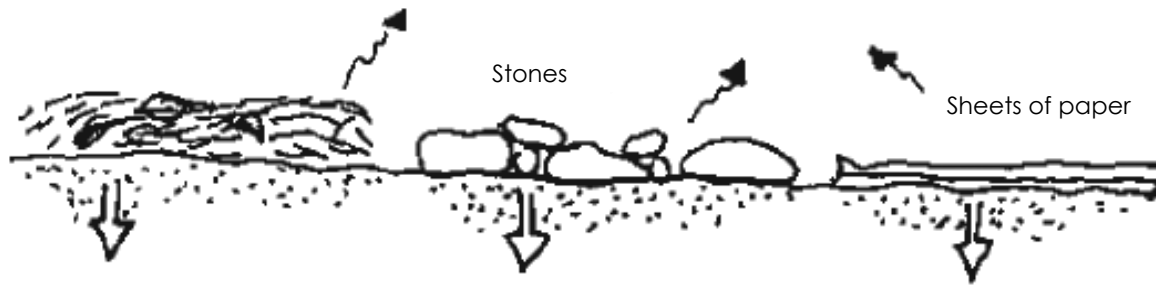


From: Food from the Veld, 1982.

You can also mulch with the leaves of legumes. This will add nitrogen to your soil.

All reduce evaporation

From: Production without Destruction,
Natural Farming Network, Zimbabwe



Phosphorous

How do you know if your soil needs more phosphorous?

You will know your plants need more phosphorous when they do not grow fast, as they should. The leaves may also start to show unusual red or pinkish colours, especially around the edges. If your plants are small and will not grow, even when compost is added, then you almost certainly have a severe phosphorous deficiency. This can also be caused by acidity in the soil.

How can you add phosphorous to your soil?

Many soils are poor in phosphorous. It is also a bit difficult to add phosphorous to the soil in an organic way, as most of the sources of phosphorous are tricky to work with. They include urine, bones, hair, feathers and blood. Usually we add these as ingredients to compost.

Natural rock phosphate can be added directly to the soil. This is also not easily available.

Another good source of phosphorous is bonemeal. You can usually buy this from an agricultural supply store – but it is not cheap.

One other way of adding phosphorous is to place bones in a fire, for a few hours. You can then grind them into a powder more easily. This powder can be spread on your garden beds or your compost heap.



The manure from animals grazing in areas where there is not much phosphorous will also have little phosphorous. You may need to bring in phosphorous in the form of chemical fertilizer. The usual source is called Superphosphate. Another chemical fertilizer known as DAP (Di-ammonium Phosphate) can also be used.

Potassium

How do you know if your soil needs more potassium?

You will know your plants need potassium when the plants become brittle and the leaf edges become brown and dry. When fruit do not form properly, you should also suspect a lack of potassium. Other signs can be hard to distinguish. One of these is a yellowing around the veins of the leaves. This could also be caused by diseases – so it is difficult to know.

How can you add potassium to your soil?

Good sources of potassium are chicken manure and fresh woodash. Never use ash from coal, as this is very poisonous to the soil and plants. Another good source of potassium is a plant known as comfrey. This plant has large hairy leaves and grows in wet shady places. The leaves contain a lot of potassium. These can be used to mulch your vegetable beds and also to make liquid feeds for your plants (We will look at liquid feeds later in this section).



The other elements or minerals needed in smaller quantities, such as Magnesium, Zinc and Iron, are found in most manure and in compost.

Comfrey is also a good spinach and medicine. A tea made from the leaves is good for high blood pressure and arthritis.

Soil acidity

What is soil acidity?

The minerals or nutrients needed by plants to grow are dissolved in the water inside the soil. This is a bit like salt or sugar dissolved in a glass of water.

Soil acidity is when the soil is sour. It is a bit like a glass of water that has vinegar dissolved in it. In places where it rains a lot, some of the minerals can be washed out of the soil. The soil then becomes acidic. The use of chemical fertilizers over a long period of time, can also make the soil acidic.

If there is too much acid in the soil, some minerals or plant food will dissolve too quickly and the plants cannot use them. Other minerals will not dissolve at all, so again, the plants cannot use them. Phosphorus is one of the minerals that cannot be used by plants when the soil is acidic – even if it is in the soil.

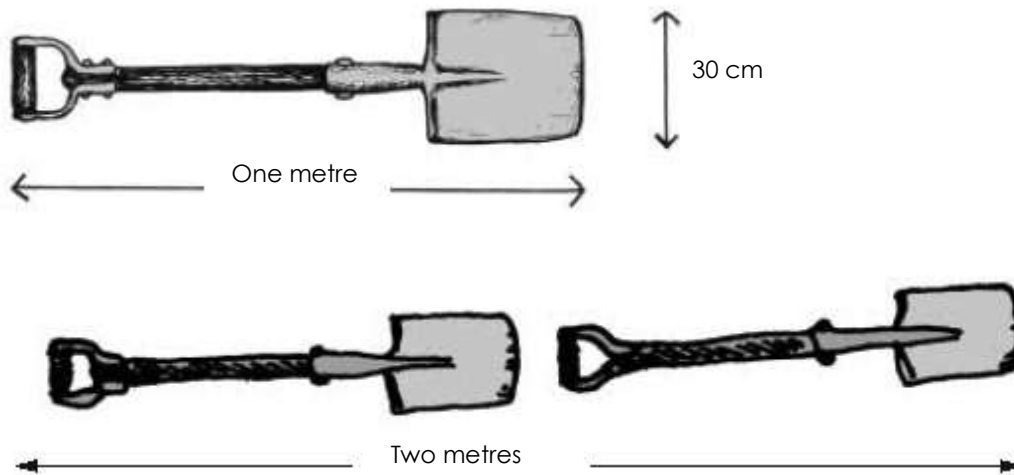
How do you know if your soil is acidic?

You will know your soil is acidic if you provide compost or manure and water for your plants, but they do not grow. The plants remain small and stunted. This is a common problem.

How will you solve the problem of acidity?

The only practical way of dealing with soil acidity is to add lime to the soil. Lime can be bought and is a white powder, or grey granules.

It needs to be dug into your soil, at least as deep as the roots of the crop you are growing. For vegetables this is between 30 - 60 cm. This is the width of 1 or 2 spades. You will need to add 1 kg of lime for every square metre of soil. 1 Kilogram of lime is a spade full. It needs to be heaped high.



For field crops like maize and sorghum that have deep roots this is from 60 cm to 1 metre deep. 1 metre is the length of a spade.

Usually Lime is added 2 or 3 months before planting, as it is slow acting in the soil. If you add Lime at the same time as you are planting your crop, you will only see the main effect of the Lime in the next season.

Other ways of improving your soil

Manure

Most kinds of animal manure can be used. This includes cattle, sheep, goats, pigs and chickens.

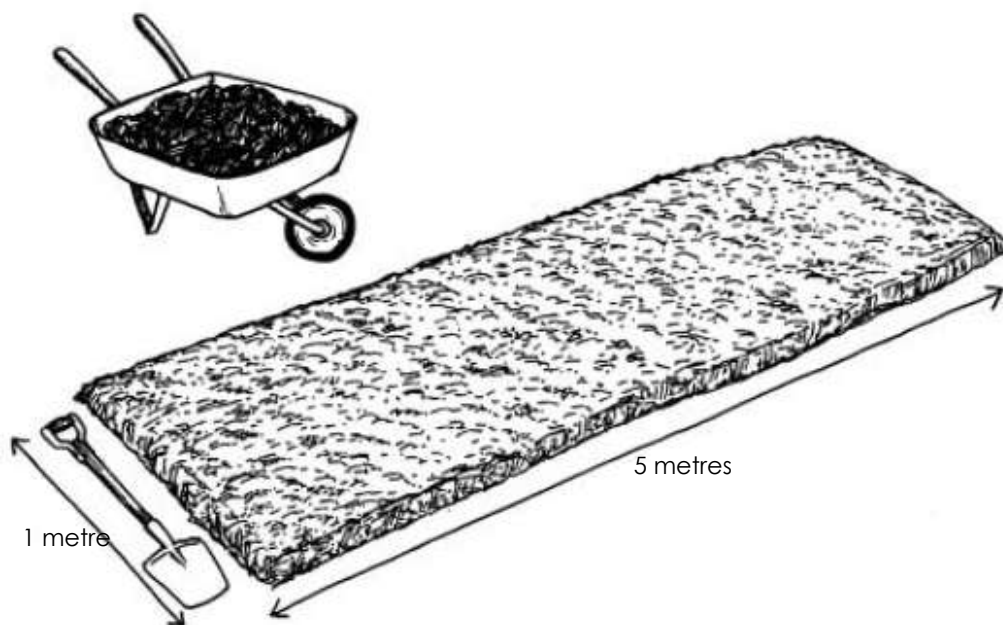
Handling manure

The best manure to use is manure mixed with straw and urine, from a kraal. Sweep this into piles at least once a week, and then cover it with grass or plastic.



Manure can be added to your soil in a number of ways:

- ❖ It can be used when you are planting your seedlings, by mixing in two to three handfuls of manure into your planting holes for seedlings.
- ❖ It can be dug into a whole bed to increase the fertility. Here you will need to use one wheelbarrow load (around 50 kilograms) to a bed size of 1 metre by 5 metres.



- ❖ It can be used in hotbeds. Here the bed is dug out to a depth of about 30 cm, which is the width of a spade. It is then filled with a layer of fresh manure about 10 cm deep at the bottom. This is about the same as the width of your closed hand. Some grass, weeds and organic matter can be placed on top of this before filling your trench with top soil only. Some manure or compost can be mixed into this soil before planting. These are called **HOTBEDS** because the manure heats up as it decomposes in the ground. This will heat up the soil in your bed. This is very good for cold winter areas.
- ❖ Manure can be spread over the surface of the ground as a mulch. It then has the added advantage of providing food to plants.
- ❖ Manure can be added to compost heaps to make the best compost.

Compost

Compost is a combination of wet and dry plant material and manure that has decomposed together to form a rich plant food. Compost also helps the soil to hold water and keep plants free from diseases.

More advantages

- ❖ Compost is ready as plant food, without the need to be broken down by soil micro-organisms first.
- ❖ Compost does not cause a lot of weed growth, like most animal manures do.
- ❖ You can get good crops without spending lots of money on fertilizers.

Some disadvantages

- ❖ Compost requires a lot of work to prepare and use.
- ❖ The value of compost depends on how it is made and what you used. If it is not made well, it will not be a good plant food.
- ❖ It may be difficult to find the organic material you need to make compost.

What do you need to make a compost heap?

You need to collect a lot of the following:

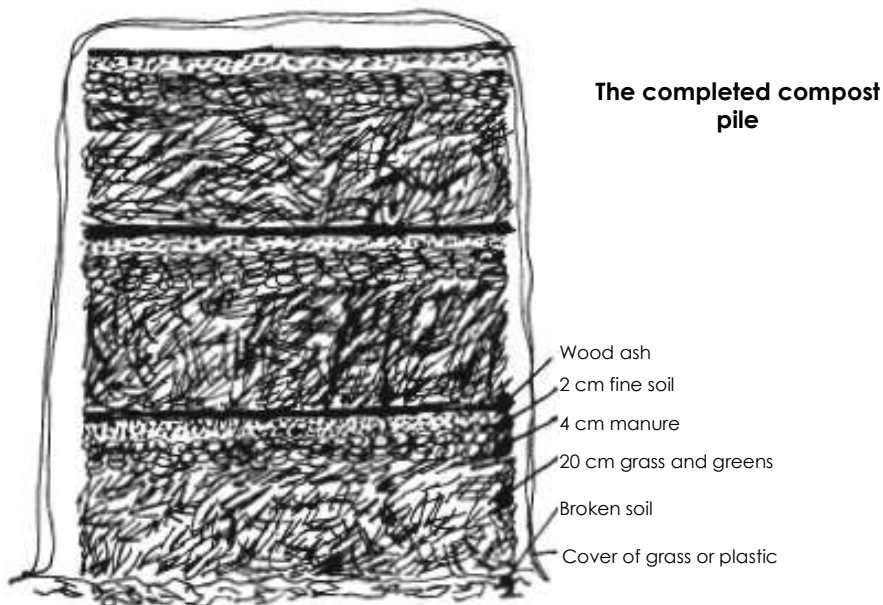
- ❖ Maize stalks or leftovers from other crops. These are called crop residues;.
- ❖ Grass (without seeds!) – it can be green or dry;
- ❖ Cabbage leaves and weeds (green or dry) with no seeds;

❖ Animal manure;

❖ Wood ash.

Some other things that can go into a compost heap are: kitchen waste, washing water, yard sweepings, dead animals, bones, wool, horns and feathers. It is a very good idea to add comfrey to compost heaps.

THINGS NOT TO ADD: Plastic, glass, metal, wood, old batteries or anything that cannot decompose (that means to break down in the soil).



Where to make a compost heap

- ❖ In a shady place but not too close to the trunk of a tree.
- ❖ Protected from too much wind.
- ❖ On flat ground.
- ❖ Close to your garden and to a source of water.
- ❖ Away from animals (especially pigs, goats and chickens).

How to make a compost heap

Step 1:

Choose your site and turn the soil over with a fork or a hoe. The area should be about 1 metre by 2 metres (1 spade length wide and 2 spade lengths long).

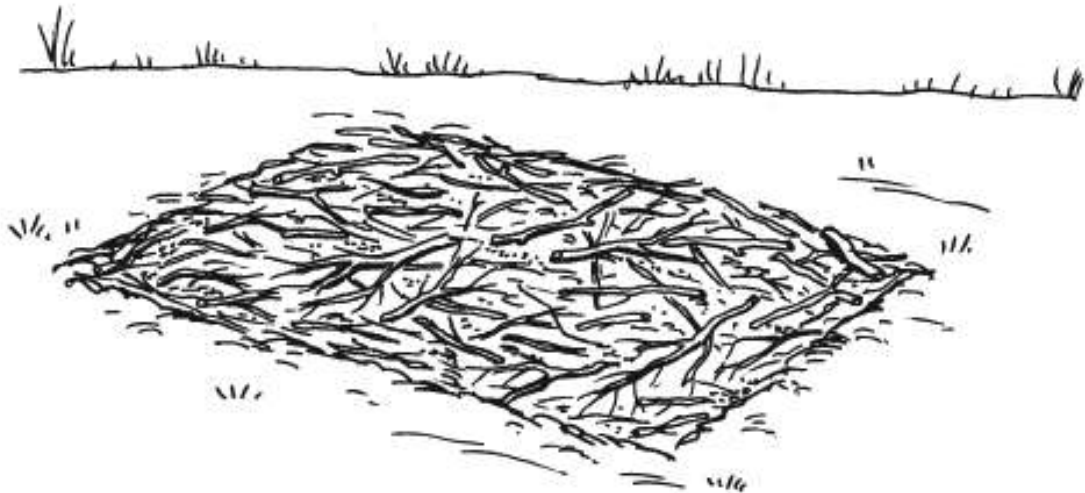


Step 2:

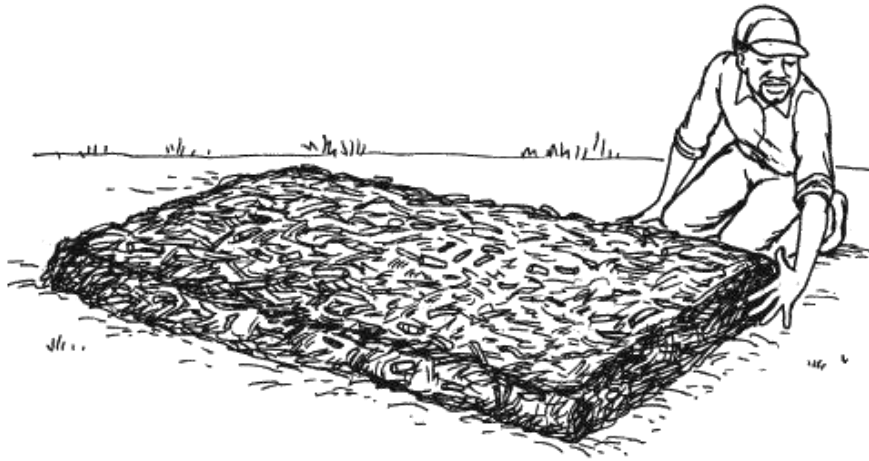
Chop the stalks and leaves of your crop residues, grass and weeds into small pieces. This includes comfrey, cabbage leaves, weeds and maize stalks. They need to be chopped into pieces about 10 cm long. This is the width of your closed hand. This will make the composting process go faster.

**Step 3:**

Lay some small branches and twigs on the soil that you have turned over.

**Step 4:**

Cover these with a layer of your chopped mixture, about 30 cm deep. This is one open hand deep. If you have kitchen wastes, they are added in this layer.



Step 5:

Spread manure on top of this about 4 cm deep. This is the width of 2 fingers.



Step 6:

Spread some soil on top of the manure about 2 cm deep – the width of 1 finger.



Step 7:

Sprinkle wood ash on top of the soil. If you are also going to add lime, bone meal or rock phosphate, this can be sprinkled on now.



Step 8:

Water these layers until the water soaks through at the bottom of the pile.

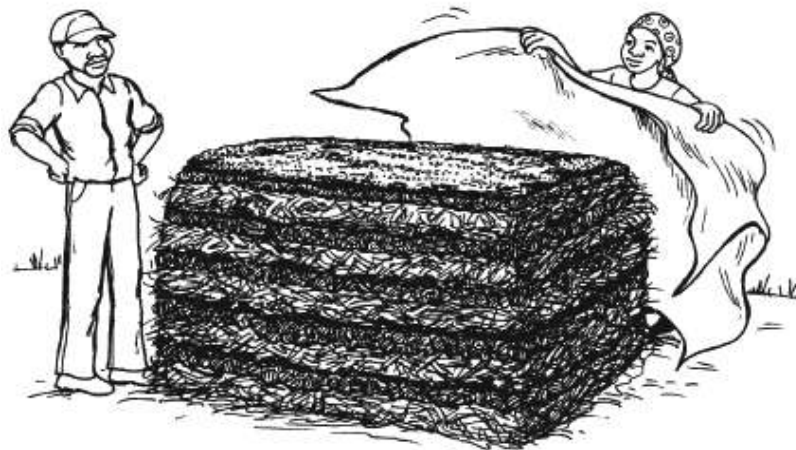


Step 9:

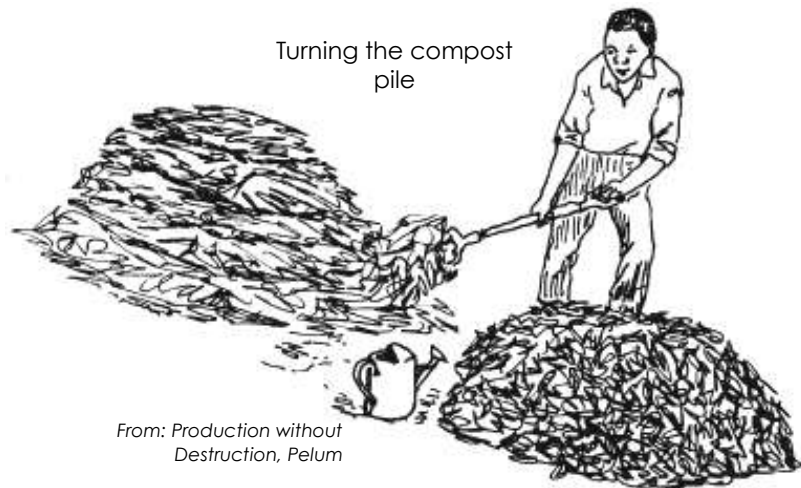
Continue to build the heap, repeating the layers as before, until it reaches the height of your chest.

Step 10:

It is best to cover your pile, either with a thick layer of straw or grass or plastic. This helps to keep the water and heat in and helps your pile decompose. It also stops animals from scratching in your heap and destroying it.



It is best to turn your compost heap every two weeks. If your heap is dry, you will need to add more water. If you do this your compost should be ready in about 6 weeks in summer and about 8-9 weeks in winter. In very cold areas that experience snow, your heap will have to be well covered – otherwise nothing will happen at all.

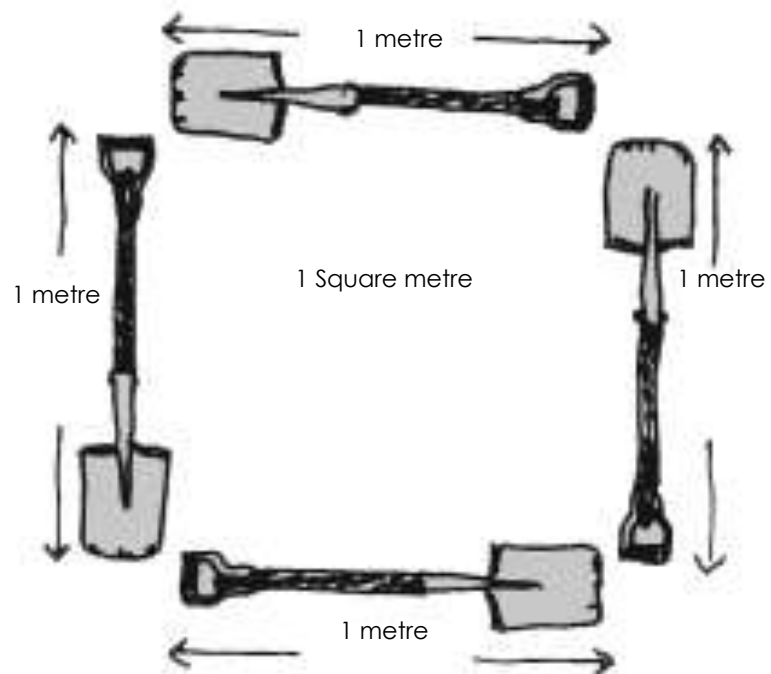


When is compost ready to use?

When there is still steam coming out of your heap it is VERY busy decomposing. The compost will be ready when it has turned blackish in colour and looks like moist soil. It will have almost no smell. (If it is smelly and warm, it is definitely NOT compost!).

Handling compost

- ❖ Plant each seedling with 2-3 handfuls of compost.
- ❖ Dig compost into the soil: Turn over the soil and loosen it to a depth of at least one spade head. Spread 4 full spades of compost in an area of 1 square metre. Dig this lightly and then plant.
- ❖ Use compost as a mulch by spreading it over the surface of your beds.



From: Vikela, May 2003, FSG



Experimentation

An experiment to test whether your soil has enough lime and phosphate

In this experiment, you will need to measure out 4 plots of the same size. Make these plots about 1 metre long and 1 metre wide. This is the length of one spade. Be sure to mark your plots out with sticks, so that you will know throughout the season where your plots are. You will then be able to do your experiment.

Plot 1:

Prepare and plant in your normal way

Plot 2:

Prepare the soil in your normal way and then add 2 big spoon fulls of Superphosphate. This is spread evenly over your soil and then dug into the soil. Then plant in your normal way.

Plot 3:

Prepare the soil in your normal way and then add one big tin (jam tin) full of Lime. This is spread evenly over the soil and then dug into the soil. Then plant in your normal way.

Plot 4:

Prepare the soil in your normal way and then add 2 big spoonfuls of Superphosphate and one big tin of Lime. This is spread evenly over your soil and then dug into the soil. Then plant in your normal way. Below is picture of what your experiment could look like.

Now you will monitor or look at this experiment. Every week you will check and write down which plants look better. You will look at the plants' growth, their colour (whether they are green or yellowish), and their health (whether they are healthy or diseased). Here is an example of how you can record your results: You can start with this table and write in your results from week 3 onwards. Or use this table to draw your own table on a piece of paper.

Experimental plot	Control 1	Phosphate 2	Lime 3	Lime & Phosphate 4
	Garden planted with cabbages			

	Plot 1 Control	Plot 2 Phosphate	Plot 3 Lime	Plot 4 Lime+ Phosphate
Week 1	Seedlings look good	Seedlings look good	Seedlings look good	Seedlings look good
Week 2	Seedlings growing, but yellowish. No disease	Seedlings growing; not yellow. No disease	Seedlings growing well. No disease	Seedlings growing well; dark green. No disease

Week 3				
Week 4				
Week 5				
Week 6 etc				
Final result Growth				
Colour				
Health				
Number of plants that look good				

You can use the Small Scale Experimentation Plan to think about how the phosphorous and lime experiment will help you improve your soil fertility.

Small scale experimentation plan	
What is the problem?	My plants are not growing well, even when I add compost or fertilizer
What is a solution to this problem?	I will add phosphorous and lime to see if that makes a difference
Why will this solution solve the problem?	My soil may need phosphorous or lime, or it may need both of these things
How will I test this solution?	I will add phosphorous to one experimental plot, I will add lime to another experimental plot, and I will add phosphorous and lime to my third plot. I will also keep one plot free, as a control, to make sure that what I am adding is really making a difference
How will I check my results? What will I look for?	I will look at the leaves to see if they are a good bright green colour. I will also look to see if my plants look healthy or diseased
How else will I check my results? What will I measure?	I will measure the growth of my plants using a piece of string
How will I measure the results or outcomes?	The plants that grow the most, and look the most green or the least yellow, and look the most healthy will be the best plants
How will I compare my experiment to my usual way of farming?	I will know that where my results were good, I should add that thing to my soil. So if I get the best results by using phosphorous and lime together, then I should add that to all my soil

In these materials there are many suggestions for improving your soil. You can experiment with any of them to see whether your plants will grow better if you use them.

- ❖ You can test what kind of soil you have, and add compost.
- ❖ You can add nitrogen, by adding manure.
- ❖ You can add nitrogen, by planting legumes.
- ❖ You can add phosphorous (which is called Superphosphate when you buy it).
- ❖ You can add potassium, by adding chicken manure.
- ❖ You can add potassium, by adding fresh woodash.
- ❖ You can add lime, which you can buy, to make the soil less acidic.
- ❖ You can add manure.
- ❖ You can add compost.
- ❖ You can add a liquid manure made from comfrey or animal manure.
- ❖ You can mulch with leaves of legumes

For each of these suggestions, you can do some experimenting, to see which works best for you. Remember to keep a record of all your experiments, so you can look back on them in a few years time. You should also keep records so that you can share the information with your neighbours and community, and compare your results with other people's results.

2. Mulching



Mulching is the spreading of a layer of material over the surface of the soil. It covers the soil and keeps it moist and cool in summer. It keeps the soil warm in winter.

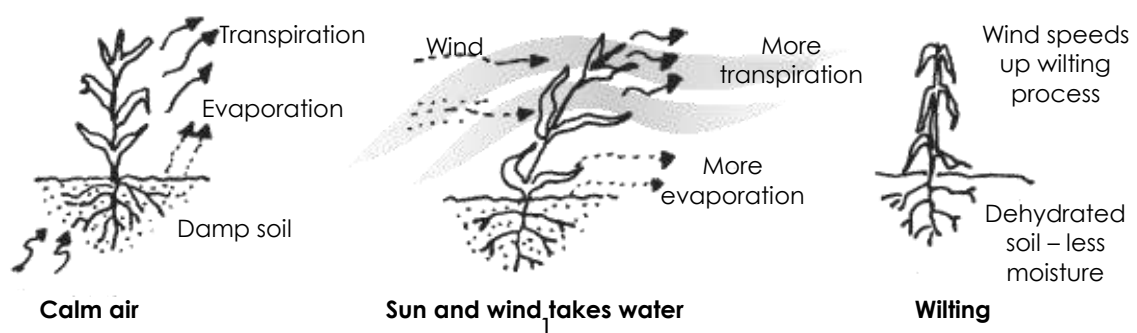
Why mulch?

Mulching has two main effects:

- ❖ It saves water, because it will stop the sun and wind from drying out the soil. That means that you will need to give less water to your plants, because it is not lost through the effects of sun and wind.

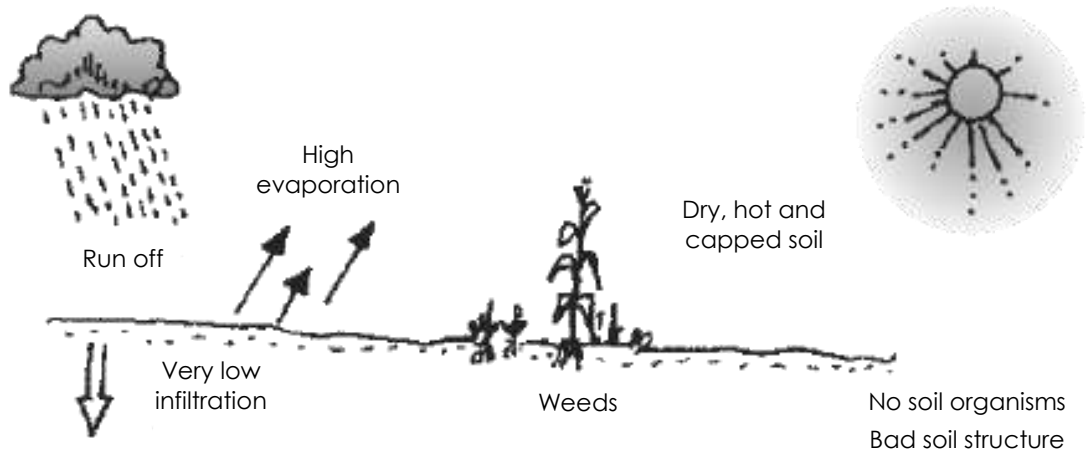
The effect of sun and wind on bare soil

From: Production without Destruction. Natural Farming Network, Zimbabwe

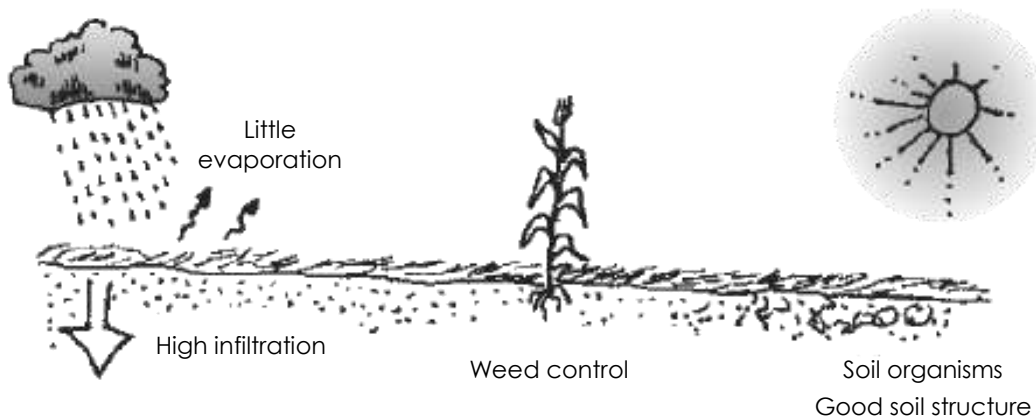


- ❖ It keeps the soil temperature more even. Mulching reduces too much heating and too much cooling of the soil. This makes it easier for plants to grow.

Bare soil



Mulched soil



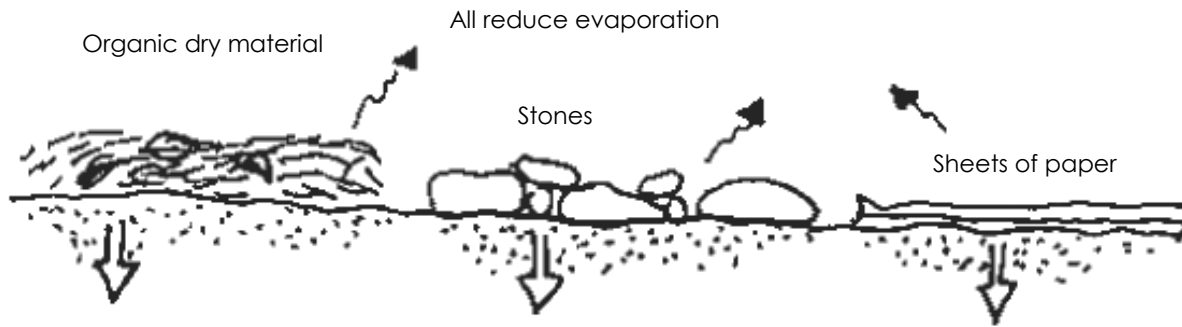
From: Production without Destruction. Natural Farming Network, Zimbabwe

More effects of mulching

Negative	Positive
<ul style="list-style-type: none"> ❖ It is sometimes hard to find enough material to mulch with ❖ Sometimes mulching on seed beds can affect the growth of carrot seedlings. They can become spindly and weak ❖ Some people think it looks untidy ❖ Mulch can encourage slugs and snails 	<ul style="list-style-type: none"> ❖ It stops loss of minerals/nutrients from the soil ❖ It encourages soil organisms ❖ It reduces weed growth ❖ It prevents capping: that is the formation of a hard layer of soil on the surface. ❖ A stronger root system develops closer to the soil surface. This makes more nutrients and air available to the roots ❖ Break down of mulch will add to soil fertility ❖ Breaks the impact of heavy rains and splashing of soil on plants - that can spread diseases

What to use as mulch?

From: Production without Destruction. Natural Farming Network, Zimbabwe



Usually we use:

- ❖ Crop residues (stalks and leaves of harvested crops). NEVER use diseased crop residue. You will infect the soil and your new crops!
- ❖ Weeds that have been pulled out and left to dry out
- ❖ Grasses from the veld. Make sure to use DRY grass. GREEN grass will take nutrients from your soil and your crops will have fewer nutrients.
- ❖ Flat stones. These will cover but will not add nutrients. They are good around larger plants and fruit trees.
- ❖ Newspaper. This will cover and add a little bit of nutrients/ plant food to the soil. Wet the newspaper when you put it on the soil, so that it does not blow away.
- ❖ Manure; use DRY or OLD manure for this.
- ❖ Leaves collected under trees.
- ❖ Old thatch grass.
- ❖ Black plastic sheeting.

How do we mulch?

- ❖ It is best to chop up your mulching material (weeds and grass) to be about the length of your hand (10-20 centimetres)
- ❖ Use a thin layer of mulch for seedlings and small plants – about one finger width deep (1.5 cm)
- ❖ For larger plants use much thicker mulch – about 2-3 finger widths (3-4 cm)
- ❖ For trees, a really thick layer, one whole hand or more (10-20 cm) can be added



One hand =
10 – 20 cm



One finger =
1.5 cm



Two fingers =
3 – 4 cm

When the mulch has broken down, you need to add more! You will be amazed how quickly this happens. Usually mulch is added at least once a season, or once every 3 months. In areas with extremely cold winters, it may be an idea to make sure your mulch is compact or squashed down once the frosts are heavy and the ground starts to freeze. Loose mulch can make the effects of frost more severe.



Experimentation

Remember to use your experimentation plan for every new thing that you try.

Small scale experiment plan

- ❖ What is the problem?
- ❖ What is the possible solution?
- ❖ Why will this solution solve the problem?
- ❖ How will I test this solution step by step?
- ❖ How will I check my results? What will I look for?
- ❖ How else will I check my results? What will I measure?
- ❖ How will I measure the results or outcomes?
- ❖ How will I compare my experiment to my usual way of farming?
- ❖ Make a drawing of the experimentation in the field.

Here are some questions that you can use to experiment with adding mulch

- ❖ Did you use mulch on all of your plants, or only some?
- ❖ Were the plants that you mulched bigger and better than the ones that had no mulch?
- ❖ Did you use less water on the plants that were mulched?
- ❖ What did you use for mulch? Was it good? What will you use for mulch in future?

3. Brews for Plant Nutrition

One way of improving plant nutrition is to make liquid teas or brews that will add fertility to the soil. This should be used as an additional soil fertility technique rather than the only one! Brews provide extra nutrients in case of small deficiencies, but cannot rectify major nutrient deficiencies.

Liquid manures/brews/ teas are a simple way of giving your plants a boost. They can be made from plant material or animal manures. The aim is to provide plants with natural plant foods quickly during their growing season. It is useful for heavy feeders like cabbages and to give seedlings a boost.

How to make liquid manures from plants

A good plant for liquid manure is comfrey. Most soft green leaves and stems can also be used and weeds are ideal. Avoid plants which are very strong smelling. Plants are made of different quantities of nutrients and take up different nutrients from the soil. It is best to use a range of plant materials to make your liquid.

- ❖ Make sure your container is clean before you use it.
- ❖ Collect the plant material and fill up the container. You must keep on adding material to the container every week
- ❖ Place a rock on top of the plant material in the container and put the lid on. Do not add water. The plant material will make its own liquid. If you are only using weeds, and no comfrey or banana stems, you may need to add a little water, to just cover the compressed plant material.
- ❖ Place it in a sunny position and two weeks later check to see if the leaves have turned black. If you tilt the container you should find a black juice. This is the concentrated plant liquid manure.
- ❖ This liquid is very strong and should be diluted as follows:

Seedlings: 1 tin of liquid manure for every 4 tins of water.

Bigger plants: 1 tin of liquid manure to 2 tins water. If you make the mixture too strong it can burn the leaves of plants.

Every two weeks pour the mixture on the soil around your plants, after you have watered them. You should pour at least one tin of this diluted mixture around each seedling or plant. The tin should be the size of a big jam tin.

Good plants for liquid manures

Comfrey



Comfrey

From: Useful Plants for
Land Design, Pelum

This plant has large hairy leaves and grows in wet shady places. The leaves contain a lot of potassium. These can be used to mulch your vegetable beds and also to make liquid feeds for your plants. Comfrey is also a good spinach and medicine. A tea made from the leaves is good for high blood pressure and arthritis.

A brew made from comfrey leaves can be diluted as mentioned above and sprayed on plant leaves to protect against downy and powdery mildew. Mildews are a problem mainly on cucurbits, pumpkins and peas.

A brew made from comfrey and stinging nettle can be sprayed on plants to protect against early and late blight, which attacks tomatoes and potatoes.

In these cases the brews are sprayed onto the leaves of the plants.

Stinging nettle

This is one of the best plants you can use in plant brews. It contains a wide variety of nutrients and trace elements and is a well balanced plant food. It is best to collect these plants in the natural forests where they occur and plant a few in your garden. They do not survive frost, but otherwise grow almost anywhere.

Banana stems

These are chopped up and placed in the container with other plants and leaves. The stems have a high concentration of potassium and water and make a good liquid base for the brew.

Weeds

Black Jack, Amaranthus, Chickweed, Galant Soldier. All fast growing weeds, with soft dark green leaves are good. Avoid using grasses and sedges.

Advantages and disadvantages of plant brews

ADVANTAGES of plant brews	DISADVANTAGES of plant brews
Plant brews are easy to prepare and use	Resources such as containers with lids are required
If diluted these brews do not harm plants	Plant brews can burn plants if they are too strong
Plant brews increase disease resistance in crops	Effects of the brews on plant growth are only visible after 3-5 days.
Plant brews provide a quick and cheap plant booster food	It is not possible to know exactly which nutrients these brews contain.
Plant brews provide mainly potassium, phosphorus and trace elements.	Some people do not like the smell of these brews, which can smell very rotten
Nitrogen can be provided if the brew is used early in the fermentation cycle (after 1 week) and care is taken to avoid it's evaporation by keeping the containers closed and cool	Nitrogen is volatile and is lost from the brews quite early in the fermentation cycle

How to make liquid manure from animal manure

Manure can be used from chickens, rabbits, cows, goats and sheep. A mixture of manures is best.

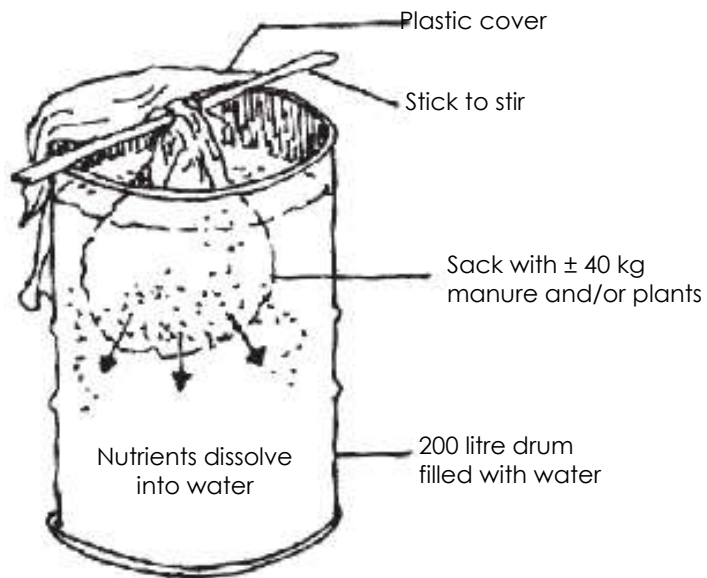
- ❖ Put your fresh manure mixture into an orange packet and tie the top of the bag.
- ❖ Put the bag in the container and attach it to a stick or a rope. Then fill the container with water. For every 1 kilogram of manure you will need 5 litres of water. This means an orange sack full of manure in a large bucket (50l), or half the bag in a normal sized household bucket (20l). This is a way of keeping the manure and the water separate, because you should not put the wet manure on your plants.
- ❖ Cover the container with a lid. Stir every few days.
- ❖ After two weeks the mixture will be ready to be used. It should look like weak tea. Before using the liquid, stir the mixture well.
- ❖ This liquid will be very strong and should be diluted:

Seedlings: 1 tin of liquid to 8 tins of water (or buckets or bottles)

Bigger plants: 1 tin liquid to 4 tins of water

If you make the mixture too strong it can burn the leaves of plants.

Every two weeks pour the mixture on the soil around your plants, after you have watered them. Again, use at least one big jam tin full for each seedling or plant. Avoid applying your mixture in the middle of the day or on very hot days.



Good sources for animal liquid manures

Kraal manure (cattle):

Either use fresh manure or use manure that has been collected in a kraal. In this way you can ensure that the manure contains as many nutrients as possible and that the nutrients have not been lost into the air through baking in the sun and drying out. This is especially important if you need your liquid manure to contain some Nitrogen.

Chicken manure:

With chicken manure it is important to collect the droppings while they are fresh. Again this keeps the nitrogen and other plant food concentrated in the dry droppings. It is possible to collect the droppings daily and keep them in a sack in a cool dark place, until you have enough to make a brew.



Liquid manure made from chicken manure can burn plants, as it can contain a high level of Nitrogen. It is important to dilute this brew properly before use. If you are unsure, test the brew on a few plants only and come back the next day. If the edges of the leaves have gone brown and crinkly overnight, the brew is too strong and has "burnt" your plants.

Goat manure:

This is a very mild manure and is well balanced. It is unlikely to "burn" plants, but may also be a little low in phosphorus, depending on the diet of the goats.

Other manures:

Manure from rabbits can also be safely used. It is suggested not to use the manure from pigs, due to the possibility of carrying worm eggs that can infect people. Do not use manure from dogs and cats for the same reason.

Advantages and disadvantages of animal liquid manures

ADVANTAGES of animal liquid manures	DISADVANTAGES of animal liquid manures
Liquid manures are easy to prepare and use	The liquid manure is only as good as the manure of origin. If the animals are suffering from deficiencies these will be transferred into the manures. As an example, there is likely to be a lack of phosphorus in cattle manure, where cattle have only been grazed on veld. This means the liquid manure made from this source will also lack phosphorus.
If diluted properly, these liquid manures do not harm plants	Liquid manures are generally low in nitrogen. Using chicken manure drastically increases the nitrogen content.
Liquid manures increase disease resistance in crops	The source manures have to be handled well to retain their nutrients before using as liquid manures.
Liquid manures provide a quick and cheap plant booster food	Effects of the liquid manures on plant growth are only visible after 3-5 days.
Liquid manures provide mainly potassium, phosphorus and trace elements.	It is not possible to know exactly which nutrients these brews contain.
Nitrogen can be provided if the liquid manure is used early in the fermentation cycle (after 1 week) and care is taken to avoid it's evaporation by keeping the containers closed and cool	Some people do not like the smell of these liquid manures, which can smell very rotten

How to make a foliar spray

This is brew made from a mixture of plant and animal material. It is used by spraying onto the leaves of plants from where it is absorbed. This brew contains antibiotics, microbes and plant hormones as well as plant nutrients (potassium, phosphate and trace elements). (from :EMBRAPA; Brazilian Agriculture Research Institute)

- ❖ Place the following ingredients in a container with a lid:
 - 30kg of fresh cow manure
 - 50-60liters of water
 - 5litres of milk (without salt)
 - 5liters of sugar cane juice/ 15kg of chopped sugar cane/2kg of brown sugar (personal variation)
 - 4kg of wood ash (not coal ash!!)
 - 4kg crushed bones or bone meal (fish bones are ideal if available. If possible do not use chicken bones) (We use bone meal bought from a gardening shop)
 - 3-5x 20l buckets of chopped weeds
 - 2-3kg of agricultural lime/ crushed eggshells
- ❖ Leave this mixture for 10-15 days
- ❖ Dilute 2-10litres of this mixture in 100 litres of water.

This spray is highly effective!! It is possible to keep the brew going for a period of time, by adding more weeds and manure and fermenting the mixture again for about 10 days.

Advantages and disadvantages of foliar sprays

ADVANTAGES of foliar sprays	DISADVANTAGES of foliar sprays
<ul style="list-style-type: none"> Foliar sprays are very effective and act quickly in the plants. If diluted properly, these foliar sprays do not harm plants Foliar sprays increase disease resistance in crops Foliar sprays provide a quick and cheap plant booster food Plant hormones and antibiotics are also supplied through the fermentation process in the making of foliar sprays 	<ul style="list-style-type: none"> Some inputs for foliar sprays need to be bought; such as agricultural lime and potentially wood ash, sugar and milk This mixture is exceptionally smelly while it is fermenting Foliar sprays can “burn” plants if they are too strong

4. How to Make a Trench Bed

Introduction

A trench bed is a way to increase soil fertility and water holding in your beds and garden. It is an intensive way of providing good soil for vegetables production on a small scale. It involves digging a hole and filling it with organic matter, so that your bed can be fertile for a long time (around 5 years).

The method

1. Dig a hole 60cm or deeper. It is usually about 1m wide (to provide easy access, without having to step on the bed) and can be as long as one likes.

2. Separate the topsoil and subsoil in piles while you are digging.

If your sub-soil is very in fertile it is not used in the trench. Spread this soil around the garden to help channel water towards your bed.

3. Place a layer of tins or branches at the bottom of the trench to help with aeration and also with supply of some nutrients.

The tins need to be squashed before putting them in the hole. Make a layer of tins about 3 tins deep. If there are no tins use thin branches instead.

4. Fill the trench with a range of organic materials and topsoil.

- First add dry grass or weeds (about 10 cm deep)

- Then add manure (about 2 cm deep)

- Add also some wood ash (a thin layer, less than 1cm deep).



Mandla (in Phuthadjithaba) is digging his trench bed and placing the topsoil on one pile (darker soil with more organic matter) and the subsoil on another (usually lighter soil with little or no organic matter).



Layer of tins at bottom of trench

- Then add a layer of sop soil (about 5cm deep)

- Mix these layers with a fork
- Stamp them down by walking on them
- WATER the mixture well!
- Then start the process again.

You can also add other organic matter like green and dry weeds and vegetable peelings, card board, paper and bones.



A trench bed in Potshini being filled and mixed. Here the top soil is being added back into the trench. Notice the yellow subsoil on the one side. It is not being used.

5. Continue to place the organic materials into the trench until it has reached ground level again.



A trench bed in Phutaditjhaba being filled, mixed and stamped down. Notice the mixture of manure, grass and soil.

6. Now build up the trench bed to about 10-15cm above soil level. Use a good mixture of topsoil and manure and or compost.

The organic material in the trench needs to decompose for about 2-3 months before planting.

7. The other option is to use your trench bed as a seed bed. In this way, when your seedlings are ready to be transplanted, the trench bed will be ready to be planted.

Growing seedlings from seed needs a well prepared bed. The roots of the small plants do not go down too deep. The materials in the trench can decompose while the seedlings grow on top.



A recently completed trench bed.



Above, Carrot and onions seeds are being planted in a seed bed in Potshini. This trench has just been prepared.

Note; Fine soil is being used to cover the seeds in the rows. This is because the seeds are small and in this way they can germinate better.



In this picture a number of trench beds have been prepared in a garden in Potshini. The owner has used two of his trenches as seed beds. They are covered with grass to hold the moisture in the soil while the seeds are germinating. This grass will be removed when the seeds come up.

The middle bed is shaped like a horse shoe. This is a nice design that makes it easy to reach all sides of the bed. It also allows run-off water to run into the middle of the shoe and soak into your bed. Here the owner has planted swiss chard seedlings. They grew well; despite our fears that the decomposition of the organic matter in the trench bed may interfere with their growth.



In this picture carrot seeds were planted in the smaller trench bed in the far corner. There are also two tubs of seedlings being produced. In the foreground is a recently completed trench bed into which bought cabbage seedlings have been planted. Again these grew well and did not show any negative effects from the decomposing material in the trench.

8. It is very important that the trenches are watered well while they are being made and afterwards. The organic material in the trench can not decompose if it is dry.

Different ways of watering are possible; as long as a lot of water is given!!!



In this picture, drip irrigation is going to be used to water a trench bed.



Later in the season the cabbages in the trench bed with drip irrigation are growing well. And so are all the other crops planted in trench beds and watered with buckets; the swiss chard and beetroot in the foreground.

5. Seedling production



Above is an example of a seedbed. The cover of reeds that are tied together provides wind and sun protection for the seedlings.

To start

- ❖ Make sure you have good, fresh seed
- ❖ Make sure you have clean water close by (really muddy water is not good)
- ❖ Make sure you have fertile, soft, smooth soil (see also the *Improving your Soil* leaflet in this series).
- ❖ Make sure you have some shade.

Golden rules with water

- ❖ Water must be close by
- ❖ Water must be clean - very muddy and dirty water will make it hard for seedlings to grow.

Golden rules with seed

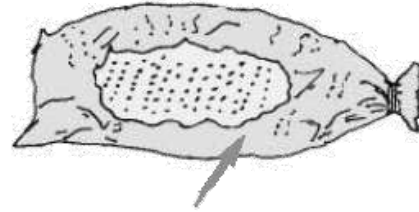
- ❖ Seed must be fresh: Keep seed for only 1-2 years. Look on the packets you buy for a date. You can do a germination test on seeds to see how well they grow, before planting them (see below)
- ❖ Seed must be kept cool, dark and dry. If you buy from a shop, look to see whether the seeds are kept in a cool, dry place. If the packets are in the sun – do not buy them
- ❖ If you keep your own seed, make sure you plant seed without any mould, scratches or holes
- ❖ If you buy seed, write the month and year you bought it on the packet, so you can check the dates later



Experimentation

GERMINATION TEST - you might want to try this if you are unsure of the quality and freshness of your seeds

Before planting seeds they can be tested for germination. You will test how many of your seeds will grow.



Evaporated moisture inside the bag from the damp cloth

- ❖ Take 50 seeds and place them on top of some damp paper, cloth or toilet tissue. Do not let the seeds stand in water or dry out.
- ❖ Place the paper or cloth with the seeds inside a plastic bag and blow air into the bag, before closing it.
- ❖ Check the seeds regularly to see how many germinate. This should take 3-10 days.
- ❖ Then count the seeds that have germinated.

Here for example 40 out of 50 seeds germinated. This is a germination rate of 80% (80/100). This means that only 80 out of 100 seeds that you plant will start to grow.

Measurements



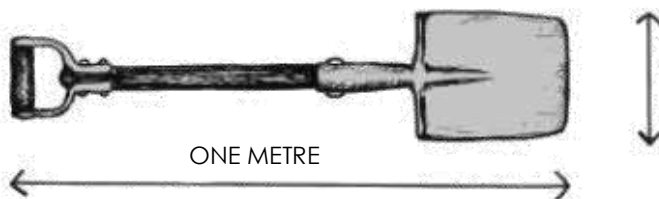
ONE FINGER = 1.5 cm



TWO FINGERS = 3 - 4 cm



ONE HAND = 20-30 cm



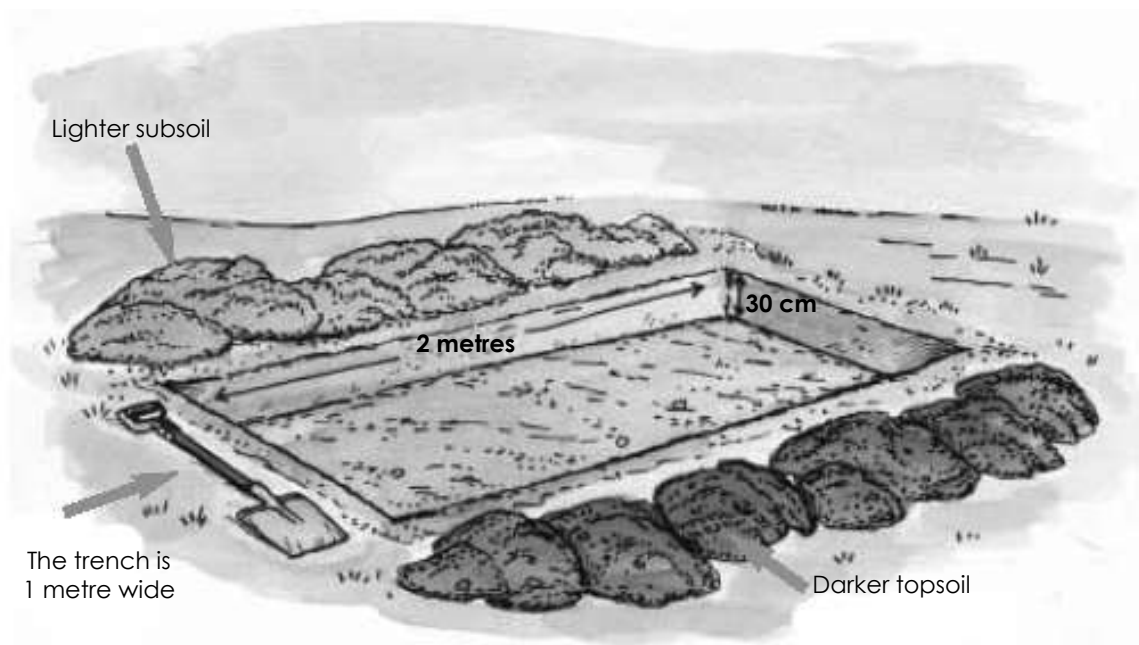
ONE METRE

30 cm

Preparing the seed bed

A seedbed is a small part of the garden with very rich soil and a roof to shade the growing seeds. The roof also provides frost protection.

Dig a trench about 30 cm deep (about as wide as a spade) and 1 metre wide (about as long as a spade). The trench can be 1 or 2 metres long.



Separate the more fertile soil on the top (which is usually darker) from the rest of the soil. Loosen the bottom of the trench with a fork or a spade.



Then mix the topsoil with an equal part of manure and ash mixture or compost.



Sieve this as you put the mixture back into the hole. If you can not sieve the mixture, make sure it is free of anything that can stop the seedling from growing, such as sticks, leaves, stones, pebbles and hard clods of soil. It is important never to step on your bed once you have prepared it.



The width of the seed bed should be about 1 metre (or the length of a spade). This is because it makes it possible for you to reach the middle of the bed from both sides, without having to walk or step on your seed bed. Stepping on soil especially when it is wet, will spoil its soft, smooth texture, and make it hard. This hardness will make it difficult for seeds to grow.

An inexpensive shade structure for the seedbed can be made with poles / reeds /bamboo and thatch grass.



Planting seeds

Different seeds need to be planted in different ways.

1. Direct sowing

Some seeds need to be planted where the crop will grow, as the small plants do

Seeds are sown thinly and evenly



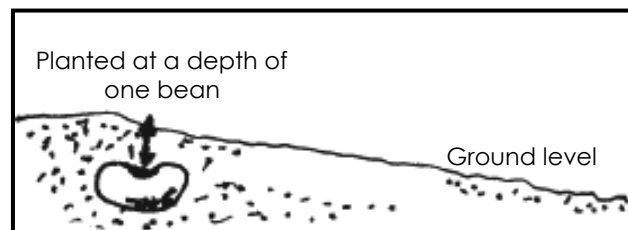
not like being moved. This is known as **direct sowing**.

This includes beans, beetroot, carrots, cucumbers, garlic, maize, peas, potatoes, pumpkins, radishes and turnips. The furrows / holes into which seed will be planted need to be fully watered beforehand.

Planting furrow is 1.5 – 2 cm deep

Small seeds like carrots, radishes and turnips are not planted very deep. Make a furrow about 1.5 cm deep (1 finger width) Sow the seed carefully with your finger and thumb into the furrow. Make sure you do not sow the seeds too thickly. Seeds need to be spaced one finger width in the furrow. Spread the seeds out as evenly as possible. Cover the seeds with a layer of fine compost, manure or soil. Press down with your fingers.

Larger seeds such as beans are planted at a depth of 1-2 times their size. If they are planted too deep, they will not grow. If they are too shallow, the small plants will fall over.



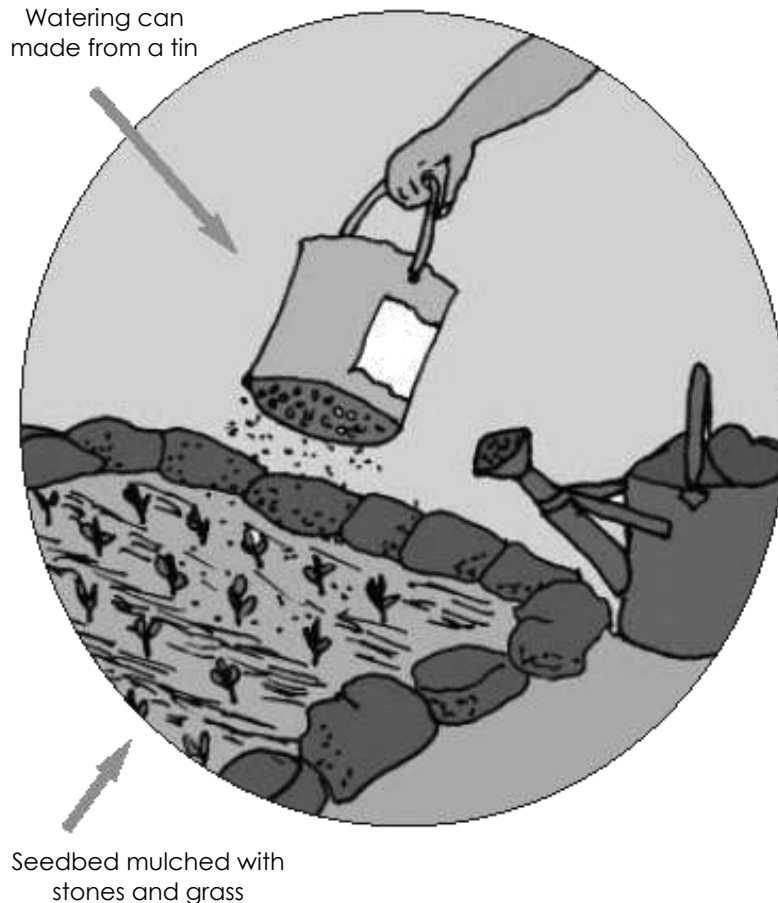
2. Sowing into seedbeds first

Some plants grow a lot better if they are first planted in seedbeds and then transplanted when the seedlings are strong. This includes broccoli, cabbages, cauliflower, chilies, eggplant, green peppers, leeks, lettuce, okra, onions, spinach and tomatoes.

Some plants can be sown directly or in seedbeds and here it is your choice which works best for you. This includes spinach, onions, garlic and potatoes.

3. Caring for seedlings in the seedbed

For small seeded vegetables like cabbages, kale, tomatoes, turnips and onions, do not plant the seed so thickly that they emerge as a dense mass. Seedlings will be weak and diseased. They need to compete for space and light. Sow thinly and evenly. Sow the seeds about one finger width apart.



Once seed has been sown, it is important to keep them moist at all times. It may be necessary to water twice a day in hot weather. It is better to water in the evenings in summer and in the mid-mornings in winter.

Water carefully, with a soft spray. Otherwise you can wash your seed out of the planting furrows, or compact the soil. You can use a home made watering can. You punch very small holes in the bottom of a tin with a nail and a hammer.

Mulch the seedbed. Here you can mulch between the rows of planted seeds. Or you can cover the whole bed and then remove the mulch as soon as seedlings start to appear. If you do not take the mulch off the seeds it can make it hard for them to grow well. It is also possible to mulch the edges of your seedbed with flat stones. This ensures that the water stays inside the bed and does not evaporate out the sides.

- ❖ It is important to weed well and often in a seedbed.
- ❖ Thinning is taking out some of the plants so that others will grow better. When the plants come up, you will see which ones are stronger and which ones are weaker. Take out the weak plants. Make sure each strong plant has enough space around it, about 3-4 cm (2 fingers wide).

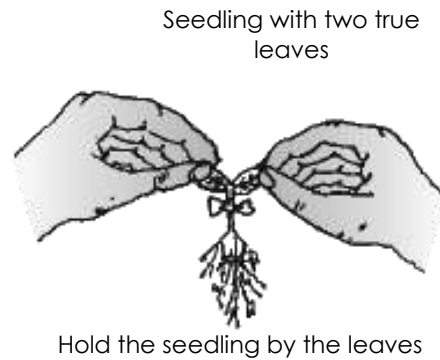
4. Transplanting seedlings

Before transplanting your seedlings it is a good idea to harden them. This will make the shock of being transplanted less. Hardening means that you make the conditions for the seedlings a bit more difficult. The shading is removed and watering is reduced. This is done 3-5 days before



transplanting.

The time to transplant a seedling is when it has 2-6 true leaves, a well developed root system and a nice strong stem. The first two leaves that pop out of the ground are usually not true leaves – so wait for the plant to develop.

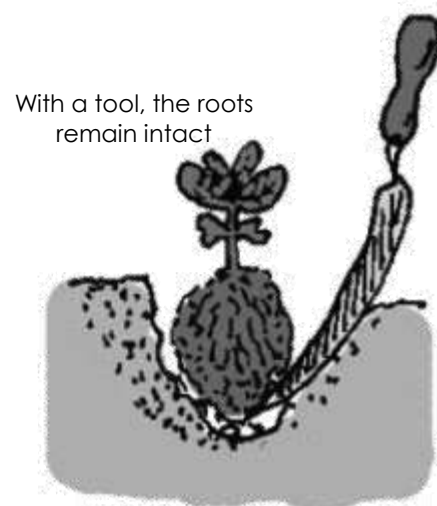


Transplant in the late afternoon or on an overcast day. This gives the seedlings a bit of time to recover before the next warm day. If it is really cold, plant them mid-morning, once the soil has warmed up a little.

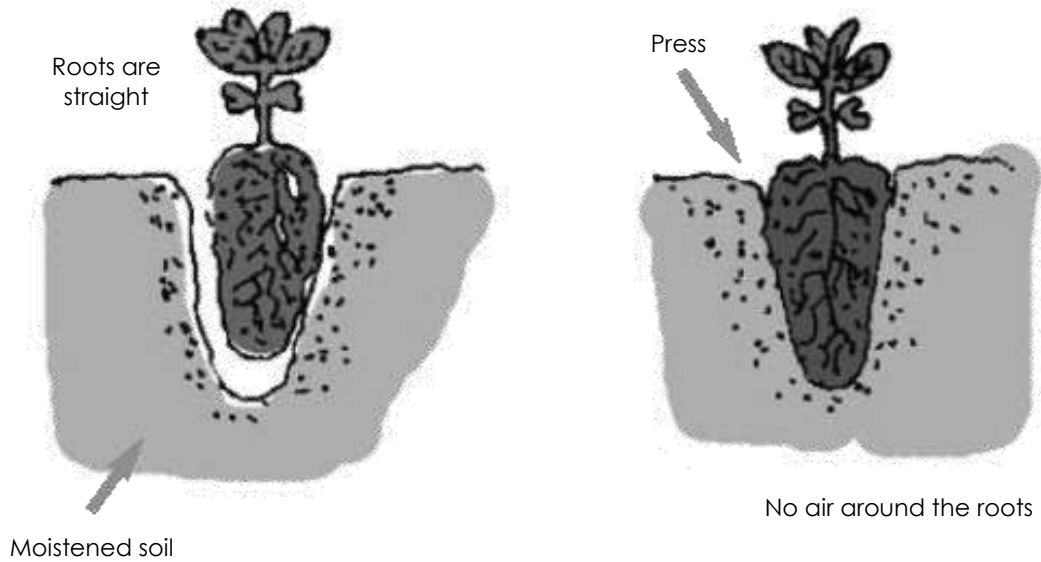
- ❖ Prepare and water your planting holes
- ❖ Make sure the soil is soft and contains some organic matter, like manure and ash or compost.
- ❖ Lift the seedlings carefully, using a tool (DO NOT PULL THEM OUT BY HAND) and try to leave as much soil around the roots as possible. Handle the seedlings by their leaves and not their stems.



Pulling up seedlings without a tool is not good



- ❖ When planting, the roots should be kept straight and not be squashed into the hole. The hole must then be filled with soil, which should be packed firmly around the roots. Press the soil down around the seedling, so that there is no air around the roots.



- ❖ Water the seedlings as soon as they are planted.
- ❖ Mulch them in their bed.
- ❖ Provide some shade for the seedling, using a leafy branch or a piece of cardboard. This can be removed after 4-5 days, once the seedling has settled in.

