

Growing Trees and Gardens for Life

*Practical Tips for Healthy Tree Nurseries
and Home Gardens*



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Acknowledgement

Articles from the *Young African Express* educational newspapers of 2006 and early 2007 are the basis for this publication. Now published as a handbook, the writers and creative team of the *Young African Express* hope this will spur young people into taking action that helps improve the quality of life of many around them, and helps to save our planet too. These are goals shared by the Learning for Life Initiative with the *Young African Express*.

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Published with World Agroforestry Centre. The production of this handbook was made possible through co-funding from the Flemish Association for Development Cooperation and Technical Assistance (VVOB), the Government of the Netherlands through its Programme for Cooperation with International Institutes (SII) of the Ministry of Foreign Affairs, and the World Agroforestry Centre.

First published 2007

ISBN 9966-956-54-9

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Designed and published by Jacaranda Designs Ltd., home of the *Young African Express*

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Photographs as cited within: World Agroforestry Centre, Tree Is Life, Fresh Produce Exporters Association of Kenya (FPEAK), US Department of Agriculture (USDA), DHD Multimedia Gallery,

PD Photo.org

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Printed in Nairobi, Kenya

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World Agroforestry Centre and Tree Is Life

How we benefit from trees and gardens

Without trees, human life would be unsustainable. More directly this means that without trees, human beings could not live! We need trees to be alive because our life depends on the availability of air, water and food. Trees help us get oxygen (air) and help in keeping our soil healthy so we can grow food.

***People who will not sustain trees will soon
live in a world which cannot sustain people.***

Bryce Nelson, Professor
University of Southern California

Understanding the degree to which trees—above all else—actually maintain life on our planet is critical to our survival, and highly interesting. Trees provide a wide range of products (timber, fruit, medicine, beverages, fodder, oils) and life-supporting services (carbon sequestration, erosion control, soil fertility, shade, beautification). The very soil we need to grow our food crops, and the health of our water resources and sources, depend on the number of trees we have on the planet, and how healthy they are.

But our trees and forests are rapidly disappearing! Towards our own self-destruction, the deforestation of our planet has happened as the world's population has grown. Especially across Africa, we urgently need to plant and grow more trees. We must replant the forests we have cut down before it is too late! Our survival depends it.

Anyone can start a tree nursery and a home garden too. This guide has been produced to help you do this at school and at home. Tree nurseries offer young people a great way to get involved in practical conservation work. Tree nursery work naturally leads on to tree planting, education for sustainable development and practical conservation. You can be involved in all stages of tree development—from seed germination to planting out.

Starting and taking care of your own tree nursery and home garden will give you more than a good introduction to biology, and a future livelihood. You'll also make a satisfying personal contribution to conservation, and to your own quality of life! Get involved. Read this book, and subscribe to the *Young African Express* magazine. Each monthly issue is filled with important facts and skills to ensure you are Learning for Life!

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Part I. Growing trees



1. Getting started: why plant trees?

Trees make the soil more fertile. They also help prevent desertification. Trees give us shade, serve as windbreaks, and provide us with fruits and animals with browse. Trees supply us with wood that we use to build houses, make furniture, build fences, and burn for fuel. Hooray for trees!

Look around you. Does your area need more trees? Ask older people in your area to tell you where trees used to grow when they were young. Ask them what happened to the trees and forests.

Today, most areas across East Africa certainly need more trees because too many people have cut them down without replanting them. From an average forest cover of over 14%, our region is now suffering with less than 2% left! By planting trees, you'll be doing something meaningful to improve your area, and the lives of people living there. Hooray for you!

Propagating or growing trees from locally gathered seed is best. Our indigenous forests are a result of thousands of years of succession and natural selection. Indigenous trees are best adapted to the climate and soils where they have evolved resistance to disease and fungal attack. An enormous variety of our plant and animal communities has become dependent on these trees too. So planting indigenous trees permits the conservation of a multitude of other living things.

Since buying tree seedlings to plant can be costly, we'll help you get started by showing you how to grow your own trees by starting tree seedlings from seed in a tree nursery and the pretreatment for these seeds too. The guidelines or tips on how to plant out tree seedlings are relevant and useful if you have started with seeds as well as if you are starting with tree seedlings. Since this **Growing trees** section is short, you're encouraged to read all of it first, referring back to specific parts as you proceed step-by-step.



Children in central Kenya tend to their tree nursery. One day these trees may repay their care by giving them shade, fruit, fuel and income.

2. Starting your own tree nursery: planning is the first step!

Speak to your family, or to your teacher about starting a tree nursery as a class or school project. It's hard work for one person but a school class or club can work together to do it successfully. Follow our instructions and one day you could be looking with pride at the healthy trees you grew!



FPEAK

A seed nursery nurtures young plants until they are big enough to be moved out to the fields.

Discuss and make good plans before you start. What will you plant and where will you do this? Different species offer us various uses and need different climates too. Planning will give you the best chance of success. Before you begin, here are important points to discuss and decide. The list of trees that follows this part will help you decide which trees to plant and grow.

a. Where will you build a nursery plot?

Once you have decided to grow trees, your next step will be to buy seedlings ready to plant out or to establish a tree nursery. Buying seedlings can be expensive. Raising your own seedlings, on the other hand, involves more time and work but is more affordable.

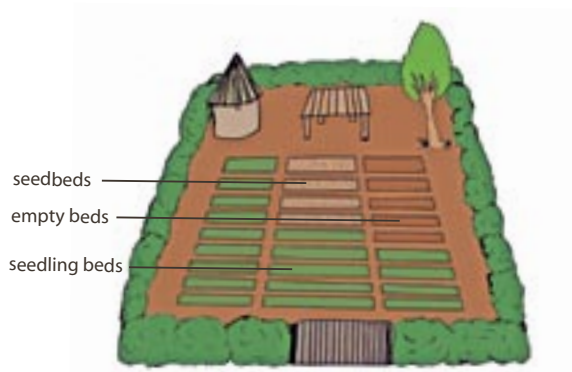
To start a tree nursery, you'll need to find a good site for it. Some things to consider:

The size of the nursery

This depends on these factors:

- The space available to you.
- The number of seedlings you want to raise.
- Whether you will grow the seedlings in pots or beds or as cuttings. The size of the pots or the spacing between seedlings affects the space needed. (More on this follows in this section, and in charts at the end of the book.)

The tree nursery also needs space for stores, seedbeds, compost and soil heaps, pathways between rows, windbreaks and drainage.



A typical tree nursery layout for bare-rooted seedlings

Water supply

Seedlings need water, so the nursery must be near a good water source—a perennial stream, dam or pond, for example. The amount of water available will also determine how many seedlings you can raise.

Saline water (water with a high salt content) is not good for most plants. If the water available is saline, choose plants that tolerate salinity.

Topography

Land with a 2–5% slope is ideal for a nursery. Excess water can run off, avoiding waterlogging without eroding the soil.

If the only land available slopes steeply, make terraces.

Avoid windy hilltops—the wind will dry out the nursery and damage delicate seedlings. If this is the only available land, make windbreaks around the nursery and smaller hedges between the beds.

Avoid valley bottoms as they are easily flooded. If this is the only space you have, make raised beds and dig trenches for drainage.



Water collects in valley bottoms and dips in the land, making them marshy. Such areas will become waterlogged during the rains.

Soil

Healthy seedlings need good soil. It should be well drained with a mix of sandy and loamy soil, high in humus and nutrients and slightly acid.

Soil for potted seedlings can be brought from outside the nursery and the soil at the site is not so important.

Bare-rooted seedlings need good-quality soil at the site because more soil is needed and it can be costly and time-consuming to transport large quantities.

Choose a site near sources of sandy loam soil, sand and manure.



Make a sieve like this to sift soil for your nursery.

Access

Choose somewhere nearby as you will need to visit the nursery often. A site near a road is useful for transporting soil and seedlings by vehicle.

b. Which trees do you want to grow?

All trees help retain soil, but some kinds of trees produce fruit and nuts, while others give us timber, fuel, medicines and fodder or food for animals. There are also trees that are worth planting and growing because they give us shade, and beauty! Trees that make us feel happy are important too.

The table on pages 73–77 offers a list of recommended tree species for East Africa. This may be useful as you select the type of tree you want to grow, and ensure it will be suitable for the climate and soil of your area.

c. Decide whether to grow ‘bare-rooted’ or ‘potted’ seedlings and where to grow them

Bare-rooted seedlings are grown directly in the soil, in seedbeds. When they are ready to be moved, they are uprooted from the soil and taken to the planting place. This method is good for cooler, moist areas where the bare roots won’t easily dry out during the move. Seedbeds drain more easily than pots, so the seedlings won’t get waterlogged.

Potted seedlings are grown in small pots or containers. When it is time to plant them out, they are transported to the planting place in their containers. This protects the roots from drying out when they are moved, so this method is good for hotter, drier areas. Less water is needed to water seedlings in pots. But make sure the containers or small pots can drain easily to avoid drowning the seedlings in too much water!

d. Where will you set up your ‘bare-rooted’ or ‘potted’ seedling tree nursery?

With either method, young seedlings will grow best if they are in a spot that offers them shade from the burning sun, healthy well-draining, soil and protection from strong winds and rainwater run-off plus nibbling animals!

- **Choose a flat, well-drained site near water.** An area 10 m² will be large enough for a bare-rooted seedbed and some storage and workspace. Clear your space of all vegetation and fence it to keep out grazing animals. If you’re setting up a potted seedling nursery, setting your containers or pots on a cleared flat area that’s near water is recommended. This helps your seedlings grow straight!



Shading young seedlings

- **The nursery needs shade to protect the young seedlings.** For either type of nursery, you’ll need to make a roof, especially if there is too little natural shade. Use a material that gives about 50% shade.
- **Prepare the soil.** The soil in the seedbed or the pots and containers must be lightweight, with plenty of organic matter, and it must hold water well. To make good soil, mix sand, soil and compost or manure together, and stir the mix well. The mixture for the nursery soil will depend on the texture of the soil.

	Soil	Sand	Compost
For heavy textured (clay) soils	1	2	2
For medium textured (loam)	1	1	1
For light textured (sand) soils	1	0	1

See page 60 for instructions on making compost.



- **Prepare the seeds, or pretreat the seeds.** The soil is important and must be prepared, but pretreating the seeds is more critical. In the next section you’ll learn about this and what you can do. Be sure to read this section!

e. Deciding when to plant and if you'll use the seedbed or seedpot method

When to plant and how best to do this depends on the climate where you live. It will be useful to ask forestry extension workers near you for their advice.

Once you've decided which method to use, and when to plant, follow these steps:

For wetter areas, grow bare-rooted seedlings in seedbeds

Step 1. Prepare the seedbeds

- Make a frame for the seedbed from sticks or stones, up to 10 m long by 1 m wide. Bury about 5 cm of the frame in the ground, leaving about 20 cm above the ground's surface.
- Cover the bottom of the bed with a 5-cm layer of stones or rubble, to give the bed good drainage, and add a 2–3-cm layer of normal soil on top of these small stones or rubble.
- Fill the remaining area with your prepared soil mix to just below the frame.
- Make sure the surface is flat and firm.



Step 2. Sow the seeds

- Sow the seeds evenly and thinly into the seedbeds. See tip on sowing different seed sizes in the diagram on page 14.
- Cover seeds with the soil mix to twice the depth of the size of seeds.
- Firm the soil covering the seed, but gently.



Step 3. Keep the seedlings moist, watering them with a fine spray

Weed carefully. Thin the seedlings if they are too close to each other. Leave the strongest seedlings.

Step 4. Transplant the seedlings from the seedbed to a transplant bed so that they have more space

For most species do this 3–5 weeks after the seeds have germinated (sprouted). Prepare a transplant bed in the same way as a seedbed.

- Water the seedling seedbed well **the day before transplanting** the seedlings so they can be lifted easily.

- Lift each seedling carefully, holding it by the top of a leaf rather than the stem. Don't lift too many at a time and keep them under shade to prevent the roots from drying out. Cut the taproots (the thicker, longer root) with a sharp knife if they are bent.
- Plant the seedlings in the transplant bed 10–15 cm apart and in rows 20 cm apart

Step 5. Keep the transplanted seedlings shaded and water them regularly

- Gradually remove the shade as the seedlings grow so that they are used to full sun by the time they are planted out.
- About 1 month before planting out, gradually reduce watering. This too prepares the seedlings for the drier environment they will face once planted outside the seedbed.



For drier areas, the method for potted seedlings is best

Step 1. First prepare the pots or containers

- Fill the pots or containers with your soil mix. Shake the pots as you fill them to shake down the soil.
- Firm the soil when you've filled the pots to the top, and place them in straight rows.
- The pots must stand upright. Leave them for a few days before sowing the seeds, to let the soil settle.



Step 2. Sow the seeds

- You can sow seeds for potted seedlings in seedbeds and then transplant them into the pots, or you can sow them directly into the pots. Seedbeds will produce better results but sowing into pots is easier and cheaper.
- If you choose to sow into seedbeds, follow step 2 for bare-rooted seedlings (page 11).

Step 3. Keep the seedlings moist, watering them with a fine spray

Weed carefully. Thin the seedlings if they are too close to each other. Leave one seedling in the middle of each pot.

Step 4. As the seedlings grow, move the pots every 2 weeks to prevent taproots from growing out of the pots

If any do grow out, cut them off with a sharp knife.

Step 5. Keep the seedlings shaded and water them regularly

- Gradually remove the shade as the seedlings grow so that they are used to full sun by the time they are planted out.
- About 1 month before planting out, reduce watering gradually, to prepare them for their environment.



Seed nursery tips

How to sow seeds

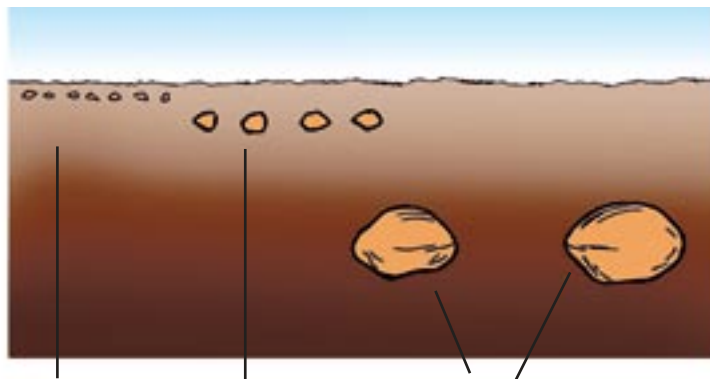
When you sow small seeds, mix 1 part seeds with 2 parts fine sand and broadcast or spread thinly over the surface. (Take a handful of the seed and soil, mix it and scatter with wide sweeps of your hand.) Scatter bigger seeds over the surface and cover with soil. For large seeds, make holes and sow the seeds individually.

Roof for your seedlings: A loose shade roof can be made from woven bamboo or similar materials. Don't use anything that creates heavy shade. Make sure the roof can be moved when necessary and that it is wider than the seedbeds, so that it provides shade all through the day.

Very dry area? In dry areas and in sandy soils, use sunken seedbeds to prevent losing precious water. In wet areas don't use sunken seedbeds because puddles may form and stay, killing the seedlings.

Save water! Large pots require more soil and more water—use small pots.

Recycled pots: You can make pots of plastic, clay or segments of bamboo. You can clean up your environment—and save on costs—if you collect old containers and use them as pots. You can recycle things like plastic bags, empty tins, milk cartons, small boxes or cooking fat containers. Place thin plastic bags one inside the other to make them stronger. Fold them over at the top to make them stiffer. Banana stems can also be used as tree nursery pots. Nowadays there are also biodegradable pots on the market.



Small seeds

Larger seeds

Very big seeds

How deep to sow your seeds? The larger the seed, the deeper it needs to be sown. As a general rule, plant a seed at a depth that is twice the seed size.

ACTIVITY

Identify your soil type using this guide

First, look at your soil. What does it look like? Now feel it. What is its texture? Dampen it and try to roll it into a sausage and form it into a ring. How does it behave? These are all clues to what type of soil you have.

Appearance	Texture	When rolled into a sausage	Soil type
Very sandy	Very rough	Cannot be rolled into a sausage	Very sandy
Quite sandy	Rough	Can be rolled into a fat sausage but cannot bend	Sandy
An even mix of sandy and smooth	Rough	Sausage can bend a little	Sandy loam
Mostly smooth	A little sandy, quite smooth	Sausage bends into a semi-circle	Loam or silty loam
Mostly smooth	A little sandy, quite smooth and sticky	Sausage bends more than halfway round	Clay loam or sandy clay
Smooth	Smooth and sticky	Sausage can bend into a ring	Clay

3. Where to get tree seeds and how to pretreat seeds

Trees can be grown from seeds and seedlings. If using seeds, it is critical to learn about how to pretreat them, and it is useful to learn where to collect or buy your seed. This section will help you decide which choice to make once you know what types of trees you want to grow.

Collecting your own seeds

The characteristics of the parent trees can greatly influence the characteristics of the seedlings. The seed can determine whether the tree will grow well or poorly.

The desired characteristics of the parent trees will vary depending on whether the trees are for wood, fodder, fruit, or medicine. It is good to consult farmers as well as forestry technicians or extension agents when selecting seed sources. Go for walks in nearby natural areas and see what is growing around you. It is good to focus on plants that are native to your area.

Here are some desirable characteristics of parent trees to look for:

- healthy trees have a large, well-developed crown
- **for timber trees**, a long, straight trunk with few branches is best and you want to consider the wood quality, such as high density, or straightness of the grain
- **for fodder trees**, choose trees that offer palatable and digestible foliage leaves that animals like to eat and are easily converted into energy
- **for fruit trees**, look for trees with low branching, which makes fruit harvesting easier, and consider
 - fruit quality, such as sweetness or ability to be transported with minimum damage
 - trees with a fast growth rate

Low susceptibility to—or the ability to quickly recover from—disease or insect attack is also a desirable characteristic for any tree!

Collect seeds from at least 30 parent trees

Ensure regular distribution of seed trees by collecting from trees at a distance of 50–100 m from each other. Pick similar quantities of seeds from each tree so that no one tree is overrepresented. This can help prevent inbreeding in future generations.



Acacia senegal



Mangifera indica (mango)

Note that for each kind of tree there is an optimum or best time of year for collecting seeds. Collect seeds when trees are at the peak of seed production. The first fruits produced are often not fully mature and may contain poor quality seeds.

Storing collected seeds

Initially, store the seed in canvas sacks or paper bags, but avoid using polythene bags because the seed may rot! Do not collect seed in very damp weather; damp seed is difficult to store. Store seed in a cool, well-ventilated room. Some seeds may be sown immediately; others must be stored before sowing. Make sure you label all seeds.



Make sure you label your seeds.

Buying seeds

Buying seeds may be useful if there are no good local seed sources of a particular species.

Bought seed should be of high standard, recently tested for its germination percentage, and indicating any presowing treatments or special propagation conditions needed. Read the label carefully, and if possible, ask for advice from a tree seed expert or a forestry agent.

Pretreatment of seeds

Before planting your seeds, find the best way to prepare each seed type. Some seeds in nature will only germinate after a fire or after being eaten by animals. We need to imitate or copy these conditions to encourage them to germinate. Ways to do this include:

Soaking in water

- Soaking in cold water
- Soaking in hot water

Mechanical methods: nicking, piercing, chipping or filing, cracking, dewinging, burning

Acid pretreatment: soaking in acid. Be careful when using chemicals!

Biological pretreatment: ingestion by animals and effects of insects and microbes

As stated in the notes above on **Buying seeds**, it is important to read any labels or consult reference books and experienced people such as forestry agents to find exactly what pretreatment is needed. Asking lets others share their knowledge with you, so do not be shy! When buying seeds, ask the supplier about the specific storage requirements and pretreatment methods needed.

4. Planting trees from cuttings: an alternative to planting seeds

Cuttings allow you to produce new plants without seeds. This means that you can grow many new plants from those you already have.

The new plants will be copies of the plant from which you took the cuttings, the parent tree. Cuttings from healthy fruit trees that produce plentiful, good-quality fruit will grow into equally useful new trees—and produce fruit early.

You can take cuttings from branches (stem cuttings) or roots. A branch still attached to the tree can also grow roots before you cut it loose—this is called layering. We'll look at growing new plants from stem cuttings and simple layering, as these methods are the easiest.

Making stem cuttings

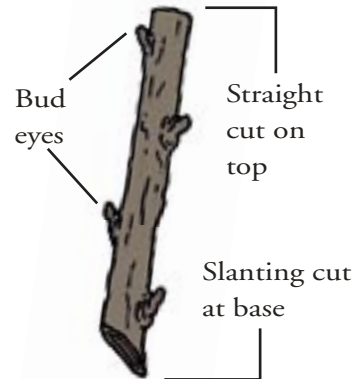
Plant cuttings from woody branches at least a year old early in the rainy season, in propagation beds or out where they are to grow. They do better in dry areas than cuttings from soft, freshly grown branches. Cuttings from soft branches need more care and equipment but develop roots faster and easier. They can dry out easily—you must keep them moist and away from sunlight before planting.

Plant the cuttings immediately.

Get your cuttings ready

Prepare your planting site or nursery before you make your cuttings. Follow the steps given below for preparing a seedbed or potted seedbed nursery for your cuttings. Then do the following:

- Select healthy, disease-free, young trees.
- Branches for cutting should have at least 4 bud eyes or nodes. You may be able to get several cuttings from one branch.
- Use a sharp knife or pruning shears to make clean cuts on both ends.
- Make a slanting cut at the base (this gives a larger area for root formation) and a straight cut on the top (to reduce drying out). This also makes it easier to identify the top when planting—never plant cuttings upside-down because they won't grow. Make the top cut 1–3 cm above a node and the lower cut just below a node.
- Plant the cuttings quickly to keep them from drying out, and label them.



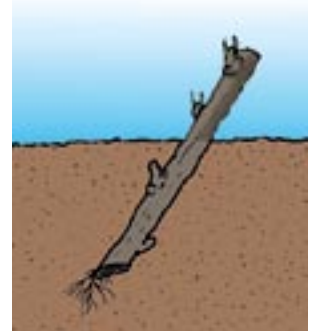
Planting cuttings

Plant the cuttings at a 45° angle. About 2/3 of the total length should be in the ground and at least 2 nodes should be above ground, facing upward.

Your cuttings will develop roots faster and easier if you nurture them in pots or propagation beds before planting them out.

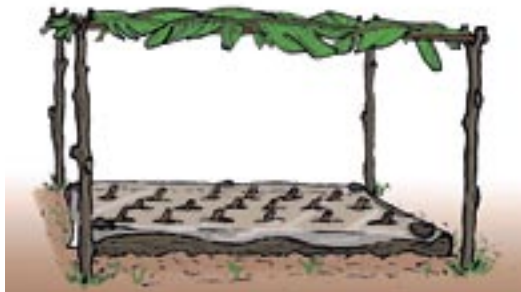
Preparing pots

- Fill 2/3 of the pot with a mixture of topsoil and compost and press down.
- Fill the rest of the pot with a mixture of equal amounts of sawdust or coffee husks and washed sand or soil.
- Water well. Dip the bases of the cuttings in a weak soap solution and insert them into the soil.



Preparing propagation beds

- Make propagation beds 1 m wide.
- Make a frame for the bed and put in a layer of coarse crushed rock for good drainage.
- Add a layer of rooting medium about 30 cm deep.
- Cuttings need humid conditions. If you live in a dry area, spread a layer of polythene over the bed, cut holes in it and insert the cuttings through the holes—but be careful not to let them get too hot.
- Firm the rooting medium around the cuttings and water well.
- Provide the beds with 50–70% shade and protect from wind.
- Water twice daily.



Cuttings need humid conditions. If you live in a dry area, spread a layer of polythene over the bed, cut holes in it and insert the cuttings through the holes—but be careful not to let them get too hot.

Caring for the cuttings as they begin to grow

New roots and shoots should develop after 3–4 weeks. Carefully remove the cuttings at intervals to check the roots as they grow.

Reduce shading and watering when roots are a few centimetres long.

When the roots are 4–6 cm long, transport the cuttings to the planting site. Take care with the delicate roots and keep the cuttings moist.

How to look after your cuttings

Cuttings need:

- Rooting medium—this should be light, moist and coarse enough for good aeration and drainage. A good example is coarse river sand mixed with about 20% compost. (See compost on page 60.)
- Airy, warm, humid nursery conditions
- A final planting site with fertile, well-drained soil
- Moderate air and soil temperature
- Rooting hormone—growth-stimulating chemicals, which most species need to propagate



Weeding and preparing the planting site and protecting it from livestock

- Store cuttings half immersed in water, wrapped in a wet sack or in a plastic bag with a little water while transporting them to the planting site.
- Planting cuttings where you want the new trees to grow is simpler and cheaper than keeping them in nurseries, though with most species it is less successful. Plant large hardwood cuttings where they are to remain.
- Weed the planting site before planting the cuttings, and regularly thereafter.
- Build a fence around the planted cuttings to protect them from nibbling livestock. Check this often to maintain the protection!

Make new plants by simple layering

Use this method for branches close to the ground that are bent and may already be partly planted in the soil. You can also easily plant higher branches that are not too far from the ground in a pot raised to the right level.



Here's what to do

- Select young flexible branches, loosen the soil beneath the branch, and add compost.
- Remove any side shoots and all the leaves except those at the tip.
- Bend the stem down to the ground or pot. Mark the ground about 22–30 cm back from the stem tip.
- Dig a shallow hole below the section stripped of leaves. About 30 cm from the tip, partly cut the stem at an angle or remove part of the bark on the underside.
- Apply rooting hormone.
- Use a wire bent into an upside-down U to fix the stem in the hole. Make sure the cut section touches the soil. Bend the tip of the stem up and tie to a thin stake.
- Fill the hole with soil, covering the stem except for the tip. Pat down and water the soil.
- Keep moist until the layer has rooted.
- Lift branch out of the hole and cut from the parent plant close to the new roots.
- Keep in a nursery first, or plant out.

When should your seedlings be ready to plant out?

Just as different species offer us different uses or products, tree species vary in the amount of time each needs to germinate and grow into seedlings ready for planting. Since the best time to plant out your seedlings is at the beginning of the long or short rainy seasons—normally occurring during March to May and October into December—this planning is important. Planting out seedlings at the beginning of the rains will best allow the young trees to become well established while there is enough rainwater, saving you a lot of work too!

5. Planting out seedlings

Now you have started your own tree nursery. With the right care, you will produce healthy seedlings ready for planting out in the places set aside for them. The length of time your seedlings will take to reach this stage will depend on the species you are growing. If your planning was good, they will be ready at the beginning of the rainy season. To plant them out follow the instructions for the nursery method you chose.



World Agroforestry Centre

These healthy seedlings are ready for planting out into the field.

Bare-rooted seedlings

Step 1. Prepare the planting sites

- Try to plant at the beginning of the rainy season so that the seedlings have plenty of water to get established.
- Clear any vegetation away from each planting site. In dry areas make a microbasin. (See the tip on page 22 on making a microbasin.)

Step 2. Prepare the seedlings for planting

- The day before moving seedlings from the nursery, water the transplant bed thoroughly.
- Remove seedlings from the bed and separate their roots from the soil carefully, being careful not to damage the roots.
- Put the roots of the plants in bags or cover them so that they are not exposed to direct sunlight. Try to keep them moist.
- Plan to lift the seedlings and plant them out in one day to prevent their roots from drying—that's best for them.



Step 3. Plant the seedlings

- Dig holes much wider and deeper than the roots—at least 30 cm wide and 30 cm deep.



- Plant one seedling in each hole and fill the hole with soil.
- Compact the soil gently around each seedling and water it if there is no rain.
- Put thorny branches or woven cages around each seedling to protect it from grazing animals.



Potted seedlings

Step 1. Prepare the planting sites

Follow step 1 for bare-rooted seedlings.

Step 2. Prepare the seedlings for planting

- Don't uproot the seedlings until you are ready to place them in the planting holes.
- Keep them in their pots and pack them in small boxes or crates to carry them to the planting sites. Don't tie the seedlings together.



Step 3. Plant the seedlings

- Follow step 3 for bare-rooted seedlings.
- Cut or peel off the containers the seedlings are in before you plant them.
- Leave the soil around the seedlings when you plant them in the holes.



How-to-do-it tips

- Choose your **planting sites** carefully. You know what you want your trees to do for you, so decide where they will be most useful. Make sure the trees won't take too much water and soil nutrients from crops or create too much shade for them.
- In dry areas, make **microbasins** to allow rainwater to collect and soak into the soil around the planted seedlings. Dig a shallow basin around each planting site, piling the soil into a ridge (30–50 cm high and 60–90 cm wide) around the downhill side, 15 cm from the edge of the basin. Plant the seedling in the middle of the basin.



6. Controlling pests and diseases in the nursery

You're working hard to grow your seedlings and plant them out. The last thing you want is to lose them to pesky pests and dastardly diseases. The best way to control pests and disease is to prevent attack. If your seedlings have already been attacked, don't despair—find out what pest is damaging them and get rid of it.

Animal pests

A big risk is from farm and domestic animals, but a good fence will keep them out. (And consider growing a living fence—smart in the long run.) Smaller creatures like insects, nematodes and rodents are harder to deal with.

Insects that can cause damage in tree nurseries include grasshoppers and crickets (both eat young seedlings); caterpillars (especially cutworm, which cuts seedlings just above the soil while feeding); scale insects and mealy bugs, which weaken seedlings by sucking the sap; termites, which damage pots and disrupt the soil in them; and ants, which attract scales and mealy bugs, and harvester ants may carry away seeds.

Some insects attack only specific tree species, like sesbania beetles, cypress aphids and leucaena psyllids. Nematodes are tiny worms that attack roots and cause swellings. Severe infection can stunt or even kill seedlings, cause chlorosis (discolouration of the leaves) and wilting.

How to control insects

First, avoid conditions that attract insects.

- Keep the area around your seedbed clear of other vegetation that offers the insect pests food and shelter.



A plant nursery protected by chilli plants to keep insect pests away.



USDA

Grasshoppers are among the most destructive insect pests.

- Grow insect-repelling plants like pyrethrum, garlic, chillies and marigolds around the beds.

Next, try to get rid of the insects without resorting to pesticides.

- Destroy the nests and queens of termites and ants.
- Pick insects off seedlings when you see them.
- If you find seedlings whose stems have been cut, look for grey or brown cutworms 1–2 cm long, in the soil beneath. Pick them out by hand and destroy them.
- Spray seedlings infected with scale insects and mealy bugs with water in which you have steeped tobacco or garlic, or with a soap and water mix.
- Many natural predators in the nursery help control pests. Spiders, lizards, snakes and frogs are among the many natural helpers that can control pest problems. Before killing any animal, first consider what it eats!

If you have to use an insecticide, DO NOT handle it yourself. Read the box carefully for instructions.

Other animals

Rats and mice can get through fencing and eat seeds or young seedlings. Place your seedbeds and pots away from stone walls and rubbish heaps, and keep the area around them clean. Don't leave food scraps lying around. Cats can control the rodent population. If you can afford it, build a frame over your seedbed and pots and cover it with mesh. If you need to poison rodents, have an adult handle the poison. Place bait where only rodents can reach it.

Birds that don't damage seedlings but eat insects that attack them are useful. But other types of birds may eat the seeds or seedlings.



Suspended lids from old tin cans clang and twirl in the breeze to scare birds away from a plant nursery. Strips from used plastic bags can also work.

Diseases

Seeds infected by pathogens that cause disease—tiny organisms such as bacteria, viruses and fungi—produce fewer seedlings. Infected seedlings may not reach the planting-out stage.

Fungi. Even in dry climates, nurseries provide the warm, moist conditions that fungi like. Symptoms of fungal disease include chlorosis and stunted growth. Common fungal diseases:

- **Damping-off**, which affects germinating seeds and young seedlings in the first 2–3 weeks after germination. One type kills the seedling before it has emerged from the soil or the seed. Another type causes the stem of the young seedling to rot just above soil level.



World Agroforestry Centre

Primary school children in Tanzania inspect their seedlings for signs of disease.

- **Root and stem rot.** Many fungi attack the fine roots of young seedlings. Damping-off can lead to root rot. Once the rot spreads to the stem, the seedling dies.
- **Shoot diseases.** Wet conditions encourage spores to germinate and enter the seedlings. Leaf spot disease causes seedlings to shed leaves. Powdery mildew covers the leaves in powdery, white spores and weakens the plant.

To avoid and control fungus

- Do not overwater.
- Space seedlings well—crowded seedlings increase dampness and warmth.
- Give the seedlings no more than 50% shade.
- Use light, well-drained soil mix.
- Be careful when transplanting young seedlings. If the stem is even slightly damaged it is more likely to get infected.
- Remove and burn any diseased seedlings.
- Use fungicides only if necessary.

Bacteria can cause **vascular wilt disease** in seedlings and **soft rot** in stems.

Viruses often infect fruit trees, causing chlorosis and deformity.

Wound pathogens can infect seedlings in patches where there is a wound. Prune just below the infected patch.

Controlling diseases

Here are 3 basic steps:

Step 1. Keep your nursery free of pathogens. Plant clean seeds from reliable sources.

Step 2. Avoid conditions that encourage disease to develop if pathogens are present.

Step 3. Use chemical pesticides.

Sometimes plants may appear infected with a disease when they are in poor health for other reasons:

- Long, thin stems and pale leaves (etiolation)—too much shade
- Discolouration of leaves (chlorosis) and leaf deformity—nutrient deficiency or waterlogged soil
- Twisted or deformed shoots— nutrient deficiency or careless herbicide spraying
- Sunscald (grey blotches)—sudden strong sunshine when shade is removed too quickly
- Frost damage—sudden cold weather even if above freezing; plants may recover when temperature rises



Tree Is Life

Be careful not to overwater your seedlings because this can cause fungal disease.



USDA

Not all insects are pests! The ladybird is known as the 'farmer's friend' because it eats the tiny aphids that feed on and destroy young plants.



Use chemicals safely

Herbicides, fungicides, insecticides and other chemical pesticides are poisonous! Use chemical controls only when all else fails. Children must not handle them, only adults—and make sure they take these precautions:

Before using the pesticide, read the manufacturer's instructions and follow them exactly.

Store pesticides in airtight containers and label them clearly. Lock them away out of children's reach.

Always use the correct pesticide for the insect pest or soil type.

Wear gloves, clothing that covers arms and legs, and a mask when spraying.

Do not reuse pesticide containers and tools for anything else. Puncture empty containers and dispose of them by burning or burying.

Spray topical pesticides and herbicides directly on the plant. Spray systemic pesticides on the soil, so that the plant absorbs them.





Fact file

Some natural remedies

- **Soft-bodied insects (aphids, mites).** Mix 1 tablespoon cooking oil with half a tablespoon of chopped soap in 1 litre of water. Mix well and spray onto the tops and undersides of leaves.
- **Fungal diseases.** Mix 2 tablespoons bicarbonate of soda (baking soda) with 1 litre of water and spray on infected areas every few days until the fungus clears up.
- **Powdery mildew.** Mix equal parts milk and water and spray on infected plants once a week for 3 weeks.
- **Cabbage moths.** Cut opened milk cartons into 5-cm squares. Cut from 1 side into the centre. Make another slit crossways in the centre. Open the slit and slide the card either side of a seedling stem. The plant will push it open as it grows. The card will prevent cabbage moths from laying their eggs at the base of the seedling stem.



Tree Is Life

7. Controlling weeds in the nursery

Weeds take nutrients, water and light from tree seedlings. If they are not controlled, they can sap the seedlings so much that they die. Nurseries have enough water and light for both seedlings and small weeds, but large weeds will take too much. Remove weeds as soon as you spot them.



World Agroforestry Centre

Prevent weeds. The first step in weed control is to prevent them from arriving.

The most likely source of weeds is the manure or topsoil used in the potting mix. Topsoil from a weedy location will contain weed seeds. So will manure that is not well decomposed. (Cattle manure can be a major source of weeds.) Make sure that any manure you use in your potting mix has been properly composted.

The grasses you use to make shade may contain weed seeds. Remove weeds and seeds from shading materials before you take them to the nursery.

Weed seeds can come in the wind or in irrigation water. Windbreaks can prevent wind-borne seeds from blowing into the nursery. Well water is likely to be free of weed seeds. If you don't have a well, check the water for seeds.

If weeds grow from the soil underneath the pots, place the pots on a sheet of strong plastic.

Weed the whole nursery area to prevent weeds from spreading to pots and seedbeds. Your nursery will look trim, too!



Use a pointed stick or piece of wire to help dig out the roots.

If weeds are a problem that happens season after season, take samples of each ingredient in the potting mix. Water them to germinate any weed seeds. The sample that sprouts weeds is the culprit! Either change the source of that ingredient or for several weeks before you sow, water pots and seedbeds to sprout any weeds. If any appear, kill them. You can stop watering them, remove them by hand or spray them with herbicide.

Get rid of weeds

Whatever you do, some weeds will appear.

What then?

Weed the whole nursery regularly. Weed around young seedlings every 2 weeks. As the seedlings grow, fewer weeds will compete and you won't need to weed as often. Weeding time is also a good time to thin young potted seedlings so that you have just 1 healthy seedling per pot.

Removing weeds when they are small is easy and saves precious nutrients for the seedlings.

Large roots of big weeds are hard to remove completely and without disturbing seedling roots.

Moisten the potting mix, then pull the weeds out gently to avoid breaking them off. Use a pointed stick or piece of wire to help dig out the roots.

Burn or bury weeds—don't add them to the compost heap.

Dodder is a parasitic weed that covers seedling leaves and stems with thin threads. Burn or bury dodder-infested seedlings before the dodder flowers and produces its tiny seeds that spread easily.



Big weeds have large roots that are hard to remove without damaging the seedling.

Chemical treatment

If you can't control the weeds with weeding, you will have to use a herbicide. Spray seedbeds or pots when they are empty. Spot spray individual weeds.

Herbicides are useful because ...

- ✓ Herbicides help control weeds with rhizomes or underground stems that are difficult to dig up and remove.
- ✓ Spraying weeds reduces the manual labour used in weeding.

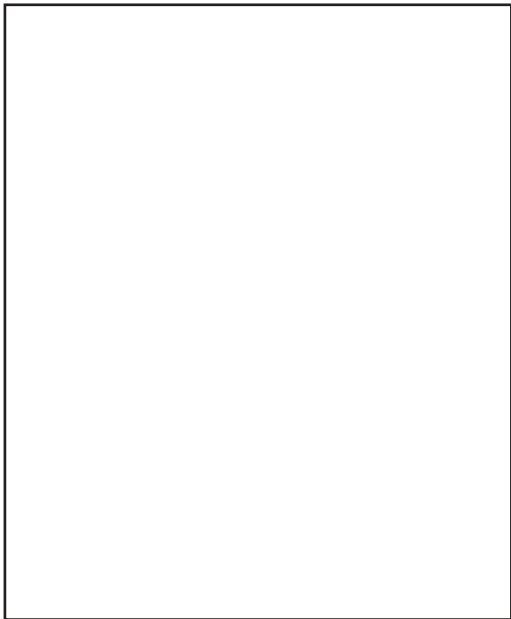
However, be warned that ...

- ✗ Herbicides are expensive.
- ✗ Herbicides are dangerous for your health if not used properly. Read the container for guidance on using herbicides safely.
- ✗ Herbicides can be difficult to apply.
- ✗ Spray can drift onto seedlings and damage them.

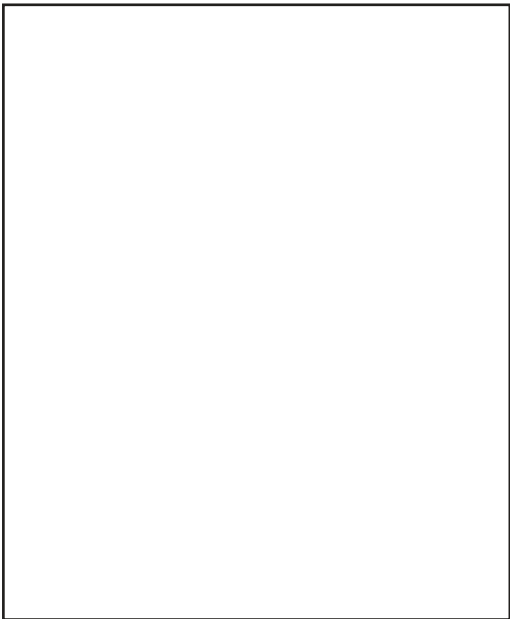
CAUTION! Read page 27 before using chemical controls.

ACTIVITY

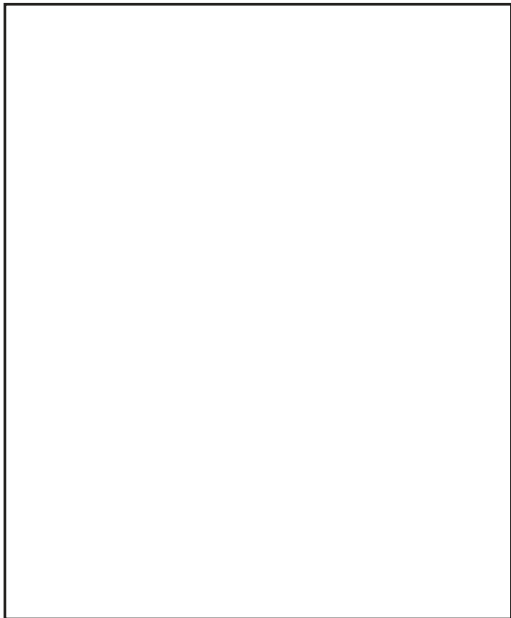
Paste samples of weeds in the boxes and identify them with the help of your teacher.



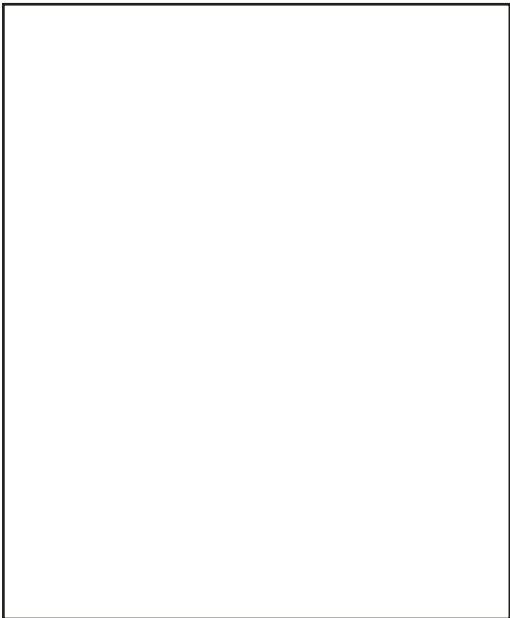
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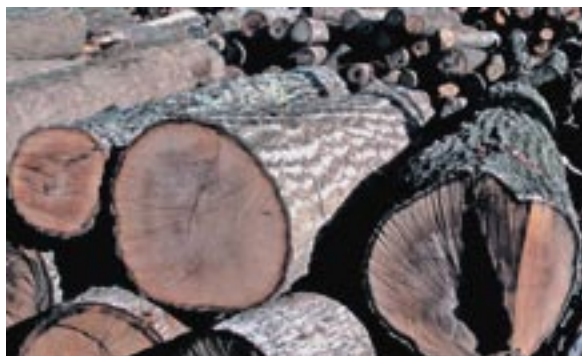
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8. Starting a timber plantation

Timber and poles are used for construction and for making doors, furniture and implements. Timber trees are grown in large plantations for commercial purposes. Small-scale plantations are called woodlots—we'll concentrate on those here.



USDA

Woodlands and timber plantations take patience. The trees you plant now could pay for your university education in years to come.

Timber with good grain (the pattern in the wood) and strength is popular for furniture making. A good timber tree for use in construction has a tall, straight stem, or trunk, that makes good planks. As few indigenous (native) species have this advantage, exotic (non-native) trees are favoured, but many are less resistant to termites and decay. Hardwoods are more valuable than fast-growing trees but as they grow slowly, they won't be commercially useful for decades. Plant African hardwoods for the satisfaction of knowing you are conserving endangered trees! Fast-growing trees will be ready for harvest sooner—the time from planting to harvesting varies according to the species.

Some useful exotic trees are Australian blackwood, gum trees, grevillea (silky oak), Indian ash, common cypress and pines.

Good indigenous timber trees include certain acacias, lucky-bean trees, silver oak, some combretums (bush willow), *Markhamia lutea*, mvule, red stinkwood, and East African camphorwood.

Grow a mix of trees to protect the soil and preserve soil fertility. Growing a mixture also reduces loss caused by extremes of weather, pests and diseases. Different species may suit different parts of the plantation.

Choosing the site

Choose well—trees won't thrive in marshy areas and young seedlings will be stunted if the site is very windy. You will need to water the seedlings until they are well established, so choose an area near water. Don't plant thirsty trees like eucalyptus close to crops because they will deprive the crops of water.



While seedlings are small, protect them from animals.

Nitrogen-fixing trees that also make good building material can be planted between crops as long as they are pruned to control shade.

Preparing the site

Timber needs rich, deep soil that holds water well. Clear the land of plants, including weeds, and remove old tree stumps and roots. Burn them on site to kill termites and weed seeds, and then spread the ash to add nutrients to the soil. Dig

the soil deeply and thoroughly so that roots will grow downwards easily. In dry areas, make microbasins (depressions around the base of the seedling—see page 22) to catch water around each seedling. Build terraces on sloping ground to reduce erosion.



In dry areas, make microbasins to catch water around each seedling. Pile the earth higher on the downhill side to hold in the water.

Planting

Choose species that will do well in the conditions of the plantation site. They should thrive in the climate of your area and survive extreme weather conditions. Healthy, strong planting stock has more chance of establishing itself fast and of growing rapidly. You can sow large seeds directly on the site. Plant seedlings from nurseries in rows and space according to the tree type, soil type and rainfall.

Fertilizing

You may need to add nutrients like nitrogen, boron or phosphorus to the soil when planting the seedlings. If they lack nutrients they will not grow as well and will struggle during dry seasons.

Be patient!

It will be years before you can harvest your timber, but in those years the trees will reduce soil erosion and provide fuel and poles as you thin, prune and pollard them. And keep reading. In the next part, we'll discuss the care of timber plantations!



USDA

Pine trees are fast growing and have long, straight trunks, ideal for timber production.

9. Caring for a timber plantation

A timber plantation or woodlot will take years to reach the harvesting stage. If you are growing a school woodlot, keep notes for the children who will care for the trees when you have left. Note down how to care for the different species you have planted, the year in which they were planted and when they will be ready for thinning out and harvesting. If you are lucky enough to ‘inherit’ an established woodlot, make sure that you know what is growing in it and how old the trees are. Whether the trees are young or old, they all need your care to grow strong and straight.

Young trees

Trees need more care in the first 1 or 2 years after the seedlings have been planted out, though they will have been hardened in preparation for leaving the tree nursery. Young trees may be harmed by frost, drought, wind, browsing animals and poor soil. Here are some practical tips:

- Protect seedlings in high, cool areas from frost by wrapping the stems or trunks with sacking on cold nights.
- Water young seedlings regularly to start with. Gradually cut down on watering as they grow older. Use clay pot irrigation in dry regions (see page 37). Liquid manure added to the water will also seep into the soil and feed the trees. (See page 65 to learn how to make liquid manure.)
- Planting holes should be half filled with compost and then soil. This will nourish the seedlings once planted.
- If you use fertilizer, put it at least 50 cm away from the tree stems to prevent it from burning them.
- Grow smaller plants between the seedlings and cover the soil around them with mulch to reduce water evaporation.
- Weeds will compete with young trees for water and nutrients. It is harder for weeds to grow through mulch. Inspect the plantation or woodlot regularly for weeds and pull them out by hand.
- Don't tie young trees to stakes to anchor them against the wind—trees will be strengthened as their tips bend and move in the wind. Rather erect a temporary fence around them, which will also keep away browsing animals and leave the top of the tree exposed to the wind.

Thinning

A good timber tree will give you long, straight logs. When timber seedlings are first planted out, plant them close together because this keeps branches small so that the tree's energies go towards developing a strong, straight trunk that doesn't taper too much (grow thin at the top). Closely grouped trees will be less exposed to the wind, too.

As the trees grow larger, they will begin to compete with each other for water, light and soil nutrients. After between 4 and 12 years (depending on the species), thin out some of the trees to allow the remaining trees to grow without competition.

Thin out trees that are weak, bent, diseased or that have dead tops. Also cut down those with trunks that lean or have branched into 2 and those with many side branches. These can be used for posts, tools or fuel.

The trees left to grow should be roughly 25 times the diameter of the thickest trunk away from each other.



Thin trees when they grow larger. The remaining trees will have enough water, nutrients and sunlight.

Pruning

Branches are pruned as the trunk grows to reduce the number and size of knots (the lumpy area left by branches). Knotty timber has less value. Branches are also cut to allow the trunks to grow better.

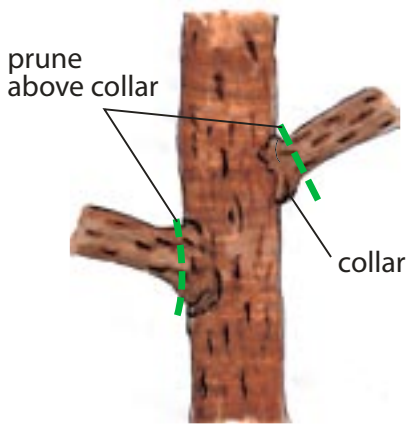
Remove branches before the stem or trunk reaches 10 cm in diameter.

Be careful! Don't prune too many branches—their leaves are need for photosynthesis.

Prune branches regularly. As the trunk grows, you will need a stepladder to reach higher branches.

Use sharp tools—panga, knife or shears—to make a clean cut because harmful fungi or bacteria can enter the tree through 'wounds'—breaks in the wood.

Be careful not to damage the raised ridge around the base of the branch.



Be careful not to damage the raised ridge, or collar, around the base of the branch when pruning.



Flush cutting—cutting the branch below the collar—damages the wood and allows wound pathogens to enter the tree

Growing indigenous hardwood trees

Our valuable hardwood indigenous trees are disappearing from our forests. Growing them in plantations is a long, hard process but this may be the best way to preserve them. The best indigenous timber trees, such as podocarpus, are climax trees in natural forests. This means that they grow after the early or pioneer species have grown. They develop in the shade of the pioneer trees and need their protection from wind and sun when young. In other words, they need 'nurse' trees! If climax trees are to be grown in a plantation, plant trees like pines or *Trema orientalis* 2 years beforehand. This will help the climax trees grow long, straight trunks. When the hardwoods are well established, the nurse trees can be harvested for their timber. This way, the plantation will provide some income in the decades before the hardwoods are harvested.

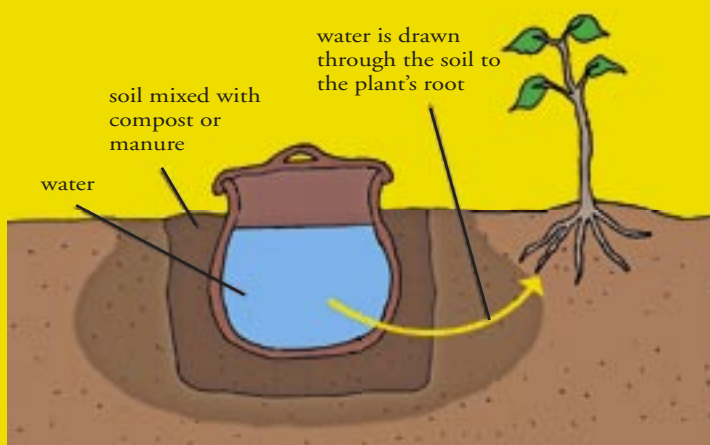


Be waterwise—try buried clay pot irrigation

This ancient North African irrigation method is still a great way to water crops and trees in dry regions. Bury a porous clay pot near crop plants or tree seedlings. (A porous surface is one that air or liquid can move through.) Pour water into the pot. It will slowly seep through the clay walls into the soil next to the plant's roots. The roots absorb the water, and as the soil dries it draws more water from the pot. Because water enters the soil only as the plant needs it, precious water is saved.

Using buried clay pots

- Use an unglazed clay pot with a lid.
- Dig a hole wider and deeper than the clay pot and break up the soil at the bottom with a fork.
- Mix the soil you dug out of the hole with 1/3 as much compost or well-aged manure. Place enough mixture in the hole so the pot sticks up 2 cm above the surface.
- Put the covered pot in the hole and fill the hole around it with soil. Press the soil down firmly.
- Fill the pot with water and replace the lid.
- Plant your seeds or plants about 1–3 cm from the pot. Add a small amount of water to the planting spot to start water seeping from the pot.
- Check and refill pots regularly. Big pots will need refilling less often.
- Dilute liquid manure and compost and add to the clay pot. The nutrients will be drawn into the soil with the water.



This information comes from the PACE Project. For more information on buried clay pot irrigation, see www.paceproject.net

10. Protecting trees from animals

Insects and nematodes aren't the only animal pests on trees; they're just the smallest! Let's look at some common larger animal pests and ways to control them.

Rodents

Rats, mice and squirrels in the tree nursery carry seeds away from seedbeds and eat the tender stems and leaves of seedlings. You can kill rodents with poison but this is just a temporary solution. The poison will kill the rodents already living near your nursery or trees but soon others from farther away will move in to enjoy the uneaten plant matter. Add to that the fact that poisons are dangerous to humans and other animals, and poisoning just isn't worth it. Instead, change the environment to make it less attractive to the rodents.

Rodents hide from predators by keeping under cover—long grass, weeds and bushy plants, rubbish heaps and stone walls all provide protection. They also make their nests in dark, hidden places. So take these precautions:

- Move rubbish heaps away from your trees and nursery.
- Remove weeds and keep grass short.
- Use fences instead of stone walls.
- Protect the stems of seedlings with tubes of wire mesh or plastic.
- Rats and mice love food scraps—clear up scraps and bits of rubbish around the nursery.

Rodent repellents

- Cats and dogs—rodents are scared of both. Cats prey on rodents and a good 'ratter' will keep the population down.
- Rats can't stand the smell of mint. Chop up and crush fresh mint, boil it in water and spray or brush the liquid around areas where you've seen rats.



US National Park Service

Rats live wherever there are people and their tempting food supplies. It has been estimated that rats damage or eat up to 20% of the food produced worldwide.



Birds

Insect-eating birds are helpful in nurseries because they eat insect pests, so don't scare birds away unless they are damaging your fruit crop or seedlings.

- Take a bamboo cane and split it from 1 end to about halfway down. Bury the unsplit end in the ground near the trees. Tie a long string around 1 side of the split cane. Hide in the bushes, holding the other end of the string. When birds arrive to eat the fruit, pull the string tight and release it—the 2 sides of the split cane will bang together and the noise will scare the birds away.
- If you make a scarecrow, don't stuff it but leave the shirt (or even better, layers of shirts) empty to flap in the breeze. That will scare the birds.
- Only use bird scarers when birds are a problem—if you leave tins or scarecrows up all the time, the birds will grow used to them.

Livestock

Cattle, donkeys, sheep and goats will browse on leaves and branches, especially the tender branches of seedlings and young trees. Make a barrier around seedlings with woven branches or place thorny branches around them. Fence nurseries to keep browsing animals out—or keep your goats and sheep in a pen. Instead of a fence made of wire or cut branches, make a live fence from quick-growing trees like *Acacia seyal*, *Acacia nilotica* or *Bauhinia rufescens*.

Tips for making a live fence

- Plant the trees in 2 rows 40 cm apart.
- Dig trenches 80 cm wide and 60 cm deep. This will be wide enough for both rows. Refill the trenches with a mixture of soil and compost before planting the seedlings.
- Leave 30–50 cm between trees in the same row and stagger the trees in the 2 rows.
- Weed 2 or 3 times in the 1st year and water regularly.
- Prune the trees once or twice a year when the weather is cool and dry. Prune near the ground to begin with, to encourage branches to grow close to the ground. Then prune the trees at the desired height (about 1.2 m).



Spacing of seedlings.

You can also make a manure repellent

- Mix fresh animal dung (goat, sheep, chicken or pig droppings) with water in a bucket and leave. After 4–5 days, stir the mixture with a small twig broom and splash the mixture onto the trees or seedlings with the broom. DON'T use this repellent on food crops—it is definitely not fit for human consumption!

Wildlife

Have you heard the term 'human–wildlife conflict'? These days there are more people and therefore more farms and gardens. Wild animals are squeezed into ever-smaller reserves and parks. In the search for food they raid and damage farms on the park edges.

To people farming near parks, these animals are a threat to their existence.

Wild animals eat their crops and can injure or kill people.

However, wildlife does have value. These animals have a place in the natural ecosystem and killing them upsets the balance of nature—this will in turn hurt humans. Tourists come to see these animals and bring money to the area. Some wild animals have religious or cultural worth. It is best to find ways to deter or put off wild animals rather than kill them.

Browsing animals like antelope can be kept away in the same way as livestock. What about monkeys and baboons? They raid maize and fruit plantations near the forests where they live. They can climb over fences and are clever enough to learn to avoid traps. Dogs or the noise of drumming or shouting can drive them away. Some farmers in Tanzania have planted more trees between the forest edges and their farms. The monkeys get seeds and fruits from the trees and are less likely to raid crops. Some Ugandan farmers have planted a buffer zone between the forest and their maize and fruit trees. The buffer zone contains timber trees and crops (like tea) that the primates don't feed on.

Elephants are a special problem. These amazing animals are endangered and protected by law, but they raid almost all crops, destroy trees and fences, and are dangerous to the people living near parks and forests. The first line of defence is an 'alarm system':



Jacaramda Designs Ltd

A male olive baboon forages in Kenya's Nakuru National Park. Baboons in forests and reserves near human settlements are a constant problem for farmers.

- Organize a small group of people to take turns guarding.
- Clear a 5-m strip between the forest and the farm or garden.
- Make a fence around the plot with poles and string. Tie cowbells (or tins with stones in them) to the string.
- When animals try to enter the plot, the bells will ring or rattle. Then bang drums or pots or shine torches at the elephants to scare them away.



William Lorentz / DHD Multimedia Gallery

Chillies: nature's elephant repellent!

The smell of chillies burns elephants' eyes and noses so they are an effective way of putting elephants off a quick farm raid. They can be used in different ways.

- Plant chillies around other crops to make a buffer zone.
- Hang cloths soaked in an oil and chilli mixture around the plot.
- Make chilli dung bricks to burn. They give off a thick smoke that drives elephants away. Light them when your 'alarm system' tells you they are around.

For more information see www.farmradio.org, www.slcs-zambia.org or the PACE project materials.



11. Replanting a forest

Natural forests are essential to our world's health, but they are shrinking as we clear them for timber, fuel and new fields. Deforestation and the burning of fossil fuels are contributing to climate change. We need to replant forests so that they can once again clean the air, absorb carbon, protect the soil and absorb water. Replacing forests is called 'reforestation'.

What is reforestation?

This is the replacing of forests that have been removed in some way. Reforestation happens naturally in areas that have been left alone by humans.

In some places, though, forests will not regrow easily—goats and other livestock may browse on the new plants. In arid areas the soil is too dry and hard for plants to seed themselves. We then give trees a helping hand with artificial reforestation. This is not the same as growing only 1 or 2 species in huge plantations but rather replacing lost natural forest with new forests containing different species of trees and shrubs. Small groves of trees grown between fields or on patches of land unsuitable for crops or grazing can be mini forests.

Reforestation also happens in existing forests when trees are planted to replace others that have been cut down. 'Managed' forests are natural forests that are looked after by foresters. Trees are thinned and pruned, selected trees are logged and replaced, and the forests are protected from fires and uncontrolled logging.

After many years of managing and protecting forests, foresters have come to realize that the forests have many old trees (some rotten) and fewer species. This is because old forests contain 'climax' trees—the tallest species. The tree species that gave these big old trees shade when they were seedlings have been crowded out as the climax species grew bigger. Foresters have discovered that clearcutting (harvesting all the trees) or burning sections of forest is beneficial to forests. Why? Forests benefit because the new growth in these sections contains a greater diversity (variety) of plant species.

What a healthy forest needs

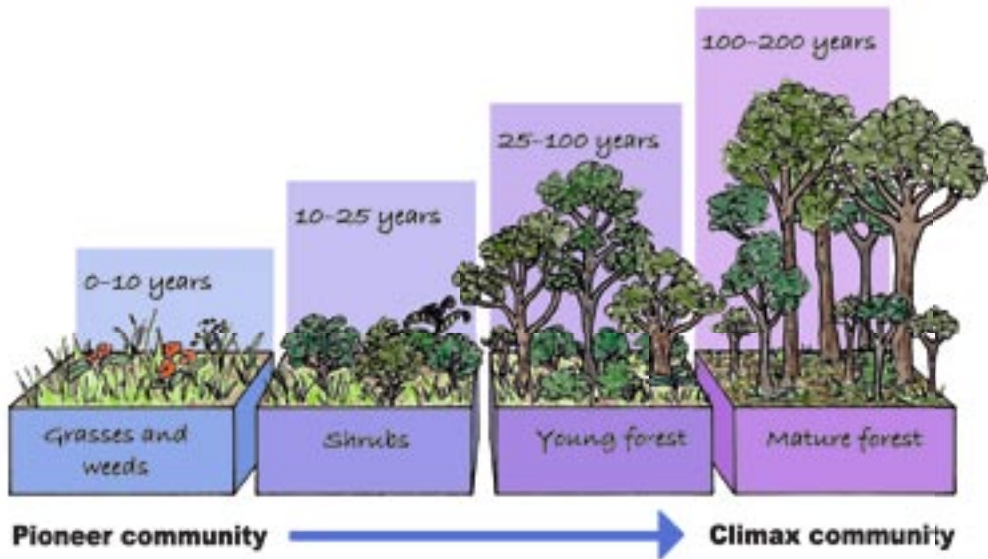
First, a healthy forest needs biodiversity—a range of different plants and animals. A forest is an ecosystem and all ecosystems need a mixture of species to be balanced. A single disease or pest could be enough to destroy a forest of 1 or 2 tree species.



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Riches for the future—school children plant a new tree.

Collect seeds or cuttings from different tree species to plant in nurseries. Plant the seedlings out together. Seeds or cuttings for each species should not come from just 1 tree, because the seedlings will then have the same weaknesses. They should be collected from a few trees chosen for their health and strength. Species that grow naturally in your area will suit the local conditions but other trees can be planted with them.



Natural reforestation happens over many years. through a process called forest succession. Bare earth turns into grassland—the pioneer community. Larger plants and shrubs gradually appear, and then pioneer tree species form a young forest. Over many years the pioneer trees are replaced by the dominant climax species in a mature forest—the climax community.

The advantages of reforestation

As the forest grows, trees can be thinned out or pruned and used for timber or fuel. People can collect fruit, seeds, nuts and medicines from the forest.

Birds and animals will return to areas they had left when their habitat is restored.

Planting a tree allows us to think about what we borrow from the future and owe to the past. To sit in the shade of a tree one's ancestors planted is to have inherited space and time and the freedom to walk with them. If you can give such things to grandchildren, you must be accounted rich and wise. Trees are powerful symbols of human aspiration.

Peter Steinhart, Audubon, March 1990

Part II. Growing food crops and fruit



12. Getting started: planning your plot

A school or home garden will provide you with nourishment and at the same time give you a chance to apply what you learn at school. You will use what you learn about plants and soil in Science and climate in Geography. At the same time you will have the fun of watching what you've planted grow into food!

Grow your own food crops

You can grow many food crops—on a large scale to sell, or in a garden to eat at home. These foods provide us with carbohydrates, protein, fats, vitamins and minerals.

The main vegetable groups are legumes (like beans, peas), root vegetables (like carrots), leafy vegetables (like kales, cabbages), solanaceous vegetables (like tomatoes, potatoes) and gourd vegetables (like pumpkins, squashes). Choose crops and varieties that do well in your region.

Before you start gardening, choose a good site.

- Choose somewhere in the school grounds or the compound at home. If there is no space, find somewhere nearby as you will need to go there frequently.
- Avoid steeply sloping land because the soil will erode easily. Avoid hollows or marshy areas—the soil will become waterlogged in the rains. The site should be protected from strong winds.
- The area should have good soil and be in a sunny spot. An area where no natural vegetation is growing probably has poor soil. If it is the only space available, you can improve the soil by adding compost or manure. Make sure the area you choose doesn't have underground pipes and cables that could be damaged by digging.
- Don't choose a site too close to walls and trees because most plants need at least 6 hours of direct sunlight each day. Trees may also take some of the nutrients and water your crops need.
- Choose a site close to water so that you don't have to carry it far. If water is scarce, find out how you can use as little water as possible. Choose



drought-resistant plants and use water-wise methods like drip irrigation.

- Decide what you want to grow and where you will plant each species. If you have space, make 4 beds and plant them 4 weeks apart. This way you will have vegetables all through the year. Draw a plan of the garden showing where each species will go. Include buildings and trees so that you have some idea of the places that will get shade at different times of the day. Your plan should include a shaded space for compost, an area for a tool shed and paths between beds to allow easy access for tending plants.



Use a hoe to break up the soil if you don't have a plough. Do this a few weeks before sowing seed so that the weeds that are broken up with the soil have time to rot and add their nutrients to the soil.

- Fence the garden with wire, wooden or bamboo poles or a live fence to keep animal pests out.

What will you grow?

In choosing what to grow, you must look at the conditions in your plot. The type of soil, the temperature range, the amount of rainfall it gets and the distance to water, the amount of sunlight and nutrients in the soil will all affect the way your plants grow. Some plants can survive frost while it kills others. Some are easily damaged by wind. The roots of drought-resistant plants may rot in waterlogged soil. Plants suited to wet areas curl up and die in dry conditions. Choose plants suited to your conditions and you will get a better harvest.

When you want to grow crops that are not suited to your local conditions, there are measures you can take to protect them.

- Cover plants in frosty areas with sacks at night.
- Add nutrients to poor soil with compost, manure and mulch, and rotate crops to keep the soil healthy.
- Water crops in dry spells and make sure there is good drainage during the rains.
- Protect delicate or brittle plants from winds by planting them near a windbreak or fence or by building one around them.
- Alternate rows of one crop (such as cabbages) with another (such as beans).
- Use terraces on sloping land.

Learn from your elders!

Traditional farming methods use the wisdom gathered over centuries. Your parents or grandparents can give you tips for growing particular plants that you won't find in manuals. There are traditional vegetables that have been neglected in favour of imported crops. They are nutritious and naturally adapted to local conditions. Find out about them and add them to your food garden.

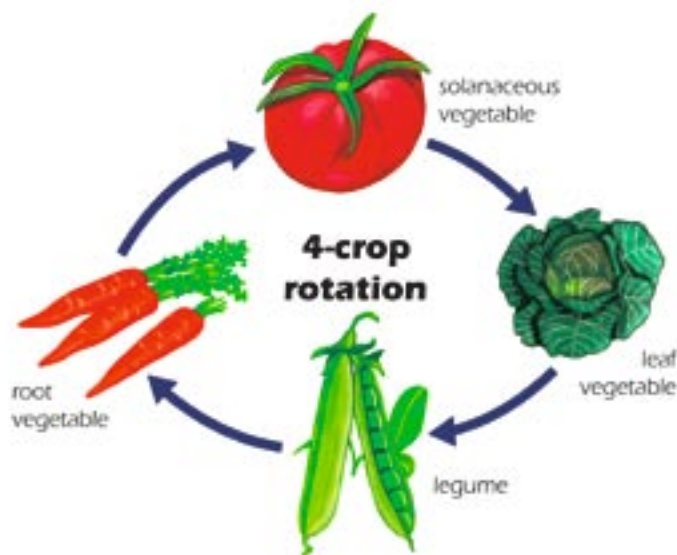


This boy is digging a trench—he will half fill the trench with kitchen scraps and compost. Then he will plant his crops in the rich soil that results. Robert Mazibuko developed trench gardening years ago in a poor part of South Africa. People still use his method because it improves the soil and saves water.

Factors influencing crop production

- Water is essential for growing crops. Choose a planting area close to water. Most planting is done at the beginning of the rainy season, though with a good irrigation system you can grow produce even in dry seasons. A watering can is ideal for a small vegetable plot!
- Shelter crops from strong wind with a fence.
- Most food crops need partial to full sun.
- Soil needs to be fertile and well textured to hold air and water and to drain well. Loam soils are ideal.
- **Rotation**—plants from the same basic vegetable groups are likely to get the same pests and need the same nutrients. After harvesting your vegetable crop, plant with vegetables from a different group. This helps keep the soil healthy and disease free.

A spacing guide for some common crops is on page 72.



Crop rotation means growing different crops in the same field one after the other. This helps keep the soil healthy and free from disease.

Growing and harvesting food crops

Clear the land, then plough it to loosen the soil and kill any remaining weeds. Break up any lumps left after ploughing.

Planting materials—seeds, tubers, vines and cuttings—should be of good quality and free from pests and diseases.

Plant seeds in a nursery or in rows or broadcast them

Spacing, seed rate (the amount of seed needed for the size of plot) and planting depth vary according to the needs of the crop. Remove excess plants to avoid overcrowding.

Vary harvesting and processing according to the crop.

Make sure stores are well ventilated, clean and dark. Fix rat guards to prevent attack by rodents.

When choosing what crops to grow, don't forget local traditional food crops. They have the advantage of being adapted to the conditions of the areas where they grow.

Keep grains dry to avoid rotting—raise the grain store to avoid moisture on the ground. Make sure the roof is leakproof.



Keep grains dry to avoid rotting—raise the grain store to avoid moisture from the ground. Make sure the roof is leakproof.

The big GM debate

Humans have used selective breeding to improve crops and livestock for thousands of years. Just over a decade ago, genetically modified (GM) crops appeared. These crops contain specific genes implanted to improve them. Most have been made stronger and resistant to specific diseases and pests. Some plants have even been made resistant to herbicides, so the farmer can spray the weeds without damaging crops. Scientists have also produced more nutritious varieties of foods like rice and potatoes.

In 1999 some people raised concerns over the safety of GM foods. Critics fear that GM foods may be harmful to our health and that companies that have developed GM crops and patented them could monopolize agriculture. There are also signs that crossbreeding with non-GM varieties can occur, and some people feel that GM crops could become 'superweeds'.

Many African countries have rejected food aid if the food is GM, arguing that they don't want something dumped on them that has been rejected in other countries. Supporters of GM crops argue that they could overcome world hunger while also reducing pollution from pesticides.

What do you think? Are these 'monster foods' or wonder crops—or something in between?

*Write or email your views to the **Young African Express** using the address given on the credits page.*

Want to find out more? Check out www.newscientist.com for more on the GM debate.



13. Useful fruit trees in East Africa

All fruits are an important source of vitamins and minerals. A few fruit trees like mango, banana, avocado, citrus and papaya planted around the homestead will provide food and shade for the family. Fruits are eaten fresh, dried or preserved, so they provide food even when they are out of season.

Fresh fruits can be sold. Fruit trees give us wood and other products, and they help prevent soil erosion. Seedlings can also be grown and sold, even on a small scale. Once they are well established they can withstand harsh conditions. Here in eastern Africa different trees are suited to our varied climatic zones and growing conditions. Choose the trees best suited to your area.

Indigenous fruit trees are a valuable source of nutritious food—but we neglect them. Baobab and wild custard apple are examples. Many indigenous fruits have no widely used common name but we know them by their local names. Which ones can you grow? Find out from your local agricultural extension officer and from older people who know these fruits.

Pruning

Pruning is important if the tree is to grow regular crops of healthy, large fruits. Pruning lets sunlight reach the interior of the tree and makes it easy to harvest fruit and care for the tree.

Because pruning weakens the tree for a time, prune when the tree is not flowering or fruiting. Don't use a panga because it causes wounds that pests and diseases can easily attack. Rather, use pruning shears, secateurs or a pruning saw.

Pests and diseases

The best way to deal with pests and diseases is to prevent their attack. Read Section 6, **Controlling pests and diseases in the nursery**, for tips (page 23). Also . . .

- Choose cultivars that are resistant to disease.
- Some birds are serious fruit pests. If you can, cover the trees with nets. Otherwise, hang tins or coloured scraps of fabric in the branches—they scare birds away as they bang and flap in the wind.



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Harvesting

- The first harvest will be ready by 18 months to 6 years after planting out, depending on the species.
- Fruits bruise when they fall on the ground. If the fruits are out of reach, use a ladder, spread a net above the ground or lay down a layer of soft weeds or leaves before shaking the tree or knocking down the fruits with a stick.
- Some fruits should be cut rather than plucked to prevent damage.
- Harvest when the day is cool, and keep picked fruit in the shade.
- Handle the fruits as little as possible. Pack them into the containers they will be stored or carried in as you pick them.

Pruning tips

- Remove shoots from the bottom of the trunk, and all dead, diseased or low-hanging branches.
- Cut off any branches that cross or rub against other branches. Leave the stronger branches and cut the weaker ones.
- Study the tree to see which are the main branches and which are secondary. You may be able to force some branches to grow in the right direction instead of cutting them off. Branches should be growing in all directions.
- Thin out branches in the centre of the tree that may block sunlight.
- Seal cuts wider than 5 cm with oil paint or tree wax—1 part beeswax melted with 9 parts candle wax.

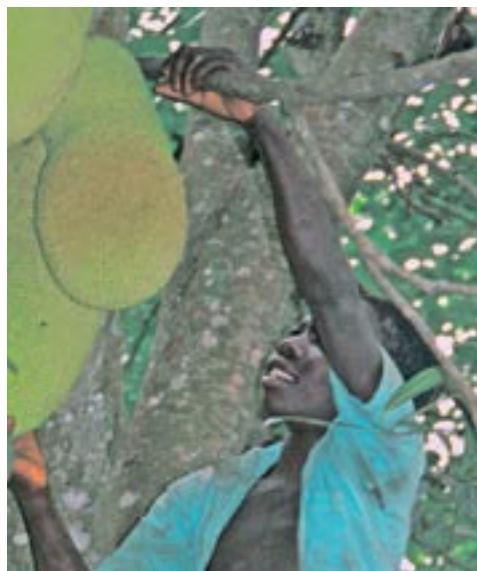
Do you
know

Like the banana, the papaya is not really a tree but a giant herb.



USDA

Cashew nuts are the fruit of the cashew tree. They are high in fat, protein and other nutrients.



World Agroforestry Centre

The pulpy flesh of the jackfruit is eaten raw or cooked in a curry. The seeds can be boiled and taste like chestnuts. The wood is often used to make furniture.

14. Fertilizer trees and how they work

You know why trees are important for farmers, don't you? Trees act as windbreaks to protect crops from strong winds, they help prevent soil erosion, they encourage rainwater to sink into the soil instead of causing floods, and they provide shade for young plants.

But some trees are even more useful than most—they actually make the soil richer so crops grow better! We can call them fertilizer trees.

Why plant fertilizer trees?

Fertilizer trees help to:

- Make the soil more fertile
- Reduce the need for chemical fertilizers
- Protect the soil from erosion
- Control weeds such as the parasite striga
- Save money on fuelwood, fodder and stakes

What are fertilizer trees?

Fertilizer trees are tree or shrub crops grown to improve soil fertility. Most fertilizer trees are legumes—flowering plants that grow their seeds in pods. Common legumes are beans and peas. Legumes have nodules on their roots that fix nitrogen into the soil, and all plants need nitrogen to grow. Legume plants used as fertilizer trees include *Crotalaria grahamiana*, *Gliricidia sepium*, *Mucuna pruriens*, *Sesbania sesban*, and desmodium species such as *Desmodium distortum*.



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Fertilizer trees help you to grow big, healthy crops without chemical fertilizers. You will also get higher crop yields.

Where and when do I plant fertilizer trees?

Plant fertilizer trees and legume cover crops in natural fallow areas, just beside your crop. Fallows are cropland areas that have been left without a crop so the soil can regain fertility. If you don't have land lying fallow, plant the fertilizer trees in the field with the crop, between the rows. Plant during the long-rains season, and let the trees grow through the short-rains season. They will make the soil richer and control weeds at the same time.

How do I grow fertilizer trees?

- You can plant seeds of some trees species such as sesbania, crotalaria, and tephrosia directly in the field.

- It is best if you start others such as calliandra, leucaena and gliricidia as seedlings.
- Tithonia grows easiest from cuttings.
- Seeds with a hard coat, such as calliandra, germinate better if you soak them in water overnight before planting.

If the field is very weedy, you may need to weed the trees once or twice while they are still young.

After you harvest the crop, leave the trees to grow for 6 to 7 months or longer to continue improving the soil fertility. Then when preparing the land for the next crop, cut the trees, haul the wood away, and work the leaves into the soil to add more fertility.

Here are some useful fertilizer trees:



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Gliricidia sepium improves the soil and controls weeds. Because it grows tall, it gives good shade for plantation crops such as tea and coffee. Its wood is useful for fences and furniture because it is termite resistant, and it burns well as fuel.



World Agroforestry Centre

Tephrosia interplanted with maize improves soil fertility for bigger and healthier crop yields. It also has use as a natural pesticide.



World Agroforestry Centre

Tithonia is a kind of sunflower that grows wild throughout Africa. It enriches the soil for maize and other crops. Cuttings and leaves can be worked directly into the soil as green manure, and tithonia compost is particularly high in organic nutrients.

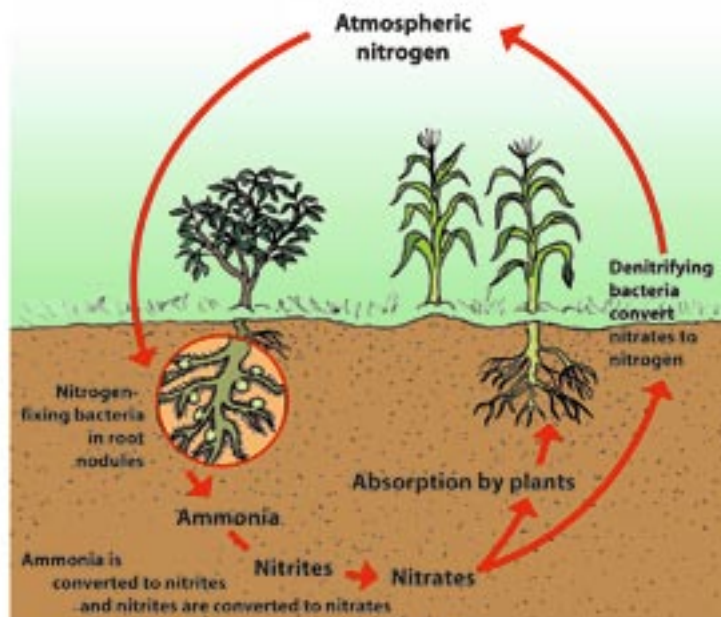
How fertilizer trees work

Most fertilizer trees are legumes. They draw nitrogen (which all plants need to grow) from the air into their roots, where bacteria form nodules in which nitrogen is converted into ammonia, nitrites and nitrates that enrich the soil.

Dropped leaves, twigs and roots from fertilizer plants also add nitrogen when they are returned to the soil. Small tree species like *Tephrosia vogelii* and *Tithonia diversifolia* can be used as green manure. When they are cut and mixed into the soil, they rot and release nitrogen as well as add organic matter to the soil.

Trees also reduce soil erosion, improve the texture of soil, provide shade and improve water absorption in soil. Fertilizer trees planted on fallow land improve the soil before another crop is planted. Where little land is available for farming, fertilizer trees and crops can be grown together.

Trees, though, may compete with crops for nutrients and moisture. Or they may cast too much shade. They may also attract birds and other pests that attack the crops. For these reasons the type of tree chosen must be suited to the crop being grown. Trees with deeper root systems than the crops won't compete for nutrients. A trench dug between a row of trees and the crop will reduce competition between root systems. Trees can be trimmed to reduce shade on crops like maize, cassava and cereals.



The nitrogen cycle: how legumes help fix nitrogen in the soil so that crops grow better.

Pros and cons of fertilizer trees

PROS

Fertilizer trees planted out in fields enrich the soil by adding nutrients, and farmers benefit as they need to buy less fertilizer for their crops. Fertilizer is expensive, and it is hard to get in areas with poor roads.

Most fertilizer tree species are tough and thrive easily, so time and labour can be focused on crops. Farmers using fertilizer trees in southern Africa are finding that they get bigger harvests than when they use chemical fertilizers.

Most species of nitrogen-fixing trees have other uses too. *Gliricidia sepium*, for example, can be cut close to the ground (so it doesn't compete with crops) as it will regrow easily and fast. Its leaves make good fertilizer. It provides firewood, posts, mulch and green manure, and it can act as a windbreak and a live fence. Its timber can be used to make furniture and tools. Find out which species that would be useful grow well in your area.



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A farmer growing tomatoes in his improved fallows.

CONS

Fertilizer trees also have disadvantages. It takes a lot of time and labour to cut the branches, gather the leaves and mix them into the soil when they are used for green manure. More work is needed to prune them so they won't compete with crops.

They may make soil with naturally high nitrogen content too nitrogenous. This can damage crops and pollute water.

Some species do so well that they become weeds—like *Prosopis*. But you can control this by selecting less invasive species or by clearing shoots as they appear.

Fertilizer trees are not new! Traditional African agriculture based on crop rotation used trees and other plants to conserve and improve the soil.



Fact file



Controlling striga weed with fertilizer trees

Striga causes much damage to maize, millet, sorghum, rice and sugarcane in the Lake Victoria Basin. It is a parasitic weed that grows on the roots of cereal crops, depriving them of water and nutrients. But some fertilizer trees help to reduce the number of striga weeds. They stimulate striga seeds to germinate in the soil instead of on the roots of their host plants, so the striga seeds die before they can grow into mature weeds.



World Agroforestry Centre

Sesbania sesban can be intercropped with crops like corn and beans.

Searching for fertilizer trees or more information on them? In addition to asking your parents and teachers, look for your local agriculture extension officer or Green Belt Movement representative.

You can also write to World Agroforestry Centre, PO Box 30677–00100 Nairobi, Kenya.

In Uganda, you can get the facts from the National Environmental Management Authority (NEMA) via their website:

www.nemaug.org or email: info@nemaug.org.

15. Pest control

Keep those pests away

A pest can be a tiny soil organism or something as large as an elephant.

Fences help to keep out rodents and grazing or browsing animals. Dogs can chase away monkeys and larger animals that may raid crops.

Rodents often eat stored crops and their droppings pollute the harvest. Cats living near food stores are useful rat and mouse catchers. Rodents can also be trapped or poisoned.



Birds can be scared by tins hung on strings that glitter and clatter together in the breeze. Not all birds are pests—some help by eating slugs and insect pests.



To control the maize stem borer, plant desmodium between the crop rows and Napier grass on the field edges. Desmodium repels stem borers, while Napier grass attracts stem borers and kills them. This 'push-and-pull' technique is working well for maize farmers in East Africa.

Nematodes that live in the soil and slugs attack plant roots. (Some nematodes help fix nitrogen in the soil, so not all are pests.) Rotate crop types after each growing season to discourage those that thrive on certain crops.

Caterpillars eat plants, severely damaging or even killing them. The cutworm damages the stems of young plants at ground level and armyworm caterpillars can attack crops in huge numbers, destroying cereal crops like maize and wheat. Locust swarms can wipe out

whole fields of crops in hours. Insects such as aphids suck the sap from plants, weakening them and sometimes spreading disease.

Controlling insect pests

Pests like unhealthy plants, so ensure you have strong, healthy plants by using good-quality seeds and looking after your plants and soil. Insect numbers increase in the rains—sow at the beginning of the rainy season so that plants can grow large enough to resist insect attack. If you irrigate, you can plant crops in the dry season when there are fewer insects. Remove weeds, the stalks and leaves of harvested plants, and nearby rubbish, where insect pests may live. Pick off larger insects by hand.

Grow insect-repelling plants like marigold, garlic, chilli, rosemary, lavender and nasturtium between crop rows and around fields and vegetable patches. Also grow some plants with small flowers. These flowers attract the small, friendly wasps that feed on insect pests.

If insects are still a problem, try a natural spray of neem, pyrethrum or chillies. These sprays are safer for you and the environment; however, they will still repel the friendly insects along with the pests.

Use chemical pesticides only as a last resort. Choose the correct pesticide for the insect or soil organism. These poisons must be used and handled very carefully—see the information on page 27.



PD Photo.org

Friendly insects like the ladybird can be your best friends in controlling stemborers and other pests. Ladybirds can eat as many as 60 borer eggs in 1 day. They also eat aphids and spider mites.



The red spider mite is tiny—little bigger than the full stop at the end of this sentence. It can feed on most vegetables and food crops. Your best weapon against spider mites is a healthy garden that encourages the predatory mites that feed on them. The useful mites thrive in compost and mulch. Avoid chemical sprays, which will kill the good mites together with the pests.



The diamondback moth is a serious pest on cabbage and sukuma wiki. Try intercropping—planting beans, onions or tomatoes between every row of your other vegetables. This helps to repel the moths and may even keep them away altogether. Natural sprays like neem or pyrethrum also work.

For more information see www.ghorganics.com or www.homeandgardensite.com/companion_planting.htm

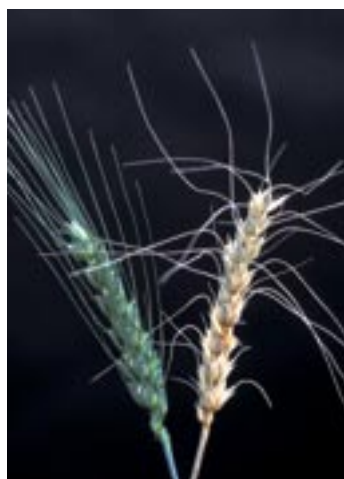
16. Controlling crop diseases

Crop diseases are caused by bacteria, viruses or fungi.

Bacteria take food from their host plants. They may reduce the amount of water a plant can absorb—if your potatoes, bananas, sugarcane or tomatoes are wilting in spite of being watered, they could have bacterial wilt. Bacteria thrive in the humid conditions of the rainy season.

Viruses live in plant sap and are easily spread by sap-sucking insects such as aphids as they move from infected plants to healthy ones. Viruses stunt crop plants and reduce crop yield. Viruses that may create problems for you include maize streak, which causes yellowish streaks on maize leaves; mosaic in tobacco and tomatoes; and rosette, which stunts the growth of groundnuts and cotton. Ratoon stunting disease affects sugarcane, causing stunted growth. Red spots on the nodes are a sign of this virus.

Fungi are plants that have no chlorophyll for photosynthesis, so many are parasites on other plants. Moulds and mildews can cause a great deal of damage. Blight may spread rapidly among potatoes and tomatoes, causing dark brown patches. Potato tubers and tomatoes rot if they are not treated. Headsmut in maize and sorghum shows as soot-like black spores on the tassel and cob tips. Other fungi include mildew on pumpkin; leaf or stem rust on wheat; and armillaria root rot on tea, which causes root decay and can kill the tea bush. Damping-off disease endangers young seedlings. Fungi spores are spread by wind and insects, through the soil, or on seeds.



A healthy wheat head contrasted with one infected with fusarium head blight disease.



Potato blight is caused by a mould.



Tomato mosaic is one of the viruses that damage tomato crops.

Disease control

As with crop pests, first try to prevent disease:

- Choose good-quality, disease-free seed. Spending money on certified seed may save you wasted time, money and labour later. Some seeds have been bred to resist certain diseases.
- Plant early in the rainy season when conditions are not so favourable for diseases.
- Control sap-sucking insects to reduce viral diseases.
- Some weeds shelter viruses, so weed your field or patch often.

If your crop plants are infected

- Prune the infected parts of plants or uproot and burn the whole plant.
- Use chemicals only if necessary. Fungicides control fungus diseases and can be applied to seeds before planting or sprayed on crops as a preventive measure.
- Remember the safety precautions for chemicals. Don't eat sprayed crops for some time after spraying—follow the waiting time recommended on the packaging.



USDA

A farmer admires his healthy maize.

17. How to make and use compost

Compost is free fertilizer for your garden!

Compost manure is the cheapest and most environmentally friendly way to make soil fertile. Soil with compost also absorbs more moisture from the air than other soil. You can make compost in your own home or at school using waste materials.

Compost is made from organic materials. These are materials that rot, like plants, kitchen waste and animal waste. So making compost helps clean up the environment through recycling.

Follow our compost recipe

Ingredients

- Dry plant waste: chopped twigs and dry leaves
- Green plant waste: grass clippings, weeds and soft leaves
- Kitchen waste: fruit and vegetable peels, eggshells and leftover food, but not meat or meat products
- Manure: dung from chickens, sheep, cows, goats, donkeys and camels, but not from animals that eat meat, such as cats, dogs and pigs
- Wood ash
- Water

There are two methods for making compost—the pit method and the heap method. The pit method is good for dry areas because it helps keep the compost moist. The heap method is better for wetter areas because it allows excess water to drain away.

How to make a compost heap

Step 1.

Select a sheltered, shady, well-drained spot about 2 m square. Start with a layer 10–15 cm deep of small branches and twigs.

Step 2.

Add a 30-cm layer of dry plant waste, green plant waste and kitchen waste.

Step 3.

Then add a 5-cm layer of manure, ash and topsoil. You can add old compost to this layer.

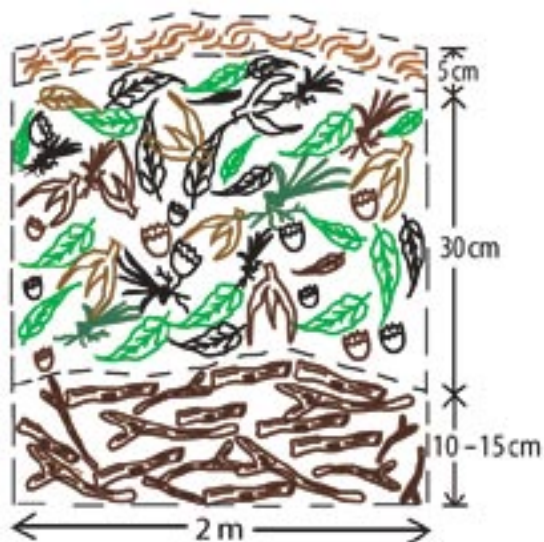


Step 4.

Water the heap so that it is moist but not too wet.

Step 5.

Repeat layers until the heap is about 1.5 metres high.



Thin layer of manure, ash, topsoil and old compost (if you have any)

Main layer of plant waste and kitchen waste

Bottom layer of small branches and twigs

Step 6.

Push a long, sharp-pointed stick into the heap at an angle. This is your compost 'thermometer'.

Step 7.

Cover the heap with a sheet of plastic or a layer of dry leaves or grass to reduce water evaporation.

Step 8.

If there is no rain, water the heap occasionally to keep it moist. After 3 or 4 days, check whether the material is rotting. Pull the stick out of the heap. It should be warm and moist and smell slightly. If it is dry, add more water to your heap. If the stick is cool or has a white fungus on it, it is time to turn the compost.

**Step 9.**

After 2 to 3 weeks, turn the compost over so that the bottom layer becomes the top layer. Do not add anything except water.

**Step 10.**

Your compost should be ready after 4 to 5 weeks.

When it is ready it has a fresh, earthy smell and a crumbly texture.

If you live in a dry area, make a compost pit

Step 1.

Select a sheltered, shady spot away from houses and standing water.

Step 2.

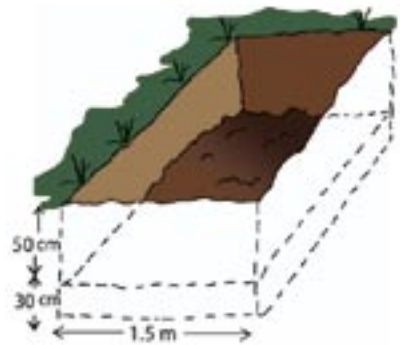
Dig a pit 1.5 m wide and 0.5 m deep. It can be as long as you wish, depending on how much organic material you have.

Step 3.

Loosen a layer of the soil at the bottom of the pit about 30 cm deep and water it.

Step 4.

Now follow the directions for the compost heap, starting with step 2.



Using the compost

Dig compost into the soil. You can also put a little in holes for planting trees and seedlings. With this nutritious food, your plants will grow faster and healthier. Your efforts will be rewarded!

Compost tips

- Look for free sources of organic materials like spoiled fruits and vegetables from shops and restaurants, bags of garden refuse awaiting disposal, feathers and stable manure.
- Very dry vegetation will take longer to rot.
- Don't use many eucalyptus leaves because they slow down decomposition.
- Don't use fat or meat products. They smell and they attract ants and rats.
- Don't compost anything poisonous.
- Don't use manure from carnivorous or omnivorous animals, especially humans! Carnivorous animals are those that eat mostly meat, like cats and dogs; omnivorous animals are those that eat both meat and vegetable matter, like pigs—and humans.
- Cover the heap or pit with a sheet of plastic, a layer of dry banana leaves or grasses to reduce water evaporation.

18. How to mulch

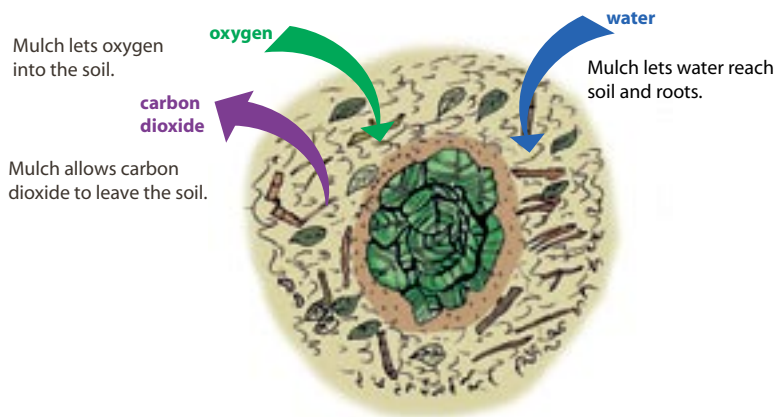
Healthy crops need healthy soil with the right mix of minerals, organic material and air. Organic material added to the soil improves soil structure and adds rich humus to the earth. Can you think of ways in which we add organic matter to the soil? Mulching is one of these.



Hay and straw are good mulching materials. Organic mulch adds nutrients to the soil as it breaks down.

What is mulch?

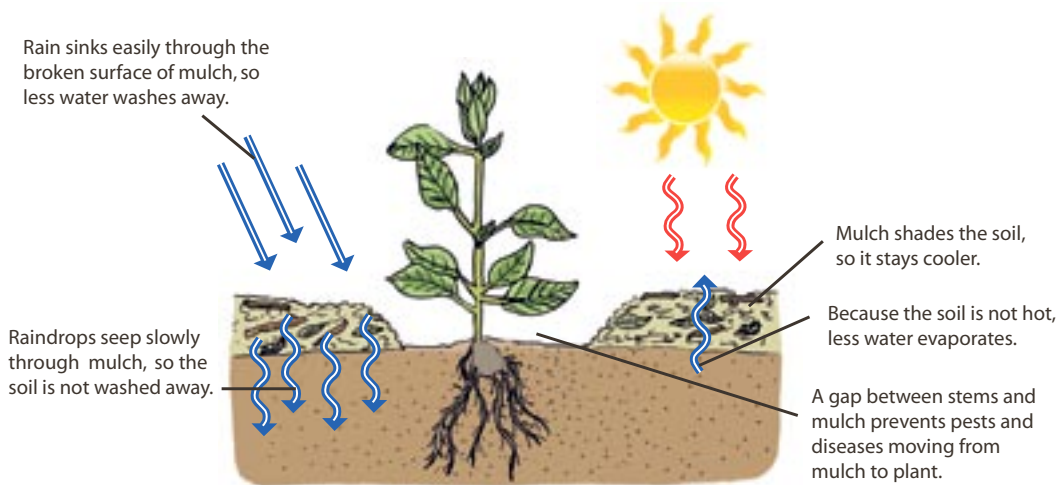
Mulch is loose plant matter used to cover the soil. Good mulching materials include straw, maize stalks, old compost or manure, dry grass cuttings, dry leaves and coffee husks. Green plant material should not be used—it blocks water from soaking into the soil and attracts pests and fungal diseases. Inorganic mulches like stones, gravel and pieces of cardboard save water and keep the soil cool, but they won't enrich the soil.



Although mulch covers the soil, air and water can move through it.

What it does

Mulch protects open soil from sun, wind and heavy rainfall, reducing soil erosion and water evaporation and keeping the soil cool. Mulch reduces weed growth by blocking the light weeds need. As insects, earthworms and micro-organisms break mulch down, they add nutrients to the soil and mix plant matter into the soil. Their burrows loosen the soil and let air and water in. Mulching can reduce the nitrogen in the soil and encourage pests but on the whole it is good for soil and crops.



How mulch benefits plants.

How to use it

- Spread mulch on warm, moist soil.
- Spread mulch around beds 2 weeks after planting or when your seedlings are well developed. Spread it between rows of small plants rather than around each plant.
- Thick mulch reduces light and the flow of air and encourages pests and disease. Mulch only in dry seasons.
- Lift it regularly to check for insects.
- Keep the mulch about 8 cm from young plants—this keeps insects like termites away from the stems.
- Use mulch with a mix of large and small pieces because it will take water well and won't blow or float away.
- Mulch should smell woody or like soil. If it smells of vinegar, rotten eggs or ammonia, it has gone sour. Don't use it because it can damage plants badly.
- Don't use material from the same crop you are growing (for example not maize stalks around maize) because it may carry pests and diseases that attack that crop.
- Use a thick layer of mulch to remove persistent weeds from a specific area.
- Reduce the labour of mulching by using woody mulches—they decay more slowly.



USDA

Raking mulch around cabbages.

19. How to make liquid manure

Nutrients are essential for fertile soil, but they are constantly removed. When we harvest crops, we take with them the nutrients they have absorbed. Rainwater washes them away too.

We need to replace these nutrients. Organic matter in the form of compost, manure and mulch adds nutrients to the soil without using chemicals. Another way to add nutrients is to use a nutrient-rich liquid or liquid manure.



Stock.xchng

Liquid manure, like compost and mulch, feeds the soil to give you beautiful, nourishing vegetables.

Liquid manure, otherwise known as manure tea, is made from animal dung, sometimes mixed with plant matter. However, the manure used must be well rotted or it can add unwanted organisms to the soil. Compost tea is made from compost (of course!)—this can include animal manure. A tea can also be made from pure plant matter and sprayed onto plants. There are different recipes for these liquids. Here's one.

Ingredients

You need:

- Well-rotted animal manure (from goats, cattle, donkeys or sheep). You can choose to use half manure and half compost
- A large container that can hold about 50 litres water—for example a large bin or drum
- An empty sack (such as a charcoal sack)
- String
- A strong stick longer than the container is wide
- Water
- Lid or covering for the container



Collect goat, sheep, donkey or cattle manure but use chicken manure sparingly.

Making the liquid manure

- Fill the sack with the manure and compost mixture.
- Tie the sack to the strong stick with string.
- Fill the container with water. Lower the sack into the water and lay the stick across the container so that the sack is suspended in the water.
- Cover with the lid or a cloth or plastic sheet.
- Remove the cover and shake the stick every day for 2 weeks.
- This mixture is too strong for plants. With a cup or dipper put some in a smaller bucket and mix with water. Add 4 cups of water to each cup of liquid manure. The mixture is safe to use when it looks like weak tea.



After 2 weeks the liquid in your drum should be a rich brown.

Using the liquid manure

Store your liquid manure in a container with a lid. Pour 1 cup of the diluted mixture on the soil around each plant every 2 weeks during the growing season. This is especially good for vegetables.



1 + 4

Make a mixture of 1 cup of liquid manure to 4 cups water before pouring it around your plants.

Tips

- Let fresh animal dung rot for about 8 weeks. Chicken manure is rich in nitrogen but the urine in chicken droppings can damage plants, so use just 2 handfuls mixed with the other manure.
- Don't use containers that have held toxic chemicals.
- Weeds like poor soil—if you have a weed that keeps growing in your plot, make it into liquid manure and spray it onto the leaves. It can reduce the growth of that weed.
- The liquid at the bottom of the drum will be stronger, so dilute it with extra water.

20. Beneficial insects and the importance of pollination

What is your reaction when you see an insect in your garden? Do you want to squash the nasty pest? (That, is if you're not running away from it ...) Now, think again. Not all insects are pests. Some insect species are the farmer's friend because they eat or weaken insect pests. And where would we be without pollinating insects?



PD Photo.org

Bees travel from flower to flower, collecting nectar (that they later convert to honey), and pollen grains. The bee collects the pollen by rubbing against the anthers. The pollen collects on the hind legs, in dense hairs referred to as a pollen basket. As the bee flies from flower to flower, some of the pollen grains are transferred onto the stigma of other flowers.

Predatory and parasitic insects

Natural control of insect pests is a less harmful alternative to pesticides. Insect predators kill the insects they prey on without damaging crops or other insects. Here are some of these useful insects:

- Ladybirds control stemborers, aphids, spider mites and other pests.
- The praying mantis is a deadly insect predator. It waits motionless for insects and strikes as soon as a victim strays too close.
- Lacewing larvae prey on soft-bodied insects like aphids and caterpillars.
- Trichogramma is a tiny parasitic wasp that enters and kills the eggs of the African bollworm. This pest attacks many crops in East Africa.
- The tachinid fly parasitizes stemborers that attack cereal crops in East Africa. It lays its eggs on stemborers. When the maggots hatch, they enter and feed on the stemborer, killing it.
- Certain wasp larvae kill the larvae of diamondback moths, which eat cabbages.
- Predatory mites eat the red spider mites that are so damaging to tomatoes.

Pollinating insects

Many important crops would not be here without pollinating insects. Pollen sticks to insects like bees, robber flies and certain butterflies as they gather nectar. The pollen they carry is transferred to the next flower they visit and fertilizes it. Most plants cannot develop fruits without fertilization.

The most important pollinating insect is the bee. Not only does it pollinate crops but it also provides us with beeswax and honey.



Kim Meyer

Though spiders are not insects, they too control insect pests. This orb spider is a common garden spider. Mulch provides a good habitat for spiders.



USDA

Adult wasps feed on the nectar of tomato, apple, corn and bean flowers, so plant these near cabbage crops.

How to encourage beneficial insects

- Provide these crop friends with vegetation for food and shelter. Pollinating insects feed on nectar. Insects like wasps and tachinid flies eat or destroy insect pests only during the larval stage of their life cycle. The adults feed on the nectar of flowering plants. These can be other crops in your garden, herbs or flowers like sweet alyssum. Even flowering weeds can provide nectar. Even predators that feed only on insects need vegetation for shelter.
- Pesticides kill all insects, even beneficial ones. Don't use pesticides unless it is really vital.



Dee Raymer

Flowers grown together with vegetables in a Kericho home garden attract pollinators.

Pollination

Pollination is an important step in the reproduction of seed plants: pollen grains (male gametes) are transferred to the plant carpel, the structure that contains the ovule (female gamete). The receptive part of the carpel is called a stigma in the flowers of angiosperms and a micropyle in gymnosperms. The study of pollination brings together many disciplines, such as botany, horticulture, entomology and ecology. Pollination is important in horticulture because most plant fruits will not develop if the ovules are not fertilized.



World Agroforestry Centre

Baobab flowers are large and strongly scented. They open at night to attract the bats that pollinate them.

A **pollinator** is the agent that moves the pollen, whether it be wind, bees, bats, moths or birds; a **pollenizer** is the plant that provides the pollen.

Natural pollination by insects is ecologically and financially important for agricultural crops, improving their quality and quantity. Forests or wild grasslands near agricultural crops such as apples, almonds or coffee can improve their yield by about 20%. This may result in forest owners demanding payment for their part in the improved results. This is a simple example of the economic value of ecological services.

Pollination of food crops has become an environmental issue, due to 2 trends.

- The trend to monoculture means that greater concentrations of pollinators are needed at bloom time than ever before, yet the area is forage poor or even deadly to bees for the rest of the season.
- The other trend is the decline of pollinator populations, due to pesticide misuse and overuse, new diseases and parasites of bees, clearcut logging, decline of beekeeping, suburban development, removal of hedges and other habitat from farms, and public paranoia about bees.

Do
you
know

Don't forget the birds

Insect-eating birds also help in controlling insect pests. They need a good source of water and trees and shrubs for shelter.



Fact file

What's on the menu for some predatory insects

Centipedes	slugs and snails
Dragonflies	aphids, mosquitoes, others
Lacewings	aphids, whiteflies, small caterpillars
Beetles	cutworms, caterpillars, grasshopper eggs, beetle larvae
Ladybirds	scale insects, aphids, spider mites, mealy bugs, insect eggs
Parasitic wasps	aphids, whiteflies, caterpillars
Predatory mites	spider mites

Appendices



Spacing guide for trees

Fruit orchards

Tree	Spacing	Production
Avocado	6 x 7 m to 8 x 10 m	10 t/ha
Cashew nut	8 x 5 m	7–9 t/ha
Citrus	1.5 x 1.5 m	8–10 t/ha (8–12-year-old trees)
Coconut	7 x 7 m to 10 x 10 m	2,000 coconuts/ha
Custard apple	2 x 5.5 m	7 t/ha for 7-year-old trees
Guava	6 x 6 m to 8 x 8 m	60 t/ha for 7-year-old trees
Jackfruit	10 x 10 m to 12 x 12 m	9 t/ha
Loquat	4 x 4 m to 5 x 5 m	6–54 t/ha
Macadamia	9 x 4 m to 10 x 6 m	3.5 t/ha
Mango	8 x 10 m or 10 x 12 m or 12 x 14 m	25 t/ha

Spacing guides for trees planted as woodlots and fodder shrubs

Timber woodlots

Recommended spacing: 5 x 5 m (this is the final spacing to be achieved; if thinning is applied use spacing of such as 2.5 x 2.5 m)

Fodder shrubs

Suitable spacing between shrubs planted in a row is 30 to 50 cm.

500 shrubs are needed per dairy cow; this will increase farmer income by about Ksh 6,800 per year.

100 shrubs are needed per dairy goat.

Spacing guide for some common crops

Crop	Spacing (cm)
maize	75 x 25
beans	30 x 15
potatoes	75 x 30
cabbages	60 x 60
tomatoes	60 x 60
carrots	30 between rows
rice	10 x 10



World Agroforestry Centre

Terraces are used in agroforestry and farming in hilly parts of Uganda

Useful trees for East Africa

Scientific name	English name	Main uses	Indigenous or exotic
<i>Acacia melanoxylon</i>	Australian blackwood, blackwood,	Fodder, timber	Exotic
<i>Acacia nilotica</i>	Egyptian thorn, Nile thorn	Fence, fodder, shade	Indigenous
<i>Acacia senegal</i>	Gum arabic tree	Commercial ‘gum arabic’, fodder	Indigenous
<i>Acacia tortilis</i>	Umbrella thorn	Fence, fodder, shade	Indigenous
<i>Acacia xanthophloea</i>	Fever tree, yellow-barked acacia	Fodder, medicine (malaria treatment)	Indigenous
<i>Acrocarpus fraxinifolius</i>	Indian ash, shingle tree	Bee forage, beehives, furniture, shade, timber	Exotic
<i>Adansonia digitata</i>	Baobab	Bee forage, fibre, fruit, vegetable	Indigenous
<i>Azelia quanzensis</i>	Lucky bean tree, mahogany bean, pod mahogany	Furniture, ornamental, poles, shade, timber	Indigenous
<i>Anacardium occidentale</i>	Cashew nut	Nuts, timber	Exotic
<i>Annona senegalensis</i>	Wild custard apple	Fodder, fruit, medicine	Indigenous



Scientific name	English name	Main uses	Indigenous or exotic
<i>Artocarpus heterophyllus</i>	Jackfruit	Fruit, shade	Exotic
<i>Azadirachta indica</i>	Neem	Medicine, shade, soap	Exotic
<i>Brachylaena huillensis</i>	Silver oak	Essential oil, poles, timber,	Indigenous
<i>Cajanus cajan</i>	Pigeon pea	Fodder, soil conservation and	Exotic
<i>Calliandra calothyrsus</i>	Calliandra	Fodder, soil conservation and	Exotic
<i>Cassia abbreviata</i>	Long-pod cassia	Furniture, medicine, poles,	Indigenous
<i>Cocos nucifera</i>	Coco nut	Fibre, nut, oil, ornamental, shade, thatching	Exotic (naturalized)
<i>Combretum molle</i>	Velvet bush willow, velvet leaf combretum, velvet leaf willow	Bee forage, dye, fodder, medicine, poles, timber	Indigenous
<i>Cupressus lusitanica</i>	Mexican cypress	Poles, timber	Exotic
<i>Cyphomandra betacea</i>	Tree tomato	Bee forage, fruit	Exotic





<i>Diospyros mespiliformis</i>	African ebony, jackal berry	Fruit, timber	Indigenous
<i>Eriobotrya japonica</i>	Loquat	Fruit	Exotic
<i>Erythrina abyssinica</i>	Flame tree, red-hot-poker tree, lucky bean tree	Furniture, soil conservation and improvement, timber	Indigenous
<i>Eucalyptus globulus</i>	Blue gum, Tasmanian blue	Essential oil, poles, timber	Exotic
<i>Faidherbia albida</i>	Apple-ring acacia, white thorn	Fodder, shade, timber	Indigenous
<i>Gliricidia sepium</i>	Mother of cocoa, Mexican lilac,	Fence, fodder, poles	Exotic
<i>Grevillea robusta</i>	Silky oak	Furniture, poles, shade, timber	Exotic
<i>Jacaranda mimosifolia</i>	Jacaranda	Ornamental, shade	Exotic
<i>Jatropha curcas</i>	Physic nut, purging nut	Biofuel, candles, soap	Exotic
<i>Macadamia integrifolia</i>	Macadamia nut	Nut, oil, ornamental, timber	Exotic
<i>Mangifera indica</i>	Mango	Fruit, shade	Exotic



Scientific name	English name	Main uses	Indigenous or exotic
<i>Markhamia lutea</i>	Markhamia	Bee forage, boat building, furniture, poles timber	Indigenous
<i>Milicia excelsa</i>	Iroko, mvule	Furniture, ornamental, poles,	Indigenous
<i>Moringa oleifera</i>	Drumstick tree, moringa	Medicine, oil, vegetable, water	Exotic
<i>Morus alba</i>	Mulberry	Feeding silkworms, fodder, fruit, ornamental, shade	Exotic
<i>Ocotea usambarensis</i>	Camphor, East African camphor wood	Furniture, medicine, timber	Indigenous
<i>Parinari curatellifolia</i>	Mobola plum	Fruit, medicine, poles, timber	Indigenous
<i>Persea americana</i>	Avocado	Fruit, oil, shade, timber	Exotic
<i>Piliostigma thonningii</i>	Camel's food, monkey bread	Dye, fodder, medicine, soap	Indigenous
<i>Pinus patula</i>	Mexican weeping pine	Paper pulp, resin, timber	Exotic
<i>Prunus africana</i>	Red stinkwood	Bee forage, furniture,	Indigenous





<i>Psidium guajava</i>	Guava	Fruit	Exotic
<i>Sclerocarya birrea</i>	Marula	Carvings, fodder, furniture,	Indigenous
<i>Sesbania sesban</i>	Sesbania, river bean, Egyptian rattle pod	Soil improvement	Indigenous
<i>Strychnos cocculoides</i>	Corky-bark monkey orange	Fruit, medicine	Indigenous
<i>Syzygium guineense</i>	Guinea waterberry	Fruit, medicine, shade	Indigenous
<i>Tamarindus indica</i>	Tamarind	Boat building, fruit, poles,	Indigenous
<i>Tephrosia vogelii</i>	Fish bean, fish-poison bean	Fish poison, medicine, soil	Indigenous
<i>Warburgia ugandensis</i>	East African greenheart	Medicine	Indigenous
<i>Ziziphus mucronata</i>	Buffalo thorn, Cape thorn	Bee forage, drink, fodder,	Indigenous





Home gardening chart



Name of vegetable	Seed planting and depth (cm)	Distance between rows / between plants after thinning	Pests / diseases	Points to remember	Months to harvest and when to pick	Estimated yield per m ²	Preservation and storage methods	How to prepare
Amaranth 	Direct into garden — shallow	150/30 cm	Lygus bug, armyworm, cutworm, aphids / curly top virus	When transplanting pour water into the furrow or hole. Let some of the water seep into the soil. Plant seedling with roots in the mud and water mixture and cover hole	1.5–2 months when harvesting whole plant, 20 cm tall. After 2 months, harvest leaves at 2-week intervals	—	Dry leaves	Boil. Add tomatoes, potatoes, onions
French bean 	Direct into garden 5 cm	90/25 cm	American bollworm, aphid, pollen beetle/ —	Plant early to avoid insect pests. Stake plants 0.5–2 m high. Mound soil around plant for support	2–4 months. When pods are young and tender	—	Dry or can young pods or mature seeds	Steam, boil, or fry

Beetroot		Direct into garden 1–2 cm	40–60/5 cm	Aphids/ leaf spot	Soak seeds 12 hours and dry before planting	2.5–4 months. Pick before large and tough	13 bunches, 5 plants per bunch	Slice then dry, can or pickle roots. Dry leaves	Boil or steam roots for salad. Use young leaves like kale or spinach
Broccoli		Direct into garden 1 cm	60/45 cm	American bollworm, aphids, bagrada bug, diamond back moth	Mound soil around plant for support	2.5–3 months. Buds fully swollen, heads compact. Pick from bottom of stem	3.7 heads	Dry individual florets	Steam, boil, or stir-fry for a few minutes
Cabbage		Seedbeds 1 cm	45/45 cm	Aphids, bagrada bug, diamond back moth	Water after transplanting	3–4 months. Heads firm	4 heads	Slice then dry	Steam, boil, or stir-fry, use raw
Carrot		Direct into moist soil 1–2 cm	30/5 cm	Aphids, avoid areas with eelworms	Do not plant in heavy soil or soil high in organic matter	2–3 months. Before full maturity	13 bunches, 6 plants per bunch	Dry leaves, slice then dry or can roots	Best raw. Steam, stir-fry or boil roots and leaves

Name of vegetable	Seed planting and depth (cm)	Distance between rows / between plants after thinning	Pests / diseases	Points to remember	Months to harvest and when to pick	Estimated yield per m ²	Preservation and storage methods	How to prepare
Cowpea 	Seedbeds 4 cm	90/10 cm	Aphids, bollworms/ —	Rotate to new planting beds after harvesting to avoid damage by nematodes	When 90% of pods have dried off. Pick leaves and young pods by hand	—	Dry leaves. Dry and grind seeds. Thresh pods by placing in sack and beating with stick	Steam or boil leaves. Roast seeds and use as coffee substitute. Boil or fry seeds
	Seedbeds 1 cm	45/30 cm	Diamond back moth, cabbage saw fly, aphids/ black rot, leaf spot	Mulch and leave through winter	2 months. Harvest outer leaves first	15 bunches, 6 plants per bunch. 4 cuttings per planting	Dry leaves	Steam, boil, or stir-fry leaves. Eat raw
Leek 	Seedbeds 1–2 cm	45/10 cm	American bollworm, thrips / mildew	Always transplant into furrows	4 months. When leaf stems are 15–20 cm	22 plants	Dry stems and leaves	Cook stems and leaves

Lettuce		Seedbeds 1–2 cm	45/30 cm	American bollworm, aphids, cutworms (severe)/ leaf spot	Protect against strong sun after transplanting	3.5–4 months. Heads firm	—	Beat raw in salads. Steam or stir-fry
Maize		Direct into garden 3–5 cm	75/30	American bollworm, cutworm, stalk borer	Plant in blocks or short rows for good pollination	3–4 months. Silks (outer covering) dry	6 ears	Steam, boil, or roast
Onion		Seedbeds 1 cm	30/10 cm	Onion thrip/ purple blotch, bulb rot	Seedlings should be planted shallow	4–5 months. 50–70% of tops fall over	33 bulbs	Raw in salad. Steam, fry, or bake bulbs and leaves
Pea		Direct into garden 3–4 cm	45/10 cm	American bollworm (severe)	Supply more water at pod-filling stage	2–3 months. Pods full and plump, before they begin to shrink	0.5 kg in shell	Steam, boil, or fry fresh peas. Steam or boil dried peas

Name of vegetable	Seed planting and depth (cm)	Distance between rows / between plants after thinning	Pests / diseases	Points to remember	Months to harvest and when to pick	Estimated yield per m ²	Preservation and storage methods	How to prepare
Potato 	Seed pieces with eyes, direct into garden 10 cm	75/30 cm	All/ early blight, late blight	As plants mature, draw soil around them	5 months. Tops die, skin is thick	6 kg	Slice then dry tuber or store tubers in a cool place	Steam, bake, boil, or fry tubers
Pumpkin 	Direct into garden, 3 seeds/site 2–3 cm	200/100 cm	Aphids, pumpkin fly	Needs a lot of water	4.5–5 months. Skin cannot be scratched by a fingernail	—	Store whole fruit in cool, dry place. Chop then dry leaves and fruits	Bake, steam, boil, or fry tender leaves and fruits
Spinach 	Direct into garden or seedbeds 1–2 cm	45/15 cm	Aphids/ leaf spot	Soak seeds 12 hours and dry before planting. Mulch.	2–4 months. Harvest outer leaves first.	15 bunches, 4 plants per bunch. 4 cuttings per planting	Chop then dry leaves	Steam, stir-fry, or boil leaves
Sweet melon 	Direct into garden, 3 seeds/site 3 cm	100/100 cm	Downy mildew, powdery mildew	Mulch to reduce chances of fruit rot	3–4 months. When fruits are yellow	—	Store in a cool place	Eat ripe fruit

Tomato 	Seedbeds 1 cm	45–100/50 cm	American bollworm and all others/ early blight, late blight, tomato mosaic	Support plants with stakes	2–4 months. Pick when green or ripe	2.15 kg	Slice then dry or can	Best raw. Steam or fry
	Direct into garden or seedbeds 1 cm	30/10 cm	American bollworm, aphids/ mildew	—	1–2.5 months. Before leaves are tough	7 bunches, 5 plants per bunch	Store roots in a cool place, dry leaves	Steam, boil, or fry roots and leaves
Water melon 	Direct into garden, 3 seeds/site 2–3 cm	200/100 cm	Aphids, pumpkin fly/ downy mildew, powdery mildew	—	3–4 months. Underside yellow, dull thud when thumped	—	Store in a cool place	Eat ripe fruit, make juice

Useful websites

The Agroforestry database by the World Agroforestry Centre is a tree species reference and selection guide for agroforestry trees covering more than 500 species. www.worldagroforestry.org/Sites/TreeDBS/AFT/AFT.htm

Agroforestry Net is a non-profit organization dedicated to providing educational resources about agroforestry, trees and sustainable stewardship of land and water. The site contains current project information, publications and links to other resources on the web. www.agroforestry.net

The **Earthbird Series** provides colourful cartoon magazines that raise awareness among young people of the importance of forests, threats to forests and sustainable resource management. www.fao.org/forestry/site/26519/en/

Eco-Schools is an international programme for environmental education for sustainability. www.eco-schools.org

Glossary for Agroforestry Editors: P. Huxley and H. van Houten, 1997. Publisher: CTA and ICRAF, Nairobi, Kenya. ISBN: 92-9059-124-2. Includes 1,400 agroforestry terms arranged alphabetically, with extensive cross-referencing. www.bugwood.org/glossary/

Pan African Conservation Education (PACE) aims to share ideas across communities in Africa by providing innovative and inspiring resources to educators working on the environment and sustainable development. www.paceproject.net

Science Across the World links thousands of schools around the world where students are exchanging information, opinions and ideas on a variety of science topics with young people in every continent. www.scienceacross.org

Setting Up and Running a School Garden: A Manual for Teachers, Parents and Communities. FAO has prepared this manual to assist school teachers, parents and communities who wish to start or improve a school garden with the aim of helping school children to grow in both mind and body. www.fao.org/docrep/009/a0218e/a0218e00.htm

TeachAManToFish is creating an international network of agricultural schools and partner NGOs committed to sustainable approaches to tackling rural poverty. www.teachamantofish.org.uk

Trees for the Future is a non-profit organization initiating and supporting agroforestry self-help projects in cooperation with groups and individuals in developing countries. www.treesfif.org

Tunza is an initiative of the United Nations Environment Programme (UNEP) that is meant to develop activities in the areas of capacity building, environmental awareness, and information exchange, with a vision to foster a generation of environmentally conscious citizens, capable of positive action. www.unep.org/tunza

World Agroforestry Centre has extensive worldwide programmes in agroforestry research and training. www.worldagroforestry.org

Young African Express is Africa's first self-instructional, curriculum-based, independent educational newspaper for young people of ages 10 to 18, accelerating their preparedness to improve their own lives and participate in social and economic development. www.youngafricanexpress.net

Glossary

botany the scientific study of plants

carbon sequestration removing carbon dioxide from the atmosphere

carpel the female reproductive organ in a flower, usually comprising an ovary, a stigma and a style

climatic zone an area of the earth that has a distinct type of climate

conservation the preservation, management and care of natural and cultural resources so as to protect them from change, loss or damage

cultivar variety of a farm plant that is developed by breeding and has a designated name

desertification process by which land becomes increasingly dry until almost no vegetation grows on it, making it a desert

ecology study of the relationships and interactions between living organisms and their natural or adopted environment

entomology study of insects

fallow agricultural land that is currently not being cropped, often to accumulate moisture

fertilize to unite a male gamete and a female gamete, thus enabling the development of a new individual to take place; to apply fertilizer to soil or plants

fertilizer a substance usually rich in nutrients added to or spread onto soil to increase its ability to support plant growth

fungicide a substance used to destroy or inhibit the growth of fungi

germination to start to grow from a seed or spore into a new individual

gymnosperm a woody cone-bearing plant such as a conifer, cycad or ginkgo in which the ovules are carried naked on the scales of a cone

hardwood wood from a broad-leaved tree, for example, mahogany, teak, eucalyptus or any tropical hardwoods, different from a conifer, which produces softwood

herbicides a chemical preparation designed to kill or inhibit the growth of plants, especially weeds

horticulture the science, skill or occupation of cultivating plants, especially flowers, fruit and vegetables in gardens or greenhouses

humus a component of the soil that is made of decomposed plant and animal remains or organic matter

indigenous tree originating in and typical of a region or country

insecticide a chemical substance used to kill insects

loamy soil an easily worked fertile soil consisting of a mixture of clay, sand and silt, and sometimes also organic matter

monoculture the practice of growing a single crop plant in a field or larger area, for example, a cereal crop such as wheat

mulch a protective covering of organic material laid over the soil around plants to prevent erosion, retain moisture and sometimes to enrich the soil

naked seed trees that produce seeds that are contained within a cone

nectar the sweet liquid that flowering plants produce as a way of attracting the insects and small birds that assist in pollination

nematode a worm, often microscopic, with a cylindrical unsegmented body protected by a tough outer skin (cuticle)

organic matter relating to, derived from, or characteristic of living things

parasitize to infest an animal or plant with a parasite, or to live on it as a parasite

perennial stream a stream that constantly recurs, or lasts for an indefinite time; a seasonal stream

pesticide a chemical substance used to kill pests, especially insects

photosynthesis a process by which green plants and other organisms produce simple carbohydrates from carbon dioxide and hydrogen, using energy that chlorophyll or other organic cellular pigments absorb from the sun

pollen grain (male gamete) a powdery substance produced by flowering plants that contains male reproductive cells

pollination to transfer pollen grains from the male structure of a plant (the anther) to the female structure of a plant (the stigma) for fertilization. Pollination is important in horticulture because most plant fruits will not develop if the ovules are not fertilized

propagation bed small plots of land where plants are placed and caused to reproduce; land prepared for the planting of seeds or plant cuttings

reforestation to replant an area with trees after its original trees have been cut down; to re-establish a forest by planting or seeding an area where forest vegetation has been removed

rhizome a thick underground stem that produces roots and has shoots that develop into new plants

soil erosion control any action undertaken to prevent or stop the process of soil erosion; to control the gradual wearing away of rock or soil by physical breakdown, chemical solution and transportation of material as caused, for example, by water, wind or ice

soil fertility the quality or condition of the soil being able to cause plants to reproduce

suburban development growth of residential areas, usually the outer limits of a town or city; improving housing standards

sustainable a situation or condition that's able to exist and can continue to do so without help or independently. Example: sustainable land use involves exploiting or using natural resources without destroying the ecological balance of a particular area

taproot a prominent and often bulky root that extends downward below the stem of some plants and fine lateral roots. The first root produced from a seed is called the radicle. In many dicotyledonous plants this root greatly enlarges to become the most prominent root of the plant and is known as a taproot. Many smaller branch roots may grow from the taproot

terrace a flat, fairly narrow level strip of ground, bounded by a vertical or steep slope and constructed on a hillside so that the land can be cultivated

transplant (transplanting) to remove a plant from the place where it is growing and replant it somewhere else

tree nursery a place where tree seedlings are planted before transplanting

waterlog (waterlogging) a condition that occurs when all or part of the soil is saturated with water. Some soils are effectively never waterlogged, while others are saturated all of the time







Notes

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Young African Express An exciting self-instructional, curriculum-based newspaper for upper primary pupils and teenagers across Africa that focuses on practical life skills including **environmental conservation, useful agriculture and agroforestry**, plus other essential topics such as **health, small business and human rights**. These issues are produced monthly by Jacaranda Designs Ltd in Nairobi, Kenya. To subscribe or to receive more information, please contact us: email info@youngafricanexpress.net or fax +254 (0)20 374-9171 or tel +254 (0)20 374-6270/7.

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This booklet is based on the Agroforestry and Home Gardening sections of the *Young African Express*, approved by the Kenya Institute of Education



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