OUTREACH

MATERIALS ON CROPS AND GARDENING

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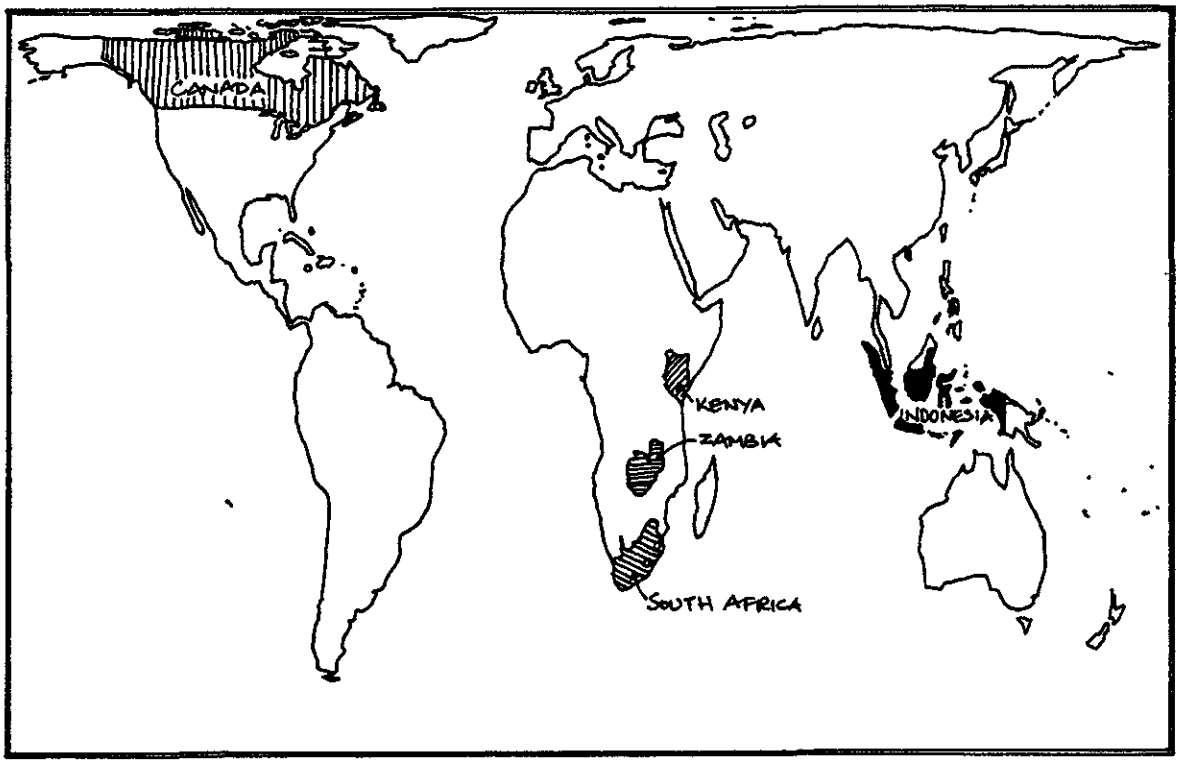
OUTREACH ISSUE NO.67: CONTENTS

[Reading level: I=children (8-10 years); II=children (11-13 years) and adults with basic literacy; III=teachers and/or people with secondary education]

LOCATION MAP

The map below shows the location of places mentioned in issue no.67.



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GROWING CROPS

One of the most important ways in which we use land is for growing **crops**. This is called **cultivation** (said: KULL-ti-vay-shon).

There are several types of crops. Food crops are grown for people to eat. These include grains such as rice, maize and wheat; pulses such as peas and beans; fruits and vegetables. Some crops are grown for beverages such as coffee, tea and cocoa. There are plants grown to add flavour to meals rather than as the main part of a diet. Herbs are cultivated for their medicinal value. Fibres are obtained from the stems or seed hairs of a number of plants, and turned into rope or yarn. Plants are also grown as a source of oil for use in cooking and cosmetics. Forage crops provide food for livestock. The single most important material obtained from plants is wood, which is used for building and for fuel.

In some countries, agriculture is an important source of income. In Kenya, for example, crops such as tea, coffee, rice and pyrethrum (kinds of chrysanthemums) are exported to earn money for the country (foreign exchange). Crops grown for sale in towns and city markets or for export are called **cash crops**. **Subsistence crops** are grown by farmers to satisfy the needs of their own families, and are not produced for sale.

CLASS ACTIVITY

INTERVIEW A CROP

This activity is adapted from:
"Interview a tree", an activity from WE CARE, a Southern African Nature Foundation programme sponsored by TOTAL, South Africa.
The WE CARE programme aims to help teachers and youth leaders introduce conservation to their classes and groups. The programme comprises a 150-page pack of 50 activities, a teacher/youth leader handbook and a colourful poster. Permission to reproduce this activity is granted for bona fide educational purposes only, and may not, under any circumstances, be sold. If reproduced, please give credit to:
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In studying a crop, the recording of important facts such as size, colour, reproduction, farming requirements etc. can be made much more interesting by phrasing the questions to relate to the children's own lives and experiences eg. where are the parents of a little seedling's? Also make the information gathering process "active", with children acting out the roles of interviewer and subject, which can be a pineapple plant, a mango seed etc.

Objectives:
* To promote a deeper understanding of the purpose of research and how to phrase questions.
* To make research more fun and enjoyable.
* To gain a deeper understanding of the lifestyles of species other than people.

Activity:
1. This activity is for groups of two. With your partner, choose a food plant (or other crop) to interview.
2. One of you take the role of interviewer, the other will be the species.
3. Work out between you a series of interesting questions and answers which will best show the lifestyle of your chosen crop to the rest of your class or group.
4. Useful questions would include:
   a) Where do your ancestors come from?
   b) Do you have any relatives?
   c) Where are your parents?
   d) What nutrients do you need?
   e) What do you drink?
   f) What are you afraid of?
   g) What makes you feel good?
   h) Who do you like as neighbours?
   i) What do you like and dislike about people?
   j) What good do you do to the area around you?
   k) What do people like about you?
5. Now act this out for your class or group, and ask them to identify the subject.

CLASS ACTIVITY

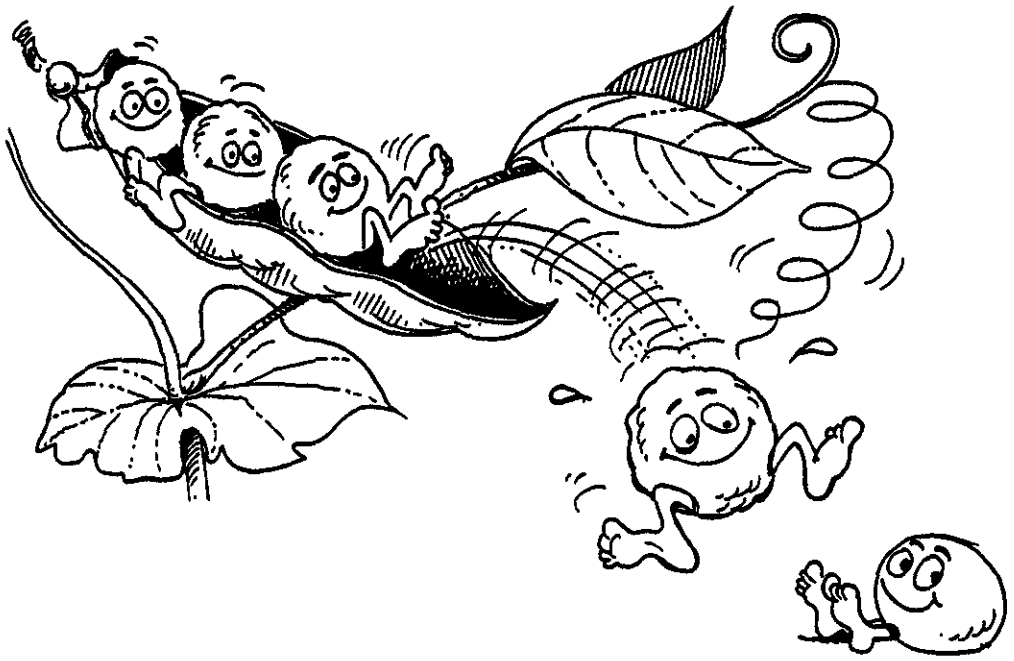
HOW DID THAT FOOD GET ON MY PLATE

This activity is adapted from:
"What's to eat?", an activity from WE CARE, a Southern African Nature Foundation programme sponsored by TOTAL, South Africa.
The WE CARE programme aims to help teachers and youth leaders introduce conservation to their classes and groups. The programme comprises a 150-page pack of 50 activities, a teacher/youth leader handbook and a colourful poster.

For further information contact: **SA Nature Foundation, P.O.Box 456, Stellenbosch, South Africa**

Do you know how the food you eat gets onto your plate? This class/youth groups activity will help you become aware of the origins of your meal.

1. The class/youth group should be divided into smaller groups.
2. Each group should choose an item of food: a vegetable, fruit, bread or drink, for example.
3. Group members should find out what happens to their chosen food/drink item before it arrives on/in the plate/glass.
4. Each member of the group should then act out a different part of the process of, for example, getting a handful of peas from the starting point of sowing the seed to spooning the peas onto the dinner plate.
5. Students outside the group should try to identify the food item, and the different roles played by the members of the group.
6. The class/youth group should discuss how important the natural environment is in getting the crops to the table.



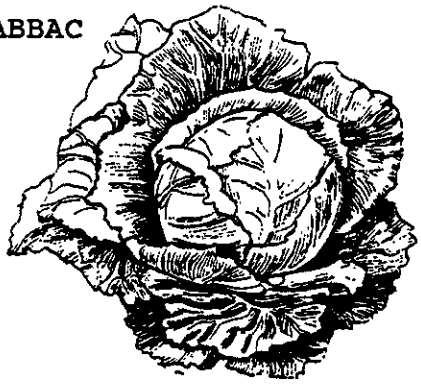
ACTIVITY

WHAT GROWS ON THE FARM?

Unscramble the letters to find the names of these food crops:

1. ROAK

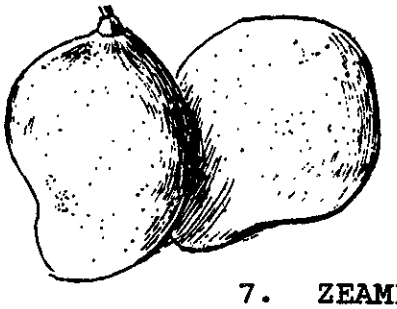
2. GEABBAC



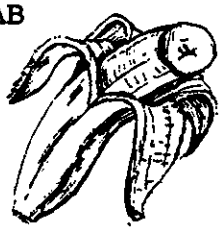
3. NESAB

4. TRACOR

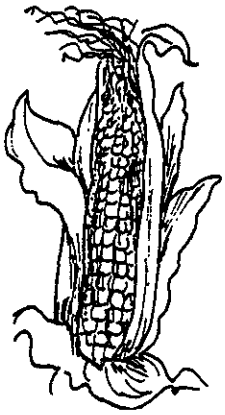
5. SENMAOG



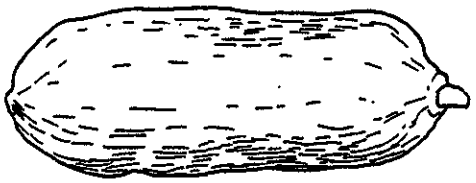
6. AANNAB



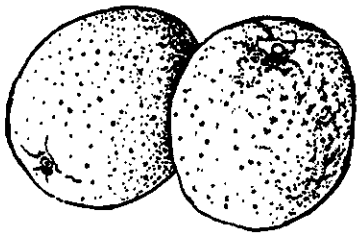
7. ZEAMI



8. MAY



9. SRONEGA



10. STEWE TOPOTA

(Answers: 1. okra; 2.cabbage; 3. beans; 4. carrots; 5. mangoes; 6. banana; 7. maize; 8. yam; 9. oranges; 10. sweet potato)

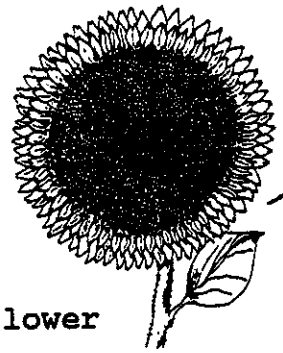
[NOTE: The crops above may be growing on small farms in Jamaica. This activity should be adapted to include locally-grown crops.]

ACTIVITY

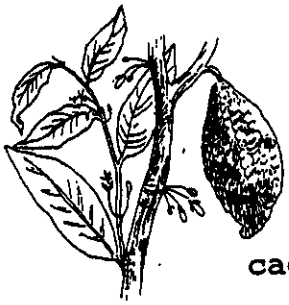
PLANTS AND THEIR PRODUCTS

Which plant is grown to produce which product? Follow the lines to find out:

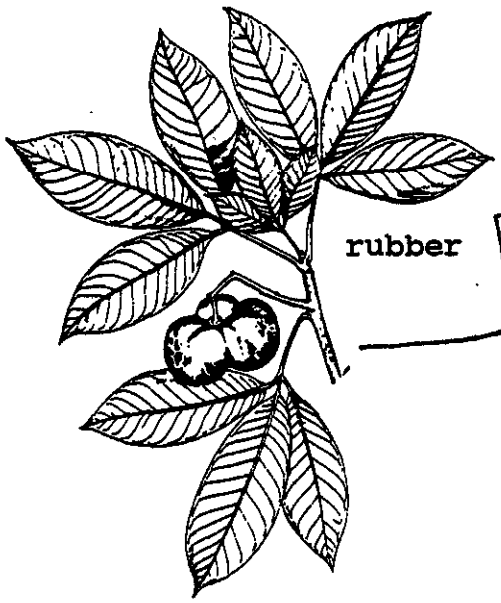
jute



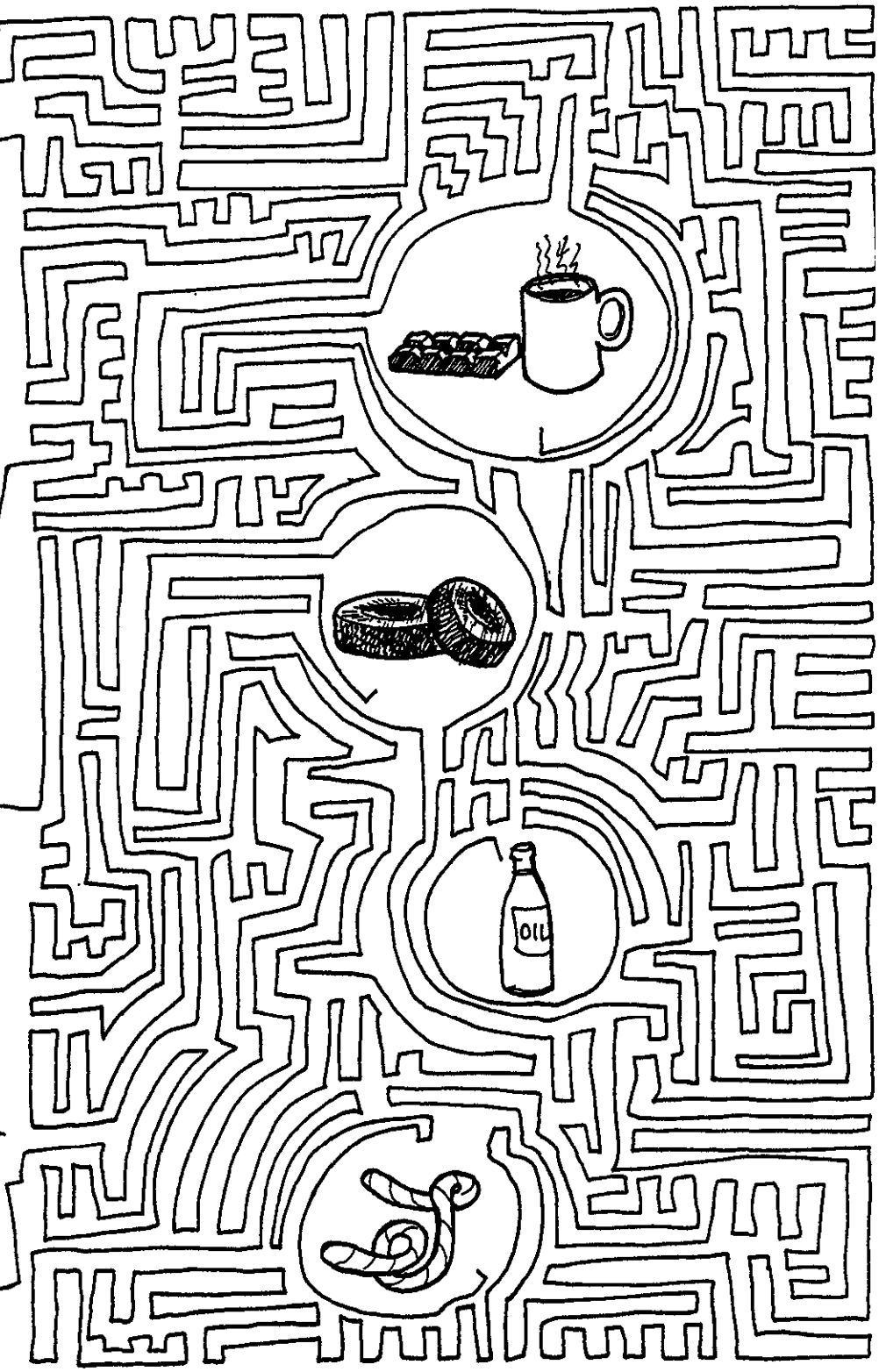
sunflower



cacao



rubber



(Answers: A4 - jute/rope; B3 - sunflower/oil; C1 - cacao/chocolate; D2 - rubber/tyres)

PARTS OF FLOWERING PLANTS

Flowering plants have roots, stems, leaves and flowers.

ROOTS

The roots grow underground and fix the plant firmly in the soil. The root system consists of a main root and thousands of delicate roots hairs. Water and nutrients from the soil are taken into the plant through the tiny tubes in the root hairs. The water and nutrients are needed for the plant to grow.

The roots also help the soil. They hold the soil particles together, and stop them from being blown or washed away.

Onions, garlic, carrots, beets are all portions of roots. Look closely at a carrot to see the small feeder roots that cling to it, (see Activity: Whose roots?). Root vegetables are often sweet, like young beets, or starchy. These and many other plants store food for their own use in enlarged portions of their roots. If you left a carrot in the garden, the plant would eventually use its stored sugars and starches to produce flowers and seeds.

STEM

The stem connects the roots to the leaves and flowers. Food-tubes and water-tubes run through the stem. Nutrients and water (absorbed by the roots) and sugars (produced by the leaves) can be transported through these tubes.

In most plants, the stem holds the plant upright and supports the leaves in such a way that they get plenty of light from the sun.

Celery and rhubarb are stems. The stringy portions of the celery stalk are part of the circulatory system of the plant, (see Activity: Transport routes in a celery stem).

LEAVES

Leaves are the food factories of a plant. They need carbon dioxide from the air and water and nutrients from the soil to make food for the plant.

The gas, carbon dioxide, is taken in from the air through tiny pores in the leaves called **stomata** (said: stoh-MA-tuh). These pores are mainly on the underside of the leaves. Water and nutrients are drawn up from the soil to the leaves as water evaporates from the leaves into the air. This loss of water by evaporation is known as **transpiration** (said: TRANS-pire-RAY-shon), (see Activity: Plants' water loss).

The green pigment, called **chlorophyll** (said: KLOR-oh-fill), that gives leaves their green colour, uses light from the sun to make food from carbon dioxide and water. As plant food is made, so oxygen is released into the air through the tiny pores in the leaves. This food-making process is called **photosynthesis** (said: fo-to-SIN-the-sis).

Much of the food made in the leaves is carried away to

other parts of the plant. Some goes to points of new growth where it is used in building the plant. Some goes into storage areas in the roots, stems and leaves. Stored food can be used later as a source of energy. Plants need energy to live and grow.

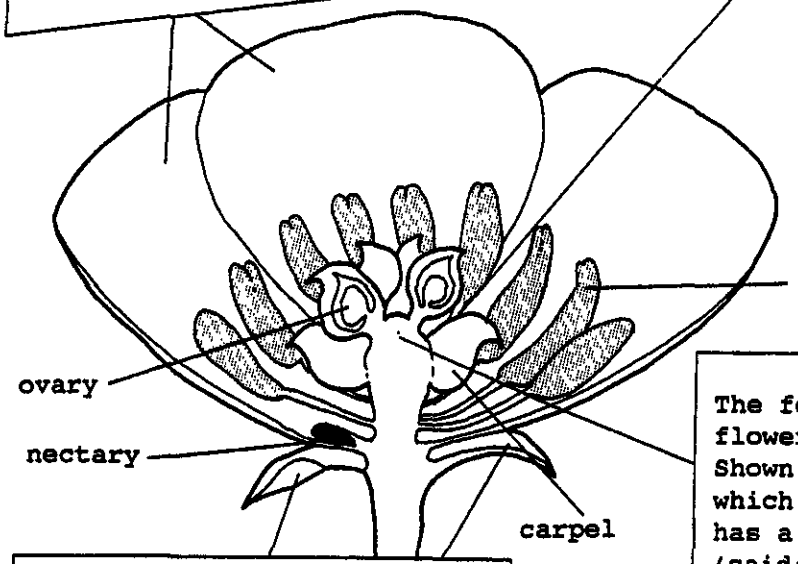
Spinach, cabbage and lettuce are leaves. Spinach is dark green because the plant grows in a cluster with nearly all its leaves exposed to the light. The outer leaves of cabbage are tough and much darker green than the inner leaves. The inner leaves have not yet opened to sunlight and, therefore, have not yet produced much chlorophyll.

FLOWERS

Plants that flower do so in order to make seeds which can grow into new plants. Here is a diagram of a flower cut in half to show the inside. This flower has four parts:

Petals (said: PEH-tullz) are usually colourful. Some petals protect the flower parts from the weather, but others are large and open to attract insects.

Flowers can have male or female parts or both. This flower has both. **Stamens** (said: STAY-menz) hold the grains of pollen which contain the male cells. The pollen is stored in pollen sacs in the bulge at the end of each stamen. Pollen is exposed when this bulge - called an anther (said: AN-ther) - ripens and splits.

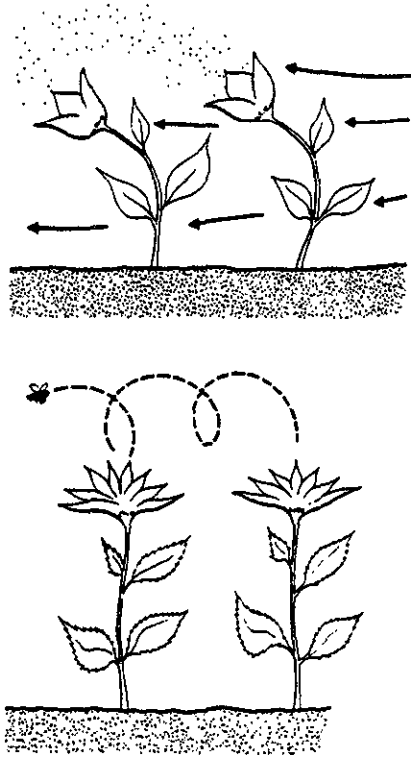


The female part of the flower of the flower is the **pistil** (said: PIS-till). Shown here are carpels (said: CAR-pullz) which together the pistil. Each carpel has a hollow in its base called an ovary (said:OH-va-ree). From the walls of this hollow grow tiny, round ovules which each contain one female cell. When the tip of the carpel - the stigma (said: STIG-ma) - is ripe, it is ready to receive and nourish grains of pollen.

Underneath the petals is a ring of **sepals** (said: SEE-pullz) which look like small leaves. These protect the flower when it is in bud, before it is opened.

For seeds to form, a male cell must combine with a female egg-cell. For this to happen, pollen grains must be carried to the tip of the carpel. This process is called **pollination** (said: POL-in-AY-shon).

Cross-pollination occurs when pollen grains from one plant are carried to carpels on another plant of the same type. Sometimes pollen grains are carried by wind. Some flowers are pollinated by bats, birds, or insects such as butterflies and bees which move from flower to flower. A flower's bright colour or strong scent attracts these creatures. Some pollinators visit the flowers in search of the sugary nectar in the nectaries found at the base of the petals. They spread the pollen from flower to flower as they drink the sweet juice. Honey bees collect both pollen and nectar for food, spreading pollen as they move from flower to flower.



Pollination by wind and insects.

When pollen grains move from stamen to carpels in the same plant, this is called **self-pollination.** In some kinds of plants, self-pollination occurs either regularly or when cross-pollination has failed to take place.

When ripe, the tip of a carpel will nourish grains of pollen which stick to it. Each pollen grain then grows a long tube which pushes down until it reaches the ovary. Once there, the male cell travels down the tube, and joins the egg-cell. The egg-cell is now **fertilized** and forms a seed. Once the eggs are fertilized, the petals fall off the flower. They are not needed any more.

A fruit is a ripened ovary. It begins to develop as soon as pollination takes place. Some fruits are **fleshy fruits**, such a peach or a berry. Others are **dry fruits**, such as a burr or a pea pod. Botanists call any ripened ovary a fruit. Squash, eggplant and cucumbers, therefore, are as much fruits as are oranges.

Sometimes a single flower has only a single ovary containing only one seed, like a peach. Sometimes the flower has several ovaries, but they fuse together to produce one fruit containing many seeds, like a pumpkin. And sometimes the single flower has many ovaries that appear as a cluster, like a raspberry. Each ovary in a raspberry contains a single seed. Some of the foods we call nuts are ovaries - or are until the outside flesh is removed at harvesting. An almond, for example, was

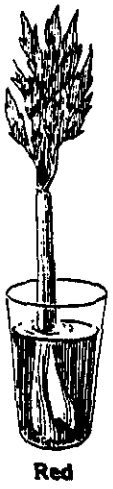
covered with a thick outer coating similar to, but not as tasty as, a peach. The kernel is the seed, which is similar to the seed inside a peach pit. A fruit may simply protect the seed during its development, but it may also serve to scatter seeds.

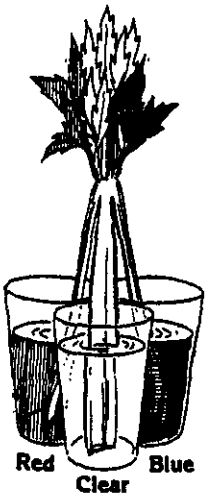
In some plants, such as tomatoes and okra, picking the flowers and fruits will encourage more flowers and fruits to grow. But in other plants, such as grasses or beans, the harvest will take place after a single flowering per season.

ACTIVITY

TRANSPORT ROUTES IN A CELERY STEM

For this experiment, you will need:
* some celery stalks with leaves turning yellow (You could also try this experiment with flowers that have white petals);
* three glasses of water;
* ink or food colouring (If these are not available, you may also use red cabbage water).





Put colouring, say red colouring, into one glass of water. Make a new cut across the bottom end of a celery stem, and place the stalk into the coloured water. Leave the glass in bright sunshine for a few hours, and watch for a change in the leaves. Cut a cross-section of the stalk to see that the celery "strings" are the connecting tissues.

Put a different colouring, say blue colouring, into another glass. Keep the third glass of water clear. Repeat the experiment above, but use one stalk of celery split three ways and straddling the three glasses of water. What do you see?

Explanation: The coloured water moves up the tiny stem tubes to the leaves, allowing the colour to be distributed throughout the cells in the leaves causing their colour to change. Minerals in the soil are carried to plant cells in this way, providing nutrients to flowers and leaves. The minerals dissolve in water, as did the colouring, and the solution is carried up to the leaves and flowers where the dissolved material is left, as was the colouring.

ACTIVITY

WHICH ROOTS?

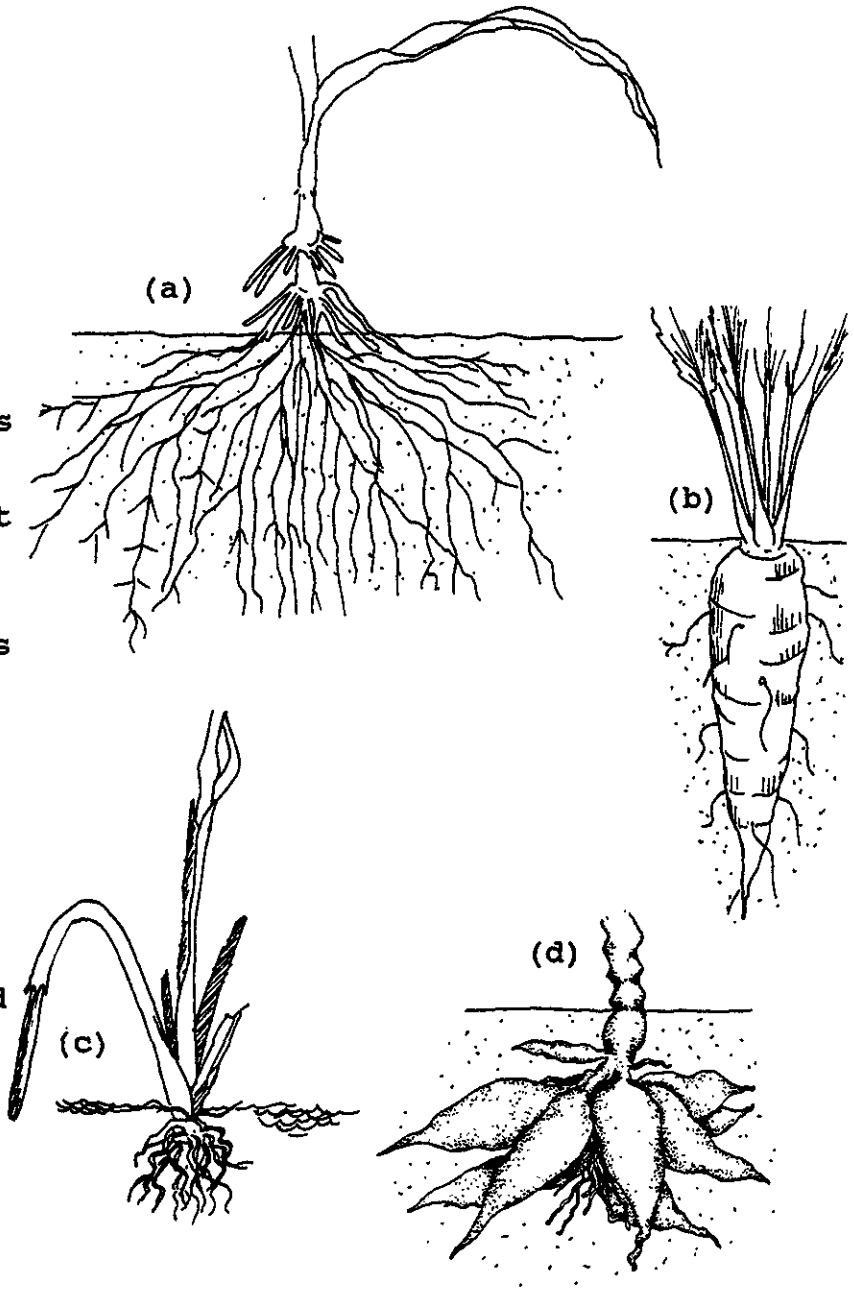
Below are some descriptions of plants and their roots. Match these texts with the drawings of roots:

1. A CARROT has one main, thick root called a tap root. The tap root has smaller fibres growing from the sides. Tap roots store food for the plant.

2. RICE and other cereal crops have small, fibrous roots which grow from the lower end of the stem, and spread out in the soil.

3. The CASSAVA plant has swellings on its roots because they store plant food.

4. MAIZE has adventitious roots. These roots grow from the stem above the ground. They help the stem keep upright and find still more water and nutrients from the soil.



(Answer: 1b; 2c; 3d; 4a)

QUESTION: Why should farmers know the root systems of their crops?

ANSWER: Crops with different root systems use different layers of soil. Farmers should take this into account when they plant different crops near each other. Plant neighbours should have different root systems so that they do not disturb each other.

ACTIVITY

PLANT PARTS: A MATCHING GAME

Edible parts of plants are called fruit and vegetables. They represent all the major plant parts: root, stem, buds, leaves, flowers, ovaries and seeds. Can you match these fruit and vegetables with the part of the plant they represent:

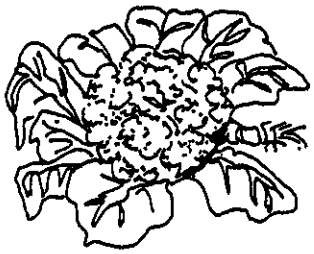
1. spinach

2. lemons

3. celery

4. carrots

5. cauliflower



6. peas

a. stem

b. leaf

c. seed

d. flower bud

e. fruit

f. root

(Answer: 1b; 2e; 3a; 4f; 5d; 6c)

[NOTE: Substitute the fruits and vegetables in the above exercise with local food crops.]

ACTIVITY

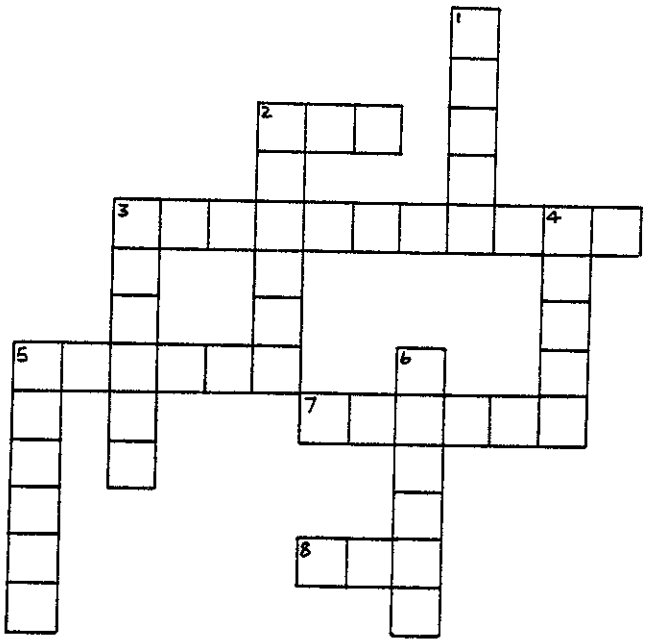
PLANT PARTS CROSSWORD

Clues Across

2,8 A ___ ___ is an example of a dry fruit. (3,3 letters)
3. The arrival of pollen on the pistil is called _____. (11 letters)
5. The male part of the flower. (6 letters)
7. _____ fruits such as berries or peaches are good to eat. (6 letters)
8. (see 2 across)

Clues Down

1. A _____ is a ripened ovary of a flower. (5 letters)
2. _____ is yellow dust that contains the male cell or sperm. (6 letters)
3. The _____ are bright, showy parts that make flowers attractive to look at. (6 letters)
4. The _____ is the part of the pistil in which the eggs are formed. (5 letters)
5. _____ cover the flower bud before it opens. (6 letters)
6. _____ is the sweet juice that bees like to drink. (6 letters)



Answers:-
Across: 3. pollination; 5. stamen; 7. fleshy; 8 & 2. pea pod.
Down: 1. fruit; 2. pollen; 3. petals; 4. ovary; 5. sepals; 6. nectar.

CLASS ACTIVITY

PLANT PARTS QUIZ

Make up cards with questions about plant parts. Divide the class into two teams. The team that answers the most questions correctly is the winner. Here are some possible questions:

1. Name four parts of a plant.
   (stem, root, leaf, flower)

2. Name three plants whose leaves we eat.
   (lettuce, spinach, cabbage)

3. Name two plants whose roots we eat.
   (carrot, cassava)

4. Name three plants whose fruits we eat.
   (tomato, pepper, eggplant)

5. Name the male part of a flower.
   (stamen)

6. Name the female part of the flower.
   (pistil)

7. Name two ways pollen is carried from one flower to another.
   (by wind and by animals)

8. What part of the plant develops into a fruit?
   (ovary)

PLANT LIFE SPANS

Plants can live for one year, two years or for many years.

Annual (said: ANN-you-ull) plants die at the end of one growing season, or after having produced enough seeds to make sure there will be a new generation of similar plants next season. For this reason, annuals will put all their energy into producing flowers and fruits. Their flowers are usually sweet-scented and brightly-coloured. Why do you think this is so? (To assure pollination in one season.) The seeds of most annuals must be collected and stored in a dry place until the next planting season.

Plants which live for two years are called **biennials** (said: by-EN-ee-ullz). They spend the growing season in the first year building up a store of food in their roots, stem or leaves. These food stores survive the cold or dry season, unless you eat them, and the food is used to

produce flowers, seeds and fruits the following year. The plants then die.

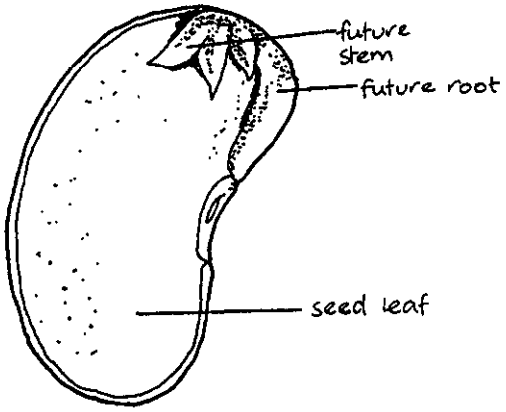
Many flowering plants live for many years. They are called **perennials** (said: per-EN-ee-ullz). Perennial plants have root systems that stay alive in the ground year after year. In cold climates and in the tropics, the shoots of some **herbaceous** (said: her-BAY-shuss) (non-woody) perennials die back each year, and only their underground parts survive the cold or dry season. These parts contain food reserves which support the rapid growth and flowering of new shoots when conditions are favourable again. Most trees and shrubs are perennials, too. Their woody stems last from year to year.

SEEDS

Inside every seed's protective seed coat lies the beginnings - the **embryo** (said: EM-bree-oh) - of a new plant. A tiny shoot is present. So is a tiny root. These are joined to seed leaves called **cotyledons** (said: kot-i-LEE-donz) which store the food needed for the first stages of growth. Some plants such as grasses and other narrow-leaved plants have one seed leaf. Other flowering plants, such as beans, have two seed leaves.

Seeds will keep for years if stored in a dark, dry, cool place. Most seeds require water to break down the seed coat before the seed can sprout or **germinate** (said:JER-min-ate). For example, the bean seed germinates when the seed absorbs water, swells and bursts through its seed coat. Some seeds sprout only after being exposed to the extreme heat of a fire. Others must go through a cold period before they sprout.

Once the seed coat splits, more water can get in, and the young root begins to grow. When the root goes down into the soil, it can take up even more water. The shoot can develop. It grows up through the soil towards the light. The seed leaves do not look like the true leaves of the plant, but they enable the plant to grow until it can start producing its own food through **photosynthesis** (said: foe-toe-SIN-the-sis).



A bean seed cut in half. The embryo fills the entire space inside the seed coat. The bean stores food in its two enlarged seed leaves, one of which is shown here.

TEACHERS'/PARENTS' PAGE

STUDYING SEEDS

* These activities are taken from:
"School Garden Manual" by Marny Smith and June Plecan produced by Save the Children, 54 Wilton Road, Westport, Connecticut 06880, USA
This publication is a step-by-step handbook for teachers and other trainers interested in taking a first step towards agricultural development: producing healthy food.
If reproduced, please give credit to the publication, authors and publisher.

a) Seeds come in a variety of sizes, shapes and colours. Get the students to gather as many seeds as they can. Seeds can be found all around us - on trees and weeds, inside fruits and vegetables such as tomatoes, pumpkins, peppers, peaches and oranges.
To the collection, add items that are not seeds (eg. stones, leaves, petals etc.). Ask the students if everything in the pile is a seed. If not, what items are seeds? What makes a seed, a seed? The students may use a good hand lens to look closely at the seeds, to see their textures and designs. Look at the colours: they may be any colour of the rainbow. Use the seeds in seed crafts.

*b) Ask the students to list the types of seeds they commonly eat. In what form do they eat the seeds - whole, crushed, ground into flour? When did the students last eat a seed?

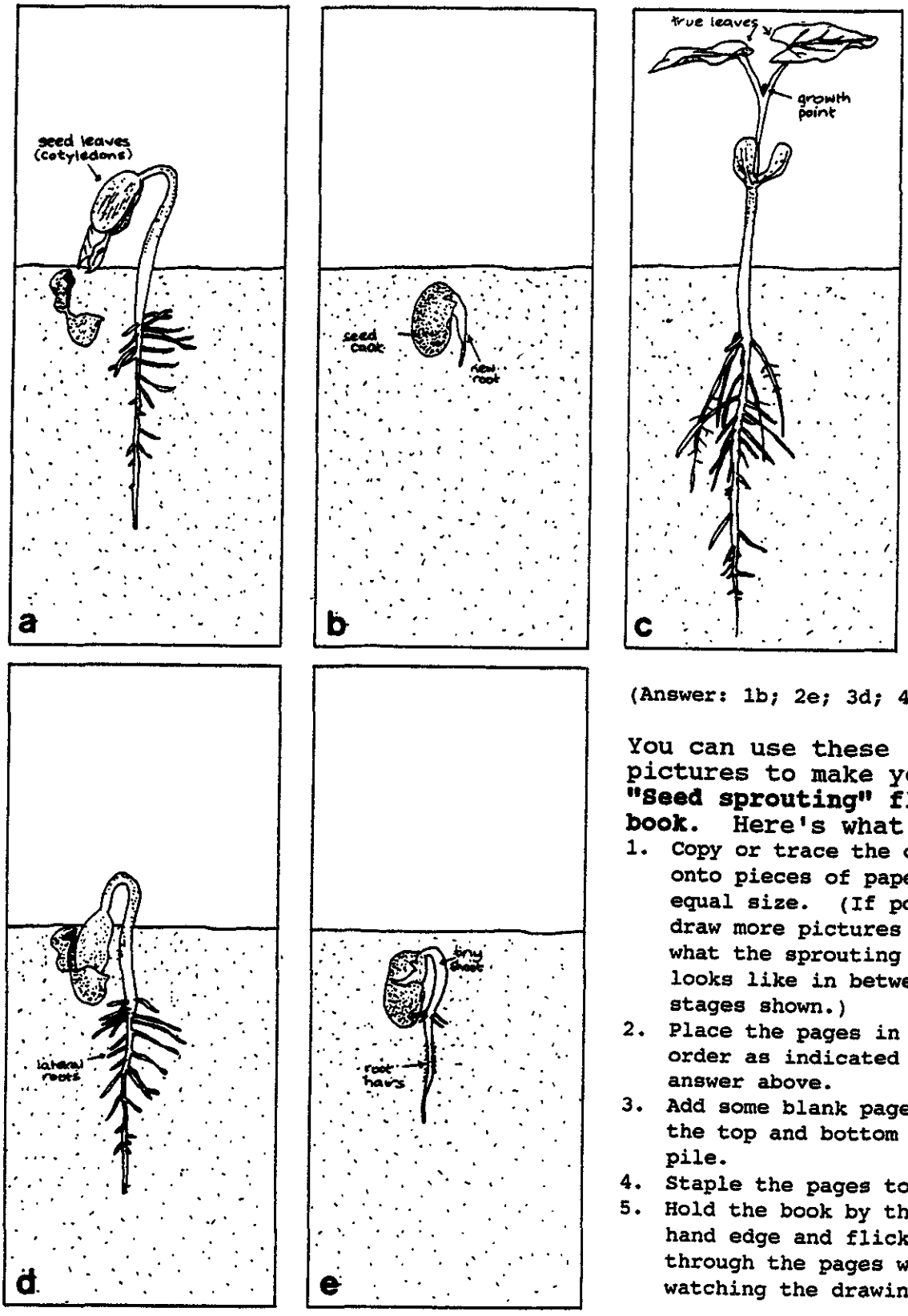
*c) Have the students cut open the fruit of a vegetable with many seeds (eg. tomato, pepper) and a sweet fruit (eg. watermelon, mango, peach). Have them count the seeds in each fruit, and compare numbers. Ask them why some plants produce many seeds. Is there a difference between a pit and a seed? (Answer: A pit is a seed with a very hard coat as in a peach, mango, plum olive).

d) Some seeds have wing-like pods or hairs so that the seeds may be carried by the wind to new growing places. Some seeds have hooks that catch on the fur of animals, and give the seeds free rides. Sometimes animals eat fruits, and the indigestible seeds inside are passed out unharmed in the animals' droppings. Certain plants have seeds in pods that explode when touched, sending the seeds far from the parent plant. Of the seeds that are dispersed by nature in these ways, only a small number take root and grow - one reason why each plant produces many seeds.
Have the students guess how the different seeds in the class collection are dispersed. Why must the seeds travel to new growing places? (Answer: If they were not dispersed, the seeds would grow in the shadow of the parent plant, and crowd each other out.)

ACTIVITY

A SPROUTING SEED MIX-UP

The pictures below show how a French bean seed germinates, but the sequence is mixed up. Put the pictures in the correct order.



(Answer: 1b; 2e; 3d; 4a; 5c)

You can use these pictures to make your own **"Seed sprouting" flip-book.** Here's what to do:

1. Copy or trace the drawings onto pieces of paper of equal size. (If possible, draw more pictures to show what the sprouting seed looks like in between the stages shown.)
2. Place the pages in the order as indicated in the answer above.
3. Add some blank pages to the top and bottom of the pile.
4. Staple the pages together.
5. Hold the book by the left hand edge and flick through the pages whilst watching the drawings.

ACTIVITY

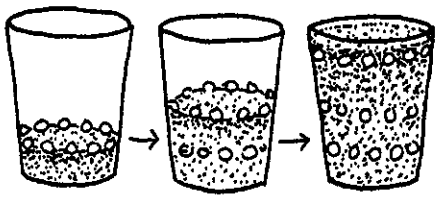
HOW DEEP TO PLANT SEEDS?

While some seeds require light for germination, most seeds will sprout in the dark. All they need is moisture, the right temperature and oxygen.

The amount of oxygen in the soil depends upon the structure of the soil and the amount of water in the soil. When water moves through the soil, it drives air out by filling in the air spaces between the soil particles. As water drains through, air carrying oxygen moves from the soil surface into the soil.

Does the amount of oxygen in the soil vary according to the depth of the soil? Does the amount of oxygen affect seed germination? Here is what you can do to find out:

For this experiment, you will need:
* a glass jar;
* potting soil;
* bean or pea seeds;
* water.



Fill a glass jar with 2.5 cm (about 1") of soil. Firm down the soil, and put a few seeds next to the glass on the inside. Use large seeds such as beans or peas to work with. Then put 2.5 cm (about 1") more soil in the glass, and firm it down. Plant a few more seeds next to the glass. Add another 2.5 cm (about 1") of soil, firm it down and place a few more seeds next to the glass. Cover these seeds very lightly with soil, see diagram above. Then moisten the soil in the glass, but do not add too much. Pour off any excess water. Place the glass in a warm, dark place. Look at the seeds each day, and record their progress.

After a few days, check to see which layer of seeds sprouted best. Be sure that you keep the soil moist during your experiment, but not too wet. If you make the soil too wet, your seeds may not sprout at all. Seeds usually germinate poorly, and most plants grow poorly in wet soils. This is due mainly to the lack of air and oxygen in the soil.

Explanation: Seeds must not be planted too deep, because they require oxygen to germinate, and the deeper the soil, the less oxygen is available. Another important reason for not planting seeds too deep is that the seed contains only a limited store of food: this food supply must be able to nourish the plant until the stem reaches the soil surface and leaves can start producing food of their own. If the seed is planted too deep, the stem might not reach the soil surface. A good "rule of thumb" is to plant at a depth of five times the size of the seed.

ACTIVITY

WARM AND COLD SEASON CROPS

Some crops need warm soil for their seeds to germinate and grow. These are called warm season crops. Seeds that can be sown in cold or cool soil, and grow best in cool weather are called cold season crops. Look at the table below.

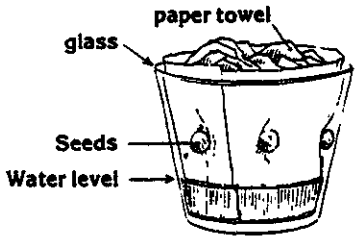
CROP	MINIMUM TEMP. F.	OPTIMUM TEMP. F.	MAXIMUM TEMP. F.
Bean	60	80	95
Beet, cabbage, carrot, cauliflower, radish, turnip	40	85	95
Corn	50	95	105
Cucumbers, eggplant, melons, okra, pepper, pumpkins, squash	60	90	100
Lettuce, onion, parsley, peas, spinach	35	75	85
Soybeans	40	50-86	95
Tomato	50	85	95
Wheat	35	60	104

Which crops would you say are warm season crops? (possible answers: beans, corn, eggplant, squash) Which do you think are cold season crops? (possible answers: cabbage, lettuce, peas) Test your answers by carrying out the following experiment.

You will need two seed view glasses, see box below:

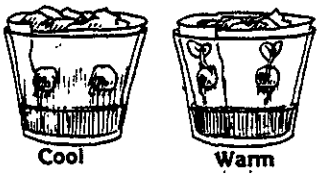
How to make a seed view glass

1. Line a glass or jar with 2 or 3 thicknesses of paper towelling.
2. Put 2.5 cm (about 1") of water in the bottom of the glass, and watch the paper soak up the water.
3. Then, place the seeds between the moist paper and the glass.
4. To make sure the paper towel stays firmly against the glass, stuff crumpled, wet paper towels into the centre of the glass.



Place the same type of seeds in each glass. Make sure each glass contains a mixture of cold weather and warm weather vegetable seeds. Place one glass in the refrigerator, and keep the other at room temperature. Check the seeds' progress each day. Keep a record of your observations. Keep the bottom of each glass covered with water.

Do all the seeds sprout at the same time? Do seeds sprout sooner in the room (warmer place) or in the refrigerator (cooler place)? From the results, decide which crops are warm season and which are cold season crops.



RADIO SCRIPT

HOW GOOD ARE THE SEEDS YOU'RE GOING TO PLANT?

The transcript below is reprinted from:
Developing Countries Farm Radio Network Package 15

DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
For further information, contact:
The Developing Countries Farm Radio Network,
595 Bay Street, 9th Floor, Toronto, Ontario M5G 2C3 CANADA

Content: A major cause of crop failure in grain or vegetable crops is poor germination of the seeds from which the crop was grown. Thus it is important that farmers first test the germination of their seeds and plant them accordingly. Details are given for a simple, practical way of checking the germination percentage of a lot of seeds before planting. (This item was originally produced as Item 1 in Package 4)

Length: 800 words; 5 minutes, 20 seconds (approx.)

The Item: Did you ever stop to think about how good or bad the seeds are that you're going to plant? If they're not too good, you should plant more. I'm thinking especially about grain seeds, but what I'm going to tell you would also apply to vegetable seeds, only in much smaller quantities.

Now you know that seeds you plant today were probably growing on living plants less than a year ago. Since then they've been harvested, maybe threshed, and then stored until now. Whether they are good seeds or poor seeds can depend on what happened to them during that period of time. If they were properly harvested, dried and stored, they are probably good for planting; --- but you can't know for sure just by looking at them. Because of this, a few days before planting, it's well worthwhile to check on just how good they are.

What you really need to know is how many of the seeds that you will be planting are likely to grow. If, for instance, only half of them will grow, like 50 out of 100 seeds or 50 percent of them, you should plant twice as many seeds as you would if they all were good. If you don't plant more, the number of plants that grow in your field or garden will be pretty sparse. How can you find out what you need to know?

Robert Cowell, has some ideas. He was an information officer who first was at the Asian Vegetable Research and Development Center in Taiwan, and later at the International Rice Research Institute in the Philippines.

The first thing he suggested was that a week or so before you expect to be planting your seeds, you should test some of your seeds to see just how many will sprout or germinate. To do this, you'll have to make up a composite sample of that seed. That means that from several places in the bag, pot, basket, or whatever your seed is in, you should take a very small handful of seeds --- This way you'll take a bit from the top, and put it in a bowl or something that will hold your composite sample. Then you can take a small amount from each side and also from part way down in the middle. --- After all these very small handfuls are in the bowl, mix them together thoroughly. This way, you are sure to have a sample of the same general quality as the larger amount of seed you will be planting.

You will then do a germination test on one hundred seeds picked at random out of this composite sample: ---You want to find out how many of those hundred seeds (that is, what percentage of them) are good and will grow.

Robert Cowell suggests that you take a piece of cloth approximately 30 centimetres (1 foot) square, flatten it out on the table, wet it, and then place, on that cloth, a hundred seeds. -- You're going to have, on the cloth, 10 rows of 10 seeds, each approximately 2 1/2 centimetres (1 inch) apart.

As soon as you get all the seeds out, lay a small strip of bamboo along one edge of the cloth and, just roll up the cloth on the bamboo stick. When you get it all rolled up, tie a piece of string around it and put on a tag. Write on the tag the kind of seed you're using and what day you made the test. For the next few days, keep this cloth moist. Now that's very important, -- Robert Cowell said to keep the cloth moist -- not sopping wet.

Whatever you do, don't let it dry out.

You should keep it for about five days.

At the end of this time, put the rolled-up cloth on a flat place and carefully unroll it.

Then what?

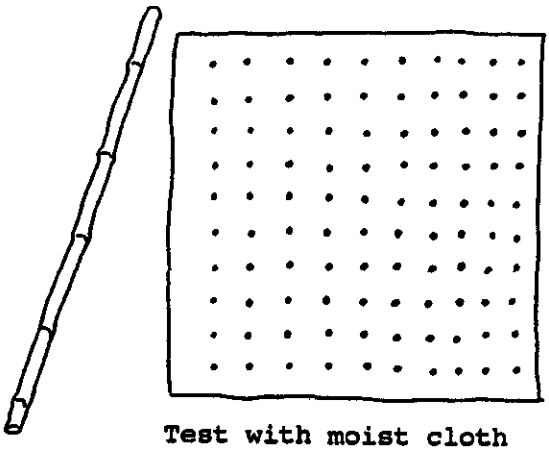
You'll see that, on the seeds that have sprouted or germinated, a very small root has grown out from the seed. You then count the number of seeds that have germinated. --- That number will give you the percentage of germination in your seeds.

If 50 of your seeds have sprouted, then you have 50 percent germination. This means that only half of your seeds are good enough to grow, so you'll need to plant twice as many of the seeds than you would if they were all good. Thus, if you should be planting 100 kilograms of these seeds on you land, you'll actually need to plant 200 kilograms of seeds in order to get enough plants growing to give you a good crop.

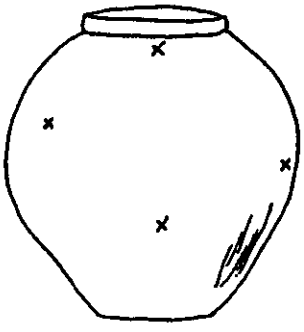
I think you'll agree with me that it's well worth taking the time to make this simple germination test. It could make the difference between growing a good crop this season or having a poor crop and thus less food for your family or to sell.

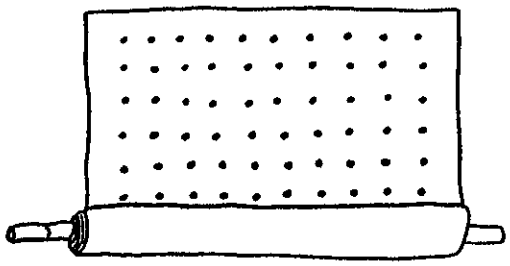
SEED GERMINATION TEST

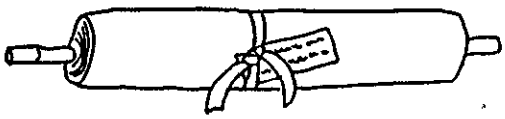
Composite sample made up of small handfuls of seeds from several places (marked X).



Test with moist cloth rolled on a stick.







RADIO SCRIPT

BETTER CARROTS FROM YOUR OWN SEED

The radio transcript below is reprinted from:
Developing Countries Farm Radio Network Package 13
The original source of the material is:
Cara Menghasilkan bibit wortel yang lebik baik by Fr. Agatho Elsener of Bina Sarara Bhakti Foundation in Indonesia.

DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
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The Developing Countries Farm Radio Network,
595 Bay Street, 9th Floor, Toronto, Ontario M5G 2C3 CANADA

Presenter: Glenn Powell

POWELL Our subject today is carrots, and I'm going to tell you how you can save money by growing your own really good carrot seeds.

Now if you've tried producing carrot seeds before, you may have noticed that the crop of carrots that grew from your own seeds was not quite as good as the crop of carrots that those seeds came from.

In a moment, I'll tell you why this happened. But first, let's think about other kinds of vegetables that grow above the ground, -- like tomatoes, squash, eggplants and others like that. When you keep seeds from them for planting next season, the seeds you keep are probably seeds from the biggest and best of those vegetables. --- Of course, selecting your seeds in this way is a very good thing to do. -- By always planting seeds that came from only the best of these vegetables you should get vegetables that are just as good, if not better, every time you do this.

All right, so what about carrots that you grow from your own seed? First of all, this is quite a different kind of vegetable. The part you eat is actually the root of the plant, and that, of course, isn't where the seeds are. Let's think then, for a moment, about how it is that you get carrot seeds if you save your own seeds.

Well, you probably get them from carrot plants that you don't pull or dig up. You usually leave a few of them growing in your garden and let them go to seed -- then you take the seeds from those plants.

Of course you can do it that way, but if you do, did you ever stop to think that you have not seen the actual carrots that your new seeds came from. The carrot roots that produced those seeds were down in the ground where you couldn't see them! Indeed, those seeds could have come from carrot roots that were not good-sized, plump, healthy roots at all; -- and if that's the kind of root they grew from, that's the kind of carrots those seeds will produce.

Because of this, you must look at the roots. --- Then only keep seeds for next season that grow from good strong healthy roots like the carrots you want to grow.

"But" you may say, "how can I tell what the carrots are like when they're down there under ground?"

Well, Father Agatho Elsener, in Indonesia, tells me that farmers in his part of the country have a good way of doing it. Here's what one of them told him.

INDONESIAN FARMER The method is really very simple. At the time I normally harvest carrots, I pick out plants that look good and strong. I dig them up, roots, stems, leaves and all, and select from them only a few plants that have good stout roots with blunt tips. I don't cut off the tops of those carrots, I just put them in a dry shady place out of the direct sunlight where they can't get wet if it rains.

After about three days, I prepare a good fertile place in the garden, -- then I plant them back in the ground, just like they were before I dug them up.

POWELL Father Agatho then asked her - "Won't they die after being out of the ground like that for three days?"

INDONESIAN FARMER No, -- actually the plants will grow very well, in fact, by doing this, the plants will now produce flowers and seeds more quickly than they would have if I had just left them growing naturally in the ground.

POWELL "But," said Father Agatho, "what happens then before you are able to harvest the seeds?"

INDONESIAN FARMER Of course, white flowers will grow on the carrot plants, -- and after that, the heads will finally turn brown or even blackish. Then all you have to do is pick the good ones and let them dry out completely in a good safe place. They will contain the seeds you will plant for your next good crop of carrots.

POWELL Father Agatho Elsener who sent us that information from Indonesia said that he himself has also tried out that method a number of times. He said that, like the farmers who told him about it, he had "far better results" than when he left a few carrot plants growing in the garden and took the seeds from them.

Why don't you try growing carrot seeds this way. If you do, you won't have to keep on buying new seeds season after season, -- and that will save you money!

Indeed, you might try growing some extra seeds this way to sell in your local market. -- Doing that, you might even make some extra money!

ACTIVITY

MAKING SOYBEAN* SPROUTS

The following information is reprinted from:
World Neighbors in Action **Vol.9, No.3 "Soybeans - The Meat That Grows On Plants" published by World Neighbors.**

World Neighbors is a non-governmental, non-sectarian, worldwide people-to-people movement building understanding through cooperative self-help projects in newly developing nations. For more information, contact:
World Neighbors International Headquarters,
5116 North Portland Avenue, Oklahoma City, OK 73112, U.S.A.

[* The spelling may be soya bean or soybean]

Soybean sprouts are good to eat either as part of a salad, or added to our cooked dishes of vegetables and grains. They are especially good for our families when we cannot get fruits and vegetables high in Vitamin C. Sprouts are very high in Vitamin C. Soybean sprouts are easy to grow if you follow these eight simple steps:

1. Select new seeds, not old ones.
2. Handpick the seed thoroughly, and discard everything except clean whole beans. We need one-half cup of clean beans.
3. Wash the beans in cool water and put them in a quart jar.
4. Fill the jar with clean, warm water. Let them stand a few hours until they are swollen.
5. Pour off the water and rinse the swollen beans in clean water. Pour off the last water.
6. Cover the top of the jar with a piece of cheesecloth, thin cloth or a piece of quarter-inch mesh screen. Tie the cloth or screen on the jar.
7. Place the jar in a dark place. The jar is in a tilted position with the opening facing down, as this allows the extra water to drain off.
8. Every four hours, we wash the beans carefully with cool water. The better the washing, the better the sprouts. The washing cleans away any mold or bacteria which may have developed. After washing, we place the jar of beans back in its tilted position in the dark.

The sprouts will be fully grown in four to six days, when they are approximately three to five centimeters in length. After we have washed free the loose hulls and poured off the excess water, the sprouts are ready to be used.

SAMPLE PROJECT WORK

OIL MAKING FROM CASTOR SEEDS

The following project work is reprinted from:
"Third World Science: Pupils' Projects from Zambia", published by the Third World Science Project (copyright TWSP 1980, 1983).
This publication is a collection of Third Form Science Projects from Lubushi Seminary, Kasama, Zambia as written and drawn up by the students themselves. The example shown below is a project undertaken by three Form III students - Kafwshi Claudius. C., Kachingwe Sicone Ellias., Chaongopa K. Martin.

The Third World Science Project was set up to collect examples of science in action in the Third World, and to produce resource packs and information sheets for use by interested science teachers in Britain.
For further information about the Project, write to:
Professor Iolo Wyn Williams, School of Education, University of North Wales, Lon Pobty, Bangor, Gwynedd LL57 1DZ WALES

NOTE TO TEACHERS: In the above publication, Father Louis Vielfaure, Head of the Science Department at Lubushi Seminary, writes:

> *"From my experience of many years in Africa, I have always been impressed by the way people were putting scientific principles into practice without any formal knowledge of science. I encouraged my students to study things done by their ancestors and still being done, and try to discover what scientific principle is involved in that particular operation e.g. iron smelting, beer brewing etc. I thought that with this approach, most students would benefit more from such simple projects and learn quite a lot themselves about their own customs and traditions. These projects may appear simple ... but they are the work of the students themselves."*

You might like to try a similar approach to student project work related to crops and local farming techniques.

Aim

We want to obtain oil, to see it, colour, thickness and how much fat it contains.

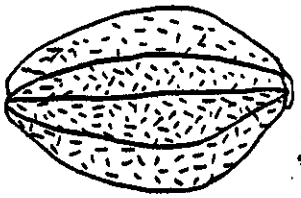
Introduction

Seeds are planted when they are planting groundnuts in early November. They last for at least 8 months for ripening time. When they are ripe the buds burst, showing the cases where the seeds are. The tree grows to a height of 3 metres (the tallest).

During the growing season (period) it is green in colour when the seeds are ripening they turn to a brown colour, and the leaves turn yellow as if withering.

There are two types of castor seeds; but they grow to the same height. The smaller ones called "Utuselelele" don't give out enough oil. The bigger ones called "Imono" give out a lot of oil. For both the extraction of oil is the same.

Usually seeds replant themsleves, that is: seeds which were dropped when collecting from the previous year do come into existence on their own.

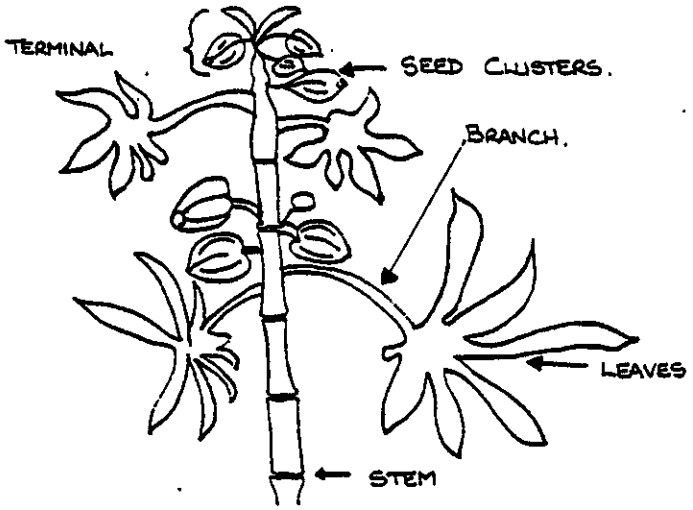

UNBURSTED SEED BUD.

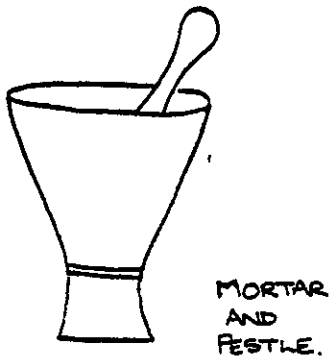

BURSTED SEED BUD.

Obtaining Oil

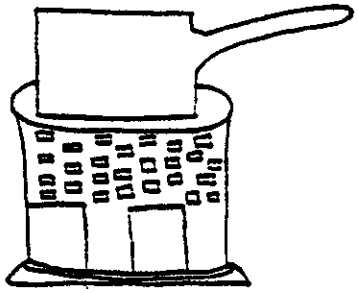
Materials needed: Castor seeds, a pan, a mortar and a pestle, water and a container to put in oil.

First the castor seeds are put in the sun to dry as they do to groundnuts. Then they are fried on a pan as they do to groundnut nuts. When cool they are put in a mortar to be pounded. It is pounded to butter.



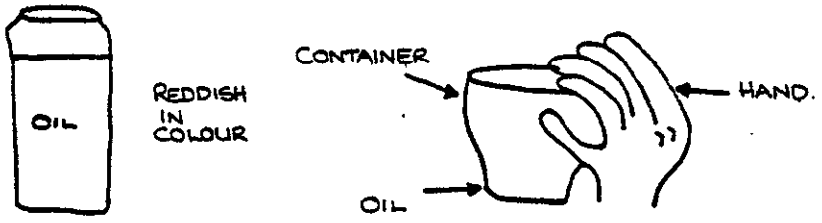

MORTAR AND PESTLE.

After it is pound, it is put in a pot with water. It is then put on fire to let it boil till its boiling point. Meanwhile we have to stir it, so as not to let it stick to the bottom of the pot.



Now we have to wait until all the water has evaporated, we then see the oil in a sort of bubbles. The oil is on top and water then the waste matters (amabiya) at the bottom. To take the oil we have to pour the oil, then when it is cool, water is added in. Now the remaining oil is removed or taken up by placing the hand on top, and the oil sticks to the hands. This process is

continued on until no oil can stick to your hands when you place on the oil. For the oil to last it is kept in a cool dry place.



Other Uses of the Seed and Oil

1) Oil

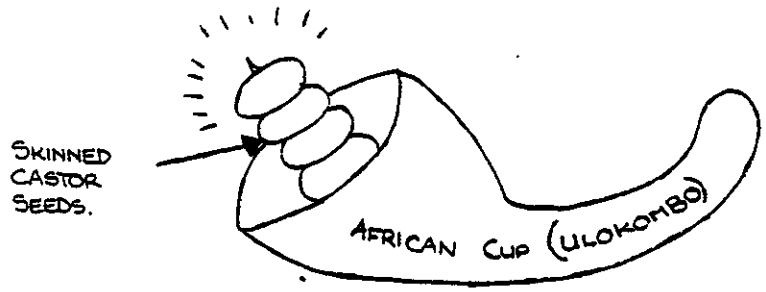
(a) It is used to rub on our bodies. It softens our skin, and it is good for our hair.

(b) It is used to fry e.g. dried bean leaves

(c) As medicine

2) Seeds

They are used to produce fire. They are prepared in this way. First the outskin is taken off, and the remaining white substance is put to a piece of grass (many are put to a grass). They put to it at least the length of 30 cm, we light the first one, and it will continue on till the last one. It gives good light as candles do.



Conclusion

Castor oil is very important in our life and to our bodies as we have seen above, in the explanation of the uses of oil and seeds. Mainly they were used in the past. To our result; we were successful in making the oil. Anyway this oil is coming to an end because of these modern oils, e.g: vaseline, glycerine etc .....

Bibliography

We got the information from our parents and elders, for we couldn't find them in books. Anyway it was difficult because we had to walk from house to house for information.

By - Kafwshi Claudius. C.
Kachingwe Sicone Ellias.
Chaongopa K. Martin.

WHAT PLANTS NEED TO GROW

If a plant could talk to you, it could tell you what it needs to grow well. The plant may say something like this:

> "I'm different from you boys and girls. I can't move around like you do. I have to put up with what's happening in the soil and air where I grow. And sometimes I suffer because of it!
>
> "If I'm thirsty, I have to wait for rain or a friend to water the soil so my roots can drink it.
>
> "If I don't get all the sunlight I need, I become weak or thin or try to grow to search for more light.
>
> ""If the weather is bad for my health, I can't move to a better climate.
>
> "If I'm not getting all the nutrients I need from the soil, I get sick."

Plants are complex in many ways, but their basic needs are very simple: sunlight, water, air, nutrients and space. Different types of plants need different amounts of these requirements to grow well.

The following text, which provides a summary of what plants need, is reprinted from: "School Garden Manual" by Marny Smith and June Plecan, published by Save the Children, 54 Wilton Road, Westport, Connecticut 06880, U.S.A. If reproduced, please credit source:

Every food plant needs at least six hours of sun to grow well, and produce flowers and fruits. Certain plants with delicate leaves must be partially shaded if there is too much sun, while others thrive in all-day sun.

Plants need nutrients to carry water through their systems. If deprived of water for a long period, a plant will become weakened and susceptible to disease or insect attacks, just as a hungry person will get sick more easily than someone with enough good food to eat. Many plants go through a mid-day wilt, during which they may look as if they are dying, but revive during the cooler evening hours. To reduce evaporation and give the plant the entire night to soak up water, it is best to water in the late afternoon.

If there is adequate water, sun and nutrients, a plant will start off well. Continued growth will depend on adequate space to meet the growth habits of the particular plant.

Each soil type will contain different nutrients in varying amounts. Most soil types will lack enough of the three main fertilizer elements - nitrogen, phosphorus and potash. However,

most of the nutrients required by plants can be furnished by enriching the soil before planting with composted materials.

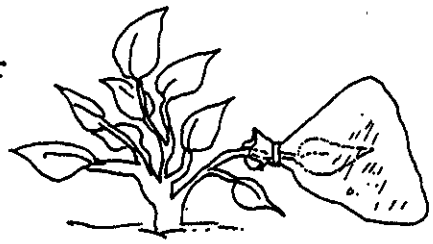
(For a detailed account of plants' requirements, see OUTREACH issue 9 page 7: "Questions and answers on plants and soil nutrients that plants need". These questions are divided into four sections: (1) photosynthesis: food-making by plants; (2) the carbon-dioxide/oxygen cycle; (3) energy for your cells; (4) soil nutrients that plants need.)

ACTIVITY

PLANTS' WATER LOSS

For this experiment, you need:
* a growing plant that is exposed to sun for two or three hours;
* a small plastic bag;
* tape or string.

Place the plastic bag over one leaf. Fix the bag securely to the stem with the tape or string. Leave the plant for two or three hours. Then, look to see what has happened in the bag. You should see are droplets of water inside the bag. The inside of the bag may appear cloudy due to the water in the air.



Explanation: This water has evaporated from the leaf into the air (and condensed in the bag). The loss of water through the stomata of the leaves is called transpiration. Evaporation of water cools the plant on hot days (just as sweating cools your body). Transpiration probably also pulls the stream of water and nutrients through the plant from its roots. Of all the water that moves from the stem to the leaves of a plant, about 90% is lost through transpiration.

ACTIVITY

WHEN THE LIGHT GOES OUT!

Here is an experiment that shows plants need sunlight. You will need:

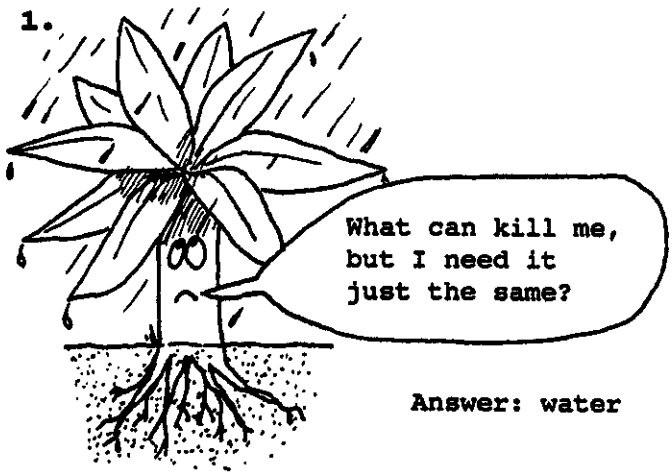
* a green plant;
* black paper;
* tape.

Cover a leaf on a growing plant with black paper. Fix the paper onto the leaf using tape. It is important that the leaf does not receive any sunlight. Wait 7 days. Uncover the leaf and see what has happened. The leaf is much paler than the other leaves on the plant.

Explanation: A green pigment called chlorophyll gives leaves their green colour. In the absence of sunlight, the green chemical is used up, and not replenished in the leaf. As a result, the leaf is a pale colour. Since chlorophyll is necessary for plant survival, the leaf will die without sunlight.

PLANT PERSPECTIVES

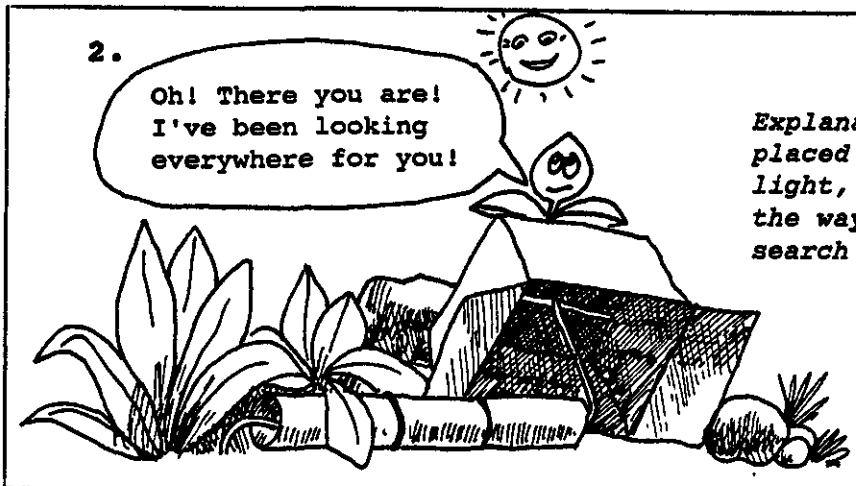
1.



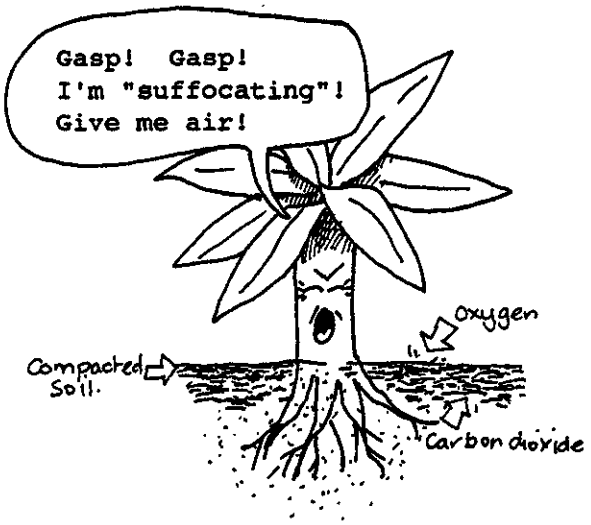
Answer: water

Explanation: A plant needs water to carry nutrients through roots, stems, leaves etc. and to help in the food-making process. But too much water in the soil drives out air, and shuts off the oxygen supply. This causes root damage or death. So, water well, but as infrequently as possible to allow air to enter the soil between waterings. Also, speed up drainage by adding organic matter to heavy soils.

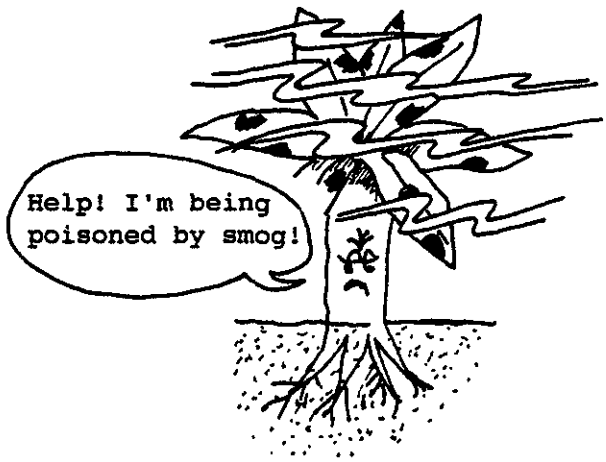
2.



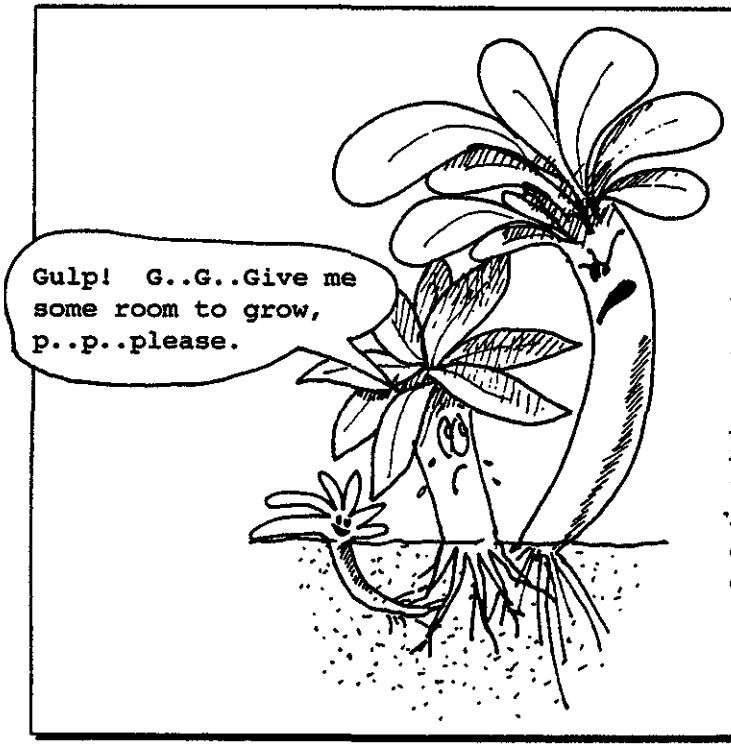
Explanation: Most plants, when placed where there's too little light, become weak and thin or alter the way they normally grow as they search for more light.



Explanation: There needs to be air circulation in the soil because oxygen must be able to flow into the roots, and gases, such as carbon dioxide, need to escape from the plant through the soil. Compacted soil prevents air flow, making it hard for plants to thrive. You can open the soil up by adding plenty of organic matter, and by cultivating around the plants.



Explanation: Many gases that pollute the air are poisonous to plants. These include sulphur dioxide, nitrogen dioxide, fluorides, chlorine and others.



Explanation: Plants compete with each other for available supplies of water, light, nutrients and the space in which to grow. Weeds in your garden will take water and nutrients that your crops need, and they will sometimes block out the sunlight, too. Also crops will compete with each other if planted close together.

ACTIVITY

HOW DOES YOUR GARDEN GROW?

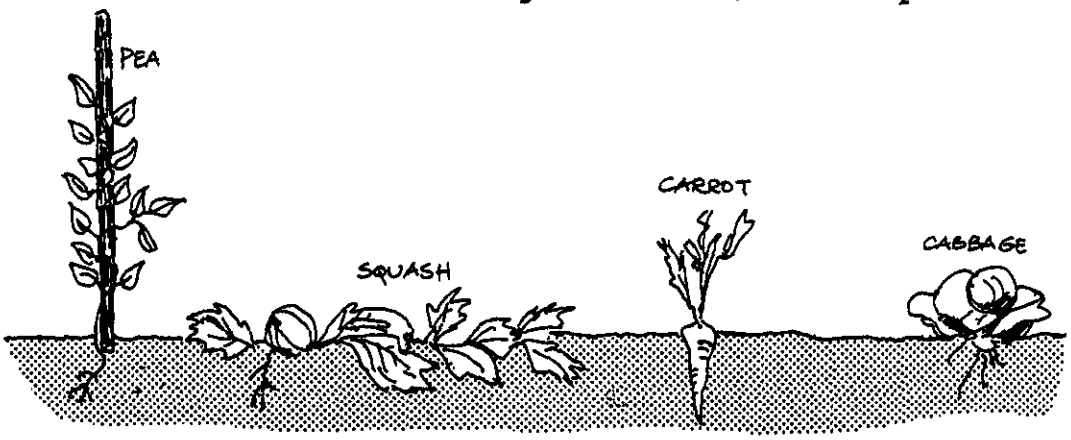
(i) The sentences below describe the way some plants grow. Match the word underlined in each sentence with a word that has the **opposite** meaning:

1. Some plants like growing in <u>sunny</u> places.
2. Some plants have <u>shallow</u> roots.
3. Some plants are <u>tall</u>.
4. There are <u>narrow</u> plants.
5. Some plants are <u>fast</u>-growing.
6. There are <u>spreading</u> plants.

(a) compact
(b) short
(c) slow
(d) shady
(e) wide
(f) deep

(Answer: 1d; 2f; 3b; 4e; 5c; 6a.)

(ii) Here are some garden plants. Under each picture, write a word that best describes the growth habit of the plant:



_____ _____ _____ _____

(Possible answers: pea - climbing; squash - spreading; carrot - narrow; cabbage - wide)

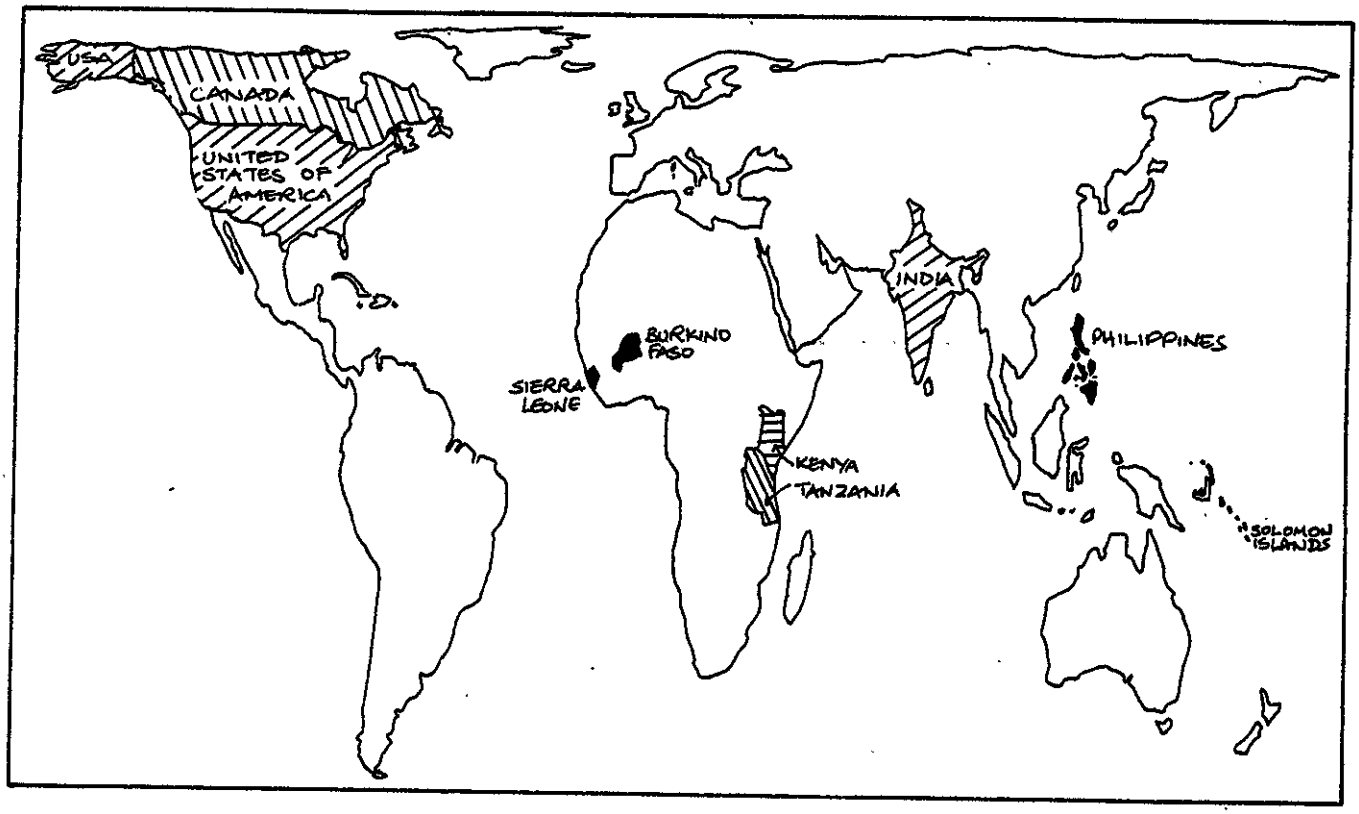
Look at the plants growing in your garden, and describe their growth habits. You can use the descriptive words above and add some of your own. It is important to know the growth habits of a plant when planning space for it in a garden.

OUTREACH ISSUE NO. 68: CONTENTS

[Reading level: I=children (8-10 years); II=children (11-13 years) and adults with basic literacy; III=teachers and/or people with secondary education]

LOCATION MAP

The map below shows the location of places mentioned in issue no.68.



ACKNOWLEDGEMENTS

OUTREACH would like to thank Marion van Schaik from Save the Children and Sharon Kahkonen for providing a wealth of information and ideas for these OUTREACH packs on "Crops". Thanks also go to Asian Cultural Centre for UNESCO, Centre for Environment Education (India), Developing Countries Farm Radio Network, Rodale Institute, Save the Children, South Pacific Commission, Deutsches Zentrum fur Entwicklungstechnologien (GATE) and other contributors to these information packs.

THE GARDEN ENVIRONMENT

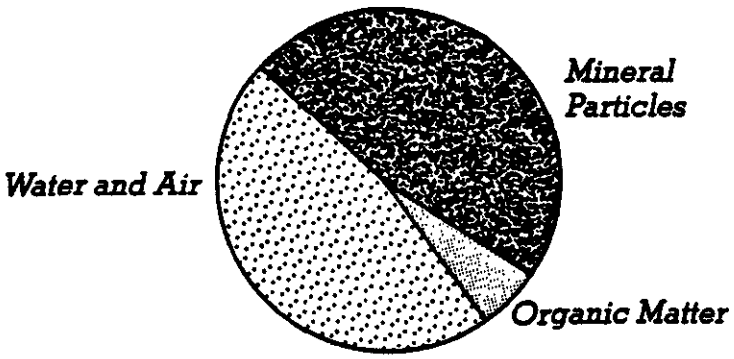
The sources for this article are:
School Garden Manual **by Marny Smith and June Plecan (published by Save the Children, 1989)**
2.84 Resources: Soil, **a wallchart produced by WWF-UK**
The Teaching of Rural Science in Tropical Primary Schools **by I.P.Shanks (Vol.II of UNESCO Handbooks published by Oxford University Press, 1967)**

Part 1: SOIL

Most plants grow in soil. So to understand how they grow, it is important to understand soil. *(For more information/activities on "Soil", see OUTREACH issues 21, 22 and 23.)*

(a) What's in a soil?

Soil is made up of tiny particles of rock, organic matter, water and air, see diagram. It is also the home of many small creatures and microscopic life such as bacteria.



Rock particles:

Weathering of rock by wind, water, the sun's heat and earth movements, breaks it into small rock particles. Rock particles vary in size from large gravel or sand grains to tiny clay particles. Sand grains are large enough to feel gritty when rubbed between the fingers. Silt particles are smaller than sand, and feel soft and velvety. Clay particles are so tiny they pack tightly together when squeezed and feel sticky when wet.

Organic matter:

Living and dead plant or animal material in varying stages of decomposition is called **humus** (said: HEW-mus). The decaying matter goes through many complicated changes until the substances of which it is made are separated out into simple chemicals which can be used as food for the plants. Humus particles are tiny, like clay, and so help the soil to hold moisture, too.

Water and Air:

Spaces between rock particles and bits of organic matter are filled with either water or air. Spaces left by draining water and burrowing creatures are filled by air. Air is needed to provide roots and other life in the soil with oxygen. Air pockets make it possible for plant roots to spread out in search of food.

Water seeps into air spaces during a rainfall. Dissolved in this water are soil chemicals which are derived from rock particles and humus. Among soil chemicals are nutrients that plants need for healthy growth. Soil water is

taken up by plant roots. When water soaks downwards through the soil, it often carries humus and dissolved chemicals out of reach of plant roots. Only water left clinging to soil particles remain available for future use by the plants.

(b) Soil types

Sandy soils, composed mostly of sand grains, pack together when wet, but the packed sand crumbles as it dries out. There are many air spaces around sand grains, and so water drains quickly through sandy soils, out of reach of plant roots. This rapid draining makes it hard for plants to grow in sandy soils. A sandy soil is easy to dig, and when mixed with other types of soil, helps to make the soil porous.

Clay soils are hard and compact when dry, and do not break up easily with ploughing. Clay becomes heavy when wet: it is difficult for water to seep through the clay because there is so little space between the clay particles. Clay soils are hard to dig in unless they have just the right amount of water. Plants have difficulty developing good roots systems in clay soils, even though particles hold many more plant nutrients than sand.

All soils are made up of a mixture of clay, sand and silt. A loam soil is made up of sand, clay, silt and organic matter. It has the good properties of both sand and clay soils. For example, it holds more water than sand alone, but is rich in nutrients, too. Loam soils are the best soils for growing food plants.

(c) Soil nutrients

Soils contain elements that become food for plants. The major elements for plant growth are nitrogen, phosphorus and potassium. There are 12 other nutrients that plants need, but only in tiny amounts. You cannot see nutrients in the soil, but you know they are present when you see plants growing well. Nutrients are made available to plants through the work of microscopic soil organisms.

(d) Life in the soil

Soil is teeming with life that is so tiny we cannot see it except under a powerful microscope. A teaspoon of soil may contain a billion of these life forms - fungi, bacteria, moulds. These soil organisms perform vital functions. They break down dead and decaying plants and animals into nutrient-rich chemical compounds that can be used again by living plants. Thus, there must be micro-organisms and organic matter in a soil in order for plants to grow well. Some bacteria also get or 'fix' nitrogen from the air in a form that plants can use to help them grow.

Not all soil creatures are invisible to the naked eye. Earthworms, insects and small animals such as spiders, mites, grubs, and centipedes live in soil, too. These animals feed on organic matter, converting it to humus - the final stage of plant decomposition. As soil creatures move about underground, they turn the soil and create air spaces as they go. This improves the soil for plant growth.

If you buy chemical fertilizers, and apply them to the land, this does not add organic matter to the soil. Rather it discourages activity by soil organisms, and reduces the soil's natural ability to fertilize and aerate itself.

(See "The Soil-makers" page 18, OUTREACH issue 21. This is a story for younger students that describes how different life forms contribute to the creation of soil.)

Part 2. GARDEN FRIENDS AND FOES

A garden is more than just a place where crops grow. It is also home to weeds and to many insects and other small creatures.

(a) Weeds

A weed is a plant growing where it is not wanted, a plant out of place. Most weeds are wild plants. The problem with weeds is that, just like other plants, they need water, light, nutrients and space to grow. And so they compete with crops. Because weeds grow only where conditions are just right, they thrive: they are tough and well-adapted.

It is best to pull weeds out of the ground, and add them to the compost pile. Weeds should be pulled up when they are small, and when the soil is moist and easy to work. In this way, the roots of nearby crops will not be disturbed. It is important to pull out *all* the weed roots. Otherwise, the plant will put out new growth, and remain a garden pest.

(b) Pests in the garden

Some insects and other small creatures that live in the garden do harm by eating plants. In particular, they will attack sick, weak, injured or poorly nourished plants. Many pests live only where a specific plant is located because that plant is their favourite food.

There are garden pests that can be seen with the naked eye, and others that can be seen only through a powerful microscope. For example, a variety of fungi, moulds, viruses and bacteria attack plants and cause disease.

(c) Beneficial creatures

But not all garden creatures cause damage. Some do gardeners a service by eating insect pests. These predators live near a specific plant where they are most likely to find their insect prey.

There are other creatures who are the gardener's friend. The earthworm, for example, builds the soil. Bees and butterflies pollinate the flowers.

No matter what its size and food preference, each animal has a role in the garden. So it is important that a gardener knows who lives in the garden, and understands which are his friends and foes. He should try to keep the "good" and the "bad" creatures in balance.

(d) Protecting crops

One of the best ways a gardener can protect crops from pests is by making sure

the crops are healthy. Here are some tips:

* Keep the soil well-fertilized with organic matter;
* Choose plants that are well-suited to the climate and soil conditions;
* Remove plants that are growing poorly, or have been damaged by a feeding insect or a misplaced foot.

Try the following methods to keep animal pests away from your crops:

* Insects like to hibernate in garden rubbish and in the top few inches of soil. So keep the garden clear of weeds and dead and decaying plant matter, and turn over the soil around plants from time to time.
* Rotate crops so that the eggs of insects will not find their host plants in the same place as the year before. This will also help stop diseases from building up in the soil.
* Insects often recognize their favourite food plant by its smell. You can confuse insects' sense of smell by mixing different species of plants in the garden. Strong-smelling herbs or flower plants are ideal for confusing insects which may well pass by its favourite plant.
* Creatures such as birds and toads help keep down the insect population. Find out which local birds are insect feeders, and encourage their presence in the garden.

(For more information/ activities on pests and pesticides, see OUTREACH issues 30, 31 and 32.)

ACTIVITY

HOW ORGANIC MATTER AFFECTS SOIL

For this experiment, you will need:

* 1 quart clay soil;
* 1 quart of sawdust;
* plates, or banana leaf;
* water

1. Moisten 1/2 cup of soil enough to form a mud pie. Put on a plate/leaf.
2. Make another mud pie by mixing 1/2 cup of soil, 1/4 cup of sawdust and water. Put on another plate/leaf.
3. Put both mud pies in the sun to dry, and see what happens. Which crumbles easier? Roots would grow easiest through which soil? How would adding organic matter improve a soil?

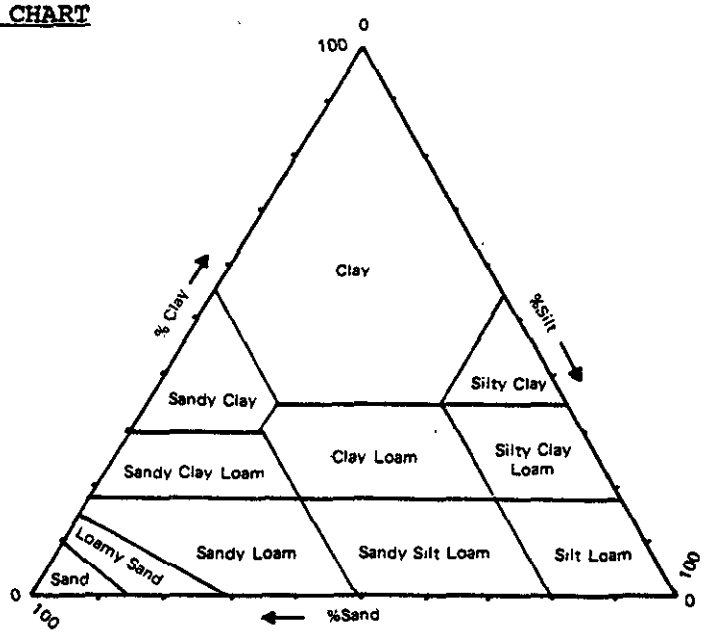
Explanation: Adding organic matter to soil improves its physical condition. The soil breaks apart more easily so that air and water can penetrate to the roots of plants. Roots can more easily grow through the soil, too.

ACTIVITY

SOIL TEXTURING BY HAND

For this experiment, you need:
* A soil texture chart (see below);
* a soil sample - a small, moist clod.

A SOIL TEXTURE CHART



1. Wet the sample until moisture glistens on the soil surface.
2. Rub the soil between your fingers, and feel how gritty, silky and sticky the soil is. Sand feels gritty and, when present in large amounts, makes a rasping sound when the particles are rubbed together. Silt feels silky and smooth. When soil is mostly silt, it has a feathery feel. Clay is sticky and plastic. The particles stick to each other as well as to the skin.
3. Rub the thumb over the moist soil and see if it leaves a smooth, polished surface. This happens when soil contains moderate amounts of clay (20% or more).
4. Try to form a cube from the soil. Soils with 5% or more of clay can form cubes.
5. Try rolling the soil into a thread or "snake". A sandy soil will not make any kind of snake. A snake can be made if the soil contains a fair amount of clay (15% or more).
6. Bend the snake into a ring. This is possible if clay is abundant (over 25%). The higher the clay content, the firmer the ring.
7. Soil contains a mixture of different sized particles. You can separate the soil sample into layers of different sized particles by mixing it with water and letting the particles settle. Crush the soil well, breaking apart all clods. Fill a quart jar 2/3 full of water and add a cup of soil. Put a

sample of the soil on a plate beside the jar. Shake the jar hard for 5 to 10 minutes. Then, leave the jar for 24 hours. After 24 hours, what has happened to the soil? Can you identify the different soil layers - sand, clay, silt that have been formed? Place a piece of cardboard beside the jar, and mark the layers. You can work out what proportions of these different particles make up the soil.

8. After trying all the above tests, use the soil texture chart to determine the soil type of your sample.
9. Try the above test with other soil samples, and compare results.

Handy tip

One way you can get used to the feel of the different soil types (as described in the soil texture chart) is by mixing different proportions of sand and flour together. (Flour has the same texture as clay.) Become familiar with the feel of soil that comprises, say, 1/2 sand and 1/2 flour; 1/4 sand and 3/4 flour; 3/4 sand and 1/4 flour. Compare the feel of these mixtures with different soil samples - sandy loam, loam, silt loam etc.

TEACHERS'/PARENTS' PAGE

WEED WORK

The sources for the following information on pest controls are:
***School Garden Manual* by Marny Smith & June Plecan (Save the Children, 1989)**
***The Teaching of Rural Science in Tropical Primary Schools* by I.P.Shanks (Vol.II of UNESCO Handbooks published by Oxford University Press, 1967)**

Here are some ways students can learn more about the weeds that grow in the garden:

1. Students can study the wide variety of weed plants. Use examples such as nut grass (a sedge); bracken (a fern); couch (a grass), and *Lantana* (a shrub).
2. Have students observe the rapid germination and quick establishment of weeds. Take samples of soil from the garden and search in them carefully for weed seeds, using a hand lens. Place some soil in a large square tin. Water for a few days until any seeds that it contains have germinated. Then, count the number of seedlings. After measuring the area of the soil surface of the tin, work out the number of weed seeds per square foot of garden.
3. Here is a way students can appreciate the speed with which weeds reach maturity. Carefully protect a herbaceous weed seedling (e.g. wild mustard), and record its rate of growth by measuring its height above the ground daily. How many days does it grow before seeds form?
4. Students can collect all the fruits of one particular weed plant, such as wild mustard again, and calculate the number of seeds produced each season.
5. Have students compare the different methods of seed dispersal found in weed plants common to the garden. Also observe the underground methods of self-propagation, such as the tiny tubers of *Oxalis*.

6. Students can discover the effect of weeds on crops in the following experiment. Mark out two equally-sized plots of a garden bed which will grow the same kinds of plants. In one area, weeds will be allowed to grow throughout the season, while the other area will be continuously weeded. Observe the results each week. In the area where weeds are allowed to grow, which plants grow best? Is there any one type of weed that really "takes over"? Is this weed easy to find outside the garden? Did any of the food plants survive? Why? Compare the growth rates of crops in both plots on a weekly basis. Compare the harvests from each area.
7. Students can make a compost of weeds, some dry material such as straw or leaves and a little soil. Moisten the pile and cover it. After two weeks, have the students open the pile, and see if they can find any traces of weeds. If they do recognize weeds, the students can mix the pile with sticks, re-moisten and cover again. The students can examine the pile two weeks later.

CONTROLLING INSECT PESTS

1. The students can bring toads into the garden, and keep them there by providing them with a cool, shady place to live, such as a small box, an over-turned flower pot or a small house made of twigs and plants. Toad homes should be in a quiet place in the garden.
2. Students can make a variety of strong-smelling concoctions to spray onto plants, and see which ones are most effective at deterring insect pests. Strong-smelling plant materials, such as garlic, hot peppers, onions, herbs or spices are good to use. Each one should be crushed and soaked separately in water. After the water has picked up the aroma or taste, spray the mixtures onto marked plants of the same variety. The students can observe which plant material provides the crop with the best protection. Combinations of plant materials in solution can also be tried.
3. Late in the day, have the students place an orange rind or some other hollow fruit or vegetable open side down on the path near a garden bed. Early the next morning, lift it up to find out if it has attracted slugs, earwigs, pill bugs etc.. Destroy unwanted insects.
4. Search the underside of crop leaves for insect eggs. Hand-pick them and place half the eggs in a ventilated box containing the same kinds of leaves, and the remaining eggs in a ventilated box containing different leaves. Observe what happens to the larvae when they hatch from the eggs. After the experiment, destroy unwanted insects and release the others.
5. When an insect population appears to have gotten out of control, have the students act as "insect-busters". Students can kill the "enemy" insects using the quick pinch method. Each student must keep a count of his victims, and a prize of a tasty vegetable may be offered to the student that kills the most insects.

EDUCATIONAL RESOURCE

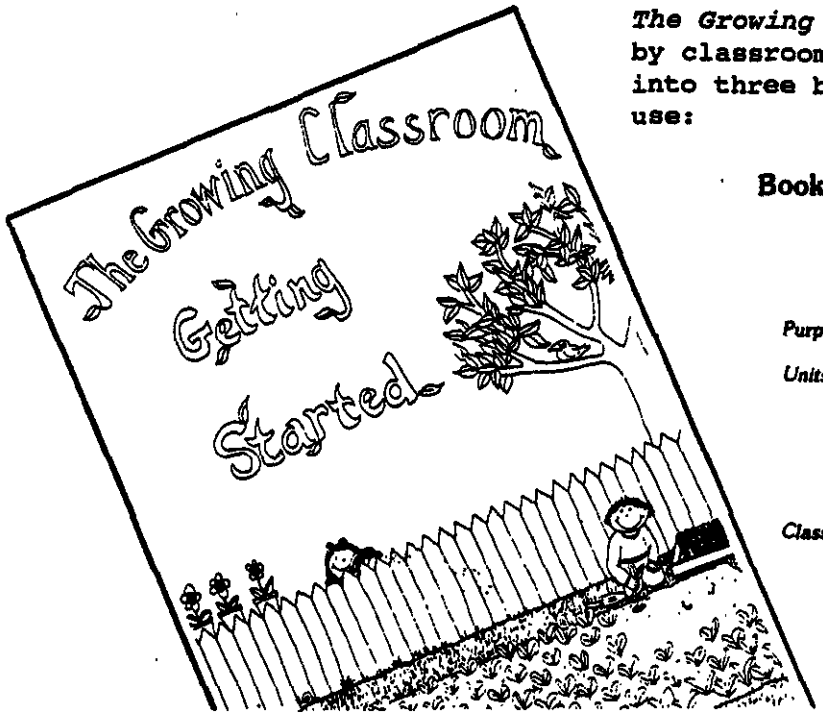
LIFE LAB SCIENCE PROGRAM
A U.S. Department of Education
National Diffusion Network Program

Many schools in the United States are busy converting their sites into exciting Life Laboratories for the study of science, nutrition and agriculture.

Life Lab began in 1979 at a school in Santa Cruz, California. Children planted seeds that tranformed their school parking lot into a thriving garden. This school, like many U.S. primary schools at the time, has little science education. The garden was planted due to the teachers' and students enthusiasm for gardening. But more than flowers and vegetables grew there. Soon both students and teachers were asking questions and discovering the world of science around them.

Over the next three years, teachers developed the garden-based science curriculum that today is known as ***The Growing Classroom***. As word of Life Lab's success spread, schools in urban and rural settings have begun to adapt the programme to suit their own sites. As a National Diffusion Network project, Life Lab provides teacher training and technical assistance to schools throughout the nation. Learning to implement Life Lab usually requires a two day workshop. Following training of a team of teachers, a school forms a Life Lab Steering Committee to guide the implementation of the programme, uses *The Growing Classroom* curriculum, develops a living laboratory for experimentation, and generates community involvement. Today, there are over 450 Life Labs.

A description of *The Growing Classroom* is given below. For further information about the **Life Lab Program** write to: **Life Lab Science Program, 1156 High Street, Santa Cruz, CA 95064 U.S.A.**



The Growing Curriculum, **field-tested by classroom teachers, is divided into three books for easy teacher use:**

Book 1 • 82 pages of curriculum
• 4 units of study
• 43 lessons

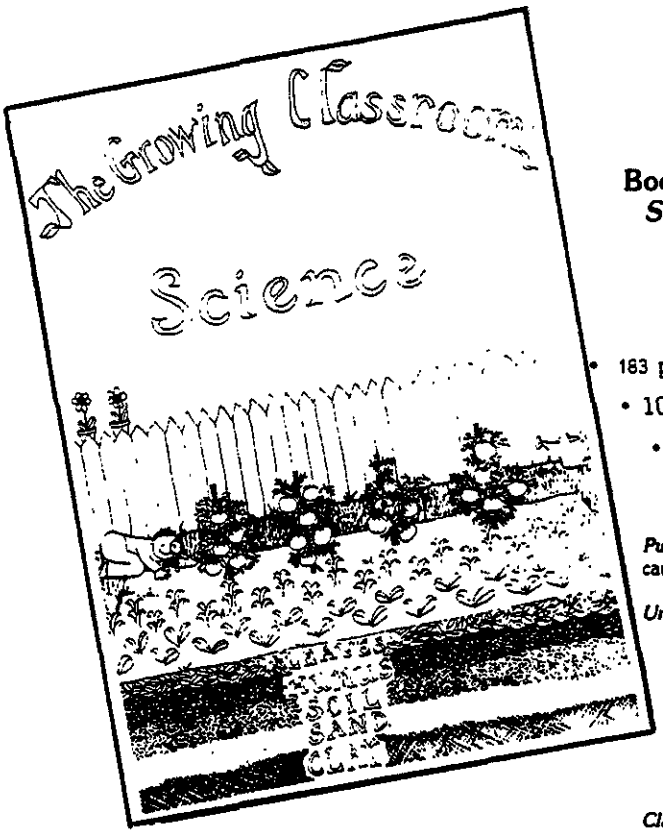
Purpose: to lay the groundwork for the successful implementation of *Life Lab.*

Units of Study:

- Breaking Ground
- Cultivating Support for Your Growing Classroom
- Basic Gardening
- Experimental Beds

Classroom Activities:

- *selecting the proper gardening site*
- *preparing the soil*
- *planting and cultivating the harvest*
- *gaining school support and community involvement*
- *involving students in their own learning*



Book 2:
Science

- 183 pages of curriculum
- 10 units of study
- 98 lessons

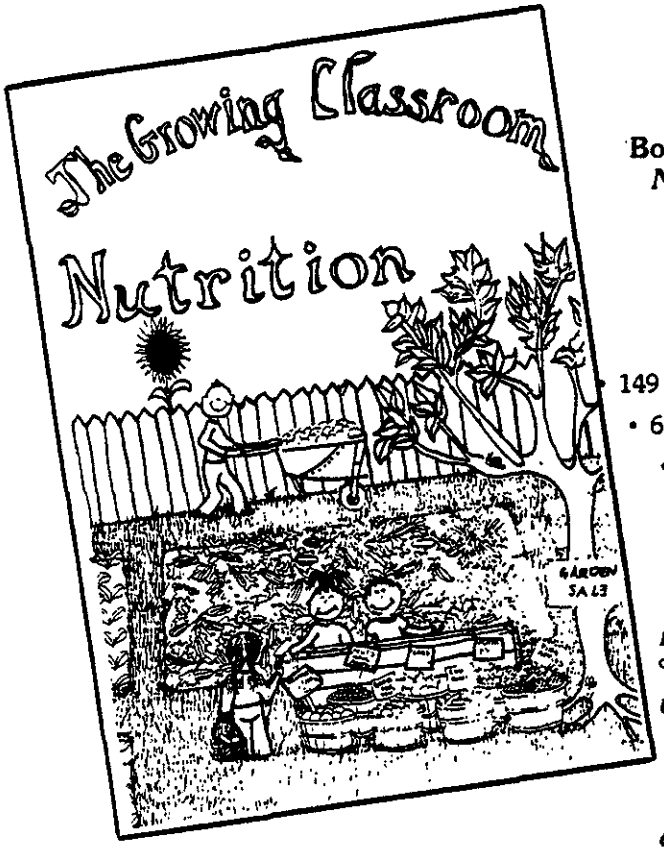
Purpose: students learn about investigation, facts, phenomena, laws of nature and life, and causes.

Units of Study:

- Problem Solving/Communication
- Soil
- Photosynthesis
- Interdependency
- Energy
- Awareness/Discovery
- Growing
- Cycles & Changes
- Insects, Flowers & Pollination
- Pest Management
- Recycling

Classroom Activities: Students are involved in experiencing "scientific discoveries" through

- group problem solving
- exact observations
- graphing
- experiments
- ordered reasoning
- charting



Book 3:
Nutrition

- 149 pages of curriculum
- 6 units of study
- 72 lessons

Purpose: students learn about the process by which food is converted into tissue in living organisms and about foods that promote growth.

Units of Study:

- Food Choices
- Nutrients
- Consumerism
- Basic Four
- Digestion
- Recipes

Classroom Activities: Students are involved in experiencing "nutrition" concepts through the following activities . . .

- language arts
- graphing
- group processing
- reference skills
- art
- cooking & food preparation

Please Note: Life Lab's curriculum *The Growing Classroom* is being published in a revised form.

ACTIVITY

Space Travelers

Description

Students work in small groups as space travelers trying to decipher the composition of soil.

Objective

To explore the composition of various soils.

Teacher Background

Soil is something all of us take for granted. However, it is one of the necessary life-sustaining ingredients of our planet. And soil is exciting! It varies dramatically within a small area. When students explore the surface soil (topsoil) they will discover many living things—roots, earthworms, insects. In addition, the topsoil contains humus (the high nutrient component of the soil that is formed by decayed organic matter) and rock particles. As students dig deeper, the soil composition changes. Soil is formed by natural processes that wear away rock and break it into tiny particles. This wear can be caused by rain, wind, glaciers, and plants. Soil formation is a very slow process. It takes over 100 years to produce 2.5 cm (1 inch) of topsoil!

Materials

Two trowels per team of three
One hand lens per team
Life Lab journals

Imagine that you are scientists journeying to the planet Earth aboard the Star Ship Life Lab. You receive the following message from President Gorgo Buerhing, the Head of State of your planet: You have been chosen to make a most important journey. The future of our beloved planet is in danger. As scientists, you well know how the planet we love has become so polluted that we are no longer able to produce our own food. Our astronomers have detected a very faraway planet called Earth. It appears to be lush, green, fertile, and productive. Our computers have been analyzing the reasons for this and have concluded that the secret appears to be a dead, brown-grey substance called soil. It is difficult for us to believe that all of their food comes from this substance. Your mission as scientists is to find this substance, dissect it, and record for our computer each and every ingredient. This will enable our planet to manufacture soil and save us from the tragedy that is about to befall us. Upon landing, divide into groups of three with two dissecters and a recorder in each team. Use the special tool [trowel] our engineers have designed especially for this purpose. Remember: It is crucial to the success of this mission that each and every substance found in the soil be recorded. Good luck to all of you.

1. Divide students into groups of three and have them explore soil in different areas of the garden and school yard. Have each team investigate just one spot.
2. Upon completion of the task, ask teams to compare and contrast the soils they investigated. Ask them to list the qualities of the soil. Have the groups discuss the ingredients they found: crushed rocks, crumpled leaves, twigs, clay, sand, and so on.
3. Assign ingredients to each team and ask them to return with a small quantity of each ingredient.
4. Upon their return, challenge teams to use the raw ingredients to manufacture soil by scraping rocks together, breaking twigs apart, and so on. When the frustration level of the students is reached, ask them whether soil can be made by hand. Why not? Explain that each inch of topsoil requires over 100 years to form. Bacteria, fungi, and other living things slowly decompose nutrients, such as leaves and twigs, recycling them into soil. Soil is alive. Over 100 billion microorganisms live in a pound of soil. Our hands and tools cannot equal the power of the bacteria and fungi.

Will the super computer on our home planet be able to manufacture soil? How is soil important to Earthlings' lives? Is soil alive? How? Do all materials in soil decompose at the same rate? What do earthworms do for the soil? What would be the result of covering, washing away, and stripping all of our soil?

ACTIVITY

ACTIVITIES WITH SMALL ANIMALS IN SOIL

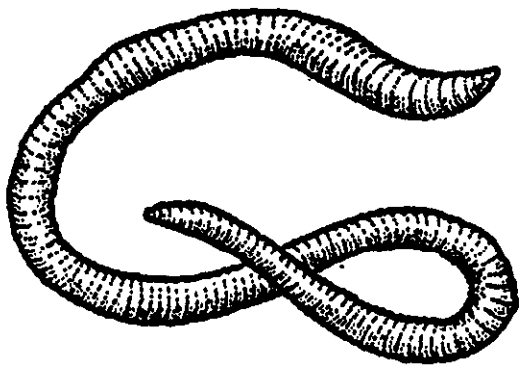
This activity is reprinted from:
Nature Study Projects No.7 **produced by the National Museum of Natural History, Department of Environment, New Delhi, INDIA**

When we talk about animals we normally think of big mammals like cows, horses, donkeys, dogs, cats or rats. But there are several small animals which are related to our life and we do not see them often. Carefully observe your surroundings, soil, plants and trees and find out ten small animals living above the soil and below the soil.

Small animals/Name	Where they make their home	
	Above the soil	Below the soil

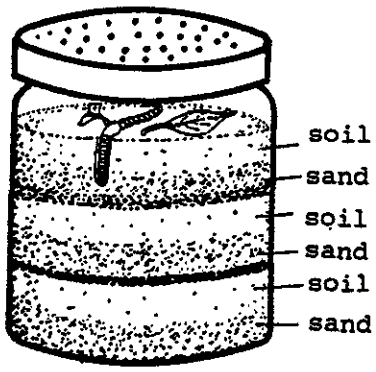
Put a tick (✓) mark in the appropriate column indicating as to whether they live above the soil or below the soil.

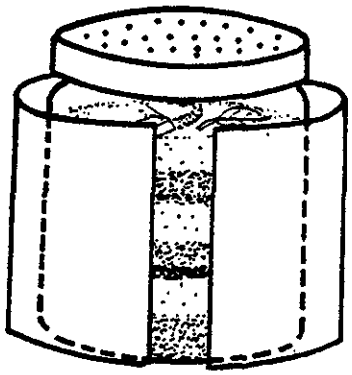
How is an earthworm a very useful animal ?
THINK AND WRITE :



Compare your answer with the information below :
Collect earthworms. After rains we find many earthworms.
Make a soil house for earthworms and observe their soil engineering.
Amongst many animals which are useful to us, earthworms are very important. They move the earth up and down and make passage ways in the soil which may bring the air to the roots. This makes plants grow well.

How to make an earthworm house





Materials:

* a big glass jar;
* wheat flour;
* sand;
* finely sieved black (or dark) soil;
* black paper;
* earthworms.

Method:

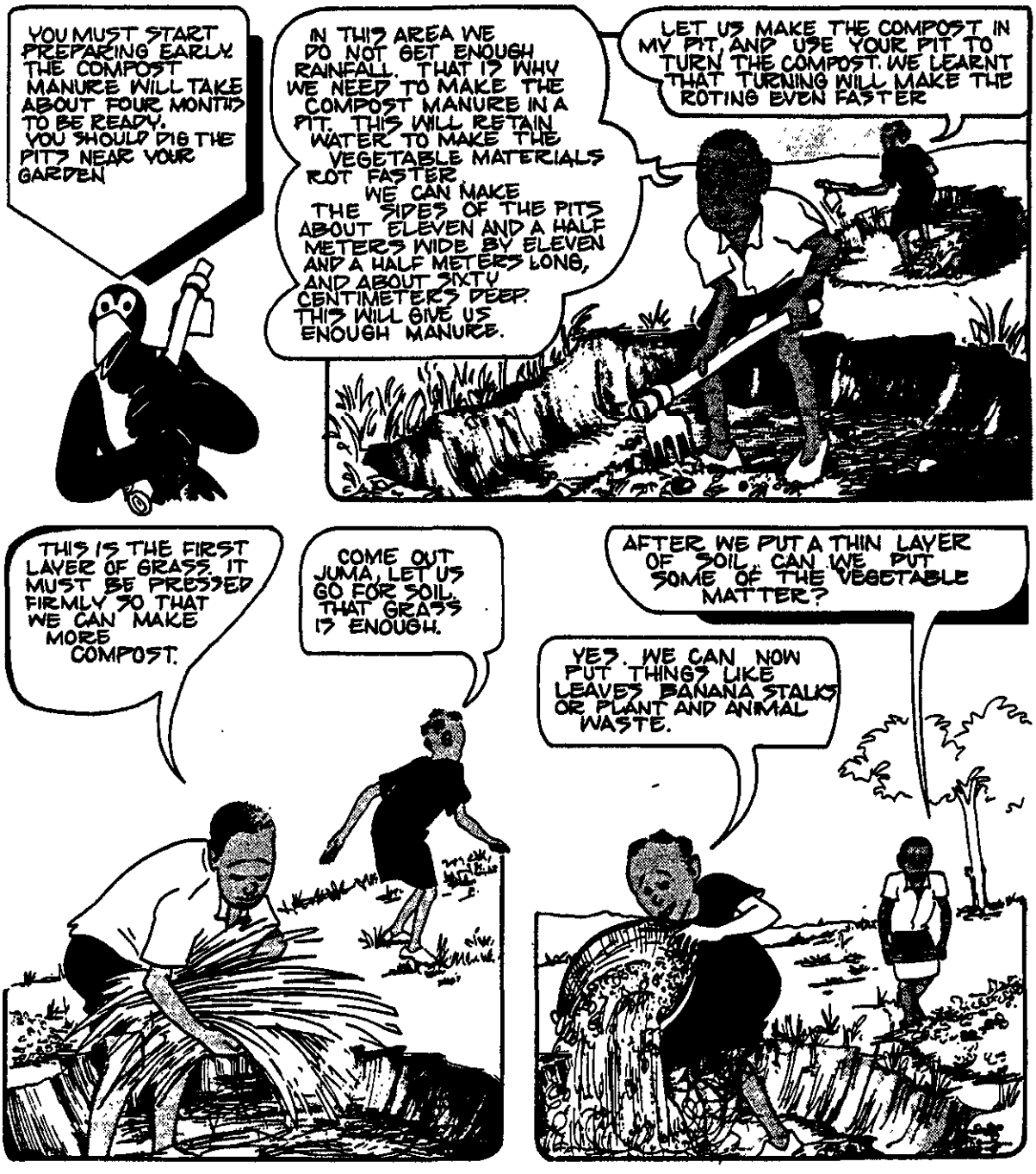
Put about 2.5 cm. (1 inch) of soil in the jar. Then, put in a layer of soil about 2.5 cm. (1 inch) thick. Continue to fill the jar with alternate and distinct layers of sand and soil until the bottle is filled to a height of 15 cm. (just over 6 inches). On top of the soil/sand, sprinkle a little wheat flour as food for the earthworms. Cover the jar with black paper as worms like darkness. Put the earthworms in the jar. See what happens after three hours. Keep a record of the earthworms' activity every three to four hours.
Observe:
1. How do earthworms make a passage through the soil?
2. How do they turn the soil?

PRACTICAL ACTIVITY

COMPOST MANURE

THERE ARE SEVERAL WAYS OF IMPROVING SOIL FERTILITY. ONE WAY IS BY USING FERTILIZERS WHICH CAN BE BOUGHT IN SHOPS. ANOTHER WAY IS BY USING MANURE MADE AT HOME OR SCHOOL. MAKING YOUR OWN MANURE IS CHEAPER THAN BUYING FERTILIZERS. YOU CAN MAKE AS MUCH MANURE AS YOU NEED.

The following comic strip is reprinted from:
Pied Crow's Environment Special Magazine,
issue: Agriculture and Practical Skills 2 - "School Gardens"
produced by CARE International in Kenya, P.O.Box 43684, Nairobi, KENYA
This magazine is distributed free to all primary schools in Kenya. Copies of this and other issues of *Pied Crow* may be ordered from CARE/Kenya.




ASH IMPROVES MANURE. LET ME GO FOR SOME. COULD YOU PLEASE GO AND COLLECT SOME MAIZE STALKS?
I WILL PRESS WHAT WE HAVE PUT FIRST. THEN I CAN GO FOR THE MAIZE STALKS. MAKE SURE YOU PUT THE ASH IN BEFORE I BRING THE MAIZE STALKS
NOW THAT WE HAVE PUT A THICK LAYER OF MAIZE STALKS LET US COVER THE PIT WELL WITH SOIL.
UZ, WE HAVE NOT FINISHED YET. WE MUST WATER THE COMPOST MANURE WATERING MAKES THE ROTTING FASTER.
TWO WEEKS LATER...
THE TOP LAYER MUST GO INTO THE OTHER PIT FIRST. THIS WILL MAKE THE STALKS AND OTHER WASTE ROT FASTER.
THAT WILL MAKE OUR COMPOST MANURE ROT EVENLY. WE WILL NEED TO DO THIS ABOUT THREE OR FOUR TIMES BEFORE THE MANURE IS READY.
YOU CAN PUT AS MANY LAYERS AS YOU WISH. EACH LAYER OF VEGETABLE SHOULD BE SEPARATED BY EITHER SOIL OR ASH.
YOU MUST MAKE SURE THAT YOU DO NOT INCLUDE IN YOUR COMPOST PIT THINGS LIKE PLASTICS METAL ETC. THESE MATERIALS CAN NOT ROT AND CAN ALSO BE DANGEROUS.
COMPOST MANURE CAN ALSO BE MADE IN A HEAP. COMPOST MANURE IN A HEAP IS BEST IN AREAS THAT HAVE ALOT OF RAINFALL.
TO MAKE COMPOST IN A HEAP YOU NEED FOUR STICKS DRIVEN FIRMLY INTO THE GROUND AT THE CORNERS OF THE HEAP.

CLASS ACTIVITY

Water in the Soil

The following activity is reprinted from:
***Floods and Droughts: An educational package for standards 5 to 8* produced by Centre for Environment Education, Nehru Foundation for Development, INDIA**

The Centre for Environment Education is a national institution engaged in developing innovative programmes and material aimed at creating environmental awareness among children, youth and the general community. Established in 1984, the Centre is supported by the Department of Environment, Forest and Wildlife, and associated with the Nehru Foundation for Development.

Floods and Droughts is an educational package comprising an activity booklet, a set of 11 exhibit panels and a set of 48 book labels. The booklet consists of 20 activities which aim at making the students aware of the intricate linkages between soil, water and vegetation and how their mismanagement damages the environment. The activities help develop skills of observation, measurement, data-collection, model-making and creative writing.

For more information, contact: **Centre for Environment Education**

BEFORE WE BEGIN...
[You can use the following information either as an introduction to the activity or in the discussions after the activity.]

Groundwater is very important to plant, animal and man. Thus the ability of the soil to absorb and allow infiltration of water is very important.

The movement and retention of water in the soil is related to the size, shape, continuity, and arrangement of the pores in the soil, their moisture content, and the surface area of the soil particles.

Some water is held in the soil pores by the forces of adhesion (the attraction of solid sufaces to water molecules) and cohesion (the attraction of water molecules to each other).

These forces keep the smaller pores full of water and maintain relatively thick films on the walls of many larger pores. The water in the soil moves downwards if the soil is dry and unsaturated. Not until the pores in one layer of soil are filled with all the water they can hold, does water move down to the layer below . Hard, impermeable rock prevents the movement of water or changes its direction, forming the base of the water table.

Water is found in the soil in both the vapour and liquid state. The air in all the soil pores (except those on the surface or a few centimetres below it in very hot, dry soils) is saturated with water vapour.

The maximum retentive capacity is the moisture content of a soil when all of its pores are filled or saturated with water.

The moisture in the soil also determines plant growth. The soil moisture available for plant use varies with different types of soil. Loamy soil, which is a mixture of sand, clay and mud, retains water in a way that is most useful for growth of vegetation. Sandy soil is unable to retain water as the pores are very large and the rate of evaporation is high. Clayey soil retains too much water and does not let it permeate to lower levels, leading to water-logging of the soil in which the roots of plants tend to rot.

The roots of plants help in absorption of rain water in the soil and the vegetation prevents excess evaporation of the water from the soil, thus maintaining the soil-water balance and recharging groundwater. Having become aware of the importance of soil moisture, the students would be interested in seeing for themselves that soil contains water. The following activity is a simple way to demonstrate this.

Objective

To demonstrate the fact that soil contains water.

Activity

Divide the students into groups.Ask each group to bring one empty tin which has a lid.
Ask the students to collect 100 gm of soil and put it into a tin. The soil should be spread out evenly on the bottom of the tin.

Let them weigh the tin with the soil and note the weight.
Then ask them to cover the tin loosely with its lid and heat it over a medium flame for two minutes.
Let them remove the lid and observe the inside of the tin.
What do they see?
Where does this water come from?
Now , instruct the students to heat the tin again for five minutes, without the lid.

Let it cool. Now, let them weigh the tin with the soil
Does it weigh more or less than before? Why?

Variation/extension

Ask the students to collect some soil in a tin . Cover the tin firmly with the lid and leave it on its side in the sun for some time.
Later, touch the inside surface of the tin. Which part of the tin is damp? Why? Where did the water come from?

Subject
Science/Social Studies

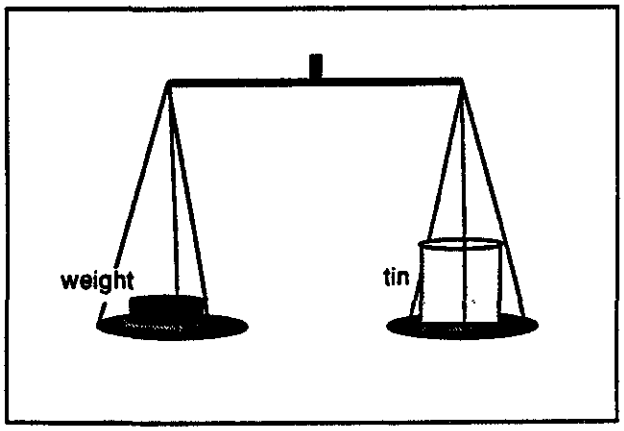
Place
Classroom/Laboratory

Group size
Four

Duration
45 minutes

Suitable time/season
Any time

Materials
Large tin with lid,
weighing scale; stove; soil



CLASS ACTIVITY

Managing the Slope

The following activity is reprinted from:
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BEFORE WE BEGIN...
[You can use the following information either as an introduction to the activity or in the discussions after the activity.]

Farming on sloping land is quite common. But the steep gradient poses many problems. During rains, water flows off the slopes very fast and carries off the fertile topsoil. Some slopes are so steep that cultivation is very difficult.

Without proper techniques, farming on hill sides can have disastrous consequences. To cultivate on slopes, the natural vegetation has to be removed and supplanted by crops. When the crops have been harvested and the land is barren, it is very vulnerable to erosion. Even light rain can cause severe erosion of the topsoil.

By allowing livestock to overgraze slopes, the vegetative cover which holds the soil together and prevents it from being washed away during rains is removed. The worst damage is done by cutting down trees on the slopes.

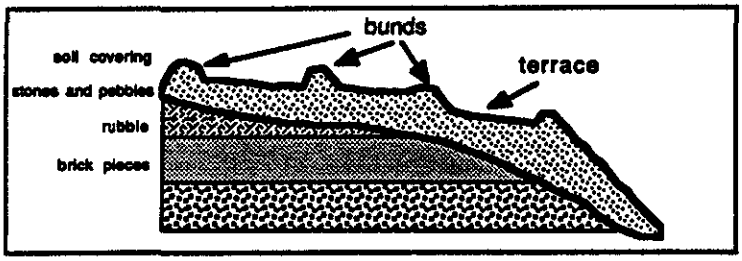
The disadvantages of a sloping terrain can be overcome by simple techniques. Terracing of the slopes and bunding of the terraces are such techniques. In terracing, the sloping surface is converted into a series of wide, flat steps, one above the other, along the slope. Cultivation is done on the flat surface of each step. Terracing slows down the flow of the water. It breaks up a long slope into a series of short ones, each of which collects and controls the excess water from a definite area of the slope above it. Each of the terraced slopes should empty into grassed waterways to prevent creation of gullies.

The edges of each of the terraces are slightly raised. This is called bunding. Bunding protects the terrace from soil erosion. Bunding can be done by raising the soil at the edges of each terrace with sticks, straw and clay to hold the soil in place.

In the following activity the students prepare a terraced slope, bund each of the terraces and grow plants on the slope. They then compare the effect of rainfall on a terraced, bunded slope which has vegetative cover with that on an ordinary barren slope.

Objective

To demonstrate that terracing and bunding can control soil erosion on hilly regions.



Subject
Social Studies

Suitable time/season
When it is not raining.

Place
Outdoors

Materials
Brick, rubble, stones, manured soil, ordinary soil, mustard seeds, one perforated can (1.5 litre capacity), digging implements.

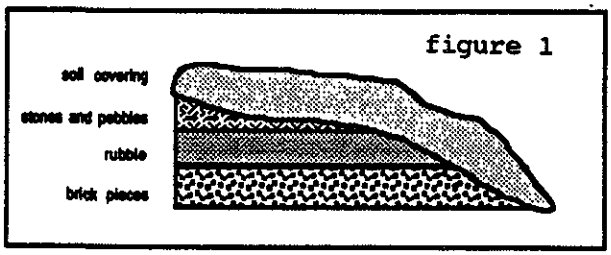
Group size
Entire class

Duration
Two weeks for preparing the models. 30 minutes for the activity

Activity

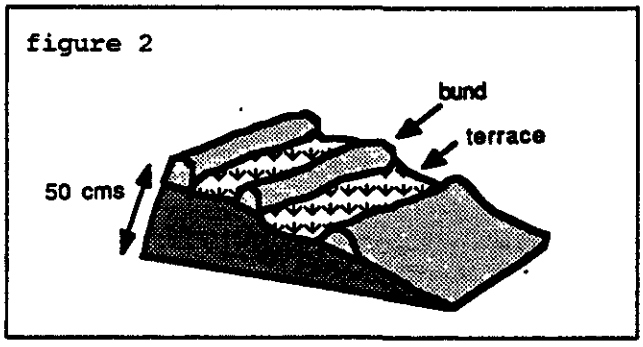
Let the students prepare two slopes. Each slope can be prepared by first piling up brick pieces, followed by a layer of rubble and a layer of stones. Each layer can be about 10-15 cm (4-6") in thickness. Cover the first slope with manured soil, the other with ordinary soil. The height of each slope may be 50 cm (about 20") and the length of the ridge 100-150 cm (about 40-60"), with a gentle slope on one face, see fig. 1.

figure 1



Now ask them to arrange the soil layer of the first slope so as to form three or four terraces (see figure). Let them raise the edges of each terrace slightly, to form the bunds.

figure 2



Let the students grow mustard or grass to a height of 8 cm on the terraced slope. Let the other slope remain bare. From the base of each slope, let the students dig out a channel.

When the slopes are ready, ask the students to pour water over the two slopes with a perforated can and observe what happens to the water flowing from the two slopes.

What is the effect of rainfall on the bare slope and the terraced slope which has vegetation? How do terracing and bunding reduce the extent of soil erosion?

Variation/extention:

The students can visit any cultivated area nearby and observe the different methods of cultivation and soil conservation being practised by the farmers.

CLASS ACTIVITY

Soil Salinity

The following activity is reprinted from:
***Floods and Droughts: An educational package for standards 5 to 8* produced by Centre for Environment Education, Nehru Foundation for Development, INDIA**

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For more information, contact: **Centre for Environment Education**

BEFORE WE BEGIN...
[You can use the following information either as an introduction to the activity or in the discussions after the activity.]

All land under cultivation needs water. This water can be received either through rainfall or irrigation or both. Where rainfall is adequate the excess salts and minerals contained in the soil are carried downwards to the groundwater and eventually to the sea, rendering the soil free from salinity. This process is called leaching.

However, soils in arid and semi-arid areas, where rainfall has been inadequate or absent, have the problem of a salt build-up. In other areas where soil has naturally restricted drainage caused by slow permeability or low retention powers due to its composition, water logging occurs. After the water evaporates, the soil is encrusted with salt.

All agricultural areas have irrigation facilities, sometimes natural and sometimes man-made. All irrigation waters contain salts, but occasionally the waters are too saline for crop production. When more salt is applied through water and fertilizer than is removed by leaching, the soil becomes saline and unfit for cultivation. Human interference also destabilizes the soil composition, leading to formation of saline soils.

Where cutting down of natural vegetation has caused soil erosion by rain or wind, soil permeability decreases and salt cannot be drained out. In such

cases mere irrigation will not help. The land has to be first reclaimed through scientific processes.

Where modern techniques of agriculture have led to excessive use of chemical pesticides and fertilizers, the delicate balance of the soil breaks down, leading to soil salinity, decrease in agricultural productivity or even the turning of the land into an uncultivable wasteland.

Saline soils may be improved by establishing artificial drainage and by subsequent leaching with irrigation water to remove excess soluble salts. Soils can be leached by applying water to the surface and allowing it to pass downward through the root zone. Leaching is most efficient when it is possible to pour water over the entire surface. The amount of water required to leach saline soils depends on the initial salinity level of the soil. If a soil becomes saline and it is not possible to improve it by irrigation, the ability of the soil to hold vegetation, recharge its groundwater or continue as agricultural land is reduced. Droughts due to lack of rain hit these areas very hard.

In the following activity students will be able to observe on a small scale the effect of salinity on the growth of plants.

Objective

To show how soil salinity affects plant growth.

Activity

Take four similar tin cans or pots. Let the students fill each of them with soil. Label these as 1, 2, 3 and 4. Plant some bean seeds or gram seeds in each of the four pots.

Take four containers. Label these as 1, 2, 3 and 4.
Let the students take 3.5 litres of water in the first container and mix enough salt in it to prepare a saturated salt solution (i.e., until salt settles down even after shaking the solution well) .

Let them take out 1.5 litres of the saturated solution into the second container and add 1.5 litres of plain water to it. They will now have 3 litres of half-diluted salt solution.

Now let the students measure out one litre of this half-diluted solution into the third container and add one litre of plain water to it. They will now have two litres of quarter-diluted solution. In the fourth container, let them take two litres of plain water.

Let the students use the water in the container 1, 2, 3 and 4 to water the pots 1, 2, 3 and 4 respectively. Let them continue watering the plants as mentioned above for a week or ten days and observe the results on plant growth.

Subject
Science/Social Studies

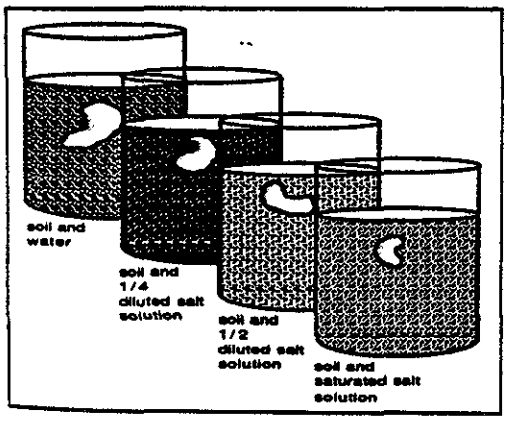
Place
Classroom/Outdoors

Group size
Entire class

Duration
45 minutes to prepare the activity and then10 minutes everyday for a week.

Suitable time/season
Any time

Materials
Four similar containers (tin cans or pots); soil, 4 containers to hold water (one large container of at least 5 litre capacity and three containers of at least 2 litre capacity each.), salt, bean seeds or gram seeds .



CLASS ACTIVITY

An Irrigation System

The exercise below is reprinted from:
Teaching Development Issues, Section 3: FOOD **published by and available from Development Education Project, c/o Manchester Polytechnic, 801 Wilmslow Road, Manchester M20 8RG, ENGLAND**

Teaching Development Issues is an integrated set of seven course books which study the processes of development and underdevelopment. The books are structured to introduce a number of 'key issues' which allow teachers to extract material to suit their own work schedules. The books are designed on a double page system: the left-hand page is for the teacher, containing background notes and teaching ideas; the right-hand page contains copyright free student stimulus material. The books are best suited for secondary school students. While the publications are primarily directed at students in Britain, they do have application elsewhere. Other titles in the series include Perceptions, Colonialism, Health, Population Changes, Work, Aid and Development. The price of each publication is £3.00 plus package & postage, and £15.00 plus postage for the complete series.

TEACHERS' NOTES

The exercise below considers how irrigation can be used to help raise food production.

Divide the class into three groups. Each group represents one of the three villages in the exercise. Ask each group to decide which plan would be the most appropriate for them. Then, bring the 'village' together to see if they can agree. Ask the groups to list the benefits and problems with each plan. They could consider:
- who would benefit the most? Are there ways of solving a situation where some benefit more than others?
- which schemes create employment?
- what are the costs to the villages?
- are there any problems with maintenance and spare parts?

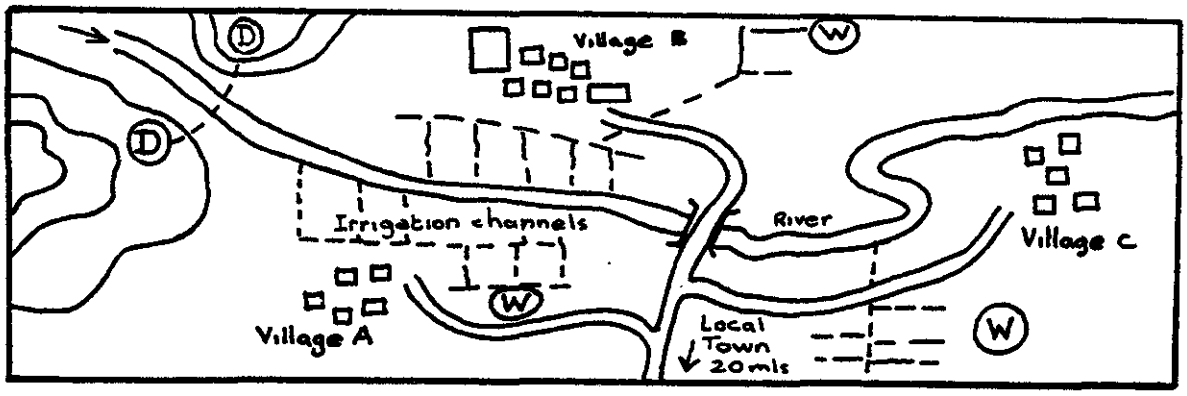
A group of villages are looking for a way to improve the irrigation of their land. The farmers and elders of the villages are discussing with their Government's Ministry of Agriculture what they should do.

THE PROBLEM

At present, there is a river which flows through their lands. The river runs dry in the dry season and sometimes floods if the rains are very heavy. When it doesn't rain,

the farmers water their land by standing in the river and pouring water with a bucket into irrigation channels which run across their land. Obviously, this is extremely hard work and not reliable as they cannot guarantee that there will always be water in the river.

A MAP OF THE AREA



THE PLANS

The Ministry has offered three different plans. All of them would enable the farmers to improve their crop yield and to open up new land for farming, but not necessarily equally effectively:

PLAN A: To build ox-driven water pumps by the riverside to improve the supply of water to the irrigation channels. These pumps are cheap and can be built from locally available materials by people in the area. Not all the farmers own oxen.

PLAN B: To drill wells at the three places marked W on the map and to fix petrol-driven pumps to them. The Ministry people say that there should be water in the wells all through the year. They will cost the villages more money than the ox-driven pumps but a grant will be made available by the Ministry. There is a blacksmith in village B and there is a Polytechnic in the nearby town which trains motor mechanics and offers advice on setting up small-scale industrial co-operatives. To run the wells would require the villagers to work together and agree on buying petrol, times it could be used, and so on.

PLAN C: To build a small dam across the river, marked as D on the map. This could supply water, through channels built by the farmers, to all the villages. It would be cheaper for the farmers in villages A and B than for C because C is further away from the dam. This scheme would also reduce the level of water in the river. It would be a very expensive scheme, requiring support aid from outside the area as well as extra taxes from the villages for many years.

WATERING YOUR PLANTS WITH POTS

The following information is adapted from:
"Irrigate Your Crops With Pots" in *International Ag-Sieve Volume II, number 8, 1989. International Ag-Sieve* is a publication of Rodale Institute.

Have you ever heard of anyone "planting pitchers"? Before you begin to imagine pots sprouting up from the ground, you'd better read on!

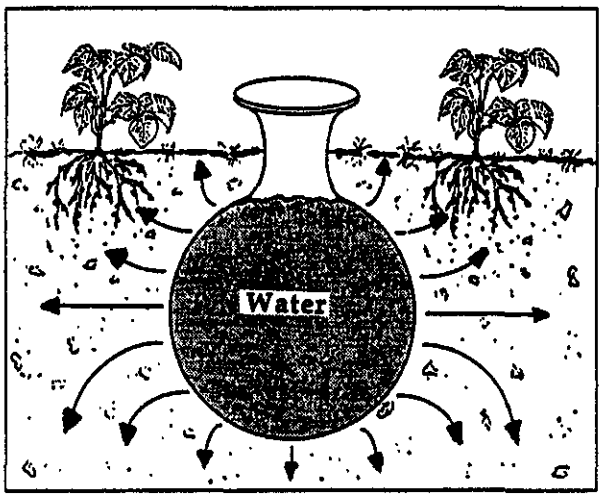
In the drylands of the state of Kernal, India, unglazed pots are buried in the soil up to their necks. The reason? It's a cheap form of irrigation.

When a pot is filled with water, the natural pores in the pot's wall allow water to seep out into the soil, creating the moist conditions necessary for plant growth. Pitchers are filled as needed, so that water is continuously supplied to the soil where plant roots grow.

This method of watering is called **pitcher irrigation.** It can be used for small-scale farming where:

a) Water is very scarce or expensive;
b) Land is uneven and the fields are difficult to make level;
c) Water is salty, and cannot be used in most surface methods of irrigation;
d) Vegetables are expensive and hard to come by.

Unlike other methods of irrigation, pitcher irrigation can be used only on a small-scale. But it is a very efficient way of watering crops. Little water is wasted because the water is delivered directly to the part of the soil where plant roots grow, see diagram. How much water a plant is given can be controlled by the amount of water put into each pitcher. Water required in a pitcher-irrigated field can be less than that needed in a drip irrigated system (of the same scale).



The amount of water that seeps out of the pots - and thus the number of plants that can be "watered" by each pot -

depends upon a number of things:
a) the type of soil;
b) the porosity (i.e. the volume of pores) in the pot wall;
c) the shape of the pot.
Pitchers are generally placed at distances so that the wet areas do not overlap.

Under pitcher irrigation salt builds up at the soil surface, leaving the water around the roots containing less salt than the water in the pitcher. So even saline water can be used in the pitchers. This is not possible with other methods of surface irrigation.

Scientists have found that 7 to 10 litre pots are sufficient to use with most vegetable crops. The number of pitchers needed per hectare varies with the crop. At least four plants of most vegetable crops could be grown around one pot. A creeping crop such as a bitter gourd may require 2,000 to 2,500 pitchers per hectare. Upright crops, or crops containing a canopy around the pot, require more pots, perhaps, up to 4,000 to 5,000 per hectare.

That sounds like an awful lot of pots! Is it worth all the time and effort needed to get, bury and fill pots? Researchers think so - at least for certain crops in certain growing places. For instance, in Karnal a variety of crops were grown using pitcher irrigation, see table below. It was found that the most profitable crops for pitcher irrigation were (in order) tomato, then bottle-gourd, then bitter-gourd, then watermelon, then cauliflower. It was not profitable to use pitcher irrigation for growing muskmelon.

In areas where water is scarce and where salinity limits cultivation, farmers may find pitcher irrigation of great benefit - if there are the farm workers to set up and run the system.

For more information and a copy of *Pitcher irrigation* by R.C.Mondal, edited by H.K.Barthwal, Central Soil Salinity Research Institute, Karnal INDIA, Rakesh Press, 1987. Contact:
R.C.Mondal, Director
Central Soil Salinity Research Institute, Karnal-132001 INDIA

Crop yield as obtained in pitcher irrigation for six vegetable crops

Crop	Yield (kg/Pitcher*)
Watermelon	11.30
Muskmelon	3.43
Bottle-gourd	21.53
Bitter-gourd	7.5
Tomato	5.83
Cauliflower	5.20

*2500-5000 pitchers can be adjusted in one hectare area. The yield in t/ha can accordingly be calculated.

ACTIVITY

DO IT YOURSELF: PITCHER IRRIGATION

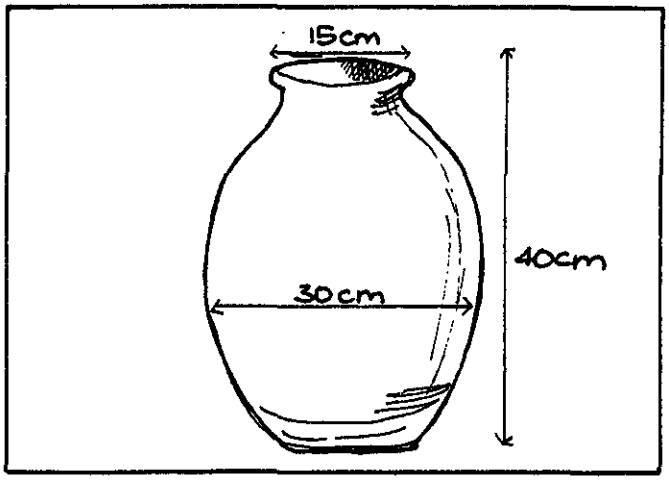
The information below is taken from:
Developing Countries Farm Radio Network Package 6
If reproduced, please give credit to:
Developing Countries Farm Radio Network

(The illustrations of the pitcher irrigation are adapted from the Government of Pakistan's booklet entitled *Under Soil Irrigation with pitcher and PVC Pipe*, a publication of the Appropriate Technology Organization, 1-B, 47th Street, F-7/1, Islamabad, Pakistan)

DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
For further information, contact:
The Developing Countries Farm Radio Network,
595 Bay Street, 9th Floor, Toronto, Ontario M5G 2C3 CANADA

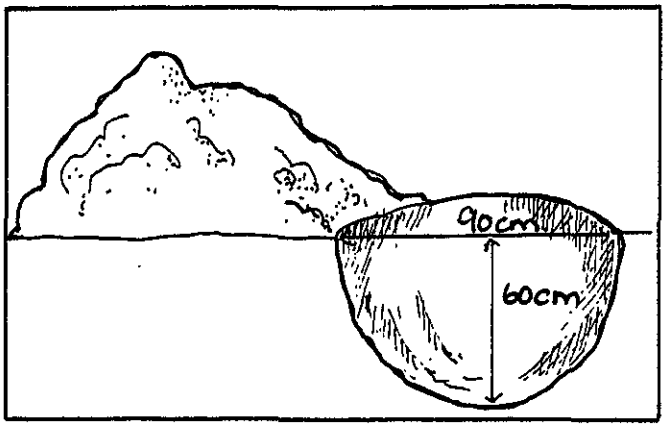
What you need

Pots, jugs or pitchers that are porous, so that water will seep out of them slowly. They should be about 40 centimetres (16 inches) tall and 30 centimetres (12 inches) across the lower part with an opening at the top about 15 centimetres (6 inches) across - big enough so it is easy to pour in the water, see right:

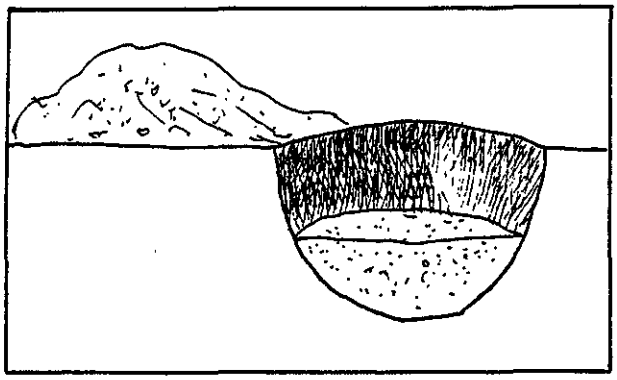


What to do

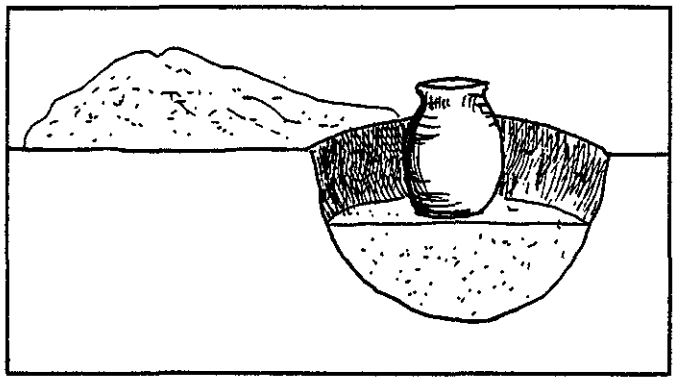
1. Dig a circular hole in the garden a bit less than a metre (about 1 yard) across, and a bit more than half a metre (about 2 feet) deep. Break up the soil you took out of the hole, and thoroughly mix some manure or compost with it.



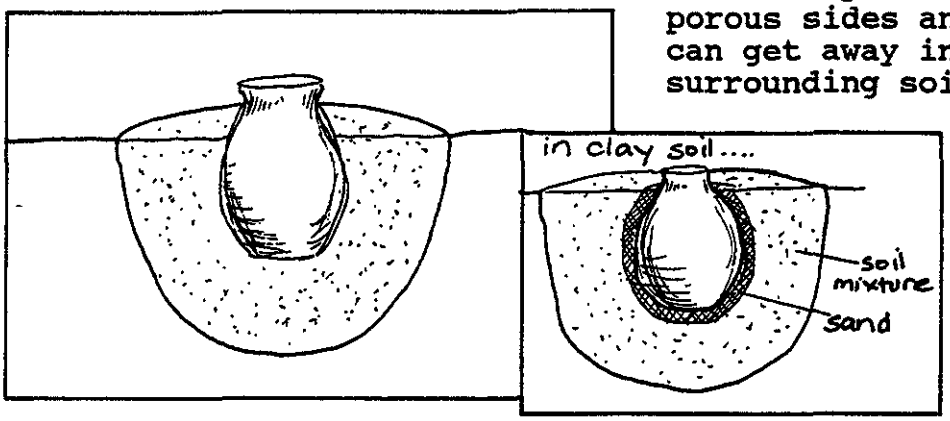
2. Now put some of this soil mixture back in the hole so that it is about half full.



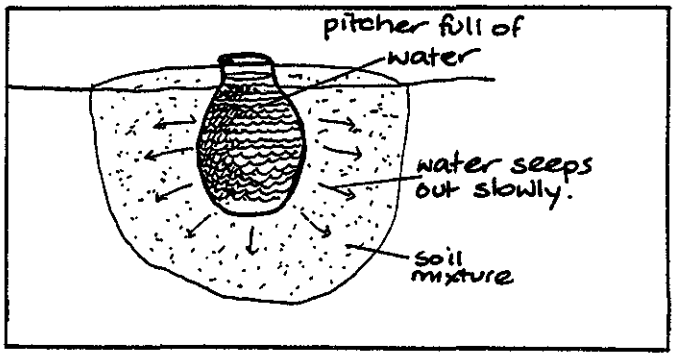
3. Next place your pitcher in the centre of the hole.



4. Fill the space around the pitcher with the rest of the soil mixture. When you are doing this, be careful not to get any soil into the jug. Perhaps, you should cover it to make sure. You should firmly tramp in the soil mixture around the jug. If your soil is heavy clay, it is important to place a thin layer of sand next to the jug - under it and all around it. This way, as the water seeps out through the porous sides and bottom, it can get away into the surrounding soil.



5. Now, see what you have - a round spot in your garden in which the soil is better than all the rest because it has been enriched with manure or compost. In the middle of the round spot you have the neck of a jug sticking out above the ground. As the jug is made of unglazed baked earthenware, its walls are porous. When you fill it up with water, the water will gradually seep into the enriched soil that is around the jug. Use clean water - never use muddy water.



6. Now all you have to do is plant your seeds or seedlings in the soil in this circular area. Then, whenever their roots need moisture, you fill the jug with water. It gradually seeps into the surrounding soil and your plants are sure to have all the moisture they need to grow well. Most people who use pots in the ground for watering their plants tried it out to begin with using one or two pots only. Perhaps, that is what you will do. The really good thing about this way of watering is that a lot more of the water you bring to the garden will find its way to your plants. That is very important if you haven't got much water or it takes a lot of time and effort to get it to your garden.

PESTICIDES: IS THE ANSWER CLOSE TO HOME?

by Andy Crump

The article below is reprinted from: ***Panoscope*** **No. 8 (September 1988).**
Panoscope is published six times a year by **The Panos Institute.**
The Panos Institute is an independent information and policy studies institute working internationally to promote greater awareness of sustainable development. For further information contact:
The Panos Institute, 8 Alfred Place,London WC1E 7EB, UNITED KINGDOM.

The solution to Third World pest problems may not lie in imported, expensive and dangerous pesticides, but in a far safer and cheaper answer nearer to home: the use of natural pesticides.

Pyrethrin is a naturally-occurring, fast-acting component of modern insecticides. It is produced from the flowers of several species of *Chrysanthemum grown in Africa.*

In common with other natural products, it is quickly degraded in the environment and therefore does not "persist" as do human-made chemicals.

At the International Rice Research Institute in the Philippines, extracts from powdered leaves and seeds of the Neem tree, native to India, have been tested against a variety of pests. So far, Neem derivatives have been found to repel 123 species of insect, including pests of stored grain.

Plants commonly grown in developing countries, such as sorghum and sunflowers, do not grow well in competition with other plants and so produce substances that act as efficient "weedkillers".

Farmers in Burkina Faso and Sierra Leone have traditionally mixed two local plants, Black Sesame (*Hyptis spicigera*) and Fly's Talo (*Cassia nigrican*), with their stored cowpea crops. Chemicals produced by these two plants inhibit reproduction in Bruchid beetles, which are the major pest of cowpeas, causing losses of up to 40% in the stored crop.

Yet little research has been carried out so far to isolate and identify these and similar natural control agents which could prove extremely beneficial.

Scientists in the United States have discovered that oil from the peel of citrus (oranges, lemons and grapefruits, etc) kills a wide range of insects but is not harmful to humans. According to Dr Craig Sheppard of the University of Georgia, "this natural pesticide could prove valuable for ridding livestock and humans of external parasites, for fumigating food handling and storage facilities, and for pest control in households."

Many developing countries are producers of citrus fruits and may therefore have an extremely useful and lucrative spin-off from their citrus industry.

The following two articles are reprinted from:
***Garden to Kitchen Newsletter* Jan-Mar 1989 No. 6**
Garden to Kitchen Newsletter is a quarterly publication of the **Family Food Production and Nutrition project, UNICEF Pacific Operation, c/o UNDP, Private Mail Bag, Suva, FIJI**

GROW LEMON GRASS TO PREVENT WEEDS

Weeds, if not managed, can reduce the yield or destroy a significant amount of garden crops. This is especially true in the...warm and rainy season when most weeds grow best.

However, a partial solution is now in practice in gardens from the Solomon Islands to Pohnpei. Lemon grass (*Cymbopogon citratus* Staph.) has been found to be effective in preventing vine-like weeds from spreading into the food garden.

How does it work?

The answer is in the structure of the plant. Lemon grass, or lemon leaf, is a clumping plant which develops a thick mat of roots below the soil and a thick mat of shoots above the soil. When several of these fast-growing plants are grown close to one another they grow together to form a barrier above and below the ground to prevent vine-like weeds from spreading. lemon grass grows well on both high and low islands so it can be planted throughout the Pacific.

Other Benefits

Lemon grass is one plant every garden [in the Pacific region] should grow. Besides the control of weeds, it prevents soil erosion; it is a useful pest deterrent especially against mosquitoes; it serves as a boundary marker; it can be used as a hot or cold "tea" drink, and as a spice in cooking. lemon grass tea is a good money saving substitute for black tea and coffee and is good for health since 'black" tea impedes the absorption of iron by the body and thus can contribute to anaemia particularly in children and pregnant/lactating women.

GROW MARIGOLDS TO DETER NEMATODES

Marigolds which are grown on low and high islands in the Pacific have been shown to improve food plant growth and yield in soils infested with root knot nematodes. [Nematodes are tiny non-segmented worms that live in the surface layers of the soil]...The ones harmful to certain plants grow inside the root system and prevent the flow of food and water through the plant.

A study was done by the Tropical pesticide Research Institute in Tanzania using African and Mexican marigolds (*Tagetes* species). Marigolds were planted beside tomatoes. The marigolds reduced the number of root galls by 85%. This resulted in tomatoes giving 6 times the fruit compared to the control plot. the Institute will test the potential of marigolds for improving growth of other vegetable crops.

RADIO SCRIPT

FRUIT AND VEGETABLE SOFT ROT

The information below is taken from:
Developing Countries Farm Radio Network Package 8
The transcript may be adapted for local radio broadcast or it may be used as a source of information for magazine and newspaper articles, leaflets, fact sheets, posters, extension visits, village or classroom lessons, flip charts, plays, stories, songs, etc.
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DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
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INTRODUCTION

Through the Developing Countries Farm Radio Network, we bring you information on ways to increase food supplies for your family, or to sell - ways that other farmers have used successfully.

Today, for everyone who grows fruits and vegetables, we'll talk about a problem you likely have from time to time. Here's the presenter, George Atkins.

ATKINS Sometimes vegetable plants, vegetables and fruits get soft and mushy. That can happen when they have a disease called "soft rot". It's caused by germs or microbes that attack these crops.

Let's think for a moment about the kinds of crops that get soft rot. There are vegetable plants that have fleshy roots or tubers, -- potatoes, for instance. Then there are leafy vegetables like cabbage; --- they can get soft rot. --- And, of course, there are vegetables and fruits like egg plant, squash, tomatoes, oranges, papaya and many others. They are often spoiled by soft rot.

Now, there are some things you can do to prevent the crops you grow from being spoiled by soft rot. First, let's talk about all of them that you grow in your field or garden that may get infected with soft rot. In most cases, germs that cause soft rot will get into the soil where a crop is growing that has soft rot. If you rotate your crops, however, you won't need to worry much about these germs spreading and infecting other crops of this kind. Rotating your crops means, of course, that you don't grow the same kind of crop on the same land two seasons in a row.

Here's something else to think about when you are deciding where you will plant a crop that can get soft rot.

You may know that if plants stay wet for too long after a rain, they can rot more easily. To prevent this, plant them if you can in well drained land, not too close together; leave enough space between plants so that after a rain, the sun and wind can get between the plants and dry them off.

Now, if you are going to grow the kind of root crop that gets soft rot -- like potatoes -- plant them, if you can, in soil that's not too wet.

You may already know that when potatoes get soft rot, the disease is sometimes called "potato black leg". That's because part of the main stem of the plant gets black and rotten. Often the plant wilts and dies. Underneath the soil, the potatoes themselves also get soft, black and watery. Certainly, potatoes like this are not good to eat or to sell.

This is such a serious disease of potatoes that if you grow them, you should look carefully at all your plants every few

days. If you see any with "black leg", carefully dig out each rotting plant and all of its roots and potatoes. Burn them up completely right away in a good hot fire or bury them some distance from your crop or garden land. This way the germs from those sick potatoes and potato plants won't be spread to other living plants. --- By the way, if tubers from these sick plants haven't started to rot, they would still be good to eat, but don't store them with other potatoes.

Whatever you do, don't ever use potatoes for seed that have come from sick plants or potatoes that are rotten, or partly rotten. If you do, they will infect your soil with the disease. Also, any plants and potatoes that might grow from these sick seed potatoes would be sick too, and they would spread the disease further.

Now, there are other vegetable plants and vegetables that can get soft rot when they are growing, -- especially if the weather is hot and there is a lot of moisture in the ground or in the air.

The soft rot germs can attack the stem of a plant that has been injured; perhaps it has been cut with a hoe or chewed by insects.

Always keep looking for plants that may have soft rot, and whenever you find one, dig it out and burn it, or bury it some distance from your garden right away.

Sometimes just the fruits or vegetables themselves get soft rot while they are growing on the plants or vines. These are mainly the kinds that grow on the ground like melons, squash, gourds and others like that.

If they are actually lying on soil that's wet or moist all the time, they can easily get soft rot. To prevent this, many farmers gently put some dry straw under them to keep them up off of the wet ground. Fruits and vegetables that touch each other can also get soft rot, or sometimes they will get it even if they are growing close together. Again, always keep looking for vegetables that have soft rot, and remove them right away from your garden or field.

In some cases, of course, the good part of a vegetable with soft rot can be used for food and this is also true of fruits that get soft rot; the bad part, however, should be cut off and burned or buried to prevent the germs that cause the soft rot from spreading.

Now, before we finish today, let's think for a few moments about your produce during and after harvest.

To begin with, clean out the baskets or other containers you will be using when harvesting and storing your produce. Make sure no dirt or bits of old plants, fruits or vegetables are stuck to the sides or bottoms of these containers. If you are going to store your produce, remember that fruits and vegetables will be good for a longer time if they are kept shaded from the sun in a clean, cool, dry place where fresh air can circulate freely. If you stored produce there before, be sure to clean your storage area as carefully as you clean your produce containers. Also, before you start harvesting your crop, try to get rid of any insects that might attack the fruit or vegetables in your storage area.

Now, you're ready for the harvest. Before you begin, however, there's something important to remember. Handle your produce carefully.

Perhaps you have noticed that if you drop a fruit or vegetable and injure it, or if you accidentally cut the skin, this makes a soft place where soft rot can start to develop.

The cut or bruised part first gets soft and mushy. Then the rot spreads, and soon the whole fruit or vegetable will be spoiled; it will get soft and watery, and may start to smell bad. To prevent this, handle your produce very carefully.

Now, soft rot also develops when the weather is warm and moist. To avoid this problem , harvest your produce when the weather is cool and dry if you can. If you have to do it in the rain, immediately take the produce to a dry place out of the rain and dry off each fruit or vegetable before putting it in your storage area.

We've also said that if one fruit or vegetable gets soft rot, the disease can quickly spread to nearby fruits and vegetables, especially if they are touching each other as they do in a basket or other container. Be very careful, then, while you are harvesting, not to put rotten or partly rotten fruit or vegetables in a container with good ones.

There is something else you should do to prevent soft rot from spreading among your stored fruits and vegetables. Look at the produce in your storage area every few days. Remove and burn or bury any fruits or vegetables that may have developed soft rot since they were harvested.

Notes

1. Some information for this item came from "Bacterial Soft Rot of Fruits and Vegetables", an article by Derek Tomlinson, in Papua New Guinea. The article appeared in Harvest , Vol. 8 No 3, 1982. For more information you could write to Mr. Tomlinson at:

   Harvest
   Publications Section
   Department of Primary Industry
   P.O. Box 417
   Konedobu, Papua New Guinea

2. The information in this item refers to both bacterial and fungal soft rots.

ACTIVITY

SOFT ROT PUZZLE

Some of the words in the sentences below are missing. Complete the sentences - using words from the word bank - and discover ways to deal with the problem of soft rot in crops.

1. Rotate your _____: don't grow the kind of crops that get soft rot two _____ in a row on the same land.

2. Be careful not to _____ vegetables and fruits because soft rot often _____ where the injury was.

3. Burn or _____ every _____ plant you can find as soon as you find it.

4. The good parts of some fruits or vegetables that have soft rot can be used as food, but _____ off and burn or bury the _____ parts right away.

5. Soft rot develops in hot, _____ conditions, so keep produce clean, _____ and dry.

WORD BANK

infected	bury	starts	seasons	moist
crops	injure	cool	cut	bad

Answers:
1. crops, seasons; 2. injure, starts; 3. bury, infected; 4. cut, bad; 5. moist, cool.

If you carefully follow these simple rules, you will have more fruits and vegetables for your family - or to sell - because you will have fewer problems with the plant disease known as "soft rot".

CLASS/YOUTH GROUP ACTIVITY

STOPPING THE CROPDUSTERS: A MORAL DILEMMA

The activity below is taken from:
***World Conservation Strategy: A Programme for Youth, Manual for Youth Environmental Projects*, prepared for IUCN Commission on Education by Klaus Berkmuller and Martha C. Monroe, in collaboration with the United Nations Environment Programme (UNEP) as a contribution to the International Youth Year.**
(Education, Training and Awareness Series No. 1)

For further information, contact:
International Union for Conservation of Nature and Natural Resources, (IUCN) Publication Services, Ave du Mont-Blanc, CH-1196 Gland, SWITZERLAND

Setting: Indoors
Time: Two hours
Format: Group discussion

Purpose: To explore the implications of actions, to raise awareness of the ethical reasons for choices, and to find ways to overcome frustrating situations.

Materials: A copy of the dilemma and discussion questions.

Concepts: A moral dilemma is a tool to explore the thought processes behind decisions based on ethics and values. The goal is not to find the right course of action, but to discuss the reasons behind choosing one. A dilemma puts people in a difficult situation — one that has no right or wrong answer. They must wrestle with it and discuss the possible resolutions from a moral perspective, justifying that decision to themselves and the others.

Procedure:

1. Introduce the activity to the group by explaining that everyone has different reasons for determining "right" and "wrong" behaviour. It is often helpful to discuss the thought process behind such decisions. This story will help set the stage for your discussion. Then read the dilemma. Afterwards, use the questions at the end of the story to guide the discussion.

2. Divide your group into small groups of three to four. Ask them to rank the following people according to their behaviour in the story. A ranking of 1 means that person had the worst behaviour; a 6 means it was the best. Although each person may have different feelings about the characters, encourage each person to discuss the reasons behind their ranking.

Roberto	_____
Other Group Members	_____
Mr. Garcia	_____
Dr. Rodriguez	_____
Newspaper Editor	_____
Farm Workers	_____

3. Returning to the large group, have each group report and explain their rank order. As you question their logic and support their concerns, these discussion questions may be helpful:

   — Would you condemn Maria and Roberto for sabotaging the cropduster plane?

   — If Maria and Roberto are arrested for trespassing on Mr. Garcia's property and damaging his airplanes, what should the judge do?

   — What other options do Maria and Roberto have?

   — What would you do if you were Maria or Roberto? If you were in their youth group?

   — What might have prevented this problem from developing?

Stopping the cropdusters:
the moral dilemma of a youth group

Maria and Roberto anxiously listened as other members of their youth group complained about their environmental action project.

"It's not like we didn't try," explained Pepe, "but we can't do any more. I think we should switch to another project."

Two months earlier the group had enthusiastically begun their local environmental action project: putting a stop to exposing farm workers to dangerous pesticides.

In the cotton growing valley south of town, many farm workers complained of strange diseases and illness. When Maria's uncle became sick with a series of convulsions, Roberto's mother, a nurse, thought the pesticides sprayed on cotton might be to blame. The group then encouraged the local health department to record the previously unrecorded cases of non-fatal, yet serious pesticide poisoning.

Dr. Rodriguez, an expert with the regional agricultural extension service, told the group that pesticides are available which are less toxic and less persistent than the ones sprayed over Mr. Garcia's vast cotton plantations. Dr. Rodriguez also mentioned that aerial dusting was probably responsible for the majority of the acute cases of poisoning. She estimated, however, that aerial application probably saves Mr. Garcia $3,000 annually over manual application. But she also noted that an early and more specific localized spraying from the ground would considerably reduce the amount of pesticides needed, resulting in a savings of as much as $2,500 per year.

continued...

After talking to other experts and officials, and reading reports and articles on the subject, the group came up with a proposal to prevent further pesticide poisoning, which includes four major points:

1. Reduce aerial dusting to a minimum and use only as a last resort.

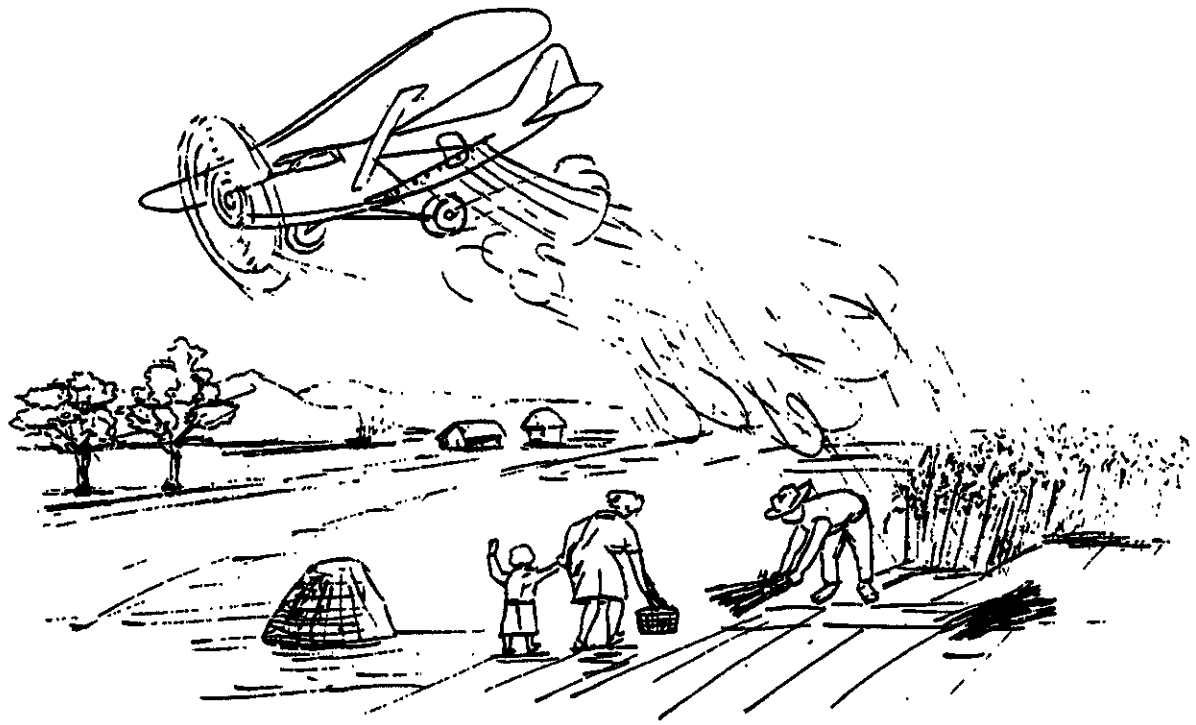
2. Warn all farm workers well ahead of time, in case aerial spraying is done.

3. Teach and enforce the safety regulations for the handling of pesticides.

4. Shift to the localized application of less toxic and less stable pesticides and examine possibilities of biological controls.

If the group thought Mr. Garcia would be very receptive to their suggestions, they were soon disappointed. He ran them out of his house, shouting that he knew how to run his business and needed no help.

Maria then talked to the editor of the local newspaper, who sounded interested but who was also apologetic and evasive. It seemed that he was very reluctant to print anything that might anger Mr. Garcia, a fellow member in the local Lion's Club. He justified his refusal to print news about the "rumours" because use of the pesticides was not illegal, and he was certain that Mr. Garcia would see to it that they were used according to regulations.



For more on safe use of pesticides, see:

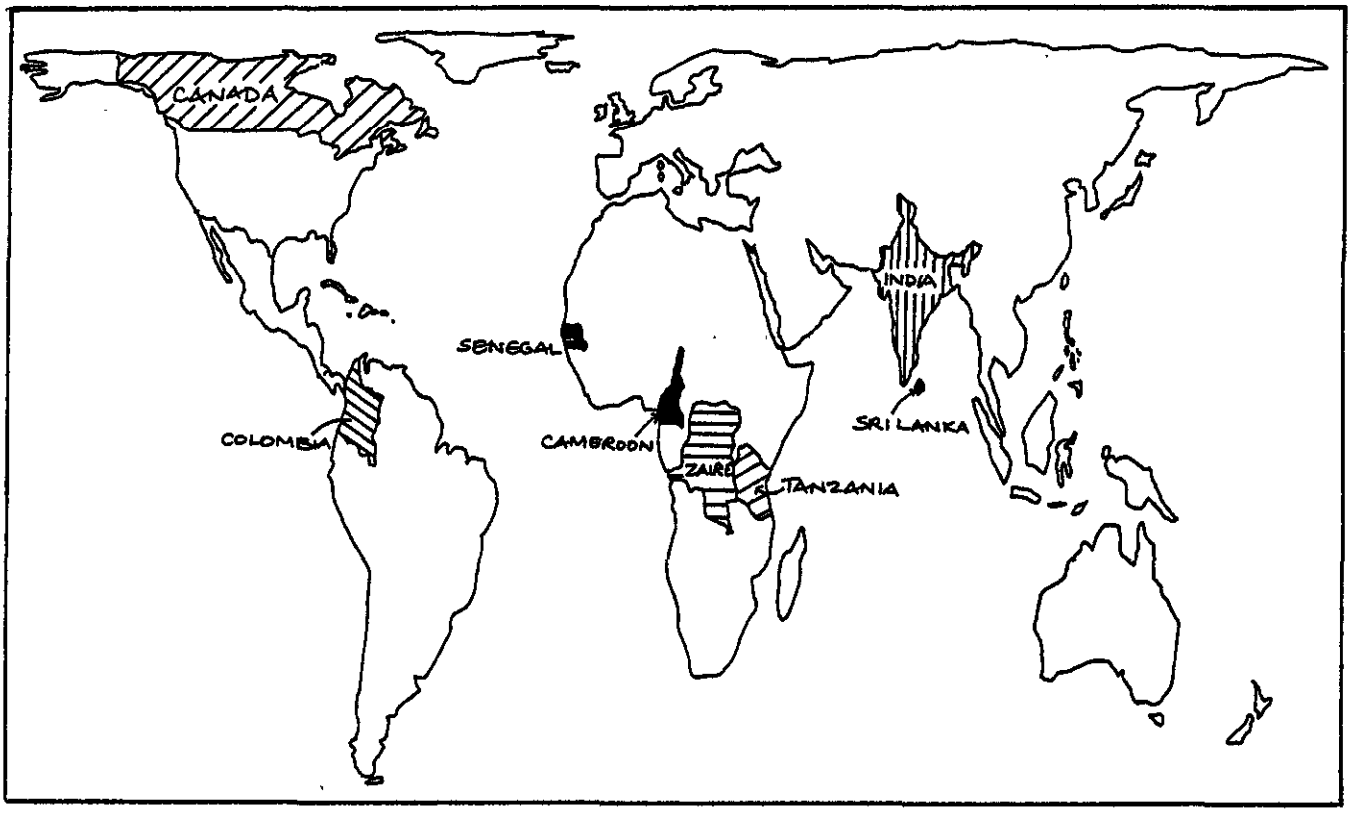
* OUTREACH issue 30 PESTS AND PESTICIDES (part 1) page 9, "The adventures of Digger McGee: the case of the missing friend";
* OUTREACH issue 31 PESTS AND PESTICIDES (part 2) page 7, "What is Project TEACH?"
* OUTREACH issue 32 PESTS AND PESTICIDES (part 3) page 8, "Pesticide Safety"

OUTREACH ISSUE NO.69: CONTENTS

[Reading level: I=children (8-10 years); II=children (11-13 years) and adults with basic literacy; III=teachers and/or people with secondary education]

LOCATION MAP

The map below shows the location of places mentioned in issue no.69.



ACKNOWLEDGEMENTS

OUTREACH would like to thank Marion van Schaik from Save the Children and Sharon Kahkonen for providing a wealth of information and ideas for these OUTREACH packs on "Crops". Thanks also go to Asian Cultural Centre for UNESCO, Centre for Environment Education (India), Developing Countries Farm Radio Network, Rodale Institute, Save the Children, South Pacific Commission, Deutsches Zentrum fur Entwicklungstechnologien (GATE) and other contributors to these information packs.

EDUCATIONAL RESOURCE

SCHOOL GARDEN MANUAL
by Marny Smith and June Plecan
produced by SAVE THE CHILDREN (1989)

The *SCHOOL GARDEN MANUAL* is designed as a practical guide for teachers, volunteers and development professionals working with school children and interested in launching their own school garden projects.

The publication has been compiled in the belief that growing food can be incorporated into school programmes anywhere in the world. They can enrich the depth and variety of the school curriculum at very little cost. With a school garden as an outdoor laboratory, a teacher is presented with many opportunities for hands-on demonstration of the ways in which the natural world functions. The principles of good nutrition can be introduced into class discussions throughout the growing season. Furthermore, the garden offers an opportunity for children to learn to grow food, a skill that will remain through life. Students may, in turn, teach adults in their own families that there are ways of growing food that are both more economical and ecologically sound.

The manual, based upon Save the Children's extensive experience worldwide, is divided into five sections. Section I suggests ways of starting a garden where there has been none before. It is to be used by the Project Coordinator, the Community Committee and key school personnel, and does not require the participation of the children, although including the children at the planning stage could be the key to a successful project.

The children should certainly become involved beginning with Section II where basic information necessary to creating and maintaining a garden is covered. Suggested activities to demonstrate and reinforce this information follow many topics throughout Sections II, III and IV. Section III is designed for the teacher and students, to be used in the classroom and in the garden. It contains lessons and activities to help them understand the how and why of what goes on in a garden. Section IV is also for the teacher and students. Its nutrition lessons and activities may be used at any time throughout the school year. The material in Section V was included to enrich and expand upon the gardening experience. Once the school garden is well established and basic gardening techniques are mastered, this section may be used to improve the garden and to continue the learning process.

The manual has been a valuable resource for the OUTREACH packs on "Crops and Farming".

Copies of the manual are available for $4.00 each including postage and handling, from:
Save the Children, 54 Wilton Road, Westport, CT 06880 USA

ACTIVITY

GARDENING MEASURING MACHINES

Did you know that to be a good gardener, you have to be good at mathematics? Now before you protest and say, "That's not true -I *like* gardening," think about it.

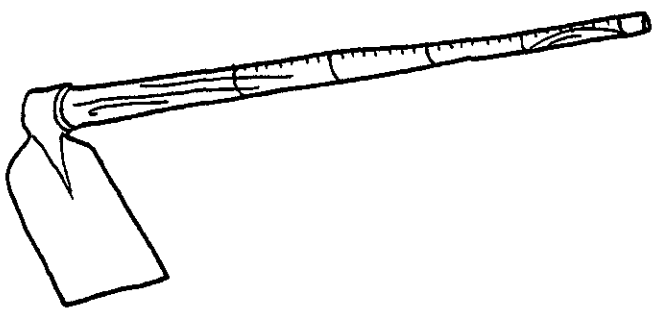
The vegetable gardener has to be a measurer in almost every garden operation:
"Dig a hole 7 cm (about 3")."
"Plant 10 cm (about 4") apart in rows 60 cm (about 24") apart."
"Spread a 5 cm (about 2") thick layer of mulch over 10 square metres (about 108 sq.ft.)"

A gardener is often trying to answer questions that begin "How much?", "How wide?", "How long?"

You might think it's hard to measure things when you're working in the garden or field. But with a little preparation, your body and your gardening tools can become your measuring machines. Common household items - spoons, jars, cartons and cans - are also useful in the garden, not only to measure volume but weight as well.

Making a measuring stick

Long-handled tools, such as hoes, make good measuring sticks. When you're in the classroom, use a ruler to mark off centimetres/inches on the wooden handle. Now you have a gardening tool that hoes *and* measures!



Use the long-handled measuring tool to measure the distance between rows of crops. Place stakes at the beginning and end of each row, and run string between the stakes to mark out the row. This string acts as a guide so that your rows are straight.

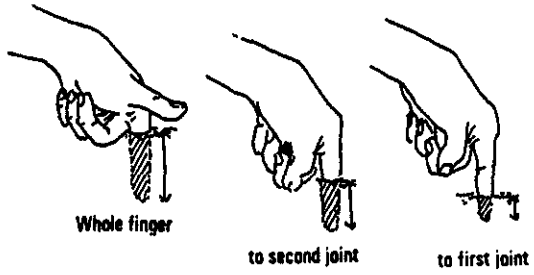
Using fingers, hands and feet

In the classroom, work with a friend to measure each other's fingers, hands, feet and paces. Write down your own measurements in the spaces below:

(a) Planting depth

How deep do you want to plant your seeds into the ground? The length of your finger might be a good gauge.

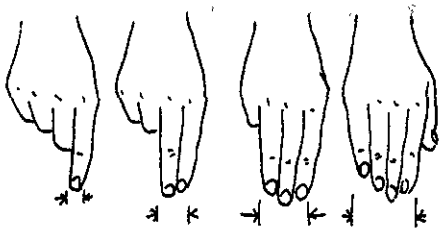
Measure your finger.



My finger is ___ cm (___ inches) long.
It is ___ cm (___ inches) to the first joint, and ___ cm (___ inches) to the second joint.

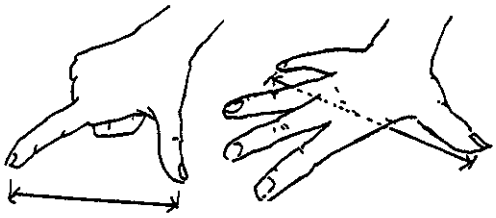
(b) Distance between seeds and seedlings

How far apart do you want to plant seeds? You may use the width of your fingers to measure the distance between seeds.



One finger is ___ cm (___ inches) wide.
Two fingers are ___ cm (___ inches) wide.
Three fingers are ___ cm (___ inches) wide.
Four fingers are ___ cm (___ inches) wide.

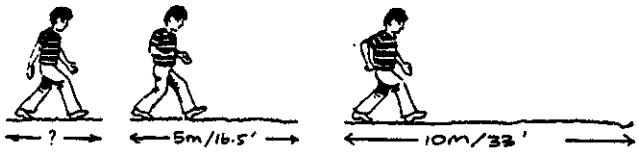
What distance should there be between seedlings? Perhaps, you can use the distance that your fingers can reach as a guide.



When I stretch my fingers, the distance between my thumb to index is ___ cm (___ inches), and the distance between my thumb and little finger is ___ cm (___ inches).

(c) Length of rows

How long do you want to make your rows? Measure the length of your pace. This distance can be used as your measuring guide.



My pace is ___ m (___ feet) long.
___ of my paces measure 5 metres (about 16.5 feet).
___ of my paces measure 10 metres (about 33 feet).

Using household goods as measuring machines

Spoons, cans, cartons and jars are all useful measuring tools in the garden. In the classroom, work out the volume of these containers. You can also use these containers to measure weight. If you have a scale, you would discover that one pint of water weighs a pound. So, with a pint of water, you can set up your own "table of equivalents" in liquid measurements and forget the scales.

Intercropping

The following information is reprinted from:
Intercropping **produced by Rodale Institute for Rodale Press Inc., in cooperation with the Tanzanian Agricultural Research Organization.**
This is a pamphlet available from Rodale Institute at a unit price of US$0.50.

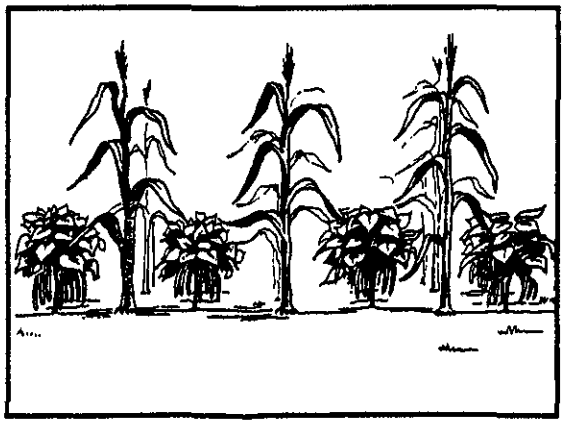
Intercropping means growing more than one crop in a field at the same time. By intercropping, you can grow **more total food** on a piece of land than you can by growing one crop alone. Also, you can **reduce the *chance of total crop loss*** from weeds, insects and plant diseases.

You can intercrop in many different ways...

Mixed Intercropping

Clear your land, then scatter seeds from several different plants onto the soil.

Row Intercropping

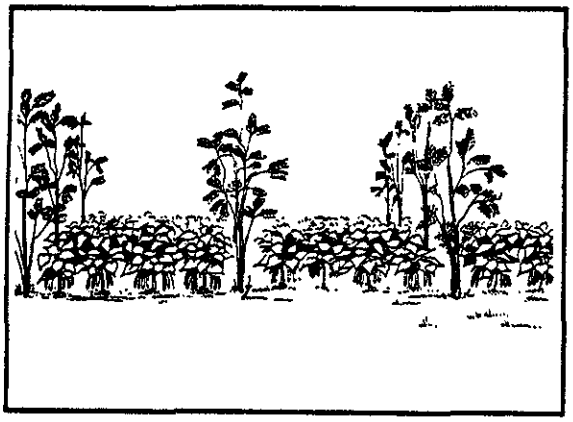


Plant two or more different crops at once in alternating rows or hills. For example, plant a row of maize, then a row of beans, then a row of maize again, until your field is covered.

Strip Intercropping

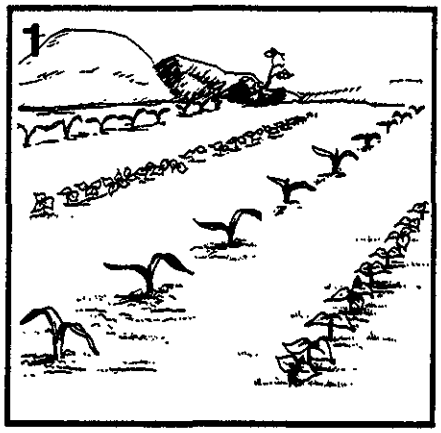
Plant several rows of one crop next to several rows of another. For example, plant four rows of maize, then two rows of cowpeas, then four more rows of maize until your field is covered. Plant more rows of the crop you want most.

Alley Cropping

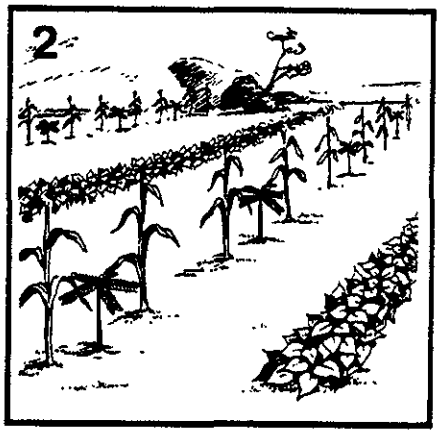


Plant a row of trees, then several rows of a food crop, then another row of trees, until your field is covered. Trees will protect food crops from the wind, and tree roots will bring up plant food and water from deep in the soil.

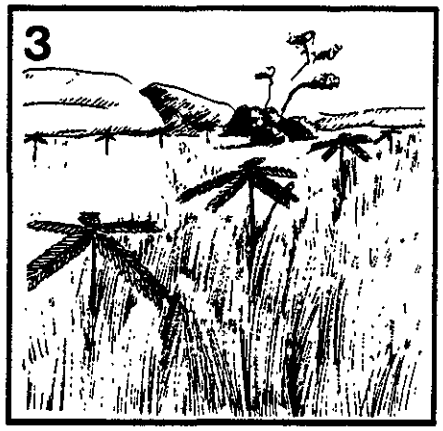
Relay Cropping



Plant a second crop after the first one is growing, but is not ready for harvest. For example, plant maize and cowpeas in alternating rows.

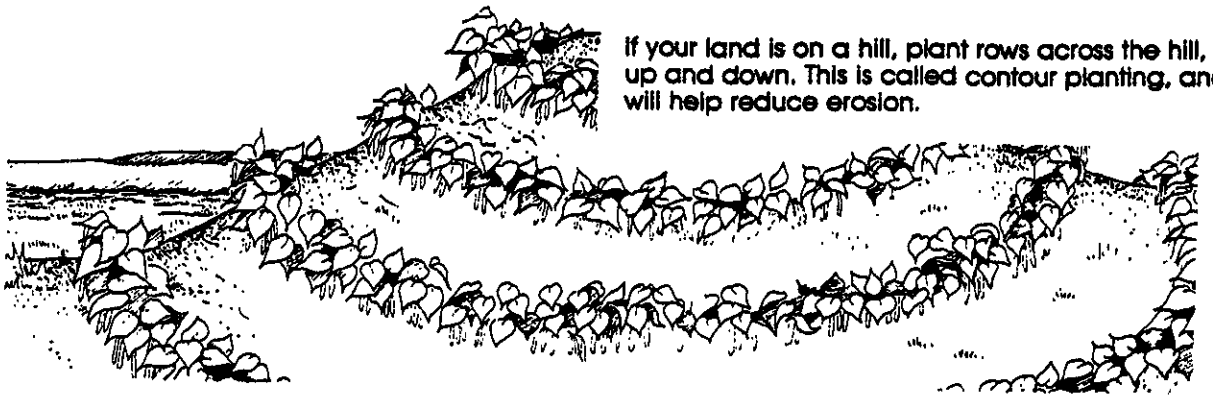


When these have begun to grow, plant cassava next to every second or third maize plant. Harvest



the maize and cowpeas, and replace them with crotolaria. Before the next planting season, harvest

cassava and dig crotolaria into the soil for green manure. Try to keep soil covered with growing plants all year.



If your land is on a hill, plant rows across the hill, not up and down. This is called contour planting, and will help reduce erosion.

Advantages of Intercropping

1. Protects soil from erosion.

2. Makes better use of water, sunlight and plant foods.

3. Helps prevent total crop failure, because most insects, weeds and diseases attack only one type of crop.

4. Helps you grow more food with the same amount of land and labor.

5. Provides your family with a healthier diet and a better variety of foods. For example:
   - Plant a row of beans between rows of maize or cassava.
   - Plant rows of cowpeas, beans or pigeon peas between strips of bulrush millet.
   - Plant finger millet and pigeon peas at the same time. Harvest millet, and replace it with sesame, cowpeas, maize or beans. You can harvest these later in the season along with pigeon peas.

6. Lets you plant green manures and food crops together. For example:
   - Plant cowpeas with maize. Harvest maize and cowpea pods, then dig cowpea plants into the soil.

7. Legumes are plants that add nitrogen (an important plant food) to the soil through their roots. When you intercrop with a legume, nitrogen will increase in the soil for use by the next crop.

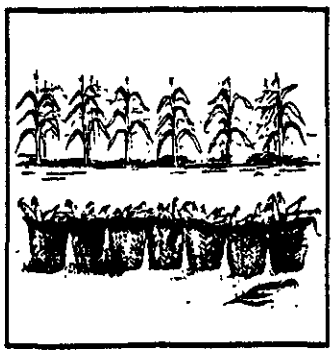
Disadvantages of Intercropping

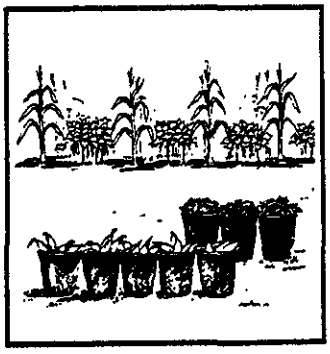
1. You must choose crops carefully so that one does not get more food, water or sunlight than the others.

2. Many of the new, high-yielding plant varieties do not grow well with other crops.

3. If your soil is rocky, very dry or very wet, you may not be able to plant crops in rows.

4. You will get more maize if you plant it alone than you will if you plant it with beans. But if you plant maize and beans together, you will get more food.





Insects, Weeds and Diseases Cause Less Damage With Intercropping

Intercropping gives insects many new places to live on your land. You will see many insects on your plants, *but not all of them are bad.* Many are good bugs that eat the ones which harm your crops. The more places there are for insects to live, the more good insects you will have.

Answers to Questions About Intercropping

Q. How far apart should I plant intercrops?

A. Close together enough to shade weeds, but not so close that one crop will steal water, food and sunlight from another.

Q. Do I have to grow the same amount of each crop in a field?

A. No. Simply grow more rows or wider strips of the crop you want most.

Q. How can I make the best use of rainfall with intercropping?

A. Plant main crops at the beginning of the rainy season. Plant crops that need less water near the end of the rainy season.

Q. How can I make the best use of plant food and sunlight?

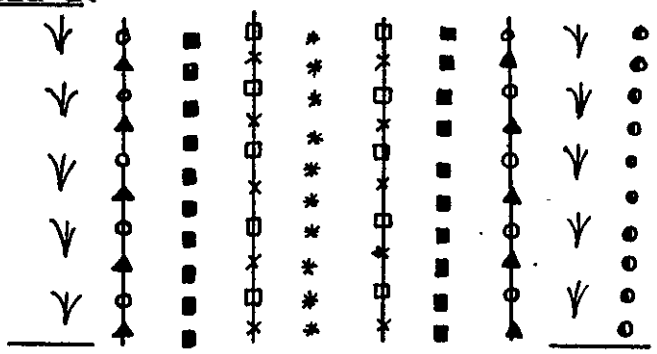
A. After planting your main crop, plant another crop that has a short growing season and requires less light, water or food. For example, plant a maize variety with leaves that do not spread out too wide. A few weeks later, plant pigeon peas, which need less water later in the season when there is less rain.

ACTIVITY

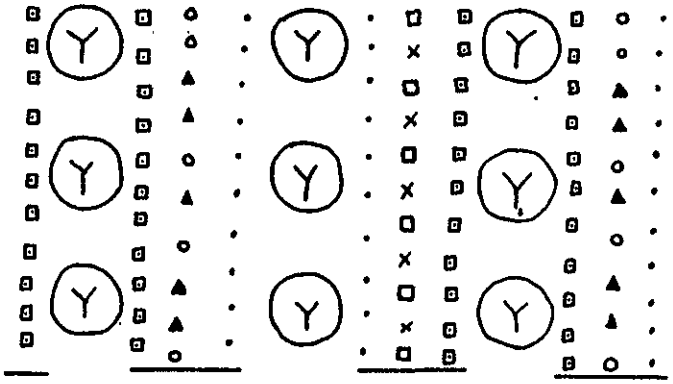
INTERCROPPING: A MAPWORK EXERCISE

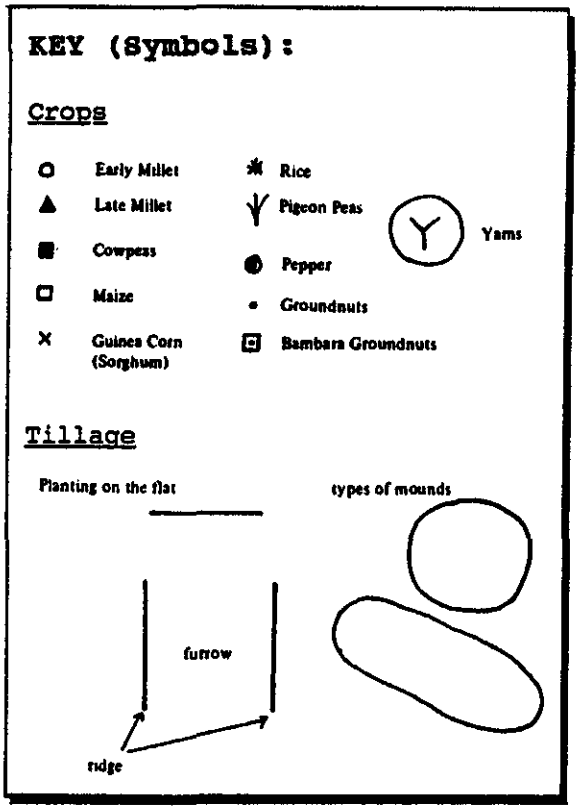
Below are plans that show how crops are arranged in two farmers' fields. Symbols are used to represent the crops and tillage patterns:

Field 1:



Field 2:





(Plans and symbols taken from: ***Primary School Agriculture Vol.II Background Information*** **by Herbert Bergman and Richard Butler published by GATE and GTZ, Federal Republic of Germany)**

Study the plans. Then, answer the following questions:

For field 1:

1. Which crops are grown on the flat? (pigeon peas, pepper)
2. How many plants are growing on the ridges? (40)
3. Which crops are grown in furrows? (cowpeas and rice)
4. How many rows of early and late millet are there? (2)

For field 2:

5. Where are yams grown? (on mounds)
6. Where are bambara groundnuts grown? (on the flat, on either side of the mounds)
7. How many rows of crops grow on the flat? (10)

Extension: Draw a plan of crops growing on a farm near where you live. Use the above symbols, and create more to represent other crops, tillage patterns, etc.

ACTIVITY

A DAY IN THE LIFE OF A FARMER IN ZAIRE

The exercise below is reprinted from:
Teaching Development Issues, Section 3: FOOD **published by and available from Development Education Project, c/o Manchester Polytechnic, 801 Wilmslow Road, Manchester M20 8RG, ENGLAND**

Teaching Development Issues is an integrated set of seven course books which study the processes of development and underdevelopment. The books are structured to introduce a number of 'key issues' which allow teachers to extract material to suit their own work schedules. The books are designed on a double page system: the left-hand page is for the teacher, containing background notes and teaching ideas; the right-hand page contains copyright free student stimulus material. The books are best suited for secondary school students. While the publications are primarily directed at students in Britain, they do have application elsewhere. Other titles in the series include Perceptions, Colonialism, Health, Population Changes, Work, Aid and Development. The price of each publication is 3.00 plus postage and 15.00 plus postage for the complete series.

Throughout Africa, the people mostly responsible for farming and preparing the food for the family are women. In Zaire, women grow manioc, a crop which forms the basis of the diet.

Working a five or six day week women will spend about eight hours in the fields during the sowing season. They do all the sowing and harvesting while the men help with cutting down trees and clearing the ground.

In addition to the farming work, women also carry fuel and water. A load of firewood weighing 30-40 kg will be collected and carried back for the evening meal's preparation. In many areas there is no local water supply and the women and girls have to walk long distances to fetch clean water. A family of seven would need some 40-50 litres of water daily. A woman can carry about 10-15 litres, so she may make four trips daily to wells that are often as much as four kilometres away. Each trip may take her about 45 minutes. Preparation of the manioc can take four hours each time - on average three times a week. Cooking meals can take around 1½ hours.

From this account, try to work out how many hours a day a woman might work during the sowing season (on average).

Time spent in the fields: ☐

Time spent carrying water: ☐

Time spent carrying firewood: (make an estimate) ☐

Time spent preparing manioc: (work out how many hours spent in a week and divide by seven) ☐

Time spent cooking meals: ☐

TOTAL WORKING DAY: ☐

Some things to consider:

- What other jobs might a woman farmer do in a day?
- What might the men be doing meanwhile? (Think about the type of crops grown).

Try to imagine you are a farmer in Zaire. How do you feel? Does life seem hard work to you? What would you do at the end of the day when the jobs are finished?

Growing without soil in barrios of Bogotá

This article is reprinted from: ***Earthwatch*** **No.37, (1989 4th Quarter).**
Earthwatch is a joint publication of IPPF, IUCN and UNFPA, reporting on population and the planetary environment. It is published quarterly with IPPF's *People* magazine and distributed separately by all three organizations in English, French and Spanish editions.

Barrio women in Colombia have combined to form the biggest community project in the world growing vegetables by hydroponics – a system by which the plants are fed by water and added *nutrients*. *Report and pictures by Sarita Kendall* in Bogotá.

Jerusalem is a barren windswept barrio of 100,000 people on the outskirts of Bogotá. Water is scarce: women have 20 minutes every other day to snatch their household ration from the communal tap. Dirt roads and breeze block houses trace brown, grey and fawn patterns across the hillsides. But here and there, rich green foliage decorates a terrace, a roof top, a small backyard.

"We'd never have thought you could grow things without earth. It's leaving us a profit too – 6,000 or 7,000 pesos (US$15 to US$18) every now and then. And that's if you only have 10 square metres, like me." Yolanda bent to avoid the sticky yellow flypaper hanging over her lettuce beds. "Those are nearly ready, a few days to go. We eat a lot of salads now."

More than 130 families in Jerusalem are growing vegetables with technology developed by Las Gaviotas. Ten years of experiments in the Colombian lowlands have produced simple, adaptable methods using cheap materials. "It's the biggest community hydroponics project anywhere," said an agronomist from Las Gaviotas. "In five months, they've produced 15 tons of vegetables – and most of them are just getting started. We subsidized the first people, but those joining now only get technical advice."

The vegetable beds can be made from old sticks of wood, and the plastic sheeting to line them is recycled from big flower farms around Bogotá. The plants grow in a mixture of rice husks and coal slag about eight centimetres deep, and have to be watered with nutrients every day. Although the solution – containing about 15 minerals and other elements – is bought commercially, it represents less than seven per cent of the cost of production.

The urban farmers are nearly all women. Those with small children can stay at home and earn some money, instead of spending a large chunk of their wages on bus fares to jobs the other side of the city. By the second harvest – lettuces are sold after 80 days – the investment has already paid off. About 40 lettuces can be grown in one square metre.

Down a steep track bordered by an open drain, Juana's roof blossomed with plants. A newcomer to the project, she had made her own growing beds and was extremely proud of some giant lettuces; three rabbits were being fed with vegetables which didn't reach sales standard: "We'll breed them, and eat them," she said. The rabbit waste fertilized a fruit tree at the side of the house, and with the extra

money that was coming in, Juana planned to build a latrine.

Carmen Salcedo had used rocks and old junk to forge tiny terraces holding hydroponic beds down the slope outside her house. In some places, there was a two-tier system, with plants needing shade underneath. Large drums held her water supply, which was measured out carefully to make enough nutrient solution for two days. Carmen has four daughters, and was delighted with the 20,000 pesos she had earned the previous month. Scattered among her celery and lettuces were a few onions and garlic. "They're 'friendly' plants, to keep away the insects," she explained.

The vegetables are watered with tap, rather than filthy river water, and no insecticides are used. This could become an important selling point in a country which is waking up to food contamination. A supermarket chain has agreed to take produce from Jerusalem, and has even suggested growing some exotic varieties. To make the system more efficient, and more profitable, some women are specializing in seedlings.

A hydroponics association has been formed. Sixta Tulia, the treasurer, was hand-pumping water up to the roof of the school, which is the show area. The first group of women learned their skills here last year, and now hydroponic cultivation has crept into the school curriculum. There are herbs, courgettes, peas, parsley, radishes, and even potatoes grown in deeper plastic sacks. Part of the terrace is covered over with plastic sheeting, which helps prevent evaporation and is essential to protect tomatoes on cold nights.

"Here the ones who work are the women," laughed Sixta Tulia. "Water is our biggest problem – look, there are no trees, there's no park. The rubbish truck comes once a week, but it doesn't go to the steep bits. Some people are recycling rubbish, and using the money to buy drugs for the dispensaries."

Next door to the school is the project centre. Backed by UN money, Las Gaviotas has rented a large room where supplies are kept and vegetables collected. Once a week produce is brought in, and weighed and paid for on the spot. With the sale of vegetables grown on the centre's roof, it will be possible to pay the rent, and, eventually, the wages of three hydroponics 'visitors' who keep records, advise growers and come up with interesting new ideas themselves. "We're learning a lot from people here," said the agronomist.

Behind the barrio, the hills are almost bare – the last stick of wood was taken for fuel long ago. "There's more awareness of the environment since the project," said Betsabe Susa, a hydroponics visitor who is also on the barrio health and solidarity committees. "We're going to flood Jerusalem with nutrition publicity. And there's a health campaign next weekend – the kids dress up, we clean each block and make rubbish containers and burn it. Everything helps." ■

RADIO SCRIPT

SOME SIMPLE WAYS TO BOOST VEGETABLE PRODUCTION

The information below is taken from:
Developing Countries Farm Radio Network Package 6
The transcript may be adapted for local radio broadcast or it may be used as a source of information for magazine and newspaper articles, leaflets, fact sheets, posters, extension visits, village or classroom lessons, flip charts, plays, stories, songs, etc.
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DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
For further information, contact:
The Developing Countries Farm Radio Network,
595 Bay Street, 9th Floor, Toronto, Ontario M5G 2C3 CANADA

Interviewers:	Sunil Hewavitharana, Assistant Director of Agriculture, Farm Broadcasting Service, Department of Agriculture, P.O. Box 636, Colombo 5, Sri Lanka.
	Sris Sriskandarajah, Agricultural Officer, Farm Broadcasting Service, Department of Agriculture, P.O. Box 636, Colombo 5, Sri Lanka.
Interviewee:	Sarath Perera, Instructor, Agricultural Training Institute, Bandarawela, Sri Lanka.

INTRODUCTION

Through the Developing Countries Farm Radio Network we bring you information on ways to increase food supplies for your family, or to sell - ways that other farmers have used successfully. On this programme today, we have some very practical hints that you could try in your garden to increase the yield of such vegetables as tomatoes and eggplant or brinjals. Here's the presenter, George Atkins.

ATKINS All over the world there are people who have found ways to get the plants in their garden to produce more and better vegetables. One of these people is Sarath Perera in Sri Lanka. Today we'll hear about some of his methods.

To start with, he has found that seedling vegetable plants will grow better in a seedling bed if the soil in the bed has something special mixed in with it. What he mixes in with the soil is half-burned rice husks (paddy husks)! Sarath told Sri Lankan farm broadcasters Hewavitharana and Sriskandarajah what he means by half burned rice husks.

PERERA When you say "half-burned" -- it's not completely burned rice husks, -- it's not ash, it should be brown color, half-burned, -- slightly burned.

HEWAVITHARANA It is more like charred rice husk?

PERERA That's right, it has given us very good results.

ATKINS So how do you mix these half-burned rice husks with soil for your seedling bed? -- And is there something else you should mix in as well?

Say you're going to mix up 10 buckets of soil mixture for a small seedling bed. Here's how to make it.

PERERA You need 4 buckets of topsoil, 4 buckets of compost and 2 buckets of half-burned rice husks. This has given us very fine seedling plants which grow very well indeed after transplanting.

ATKINS So Sarath's soil mixture for a seedling bed that will grow strong healthy vegetable seedlings is made up by mixing:

* 4 buckets of good topsoil
* 4 buckets of good compost and
* 2 buckets of half-burned rice husks

And now, he has a special hint about how to handle young seedling tomato plants when you are transplanting them from the seedling bed to your garden.

PERERA At the time of transplanting, this plant is, say about 2 to 3 weeks old. Still it's a very young tender plant and the stem has some hairs on it. If you hold it by the stem, its hairs get damaged. You can't see it at the time, but later on, the stem can start rotting right at the place your fingers held it. So the best way to hold it is with the leaves. You can hold the plant by the leaves, --- never hold the small plant by the stem.

ATKINS Sarath has done a special test on handling seedling tomato plants. -- In one plot he planted seedling plants without touching the stems, and for the other plot he held the plants by the stems when he was transplanting them. When the tomatoes were ready to pick, the plants he had held by the stems didn't produce as many good tomatoes as the others he had held only by the leaves. -- So now you know why Sarath says not ever to hold your young tomato plants by the stems.

But now, what about the place where you will be planting your young seedling plants? Sarath says that tomato and eggplants will grow better and they'll yield more if the soil you plant them in is good soil and well cultivated, -- quite deep.

PERERA These plants have a very deep root system so the soil must be fertile at the top and also at the bottom --- so that the root system can grow right down into the soil.

There are a lot of advantages:

* One thing, - often irrigation is not necessary,
* And another thing, - the root system can take up all the nutrients from the deep soil, -- this has helped in increasing yield.

HEWAVITHARANA Sarath, you said "deep". What do you mean by deep? How deep should this good soil be?

PERERA Well say a tomato plant grows to be 2 feet (60 centimetres) high. -- That is what you see above the ground. The root system can also grow about 2 feet (60 centimetres) down into the ground. So if soil conditions down there are very hard, these roots can't grow deep into the soil -- so you have to make the soil very loose so the root system can grow down into the soil, say about 1-1/2 to 2 feet (45 to 60 centimetres).

SRISKANDARAJAH If somebody plants one or two plants or maybe five plants in the garden and isn't able to plow so deep, what can he or she do about this deep root system?

PERERA Well it's as simple as this: -- you can dig a deep hole,

say 1-1/2 feet (45 centimetres) by 1-1/2 feet (45 centimetres) and 2 feet (60 centimetres) deep and you can fill the hole with a mixture of compost and soil, -- that's all you need to do. Then do the planting. -- This way, you'll get a very good root system. --- And that can result in a very high yield.

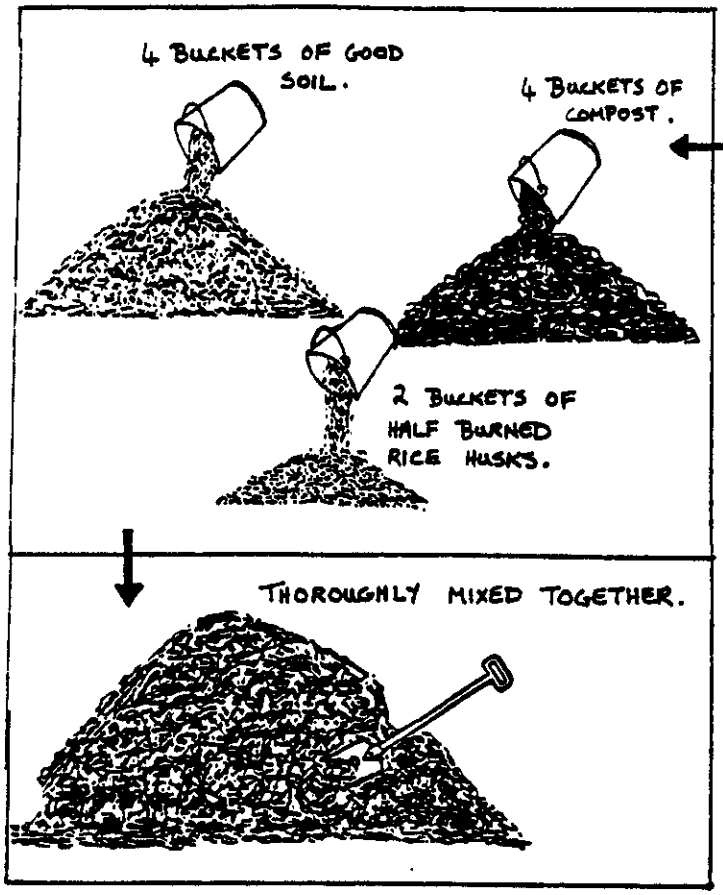
This is not only for tomatoes. -- Also for brinjals that some people call eggplant. Eggplant also has a very good root system. -- So when growing eggplant it will be the same thing and you'll get very good results by planting them in very deep soil with compost mixed well with the soil so the root system can develop very deep into the soil.

ATKINS Now finally, when the time comes for you to harvest your eggplant or brinjals, Sarath has something to tell us about that very strong stem that holds the fruit of the eggplant onto the rest of the plant. He says you should be careful not to try to break the fruit off by pulling it. If you do, you may pull so hard that the plant's important deep roots will be loosened in the soil. -- "That's bad," he says.

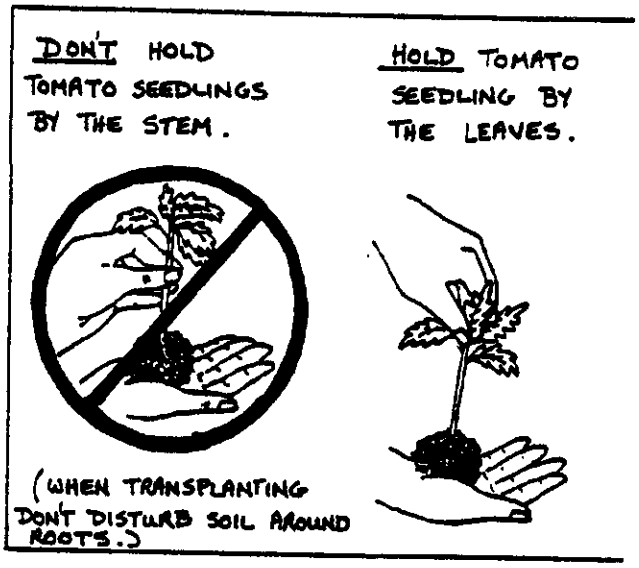
PERERA -- and it can give a very big shock to the plant because the root system can be damaged. So it's always better not to pull from the plant, always to use a knife, a blade or scissors or something like that to cut the stem of the fruit when you take it from the plant. This way, you are not harming the plant and you can increase the yield.

ATKINS So there you have four good hints from Sarath Perera for increasing yields from your vegetable garden.

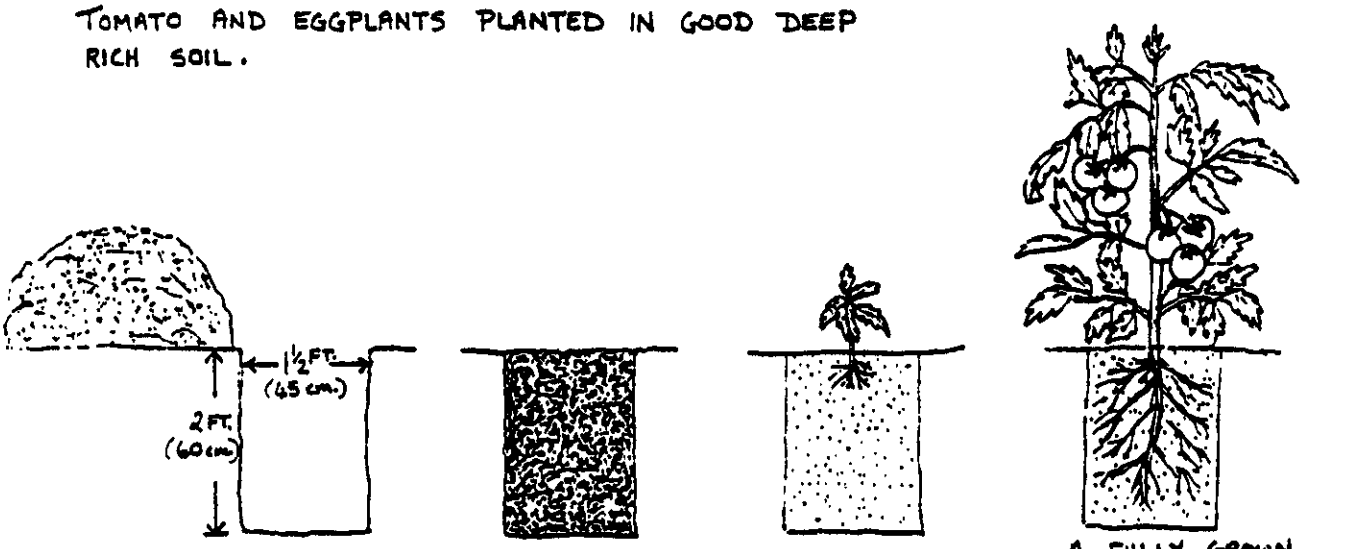
SOME SIMPLE WAYS TO BOOST VEGETABLE PRODUCTION : ILLUSTRATIONS



A GOOD SOIL MIXTURE FOR A SEEDLING BED.



TOMATO AND EGGPLANTS PLANTED IN GOOD DEEP RICH SOIL.



FILM REVIEWS

The reviews below are taken from:
MOVING PICTURES BULLETIN **Issues 3 (September 1988) and 5 (April 1989)**
MOVING PICTURES BULLETIN **is a quarterly guide to films on development and the environment produced by Television Trust for the Environment (TVE), 46 Charlotte Street, London W1P 1LX United Kingdom**

ROOTS OF HUNGER, ROOTS OF CHANGE

CHRIS BRONZE PLAQUE, COLUMBUS FILM FESTIVAL, 1986: AMERICAN FILM FESTIVAL FINALIST, 1986: VUES D'AFRIQUE AWARD, QUEBEC

COUNTRY: Canada YEAR: 1986 LENGTH: 28'

LANGUAGE: French, English

PRODUCTION CO: Asterisk Film & Videotape Productions Ltd for Church World Service

PRODUCER/DIRECTOR: Felicity Mulgan

DISTRIBUTORS: Asterisk Film & Videotape Productions Ltd, 703-110 Spadina Avenue, Toronto, Canada. Telex: 06 986766 and Church World Service, 475 Riverside Drive, New York, NY 10015, USA. Tel: (212) 870 2079

Looks beyond drought for the causes of hunger in one area of the Sahel, Keur Momar Saar in northern Senegal. The colonial inheritance and the introduction of cash-cropping are shown to have had a damaging effect on both the economy and ecology.

RETURN TO THE LAND

COUNTRY: Canada YEAR: 1988 LENGTH: 23'

LANGUAGE English, French

PRODUCTION CO CBC Enterprises

PRODUCER DIRECTOR: Nishnua Mathur

EXECUTIVE PRODUCER James Murray

DISTRIBUTOR: CBC Enterprises, C.P 6000 Succarsale A, Montreal, Quebec, Canada H3C 3A8. Telex. 05 561718 and 45 Great Titchfield Street London WIP 8DD Telex: 52 23771

The story of the remarkable Chundra Shaka Ketka and the Rural Agricultural Institute he runs in Narayangaon in India, teaching local farmers new methods of sustainable agriculture. Herds of goats, grazed indiscriminately, have destroyed much of the vegetation in the countryside, causing soil erosion and desertification. Tethered and fed in pens, they produce higher milk and meat yields. New plantations of selected tree species — sabubo and acacia — actually improve the fertility of the soil, as well as providing firewood and fodder for livestock. Cooking stoves cut back on the need for firewood and rudimentary biogas plants provide cheap burning fuel and fertiliser for the fields. And the work of the Institute is encouraging many people who have fled the country for the crowded shantytowns of the city, to return and make a new start in the countryside.

HOW TO GET HOLD OF THE FILMS

The MOVING PICTURES BULLETIN is designed to inform subscribers how to get hold of films on development and environment issues.
TVE cannot supply you with these films (unless TVE is listed as the distributor). You must contact the distributor who address is listed for each film, keeping in mind the following points:
AVAILABILITY: Unless otherwise specified, the distributor deals with requests for both TV sales and non-theatric use (ie showing the films to a non-fee-paying audience). Some films may only be available for broadcast. Films available for non-theatric use are usually supplied on VHS cassettes which you can keep. Some films can be borrowed free of charge or hired for a small fee.
FORMATS: Most films are available on all video cassette formats, (U-Matic High Band, U-Matic Low Band, VHS and Betamax), and on 1" tape for broadcasters. Some films may also be available on 16 mm. Always specify which format you require.
LANGUAGE VERSIONS: If the film is not available in your language, you can usually obtain an international version (ie sound without commentary) and a commentary script which can be translated. This enables you to dub the film into your own language.

TEACHING RESOURCE

PRIMARY SCHOOL AGRICULTURE by Herbert Bergmann
Vol. I: Pedagogy; Vol II: Background Information

These are publications of:
Deutsches Zentrum fur Entwicklungstechnologien - GATE
and Division 22 - Education, Science and Universities, Sports
in: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH

Eschborn 1985.
Published by Friedr. Vieweg & Sohn, Veragsgesellschaft mbH, Braunschweig
For further information, please contact:
Deutsche Zentrum fur Entwicklungstechnologien (GATE), Dag-Hammarskjol-Weg 1
D-6236 Eschborn 1, Federal Republic of Germany

This excellent manual is intended for teachers who are teaching agriculture or gardening to the upper classes of primary school. Its aim is to provide a realistic and up-to-date pedagogical background to primary school agriculture. It is based upon the principle that the content of teaching should be drawn from students' local environment.

The manual is based upon research and project work carried out in Cameroon, but since the two major types of environment that are treated -namely tropical rainforest and humid savannah - are typical for the humid tropics, the manual is of value in other African countries with these natural conditions, as well as in other tropical regions.

Volume I, entitled *Pedagogy* (144 pages), is divided into three parts:

* pedagogical foundation
* teaching methods
* examples for practical use

Under *Pedagogical Foundations*, several approaches regarding the inclusion of agriculture as a subject in primary school are discussed; a short analysis of agriculture in Cameroon and an East African country is provided; a scientific pedagogical approach is proposed - an approach adopted throughout the manual.

Under *Teaching Methods*, topics of practical importance in everyday school life are considered: for example, the "scheme of work", the structure of teaching units, various indoor and outdoor activities as part of primary school agricultural instruction, the use of scientific methods of observation and experimentation etc.

These discussions, which are sometimes of a general nature, are given a practical basis in part three. It contains a number of lesson notes and teaching units organized according to the principles laid down in the first two parts. In addition, it

contains a few background information texts written by teachers. These notes illustrate how classroom teaching and practical work may be combined.

Volume II, entitled *Background Information* (190 pages), provides factual information on questions which may arise when teaching agriculture. It should only be used together with volume I. It consists of three parts:

* farming methods;
* crops;
* crop storage.

Part 1, *Farming Methods*, is intended as a documentation on various agricultural methods. In the first section, the objectives are discussed, i.e. why pupils should learn about farming methods and what results are to be achieved.

This is followed by information about traditional farming, covering such topics as clearing and tilling, planting and sowing, weeding and tending, and, most important of all, multiple cropping and crop rotation. Teachers will find ample information about these aspects of traditional farming. Thus, it should be easy for them to study farming activities near the school and to contrast them with distant regions.

The section on traditional agriculture ends with a number of observational questionnaires and survey instruments to guide teachers in outdoor observational activities concerning traditional farming.

The next section deals with Scientific Agriculture. It compares modern agriculture as practised in the industrialized countries with the Scientific Agriculture advanced in the subject of "Rural Sciences" and with traditional agriculture.

The last section outlines developments in tropical agriculture, showing that there is a general tendency to encourage a new and unbiased approach to traditional African farming. Some of the most interesting research results in this area have been summarized; the section ends with suggestions on how to experiment with this new approach in school.

Part 2, entitled *Crops*, should be used when a teacher needs information about the crops being grown on the farm. Twelve crops are described and illustrated: the plant, its origin, farming the crop, and processing are the topics covered for each plant. It also provides general information on the range of yields per hectare according to natural conditions and tending.

Part 3, entitled *Crop Storage* (written by Richard Butler), gives an account of traditional and simple, modern methods of storage and pest control. The language level is such that teachers may use it as reading material in the final classes.

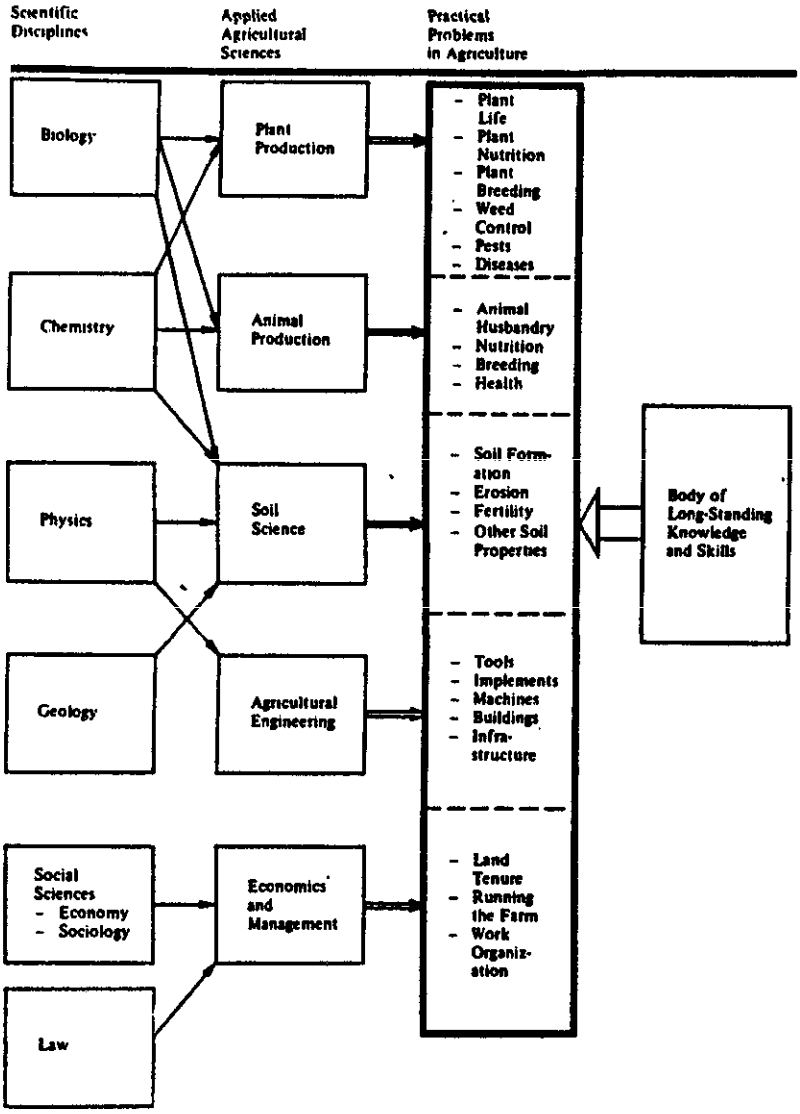
Here are some excerpts from Volume I, *Pedagogy:*

From part 1: *Pedagogical Foundations...*

Exploring the link between Science and Agriculture

Agriculture draws upon several scientific disciplines. Yet it "does not rely on science alone. It draws on a body of long-standing traditional experience and skills which cannot be replaced by science."

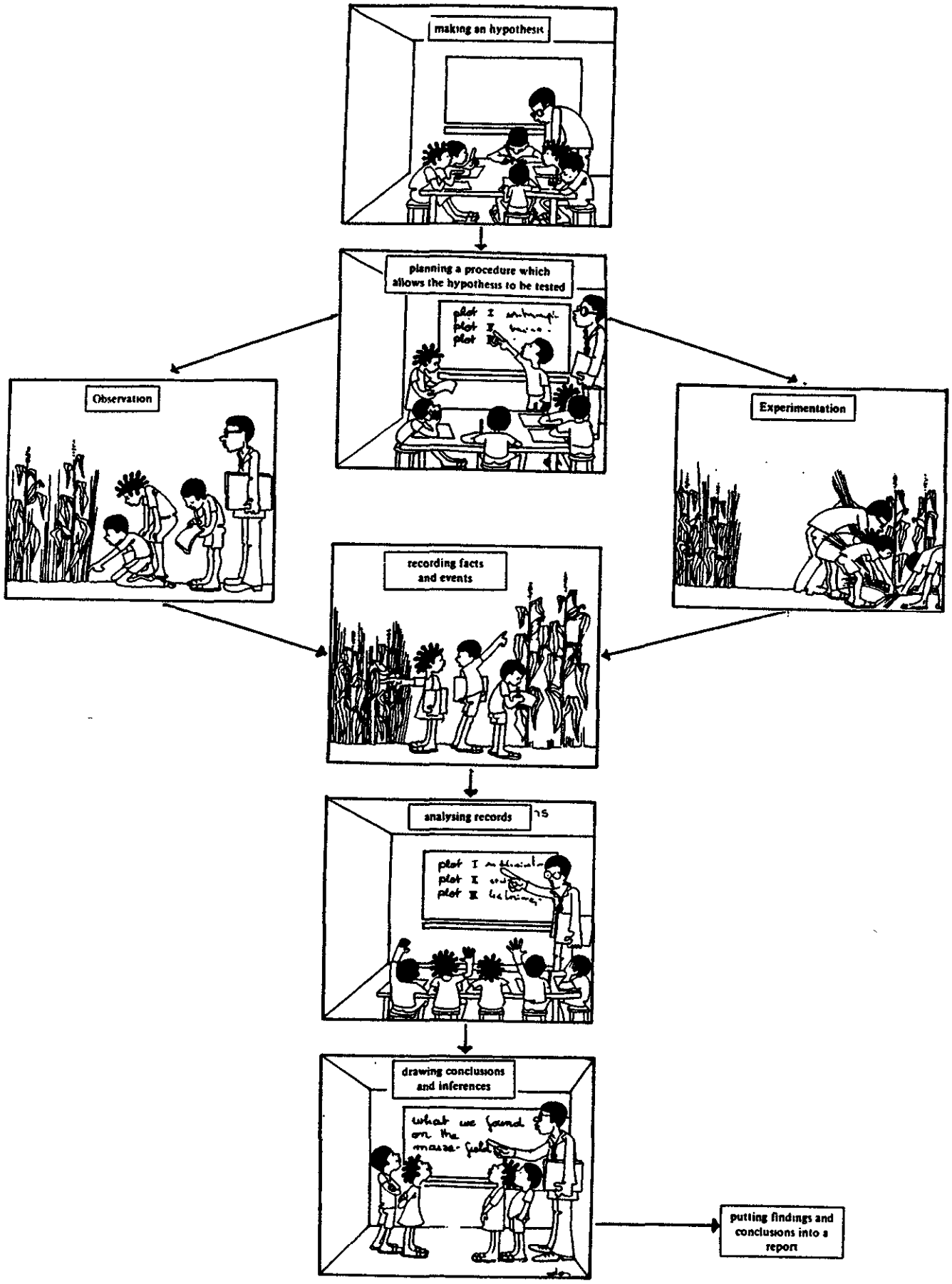
The diagram below shows the relationship between agriculture and science:



"It seems clear that all the basic scientific skills can be taught through primary school agriculture."

The illustrated flow chart shown on the next page demonstrates this in a rather general way. (Detailed examples are given later in the manual.)

Basic Scientific Skills Taught Through Agriculture



"The emphasis in science teaching should be on method rather than on content. It would be possible to memorize a large amount of scientific knowledge. However, without an elementary grasp of the scientific method one might not be able to apply such knowledge to practical problems. On the other hand, somebody who masters the basic scientific approach will be in a position to find out for himself answers to problems in everyday life which he would not find in books. He would understand that a scientific approach to problem solving is open to everyone.

In order to understand better what is meant by the scientific method let us look at the meaning of science. The Oxford Advanced Learner's Dictionary offers the definition:

"Knowledge arranged in an orderly manner, especially knowledge obtained by observation and testing of facts; pursuit of such knowledge."

Significantly, this does not refer to any content of knowledge but rather to its orderliness and to the methods by which it was obtained. Therefore we are fully justified in stressing the need to familiarize children with elementary scientific methods rather than with a mass of findings.

Science based education, if well done, enhances personal self reliance. It will not only enable a person to take a rational stand in matters concerning traditional ways and beliefs, it will also protect him or her against uncritical acceptance of new methods and proposals.

Thus, in agriculture, a farmer with a basic scientific outlook will retain from tradition whatever seems valuable after comparison with other ways of doing things. On the other hand, the same person will carefully listen to the advice of the agricultural extension agent and ask for proof. Maybe he sets up his own little experiments in order to test the innovation under local conditions. In this way he would be better protected from risks than if he accepted the new ideas and methods mainly because the extension man is a government employee."

Objectives for Primary School Agriculture

Here is a set of potential objectives from which curriculum developers may choose and which could be complemented by other ones.

General Objectives		
Knowledge and Skills 1. Pupils should acquire basic facts relevant to agriculture. 2. Pupils shall master basic scientific principles and procedures. 3. Pupils shall be able to apply basic scientific principles and procedures to agricultural problems.	– *Attitudes* 4. Pupils shall accept the need for change and adaptation. 5. Pupils shall develop the self-confidence necessary to survive in a changing environment. 6. Pupils shall develop the motivation to participate actively in the improvement of	their environment. 7. Pupils shall develop the social skills and attitudes necessary for co-operation with other members of the community and nation.

Specific Objectives in Science Education Through Agriculture

Most of these objectives deal with study skills. As such, they are valuable beyond their field of application, agriculture. The more they are pursued, the better will pupils be prepared for further education after primary school.

– *Basic Scientific Principles*

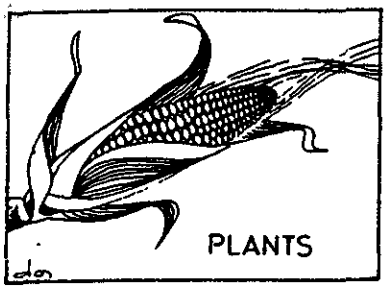
1. Logical thinking.
2. Curiosity and open-mindedness.
3. Intellectual honesty.
4. Acceptance of the fact that knowledge is relative: what is thought to be right today may be proved to be wrong tomorrow.
5. Accuracy in scientific procedure.
6. Insistence on factual evidence.

– *Basic Scientific Procedures*

7. Pupils will be able to make a simple hypothesis, stating a relationship between two phenomena.
8. Pupils will be able to design a simple way of testing such an hypothesis. "Simple" here means simple apparatus and low or no costs.
9. Pupils will be able to collect information by way of experiment, survey work, direct observation.
10. Pupils will be able to measure properties such as extension, volume, and weight of objects.
11. Pupils will be able to record their observations. Record-keeping may be in written or in graphical form.
12. Pupils will be able to analyse observations. This essentially means grouping of information for comparison, calculating elementary statistics (mean, percentages, simple ratios).
13. Pupils will be able to make systematic comparisons according to initial hypotheses.
14. Pupils will be able to draw conclusions from comparisons.
15. Pupils will be able to report their findings in such a way that the reader can repeat the whole process by himself.

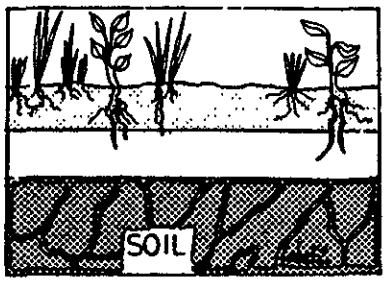
Specific Objectives in the Field of Agriculture

These are objectives which cannot easily be generalized beyond the field of agriculture. The more important they become, the more primary school agriculture becomes pre-vocational training.



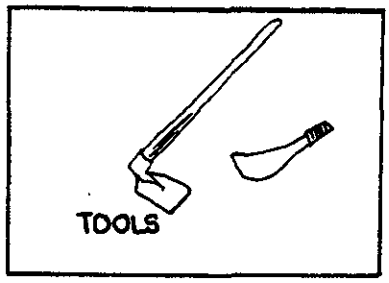
Knowledge
- Parts of a plant
- Life cycle of plants
- Crops and their requirements
- Modes of propagation
- Diseases and pests
- Plant improvement: breeding and selection
- Main crop associations
- Sources of improved planting material

Skills
- Propagate plants by seeds, suckers, cuttings etc.
- Distinguish suitable and unsuitable patterns of mixed cropping
- Identification of pests and diseases
- Prevention and cure of pests and diseases (elementary)



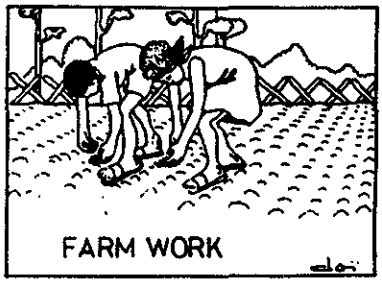
Knowledge
- Properties of soil
- Conditions of soil fertility
- Dangers to soil fertility
- Improving soil fertility
- Soil types

Skills
- Take and analyse a soil sample
- Manuring and mulching
- Simple erosion control
- Compost work, green manure, fallow and cover crops, chemical fertilizer
- Selecting crops adapted to a few soil types



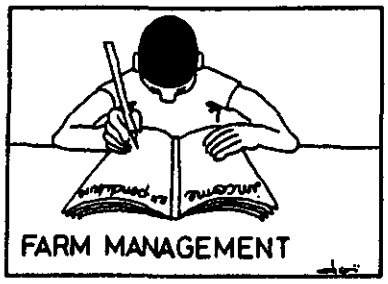
Knowledge
- Common tools
- Maintenance of tools
- Measuring equipment
- Animal-powered equipment
- Main agricultural machines

Skills
- Handle some common tools
- Correctly care for tools
- Making and using simple measuring equipment



Knowledge
- Set of operations required for different farm crops
- Sequence of farming operations for different crops
- Time required for different farm operations
- Rejuvenation of tree crop farms

Skills
- Make a plan for the farming of a given crop
- Laying out a farm plot with right angles
- Doing light tillage as required by the crops farmed
- Preparing nurseries for vegetables (e.g. tomatoes, lettuce), for coffee, cocoa, or oil palms according to area, for Eucalyptus and fruit trees, etc.
- Thinning
- Earthing up
- Weeding
- Harvesting
- Simple methods of drying and storage



Knowledge
- Notions of profit and loss
- Elements of planning

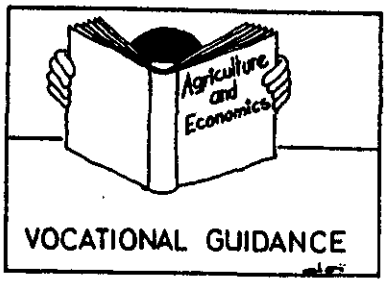
Skills
- Calculate profit and loss of the school farm (the class plot)
- Make a simple time-table for farming a standard crop
- Keep records

Knowledge
- Division of labour by sex and age
- Forms of group work

Skills
- Draft the regulations of a mutual help group
- Draft the rules for a contract job

Knowledge
- The local market
- Local measures of weight and volume
- The Licensed Buying Agent
- Sale on credit before the harvest
- The Cooperative Society
- The Produce Marketing Board

Skills
- Convert local measures into standard measures
- Compare prices
- Use and check a balance
- Establish and check a receipt
- Calculate the interest on a loan



Knowledge
- Agricultural employment
- Information on rural training schemes
- Information on sources of agricultural knowledge

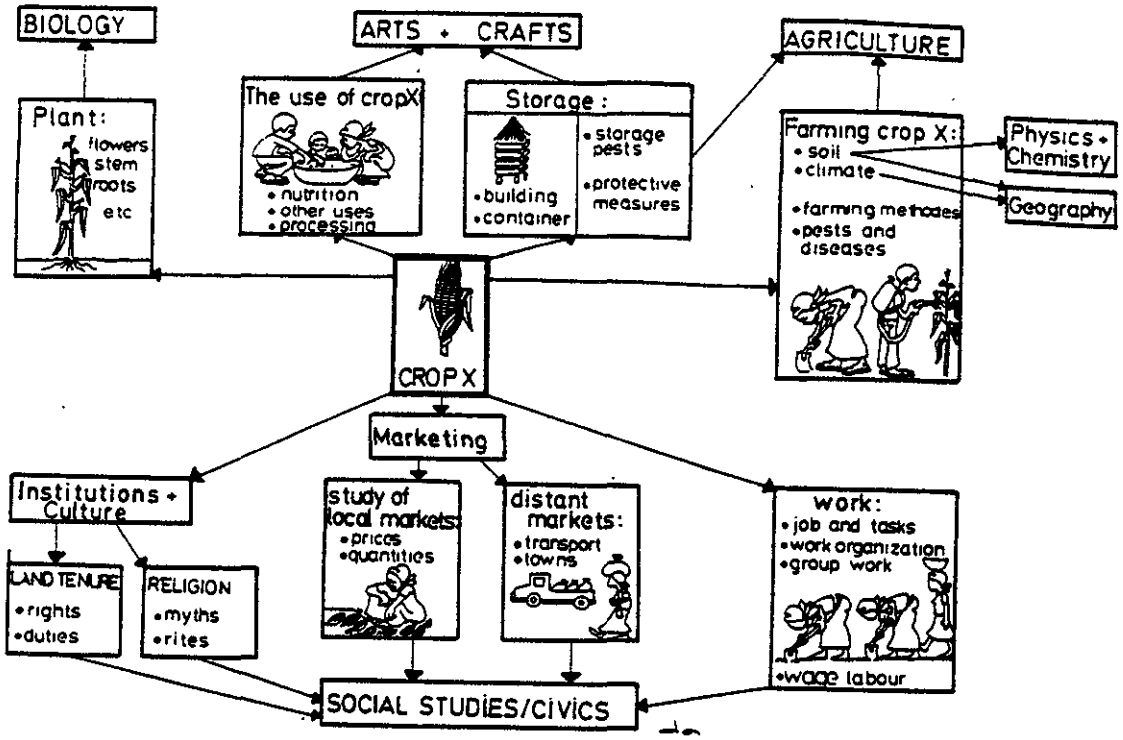
From part 2, *Teaching Methods*:

Scheme of Work

"...Topics in...rural science are related in such as way that many topics can be starting points for a number of lessons, the sequence of which pupils and teachers can determine together according to their interest and liking. This can best be illustrated by the *topic web*.

The topic web is a diagram organized around a central theme, e.g....*The Maize Crop*..[see diagram on the next page]. Such a diagram shows how the main topics are related to the central theme and to each other. It also shows how the various topics are related to the traditional school 'subjects'. The topic web carefully avoids any time sequence. Pupils and teachers who want to study the central theme would start with a brief introduction and are left to decide which related topics to study at what time. Therefore, the topic web is not yet a scheme of work. It is like a set of building materials without any exact plant for joining the pieces together. All a teacher would have to do is to decide beforehand on how many periods he/she

A Topic Web for "The Maize Crop"



wants to use for the whole theme. How this time is divided up among the various elements of the topic web is left to the whole class (or the teacher alone if he/she feels he/she is the only one who should make decisions).

Yet the topic web is not sufficient for the teaching of agriculture if practical farming is involved. Farming a crop or a crop association imposes a definite time schedule on the practical activities, from tilling to harvesting and storage or sale. There is a principle which would seem to make sense, educationally:

Practical work and classroom teaching in agriculture should be closely connected.

This means that the work on the school farm should be used in classroom lessons. This has the immediate advantage that the pupils' immediate experience can be utilized during lessons, and practical work is seen to be an outcome of teaching/learning in the classroom. It has an important consequence, however: the scheme of work for teaching agriculture will by and large be determined by the growth cycle of the crop(s) farmed by a particular class. This departure from the topic web where timing and sequence of lessons can safely be left to teachers and pupils."

The integration of practical work and classroom work in agriculture, as well as the integration across school subject boundaries is shown in the example of an integrated scheme of work provided on the next page.

Integrated Scheme of Work: Maize and Beans Intercropped

continuous and systematic observation and recording of local maize farming
continuous and systematic observation and recording of work on school farm, prices for maize and beans on local markets

Month	Farm Work	Sciences Using Observation as their main Method	Civics and Social Studies
October	superficial *clearing*, compost work	the nutritive value of maize and beans – different types of *foodstuff* Cameroonian dishes with maize and beans; maize beer; planning the farm work: single cropping versus multiple cropping dwarf beans or climbing beans	the concept of land tenure – how people get land for maize farming
November	compost work,	– *compost manure:* the role of micro-organisms in plant decay, plant food and how compost supplies it – experiments showing the composition of plants: water, dry matter, ashes	
December	outlay of plot: clearing paths, fencing, compost work	– fencing material: availability, strength	social reasons for fencing: conflict management (boundary conflicts, thefts, damage done by domestic animals)
January	fencing, final clearing	– methods of clearing; – burning and its effect on soil fertility, various methods of burning, prevention of bush fires; – the effect of decaying grasses on soil fertility	division of labour between sexes: men's and women's work in maize growing; forms of labour: hired labour and mutual aid groups in maize farming
February	getting seed material, final clearing, pegging,	– germination test with the seed material chosen – at the end of the month: plant a very small plot to see the effect of planting 1–2 weeks before the rains	solidarity: how mutual work groups operate, how the supply of seed material is organised: – individual storage – local market – Agricultural Extension Service, – Agricultural Research Stations
March	tilling, planting, mulching	experiment: maize as a single crop, beans as a single crop, maize and beans intercropped; comparison: germination of a maize grain and a bean seed (planting in a seed box at the same time as planting on farm is done) experiment: hybridisation of maize (cross pollination); the soil: air and water in the soil, the reasons for tilling, different ways of tilling and their effects, how to till with minimum effort, the effect of mulching, *end-of-term comparison:* timing of operation, methods, inputs, work arrangements, reasons for difference.	traditional rites associated with planting maize
April	weeding	the action of weeds on crops: the idea of competition for water and food; comparison: weed growth in single and mixed cropping.	
May	weeding, thinning, fertilizing/ manuring, earthing up	observation of stem borer attack: introduction or revision: insects: observation of diseases on leaves – virus and fungus diseases on maize; how to fight them, reason of thinning, principles to be observed in thinning; plant nutrition: getting additional food for plants, introduction or revision of the chemical fertilizers; the application of manure and/or fertilizer to maize and beans on a few different types of soil; soil exhaustion by maize grown without fertilizing (planning an experiment for the following year)	the social reason for the use of manure/ fertilizer: population density – settlement pattern – shortening of fallow period – soil exhaustion
June	earthing up, building/ repairing storage, harvesting beans	observation of stem-borer attack – the use of chemicals in fighting insect attack; different types of roots in maize – the reasons for earthing up; preparing for the harvest: revision: the action of micro-organisms on plants; introduction or revision: fungi, rats, principal dangers with maize storage: rotting, getting mouldy, insect attacks, rats; principles of good storage for maize, methods of drying and storing maize	providing for the future: the social importance of storage
July	harvesting beans and maize, drying, storage	*end-of-year comparison* between local farming and school farming: timing of operations; end-of-year revision: introduction or revision of the concept of life-cycle of a plant-the complete life-cycle of maize and beans, comparison of yield for single cropping and intercropping	aspects of land tenure: the landlord's basket of maize (some areas of North-West Province) saving and investment: seed material; the solidarity: sharing one's harvest; the proper use of income: planning the use of the income derived from the maize harvest

continued on next page...

Month	Geography		Language	Mathematics
October	maize and beans growing areas in Cameroon, maize growing countries in Africa, maize in other parts of the world	develop texts which summarize the observations made on the school farm and with local farmers	preparation of farming activities: introductory text using the vocabulary	measurement: outlay of the compost heap (shape, permeter, area, volume)
November			phrase an application to a traditional landlord for farmland	
December	a country with fences – Bamileke land population density, settlement patterns, land use system		local names for maize and beans	measurement of the plot: right angle, perimeter, area, triangle, circles, trapezium, drawing to scale, the concept of gross and net: farm area and planting area; calculate the amount of material needed for fencing; *end-of-term* analysis of quantitative data recorded throughout the term
January	regional differences in the division of labour between sexes		work out a text explaining why and how you fence	calculate labour requirements and costs associated with local work groups for clearing of farms.
February	Agricultural Research Stations in Cameroon: The location of Agricultural Extension Services		write a letter to an Agricultural Research Station, to the Agric. Extension Officer asking information about suitable maize and bean varieties.	*standard units:* the seed rate for maize and beans; farming for single cropping, mixed cropping, and different planting distance, ratios, proportions.
March				the concept of average, the cancelling out of errors with large numbers of observations: average planting distance for maize, average area per plant, average germination time; densities: e.g. seeds/unit volume end-of-term analysis of quantitative data
April				simple graphing
May	map work: population density and length of fallow period in the province, in Cameroon, map of soil types		write a report to the Agricultural Extension Service about diseases and insect attack, apply for chemicals to fight the pests; read an extension leaflet about fertilizers	find out number of affected plants (sampling), establish proportion of affected plants; calculate from the amount of fertilizer needed per plant the total amount of fertilizer, calculate costs, simple graphing
June	different types of maize storage in Cameroon			reading and reproducing a simple plan, measuring for the storage unit, calculate the amount and costs of materials needed,
July	where people drink maize beer in Cameroon, crop calendars in different parts of Cameroon			measuring weight: the concepts of gross and net: weight of unshelled maize versus weight of shelled maize, end-of-year analysis of quantitative data recorded throughout the year; evaluation of experiments; analysis of price fluctuations for maize on local market throughout the year; P5 or P6: simple economic analysis of maize and beans farming

Breaking down a Scheme of Work into Units

"Farming a crop or a crop association is a teaching project which for some crops extends over a whole academic year, sometimes more, for others over one or two terms. Such a project must be divided into smaller units, e.g. farm preparation, farm care, harvesting, storage and processing, according to the seasons. These units in turn consist of sub-units built around one practical activity - practical work or observation. Sub-units are made up of different lessons, some of them pure classroom lessons, some of them outdoor activities....The diagram on the right illustrates how units, sub-units and lessons fit together.

Level	time needed	
Project	determined by growth cycle of crop	e.g. Maize Farming - Planning – Implementation – End-of-year-revision
Unit	varies with duration of main farm operations	e.g. farm preparation – planting – farm care - harvesting – storage, processing, marketing
Sub-units	4 - 6 lessons	built around a practical activity, e.g. planting, weeding, observation of plant growth, of insect attacks etc.
Lesson	40 - 55 minutes	types of lessons: preparation of practical activity, practical activity itself, follow-up lessons

"The basic element in this approach is the sub-unit. Lessons in a farm project can only rarely be regarded as self-contained, independent blocks. The sub-units, on the other hand, with their sequence of classroom and outdoor activities can be regarded as relatively self-contained, ending with some conclusions at least..."

"...Since a sub-unit is a sequence of lessons organized around one or a few closely related practical activities, objectives should be defined at this level. [Objectives for units are general in nature.] During lesson planning, the various objectives can then be apportioned to single lessons."

From part 3, *Examples for Practical Use:*

An example of a sub-unit

Here is an example of a sub-unit. It is built around the activity of harvesting a maize crop. It consists of ten single lessons, but the objectives are defined for the sub-unit as a whole. (The objectives for this sub-unit are discussed in part 2, chapter 2: "The Structure of Teaching Units"). These notes try to show how the aim of using school farm work can be achieved.

"Harvesting is a very important moment in any farm project. The crop harvested is the ultimate measure of success or failure. It is therefore a particularly good moment to revise and critically assess the work done on the crop harvested. Teacher and pupils can assess critically whether they made any mistakes in farming."

(The excerpt below is a combination of text appearing in parts 2 and 3.)

1. Objectives Concerning Farm Work

- harvest a crop of maize,
- weigh the crop in preparation for storage and drying.

2. Objectives in Agriculture

- revise and deepen knowledge of maize farming,
- identify possible causes for the yield recorded,
- discuss ways and means of reducing losses,
- discuss the main pests and diseases affecting maize,
- teach about weights and weighing,
- teach about the concept of yield per standard unit.

3. Skill Development

1. Study Skills
- do observation,
- sort and grade objects,
- keep records,
- analyse observations and draw conclusions,
- summarize results (use of graphs, charts, and summary reports).

2. Social Skills
- team work during practical work and during classroom work,
- work organization.

These objectives are divided among the lessons of the sub-unit and broken down into more detailed objectives:

A. Introductory Lessons

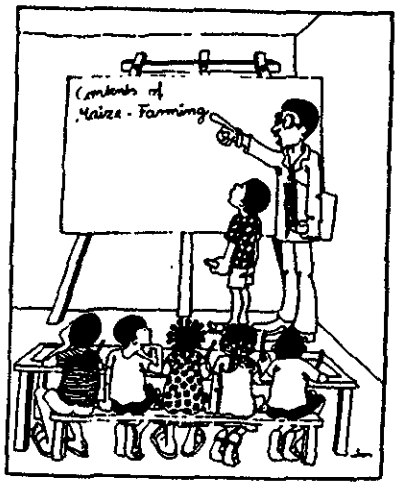
1. Lesson on Content Preparation

Objectives
- Pupils recall the main steps in maize farming.
- Pupils know the main pests and diseases of maize in the farm.
- Pupils know the signs of bird attacks, weevil attacks, and fungus diseases in maize.
- Pupils have an observation sheet for sorting and grading maize cobs.
- Pupils are able to use a balance.

Teacher's Preparation
- Specimen of maize cobs showing the various types of damage are taken to the classroom.
- A table for collecting data on maize is prepared and a sample drawn on the blackboard.

Lesson
Teacher asks pupils about their maize plot: planting time, preparations for planting, signs of maturity, when are cobs ready to be eaten green, treatment of maize after harvesting.
- Teacher and class recall how last year's maize harvest had been handled.
- Teacher discusses damages to be observed on the maize cobs *using specimens from the farm*. The main damages are those due to

Introductory Lesson



birds, to weevils, and to smuts. In connection with smuts, fungus diseases are discussed or revised.

If weighing has been taught earlier a short revision will be sufficient. If weighing is a new topic, an extra lesson in mathematics is necessary in order to introduce it.
Teacher draws the observation sheet on the blackboard and explains using the specimen cobs.

Observation sheet

Cobs Damaged by			Good Cobs		Cobs
Birds	Weevils	Smuts	Big	Small	Total

2. Work Organization

Objectives
– Pupils know the various tasks to be performed during harvesting: harvesting, dehusking, assembling the harvest row by row, sorting and grading, counting cobs, recording observations, weighing.
– Pupils are grouped in teams of two or three.

Lesson: Explanation of Work to be Done on the Farm
The teacher explains in detail the tasks to be performed on the farm:
– harvesting and dehusking maize cobs row by row,
– piling up the harvest of each row at the numbered peg of that row,
– sorting and grading the cobs according to size and damage observed,
– counting the number of cobs in each group,
– recording the result in observation sheets,
– carrying the different groups of cobs to the weighing stand,
– taking turns in weighing.

The class is organized into teams of 2 pupils each and given numbers according to the rows in the school farm. The team leaders copy the observation sheet on the blackboard into their exercise books, using the measurements of columns previously determined by the teacher for uniformity.

B. Practical Work – Harvesting

Objectives
– Pupils harvest the maize.
– Pupils grade and sort the maize row by row.
– Pupils weigh the maize row by row.
– Pupils record the results of grading, sorting, and weighing row by row.

Teacher's Preparation
– The rows on the school farm are pegged and numbered.
– A stand is made for weighing.

Apparatus
A spring balance.
Paper and pencil by each pupil.
Utensils for carrying of maize (children are instructed to bring them from their homes on the day of harvesting, e.g. buckets, small basins or baskets).

Lesson
The teams take up their position at the end of the rows assigned to each of them. They carry out their various assignments. The teacher supervises the teams and helps where necessary.
The teams carry each group of cobs separately to the weighing stand and heap them according to grade and quality.

All the maize cobs damaged by smuts should be piled at a corner of the farm and burnt. The other heaps of maize cobs should be weighed separately. During the process pupils should take turns in weighing each heap and record the weight in the observation sheet.

C. Follow-up Lessons

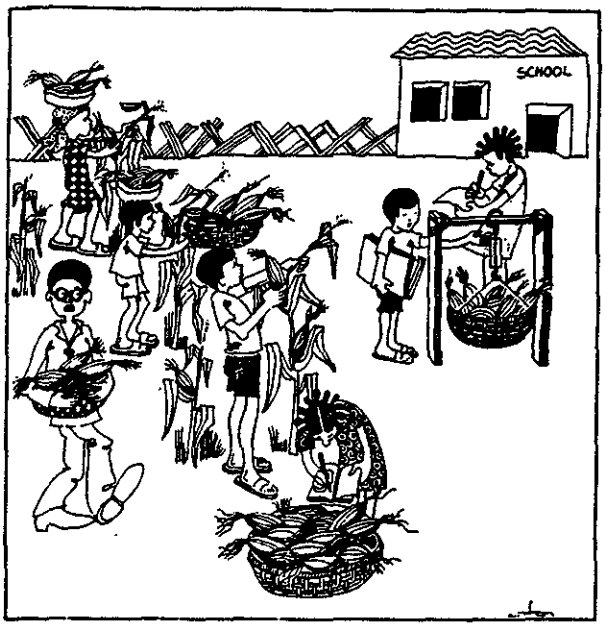
1. Assembling the Observations

Objectives
– Pupils and teacher have the complete picture of all observations (row by row).
– Pupils know the total number of cobs and the total weight harvested, according to the various grades of cobs and for the whole farm.
– The observations are assembled in a way which permits further analysis in class.

Lesson
Time: Immediately after farm work.
Teacher draws the observation sheet on the blackboard. The teams read out their observations starting with row 1 and going up to the last row.
Teams are asked to copy the complete table of observations into their exercise books. A number of sums are given out to the teams to work.

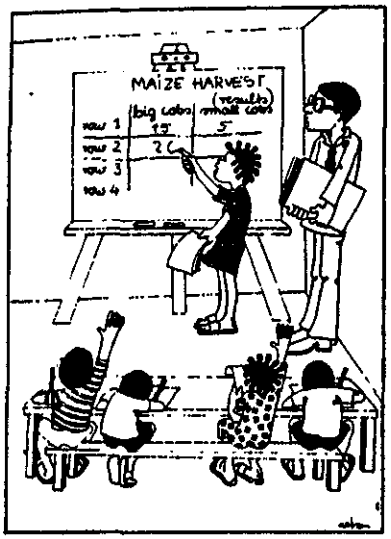
2. Lesson on Yield

Objectives
– Pupils know the yield per hectare realized on the farm,
– Discuss why it is useful to know the yield



Practical Work: Harvesting

per standard area (hectare or square meter): farm.
– Pupils assess the yield in comparison with maize yields elsewhere.
– Pupils list the main factors responsible for the yield of maize.



Follow-up Lesson

Lesson
– Discuss why it is useful to know the yield per standard area (hectare or square meter): the need for comparison in order to know whether the result was good or bad.

– From the yield recorded work out the yield per hectare.

Example:
Total yield of plot = 194 kg
Area of plot = 2245.5 sq. metre
Yield per hectare:
If 2245.5 sq. metres yield 194 kg,

1 sq. metre yields $\frac{194}{2245.5}$ kg, and

1 hectare = 10000 sq. metres yield

$$\frac{194}{2245.5} \times \frac{10000}{1} = 863.95 \text{ kg.}$$

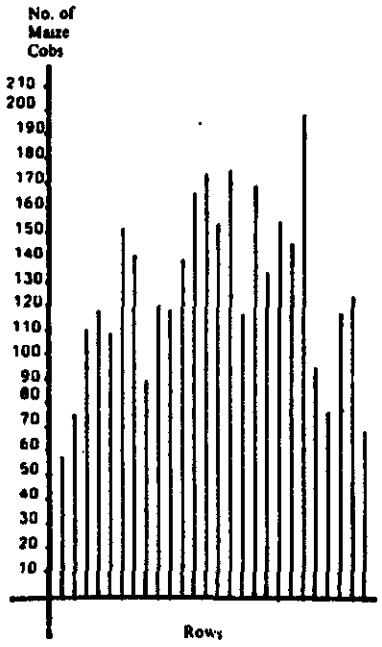
– Compare previous yields from the school farm from records if available. Is this year's yield better or worse?
– From the above figures showing maize yield, compare with other parts of the country (for data on maize yields see volume II, part II on crops).
– Discuss whether the yield was poor or good.
– Get reasons for good or poor yield from the pupils.
– List out the factors affecting the yield: soil fertility, climatic conditions, seed material, timing of work (planting, weeding, earthing up etc.), pests and diseases.

3. Lesson Topic: How did Soil Fertility Affect our Maize Crop?

Objectives
– Pupils are able to assess soil fertility at the beginning of maize farming in term of initial soil quality, previous farming, and activities to maintain or improve soil fertility.
– Pupils are able to read a graph and draw conclusions.

Lesson
Discuss with the class
– whether the soil had already been exhausted by previous crops,
– what had been grown before (rotation),
– what the class had done to improve soil fertility (mulching, manuring, chemical fertilizers, leguminous crops, fallowing),
– whether the soil fertility is the same on the whole farm.
The last question can be tackled by looking *at the number of cobs harvested row by row.* Are there areas with fewer cobs per row than others? A graph is developed in order to answer this question (Graph 1). If so this could be attributed to differences in soil fertility within the plot unless other causes can definitely be established.

Graph 1: Total Number of Maize Cobs (per Row)



Conclusion
a) How did soil fertility probably affect the yield?
Let the class develop a few sentences which they copy into their Rural Science exercise books. Write into summary table of factors (see summary table of factors, p. 32).
b) If there are differences in soil fertility – What can we do? Discussion with the pupils.

4. Lesson Topic: How Did the Climate and the Seed Material Affect the Yield?

Objectives
– Pupils are able to check the water requirements of maize during its growth against the distribution of rains during past seasons (in terms of observations about particularly dry and wet periods).
– Pupils are able to discuss the properties of the seed material used.
– Pupils recall methods of selecting seed material.
– Pupils are able to state an hypothesis on the effect of seed material on the maize crop.

Lesson
Revise water requirements of maize – quantity and timing.
Was there much rain or was it unusually dry?
Did the rain fall at the right time?
Conclusion – How did the rainfall probably *affect our yield?*
Let the class develop a few sentences which they copy into their Rural Science exercise books. Write into summary table of factors.

Seeds
Revise the following
– Variety of maize planted and the yields to be expected from this variety.
– Origin of seed material (school farm, homes, research stations).
– Method of selection of seeds – conscious selection of best grains or using whatever was available.

Conclusion
How did the seed material probably affect our yield?
Which aspects (variety, origin, method of selection) should make for good yields, which ones should make for poor yields?
Let the class develop a few sentences which they copy. Write into summary table of factors.

5. Lesson Topic: How Did our Work Schedule Affect Yields?

Objectives
– Pupils are able to draw conclusions from a comparison between an ideal crop calendar for maize and the actual work schedule as documented in the Labour Records of past season.
– Pupils are able to identify farm operations that were so badly out of time that they might have affected yields.

Lesson
– Discuss in general the idea of working to schedule.
– Develop a time chart on the blackboard which makes the comparison between planning and actual work possible (see p. 31).
– Revise the correct timing of work for maize farming, according to the beginning of

Time Chart for Maize Farming (Specimen)

Season: Dry Season 1977, late Maize

Month	Best Time for the Work	Time when Work was in fact done
September 10 20 30	Sept. 15 Planting	
October 10 20 30	Oct. 23 First Weeding	Oct. 6 Tilling Oct. 13 Planting Oct. 15 Last Rain
November 10 20 30	Nov. 13 Second Weeding	Nov. 1 First Weeding Nov. 29 Second Weeding
December 10 20 30		
January 10 20 30		

the rains, and enter into the time chart.
– From farm records enter the dates of the different farm operations (planting, first and second weeding, earthing up, harvesting) into the time chart.
– Find out operations that were not carried out at all or badly out of time (mark in time chart).

Conclusion
How did timing of work probably affect the yield?
Let the class develop a few sentences which they copy. Write into summary table.

6. Lesson Topic: How Did Pests and Diseases Affect Yields?

Objectives
– Pupils know the damage done by birds, weevils, and fungus diseases on maize.
– Pupils are able to estimate the loss due to birds, weevils, and smuts, in terms of quantity and in cash value.
– Pupils are able to use a graph in order to find out how different types of damage are distributed over a farm.
– Pupils know simple ways of fighting pests and diseases in the farm.

Lessons
– Find out from observational data the incidence of damage done by birds, insects, and fungus (smuts).
– Are there areas where these damages are heavily concentrated or are they spread out evenly over the farm?
– Work out percentage of damages row by row and graph (see graphs 2 and 3).

How did pests and diseases affect the yield?
Teacher leads pupils to estimate the loss due to the pests and diseases found on the maize. Since the reasoning leading to the estimates is somewhat complicated, teachers should take great care introducing it. The following might be a useful approach:
"What have the birds done? They have eaten some or all the grains of a cob. The cob is partly empty. Maize grains have a weight. If birds eat grains from a cob – is that cob heavier of lighter than if birds had not eaten some grains? The loss is restricted to the grains eaten."
Using the weight of good cobs and the weight of cobs attacked by birds one can estimate the loss due to birds. The procedure is as follows:
– Calculate the average weight of good cobs:

$$\text{average weight} = \frac{\text{weight of all good cobs}}{\text{number of all good cobs}}$$

– Calculate the average weight of cobs damaged by birds:

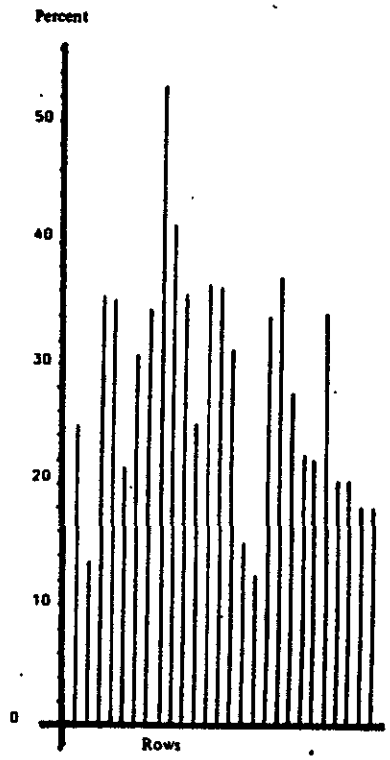
$$\text{average weight} = \frac{\text{weight of all cobs damaged by birds}}{\text{number of all cobs damaged by birds}}$$

One assumes that cobs damaged by birds would have had the same average weight as good cobs had they not been attacked by birds. If this is sound, one can calculate the loss due to birds as the difference between the average weight of good cobs and the average weight of cobs attacked by birds. This is the *estimated* average loss per cob due to bird attack.

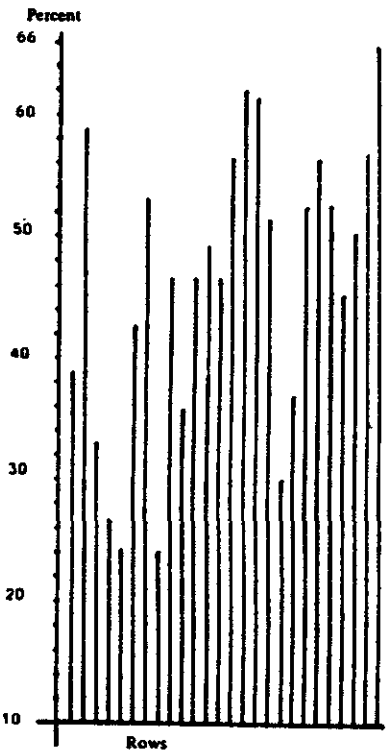
Average loss due to birds equal average weight of good cobs minus average weight of cobs damaged by birds.

– Calculate the estimated total loss due to birds: Multiplying the average loss per cob by the number of damaged cobs one arrives at an estimate of the total loss of grains due to birds.

"Some of the cobs have been attacked by weevils. What part of the grains have been



Graph 2: Percentage of Maize Cobs Damaged by Birds (per Row)



Graph 3: Percentage of Maize Cobs Damaged by Weevils (per Row)

eaten by weevils? Has the maize cob lost or gained weight? If the cob is weighed after removing the eaten grains it will be noticed that there is a loss of weight compared to the same cob if it were eaten by weevils."
Here, a comparison of the weight of good and weevilled cobs is not possible since the weevilled grains on the cobs have gone into the weight but cannot be used. We propose the following procedure:
– Take a sample of 100 weevilled cobs, taking small ones and big ones in the same proportion as in the total harvest.
– Remove all the grains damaged by weevils.
– Weigh the cobs after removing damaged grains.
– Calculate the average weight per cob.
– Calculate the difference between the average weight of good cobs and the average weight of the weevilled cobs. The difference is the estimate for the average loss due to weevils.
– Multiply the average loss by the number of weevilled cobs. The result is the estimate of the total loss due to weevils.

"What has smuts done to the grains of maize? It has damaged them badly. They don't look like maize grains any longer. Can they be eaten? They are poisonous. Since the whole cob is bad, cobs attacked by smuts were not weighed. We burnt them straight away."
To estimate losses due to smuts, multiply the average weight per good cob by the number of cobs attacked by smuts.

The table below shows in detail the results of the different steps needed in order to estimate the loss. Using these estimates, the teacher can discuss the following problems:
What would the total yield have been had no damages occured?
What would have been the yield per hectare had no damages occured?
What is the proportion of the yield lost?
Taking maize prices at harvesting time, how much money was lost to birds, weevils, and smuts?

The class now is in a position to discuss whether it is worth while doing something to prevent damages from pests and diseases. Discuss different methods of fighting against pests and diseases and their respective costs.

7. Summary

Objectives
– Pupils are able to make a summary table of factors affecting maize yields.
– Pupils are able to draw conclusions from a summary table.

Lesson
– Teacher puts the summary table completed during the last lessons on the blackboard.
– Discussion about the importance of each factor and whether, on the whole, the yield could have been better.
– The class makes recommendations for next season's farming.

Summary Table of Factors Affecting the Yield of Maize Season: Dry Season 1977, Late Maize

Factor	How it was on our Farm	Yield Expected
Soil Fertility		
– previous crop	none, plot was fallowed	good
– measures to preserve/ improve soil fertility	none	–
– distribution of soil fertility	uneven	less than would have been possible
Climate		
– amount of rain fall	insufficient	poor
– timing of rain	stopped too early after flowering and cob formation	poor
Seeds		
– variety	Ekona White	good
– origin	Agricultural Department	good
– selection	hand picking	good
Timing of Work		
– planting	late	poor
– first weeding	late	poor
– earthing up	not done	poor
– second weeding	late	poor
– harvesting	late	poor
Pests and Diseases		
– bird attack	heavy	poor
– weevil attack	heavy	poor
– fungus	light	no effect

Type of Maize Cobs	No. of Cobs	Weight	Average Weight	Average Loss	Total Loss
Good Cobs	787	58.2 kg	73.9 g		
Damaged by Birds	933	46.6 kg	49.9 g	24.0 g	22.39 kg
Weevils	1522	89.2 kg	62.7 g	11.2 g[1]	17.05 kg
Smuts	29	not recorded		73.9 g[2]	2.14 kg
	3271	194 kg	59.3 g		41.58 kg

[1] Estimate based on sample of 100 weevilled cobs.
[2] It is assumed that cobs attacked by smuts would have had the same average weight as good cobs had they not been attacked by fungus.

ACTIVITY

A YAM PLOT

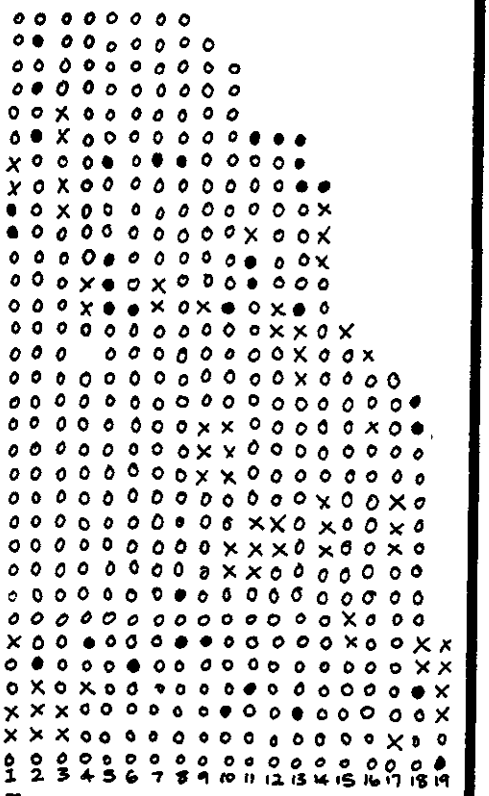
(This activity is adapted from: ***Primary School Agriculture Vol.I Pedagogy*** **by Herbert Bergman published by GATE and GTZ, Federal Republic of Germany)**

A farmer had a plot on which she wanted to grow yams. On the plot there are 19 rows. The rows are 1.5 metres apart. The yams are to be planted at intervals of 1 metre. Holes for the yams were dug by a group of three men. When all the holes had been dug, the farmer counted them in order to pay the group, and to find out how many yams could be planted. In each row, she noted the holes which could not be used for planting because they had stones in them. She also noted the holes which were not deep enough and needed more digging. The sketch map and table below show what the farmer discovered:

Table: holes dug

row number	total number of holes	holes with big stones	shallow holes	holes ready for use
1	32	2	5	
2	32	4	3	
3	32	0	6	
4	32	1	3	
5	32	4	0	
6	32	2	0	
7	32	1	2	
8	32	3	0	
9	31	1	4	
10	30	2	5	
11	27	4	4	
12	27	1	4	
13	27	5	3	
14	26	1	6	
15	19	0	3	
16	18	0	2	
17	17	0	4	
18	16	3	2	
19	6	1	4	

Sketch map: yam plot



Key
- ● holes with big stones
- X shallow holes
- o holes ready for planting

Complete the table above.

1. What is the total number of holes?
2. How many holes cannot be used because of stones that could not be removed?
3. How many holes can be moulded up and planted immediately?
4. How many holes must be made deeper?

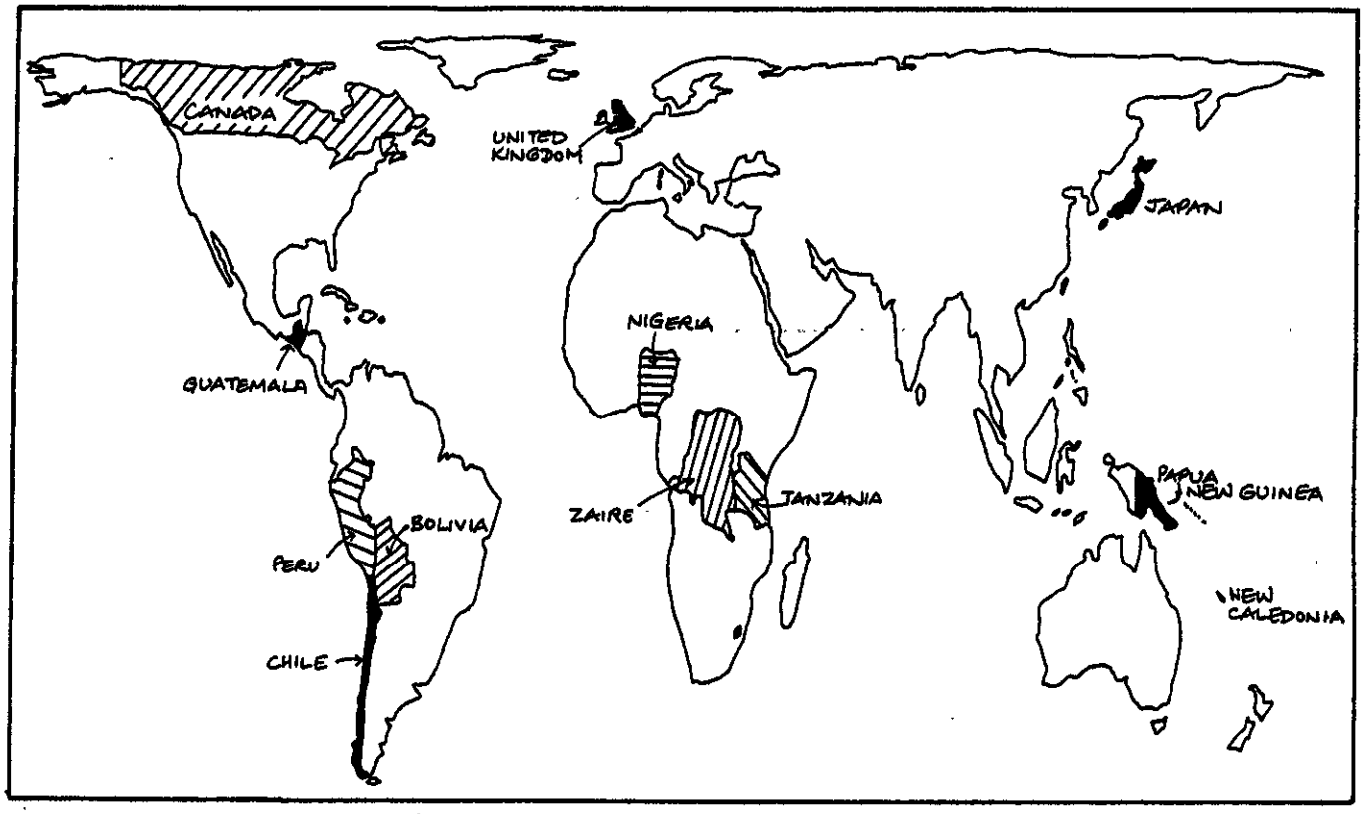
5. How many seed yams will the farmer need once all the holes without stones have been made deep enough?
6. The farmer has agreed to pay the group 15 frs. [use local currency] for each hole which can take a seed yam, and one third this amount for holes which cannot be completed because of the stones. How much does the farmer pay?
   Payment for completed holes ready for planting?
   Payment for incomplete holes with stones?
   Total sum of money paid?
7. The farmer asks the headman of the group to write out a receipt. How should the headman do it?
8. What is the percentage of holes that cannot be used because of the big stones?
9. What is the percentage of holes that the group has to make deeper before they can get their pay?
10. Draw a scaled drawing of the yam plot. In order to do this, you must know:
    a) All rows are at right angles to the base line.
    b) All rows are straight.
    c) The first row starts at a distance of 75 cm. from the end of the yam plot. Each row is 1.5 m. apart from the next one. The planting distance along the row is 1 m.
    d) Your drawing should be on a scale of 1:100
    e) Show each hole by a mark x on your plan.
11. What is the area of the plot (in square metres)?
12. Each yam hole is 60 cm. long, 60 cm. wide and 50 cm. deep. What is the volume of soil from one hole (in cubic metres)? What is the volume of all the soil removed from the holes which later can be planted with yams?

OUTREACH ISSUE NO. 70: CONTENTS

[Reading level: I=children (8-10 years); II=children (11-13 years) and adults with basic literacy; III=teachers and/or people with secondary education]

LOCATION MAP

The map below shows the location of places mentioned in issue no.70.



ACKNOWLEDGEMENTS

OUTREACH would like to thank Marion van Schaik from Save the Children and Sharon Kahkonen for providing a wealth of information and ideas for these OUTREACH packs on "Crops". Thanks also go to Asian Cultural Centre for UNESCO, Centre for Environment Education (India), Developing Countries Farm Radio Network, Rodale Institute, Save the Children, South Pacific Commission, Deutsches Zentrum fur Entwicklungstechnologien (GATE) and other contributors to these information packs.

AFTER THE HARVEST

Much of the crop harvest in developing countries never reaches local markets and hungry people. The reason? Inadequate storage facilities, and poor methods for handling, drying and processing the produce.

No one knows exactly how much food is lost. Reliable statistics are few in number and highly variable. The UN Food and Agriculture Organization estimated that in 1984 about 180 million tonnes of grain - 10% of the global harvest - were loss in that year alone because of poor storage and handling. Valued at US$18 billion, the spoiled or otherwise wasted grain could have fed about 818 million people in numerous countries suffering from severe food shortages. Most experts in developing countries figure that post-harvest food losses amount to 5-30% for cereal grains and possibly 15-60% for fruits, vegetables, roots and tubers.

These losses contribute to poverty, malnutrition and foreign dependency. Food losses increase the amount of food that must be imported by developing countries. It also slows down development because money must be spend on food rather than on development projects. For example, in Nigeria, a 5 percent reduction in grain loss for the period 1975-76 would have meant no grain would have had to be imported. This would have saved the country $80 million in foreign exchange.

RADIO SCRIPTS

STORING GRAINS AND VEGETABLE SEEDS

On the next page are two radio scripts that suggest ways to improve the storage of grains and vegetable seeds.
"Storing Grains" is taken from **Developing Countries Farm Radio Network Package No.4 item No.2.**
"Storing Vegetable Seeds" is taken from **Developing Countries Farm Radio Network Package No.8 item No.1C**
These transcripts may be adapted for local radio broadcast or they may be used as sources of information for magazine and newspaper articles, leaflets, fact sheet, posters, extension visits, village or classroom lessons, flip charts, plays, stories, songs etc.
If reproduced, please give credit to: **Developing Countries Farm Radio Network**

DCFRN is a worldwide information network that gathers farming information from developing countries and provides information in the form of broadcast material for communicators in developing countries. The Network aims to help small farmers increase their food supply for their families, or to sell. The Network is sponsored by the Canadian International Development Agency, Massey Ferguson and the University of Guelph.
For further information, contact:
The Developing Countries Farm Radio Network,
595 Bay Street, 9th Floor, Toronto, Ontario M5G 2C3 CANADA

Title: "Storing Grain"

Participant: George Atkins

Suggested Introduction:

You may not have heard of it before, but we're now part of a Radio Network that links together farm radio programs like this all around the world. With the assistance of Massey-Ferguson, the Developing Countries Farm Radio Network was established by George Atkins. Today he has some information for us, part of which was sent to him by a Network participant in Southern Africa, Phillip Skosana in Swaziland. Here's George ---

ATKINS . I have a question for you today. --- If you grow grain that you keep for some time after harvesting, is it always in good conditiion when you want to use it? --- I'm talking about wheat, rice, maize, sorghum, peas, beans, soybeans, groundnuts and many other such crops. This is grain you grow for food for your family or for your animals or poultry; it may be grain you'll want to sell or to use for planting as seed for your next crop. If you keep it right, it'll be good for any of those uses. If you don't, it won't --- it's actually up to you. That's why you need to do it right!

For any of these stored crops to be good when you want to use them, you must see to it that when they're in storage, they don't get hot, they don't get wet or get mouldy and that they aren't spoiled by insects or by rats.

All those are the things that reduce the quality of your grain, --- heat, moisture, mould, insects and rats.

Although most of these things affect each other, let's talk about each one of them.

First heat; --- I'm sure you know that before you put your grain into storage, if your grain is all spread out in the sun, heat from the sun is very good. Not only will it rid your grain of beetles and moths that may be in it, it will dry out your grain. --- That's very important, because unless it's absolutely dry when you put it in your storage, it will heat up after it's in, --- and that's very bad. Grain must not heat up when it's in storage. Now if your storage isn't properly constructed and in a good location, just the hot sun beating on the storage can cause the grain to heat and that's very bad, too.

But why is it bad if your grain gets hot in storage?

Two reasons --- mould and insects. --- Let's talk about mould first.

When your grain gets hot in storage, moisture that's in there along with the heat provides perfect conditions for mould to grow. Mould is that small fuzzy black, white or coloured stuff that grows in and on the grains. It makes the grain musty and smell bad --- musty grain is not good for food or feed, and if you had intended using it for seed, don't --- because it won't grow.

--- So there's reason enough to be sure that your grain goes into storage dry, that it stays dry and it doesn't get hot.

There is, of course, one kind of grain that you can put into storage without being absolutely dry.

If you grow maize and you store it while the grains are still on the cob, it can be stored in a crib and in there, it will dry out while it's in storage. When most other grain crops are stored, though, the individual grains pack much more closely together, so they must be dry before they're put into storage.

But now, what about insects that chew your grain up into fine dust or that can eat up part or all of it?

They too like a nice warm place to live and multiply where there's lots of food for them; --- and the warmer it is the more insects you'll have in your grain; --- and the more insects you have, the warmer it will get because their activity creates heat. This heat, then, along with moisture provides even better conditions for mould to grow. ---

One more thing --- the combination of heat and moisture will often cause grain near the top of the grain-storage to sprout and sprouted grain is really not much good.

So the combination of heat, moisture, mould and insects is really bad for your grain, isn't it?!

Now you want all of the grain you put in storage to be good when you take it out, --- so the important question is, what can you do about all this?

Let's talk first about your grain storage. When you put dry grain into it you want it to stay dry, so the storage must be well constructed to keep out all rain water and also any moisture that could seep up from the ground. Then to keep out the heat from the hot sun, your storage should be built where it's shaded by trees if possible or good thatch; and good ventilation also helps keep the grain cool.

Now there's one thing more that we have to talk about in this heat, moisture, mould, insect combination. It's the insects that attack your grain. --- What can you do about them?

Well the first thing you can do is to be sure that before storing new grain, the storage is clean, --- and I mean thoroughly clean with no insects, insect eggs, grubs or larvae anywhere in it or in cracks and crevices where they could hide. Painting the cracks with old motor oil will get rid of them. The bark of many kinds of wood provides good hiding places for insects; so if building materials like poles or posts are used for your storage, before construction begins, all bark should be removed, leaving only the smooth wood.

Another way that insects are controlled is by constructing the grain storage so that it can be closed up and sealed absolutely air tight. Insects just can't live, you know, without fresh air.

Many farmers use insecticides that they can buy to kill or ward off insects. Others, however, without spending any money, have good success mixing ashes with the grain as it is being stored. (Later, the ash is winnowed or washed out before the grain is used.) With ashes you need to use plenty, like a whole bucket-full of seived ashes for every 70 kilogram (150 lb.) bag of grain. Then some more should be sprinkled in a layer on top of grain stored in mud cribs, baskets or pots. Some people who burn goat or cattle dung for fuel find that those ashes are specially good, while others prefer wood ashes from just certain kinds of trees.

Finally, I must mention rodent damage to stored grains. Nothing can foul up your food or grain like rats and mice. With maize, they'll eat the germ end of the kernel and leave the rest. The germ, as you know, is the best part. It's the part from which new plants grow. Urine and droppings from these wretched animals contaminate more than they eat. Also, rats carry disease and can deposit the disease germs right in the grain that you and your family depend on for food.

Your best defence from rats and mice is to have neat clean tidy premises where they can't hide and can't get at your food supply ... also a good cat or dog can be a big help.

In summary, then, after harvesting your grain,

- Do everything you can to keep your grain from heating in storage.
- Moisture in the grain causes it to heat.
- Grain that has heat and moisture gets mouldy.
- Heat also encourages insects.

Remember those 4 things, heat, moisture, mould and insects all help each other to spoil the grain that you worked hard to grow and to harvest.

- Also to control insects,
  - be sure your grain storage is absolutely clean before you put new grain into it and paint cracks with old oil;
  - you can use insecticides or mix ashes with the grain.
- To control rats and mice,
  - keep your place neat and tidy so there's nowhere for them to hide,
  - and a good dog or cat will help rid you of these pests.

Note: Some of the information in this item was contained in a report on pest control by Farm Broadcaster Phillip Skosana in Rural Development News published by the Ministry of Agriculture, Box 162, Mabane,Swaziland.

For more information on storing grain so that it is as good when it comes out of storage as when it went in, you could write to:

Mr. P.S. Tyler
Overseas Development Natural
Resources Institute
Storage Department
London Road, Slough
Berkshire SL3 7HL
UNITED KINGDOM

"Storing Vegetable Seeds"

ATKINS Let's talk about vegetable seeds; -- about storing them until planting time.

You probably know that if grain is not dry when it is stored, or if it gets wet in storage, it will spoil and it won't be good for seed.

Well, the same is true of vegetable seeds. They also must be dry before you store them and they must stay dry until its time to plant them.

In a moment, I'm going to tell you how you can be sure that your small vegetable seeds stay dry until the time comes to plant them.

As you know, there are certain times when there is more moisture in the air than at other times. Well, during those times when the air is moist, vegetable seeds that you are keeping can absorb, or take up, some of that moisture from the air. When they do this they become damp -- and that's bad, especially if the weather is warm. -- Even though they may look good, they can be spoiled so they won't grow later on when you plant them. So, this is important to remember, - moist warm or hot conditions can spoil your vegetable seeds.

What you need to do with your vegetable seeds is to keep them as cool as you can; you also need to keep them dry. You probably already store your seeds in your house or in a shed, shaded from the sun. -- But how can you keep moist air from getting to them? -- Well, you can keep them in a jar with a tight lid, -- even a tin can with something to cover it. Whether you use a jar or a can, it should be tightly covered. -- A piece of thin plastic

tied on with string over the open end of a jar or can would be fine. Before putting on the cover, though, you should coat the rim of the opening with oil or grease to make an airtight seal; --- or I'm sure there are other ways you can think of to seal up the container for your vegetable seeds.

There is one more thing you can do to be sure that your seeds are dry enough so that they will be good for planting when the time comes. You can put something in the container with the seeds; -- something that will take moisture from them and from the air that's in the container, and keep everything in it dry. What can you use? You can use freshly toasted grains of rice, wheat or maize --- or even toasted dried peas will be good. You'll need about twice as much toasted grain as the amount of vegetable seed you are storing. To toast the rice, wheat or maize grains or dried peas, slowly heat them, continuously moving them around in a shallow pan over your stove. This dries them out completely. Don't heat them long enough to burn them, just until they are toasted a little.

Now, so that the toasted grains won't be mixed with the vegetable seeds in the jar or can, you could make a little cloth bag for them. After you've filled it with toasted grains, you can put it in the container with the seeds.

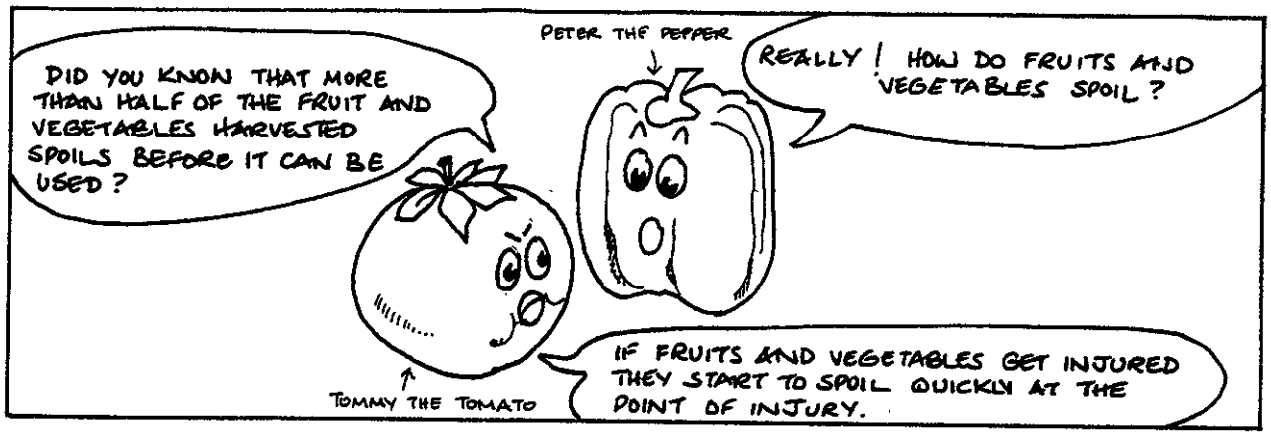
Do this as soon as the toasted grains have cooled down. Then seal up the container.

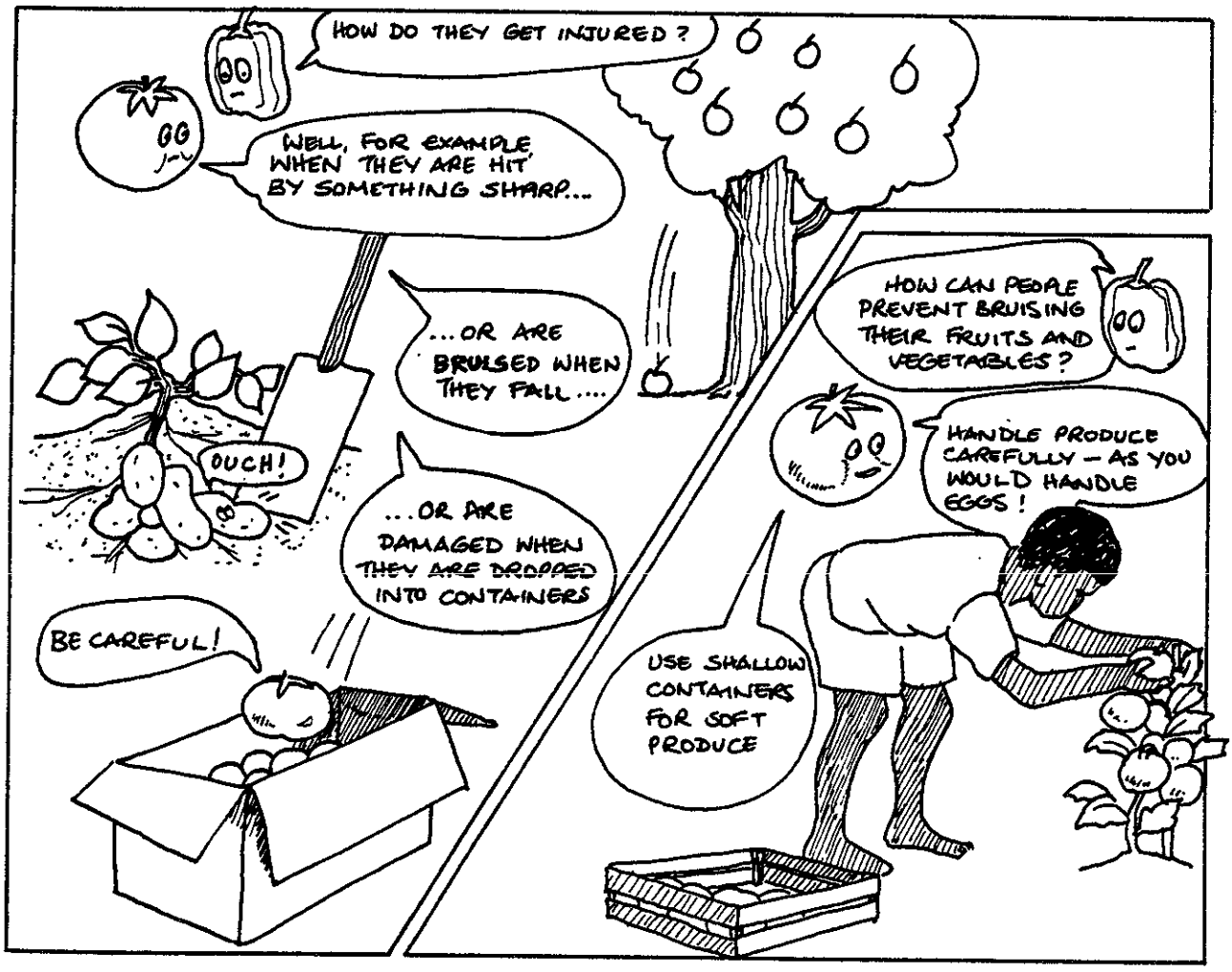
If you open the container to take out some seeds, but if you want to store the rest for a longer time, take out the old toasted grains, and replace them with fresh toasted grains before sealing the container.

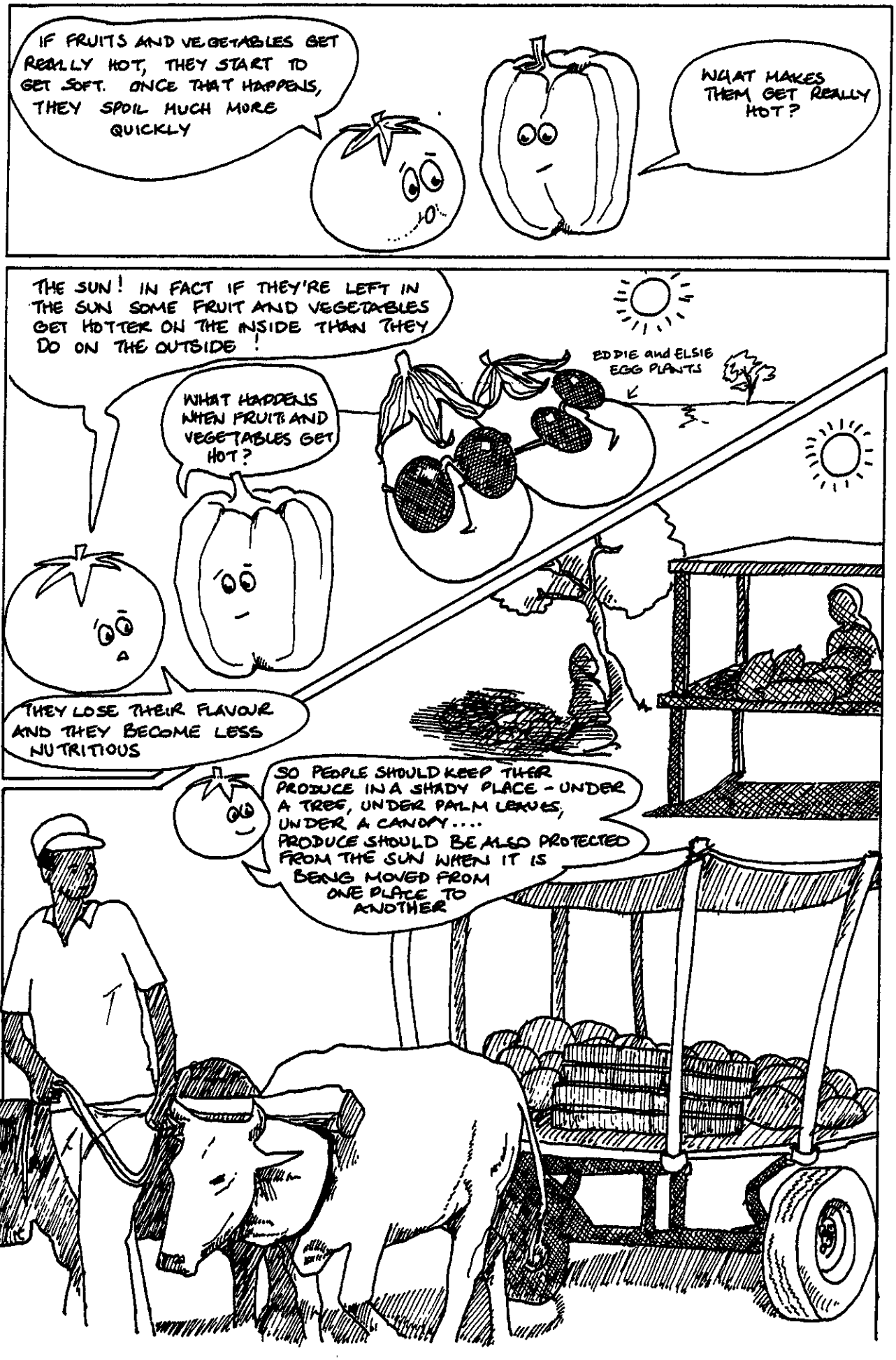
Some information in this item came from Dr. Orville T. Page, Director of Research, The International Potato Research Center (CIP), P.O. Box 5969, Lima, Peru; and from Volume IX, No. 7, the July 1981 issue of a CIP Circular entitled "Toasted Small Grains as Seed Drying Agent". For a copy you could write to Dr. Page.
Other information came from an article in Volume 9, No. 1, First Quarter 1983 edition of Harvest entitled "Safe Storage for Small Quantities of Seed" by Jan E. van S. Greve, Senior Entomologist, Department of Primary Industry, Konedobu, Papua New Guinea. For a copy of the article you could write to Mr. Greve.

HOW FOOD SPOILS

This cartoon strip is based upon information in "Too Much Sun Spoils Food" Developing Countries Farm Radio Network Package No.3 Item NO 1. Please credit source if reproduced. For further information contact D.C.F.R.N. Massey Ferguson Ltd. 595 Bay Street Toronto Ontario M5G 2C3 CANADA






IF FRUITS AND VEGETABLES GET REALLY HOT, THEY START TO GET SOFT. ONCE THAT HAPPENS, THEY SPOIL MUCH MORE QUICKLY
WHAT MAKES THEM GET REALLY HOT?
THE SUN! IN FACT IF THEY'RE LEFT IN THE SUN SOME FRUIT AND VEGETABLES GET HOTTER ON THE INSIDE THAN THEY DO ON THE OUTSIDE!
WHAT HAPPENS WHEN FRUITS AND VEGETABLES GET HOT?
EDDIE and ELSIE EGG PLANTS
THEY LOSE THEIR FLAVOUR AND THEY BECOME LESS NUTRITIOUS
SO PEOPLE SHOULD KEEP THEIR PRODUCE IN A SHADY PLACE - UNDER A TREE, UNDER PALM LEAVES, UNDER A CANOPY.... PRODUCE SHOULD BE ALSO PROTECTED FROM THE SUN WHEN IT IS BEING MOVED FROM ONE PLACE TO ANOTHER

HOW RADIO CAN HELP MARKETING PRODUCE

Farmers often cannot sell what they grow for a reasonable return. Truck drivers or buyers come out to the countryside, and one of the drivers is chosen to go to the farmers to see what is for sale. He offers the farmers in the village about half of what their produce is worth, and they turn it down. He tells them, "That is all you can get." So finally, someone sells produce at that price. This sets the price for that day. All the other buyers come into the village and buy at that rate. And they take the produce to market and sell it for two or three times what they paid for it! The farmers, not knowing what the commodity is worth, are really at a disadvantage.

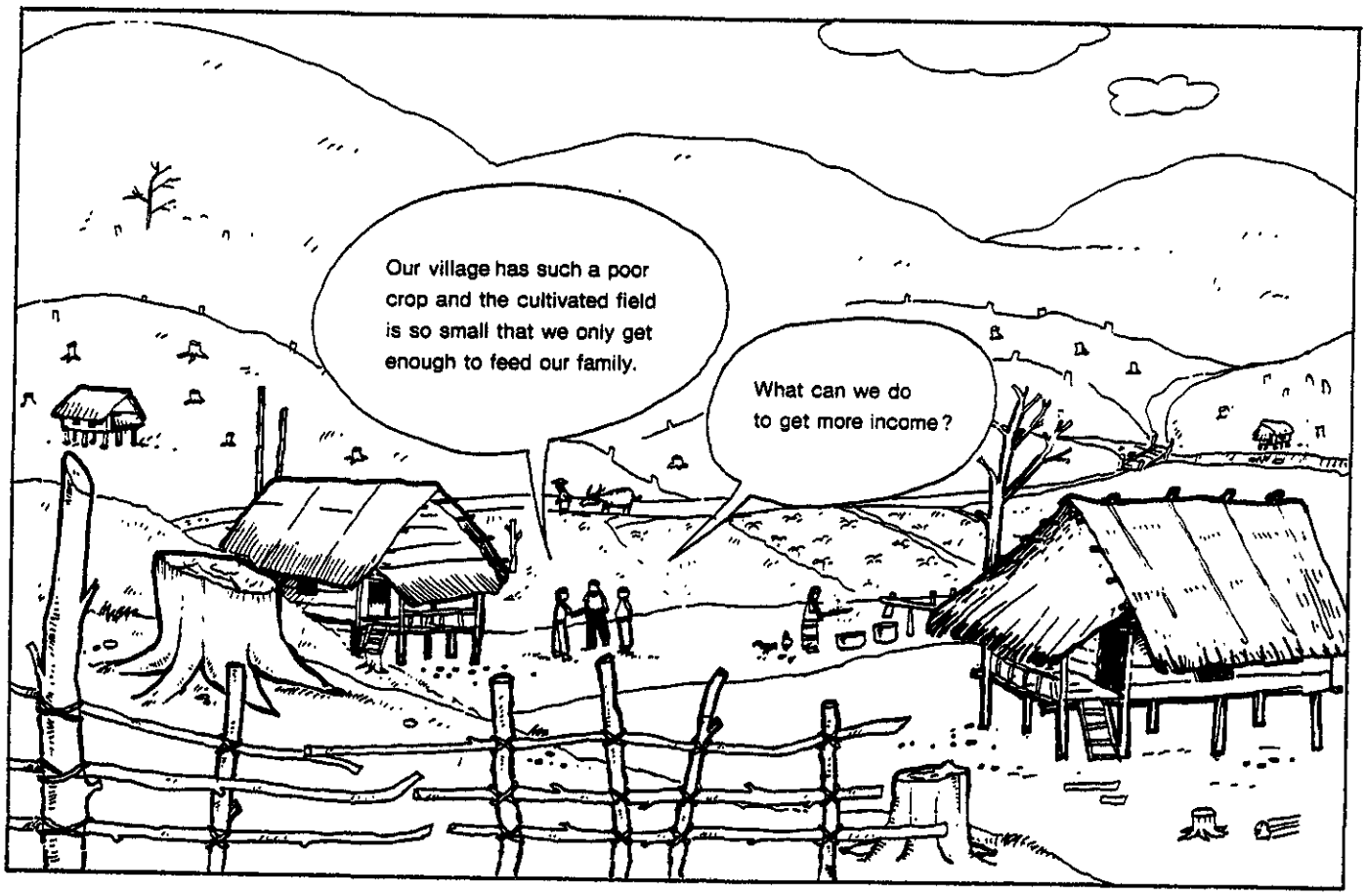
But now radio stations in Guatemala, Bolivia and Chile are coming to the aid of the farmers in those countries. There, radio stations put the market news on the radio in the morning, just before the farmer goes to work. The radio gives the prices of farm produce paid in the city markets the day before. Then, in the afternoon, just after sun-down when farmers come back from the fields, the radio broadcasts the market for that day. So when a truck driver or buyer comes and offers the farmers a quarter of what the commodity is really worth, the farmers are not tempted to sell at that price because they know in advance what the market is. The farmers have a great advantage when they know what their produce is worth.

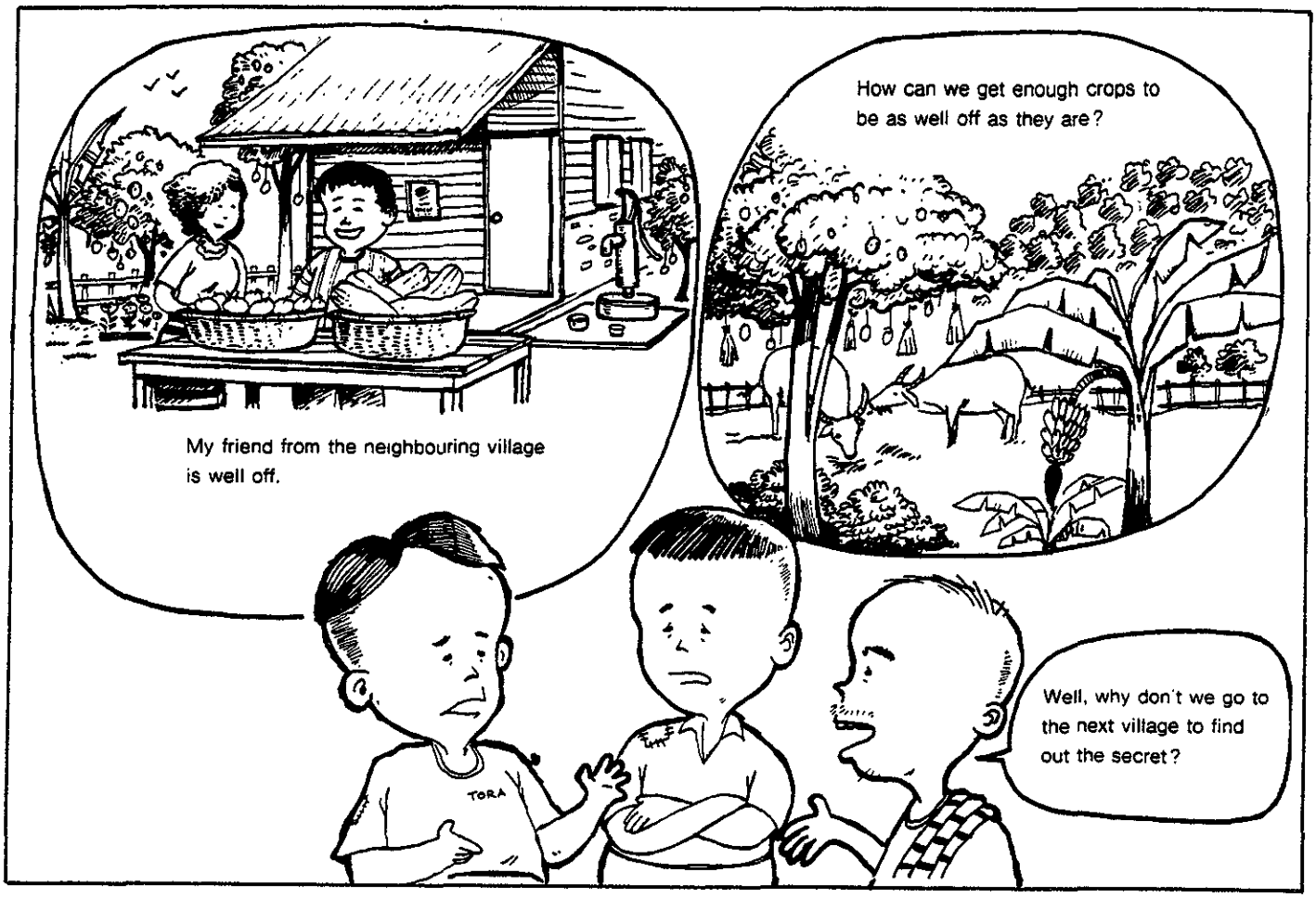
Source: **The Developing Countries Farm Radio Network Package No 3, Item 7: "Better Marketing of Farm Products"**. If reproduced, please credit source. For further information, contact: **DCFRN, c/o Massey-Ferguson Ltd. 595 Bay Street, Toronto, Ontario M5G 2C3 CANADA**

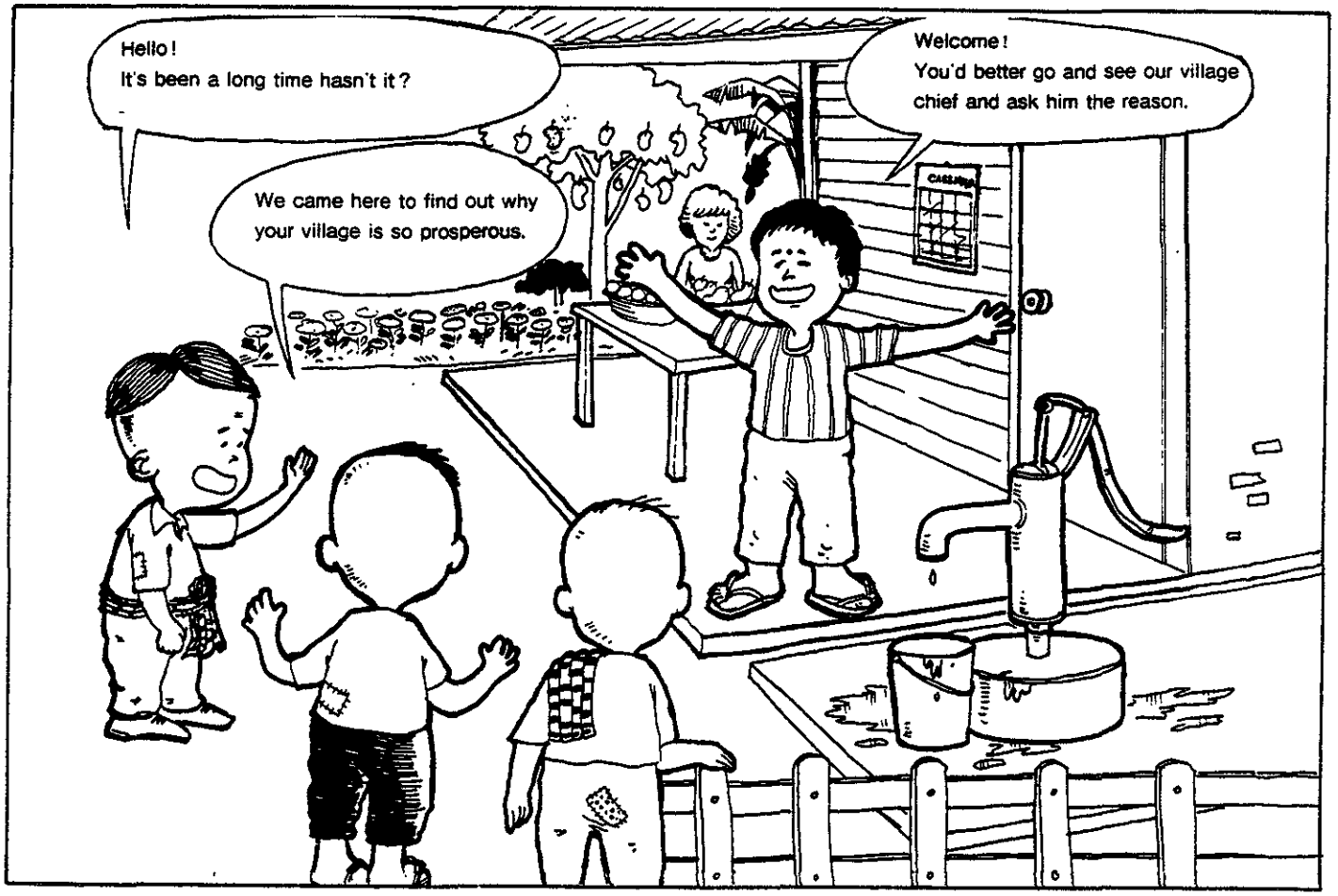
MORE INCOME BY TREE PLANTING

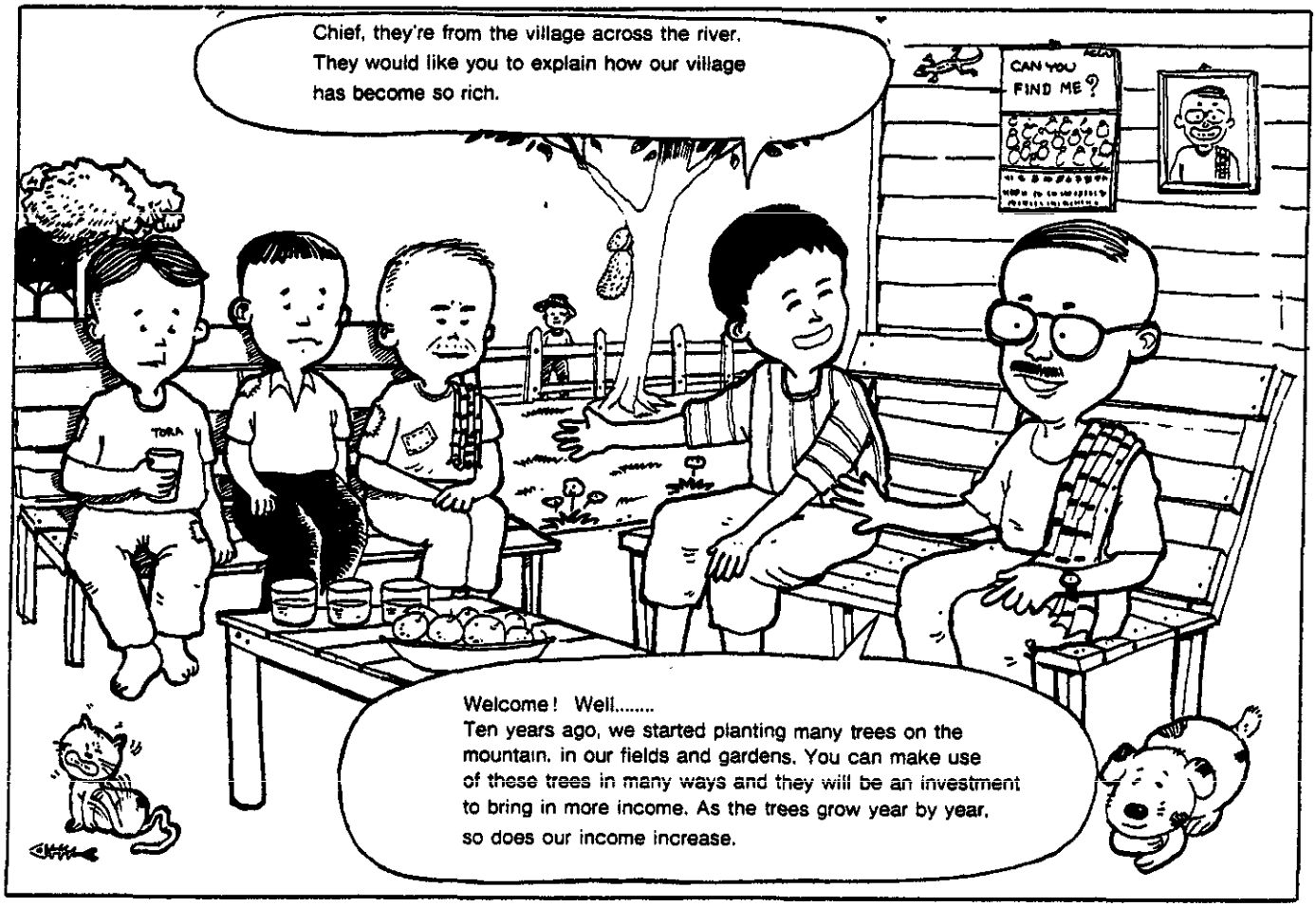
The booklet is directed at middle-level and self-learning neo-literates. The purpose of the booklet is to motivate learners to plant trees for supplementing their income, providing concrete information on kinds of trees according to their uses, as well as time required for growth.

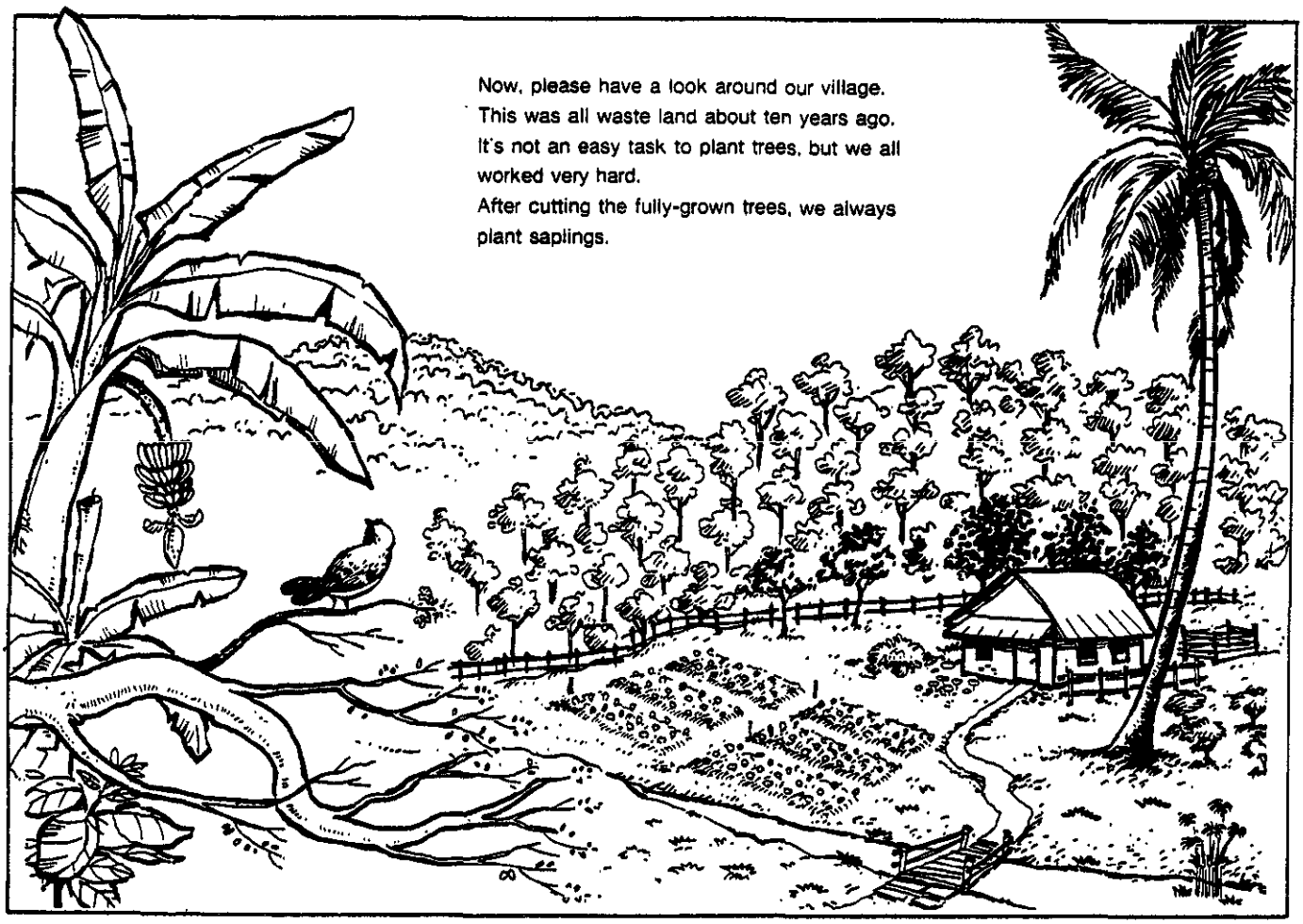
NOTE TO TEACHERS: Before students read the information, discuss forests and the variety of trees found in the locality. After distributing the booklet, ask the students to read and discuss the possibility of planting trees and which tree(s) is/are suitable for supplementing their income. You should offer suggestions and advice to students on how to plant trees correctly. (See OUTREACH issue 29, page 1 "Let's grow trees from seeds - in 10 easy steps")




My friend from the neighbouring village is well off.
How can we get enough crops to be as well off as they are?
TORA
Well, why don't we go to the next village to find out the secret?


Hello!
It's been a long time hasn't it?
We came here to find out why your village is so prosperous.
Welcome!
You'd better go and see our village chief and ask him the reason.


Chief, they're from the village across the river. They would like you to explain how our village has become so rich.
CAN YOU FIND ME?
Welcome! Well.....
Ten years ago, we started planting many trees on the mountain, in our fields and gardens. You can make use of these trees in many ways and they will be an investment to bring in more income. As the trees grow year by year, so does our income increase.


Now, please have a look around our village.
This was all waste land about ten years ago.
It's not an easy task to plant trees, but we all worked very hard.
After cutting the fully-grown trees, we always plant saplings.

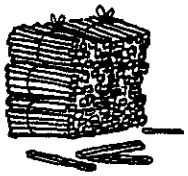
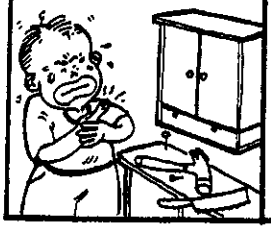
I'll explain in more detail....

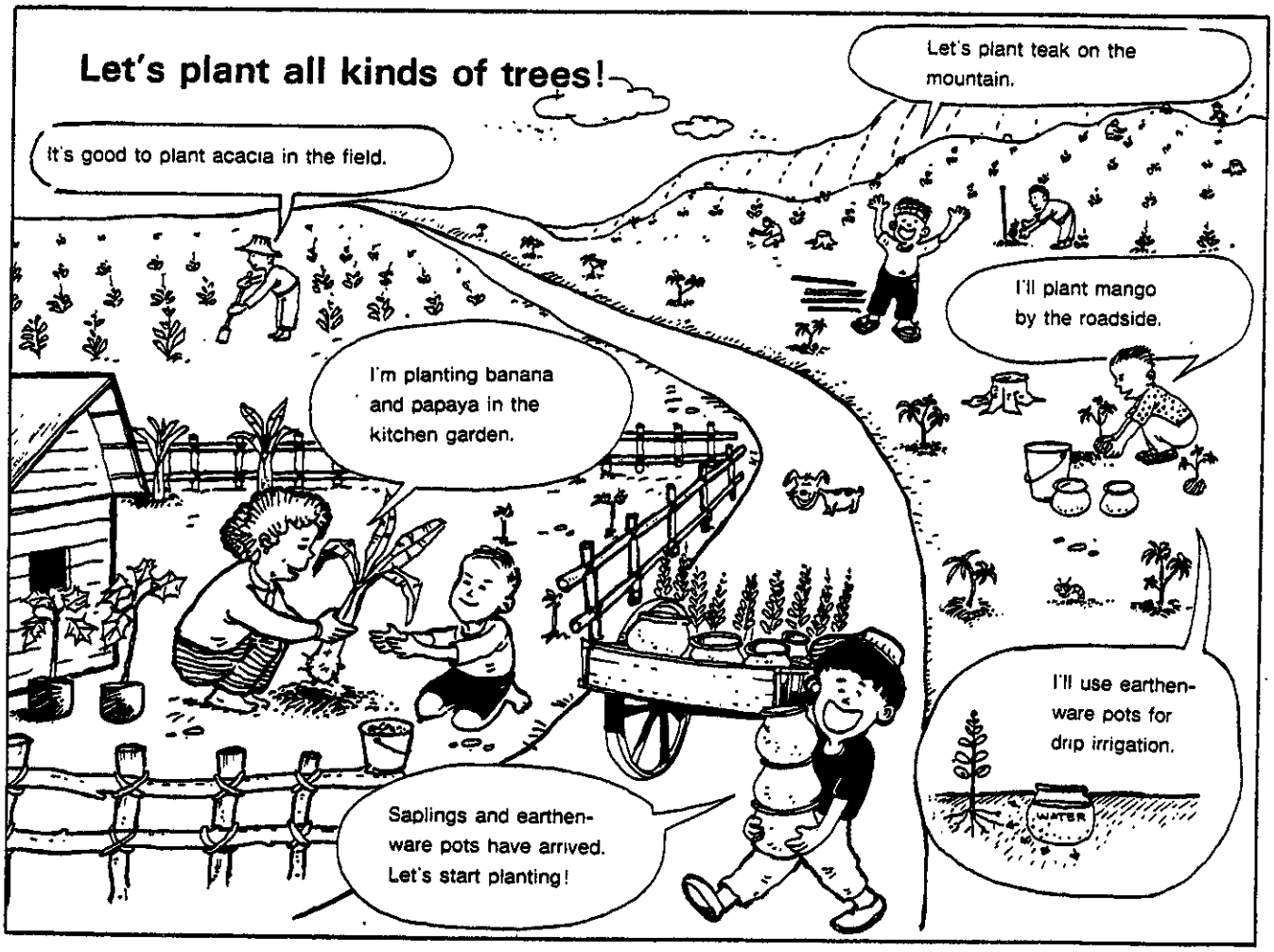
The trees we planted can be divided into seven kinds according to their purpose.

1. Fruit trees
2. Medicinal trees
3. Spice trees
4. Fodder trees
5. Industrial trees
6. Fuel trees
7. Timber trees

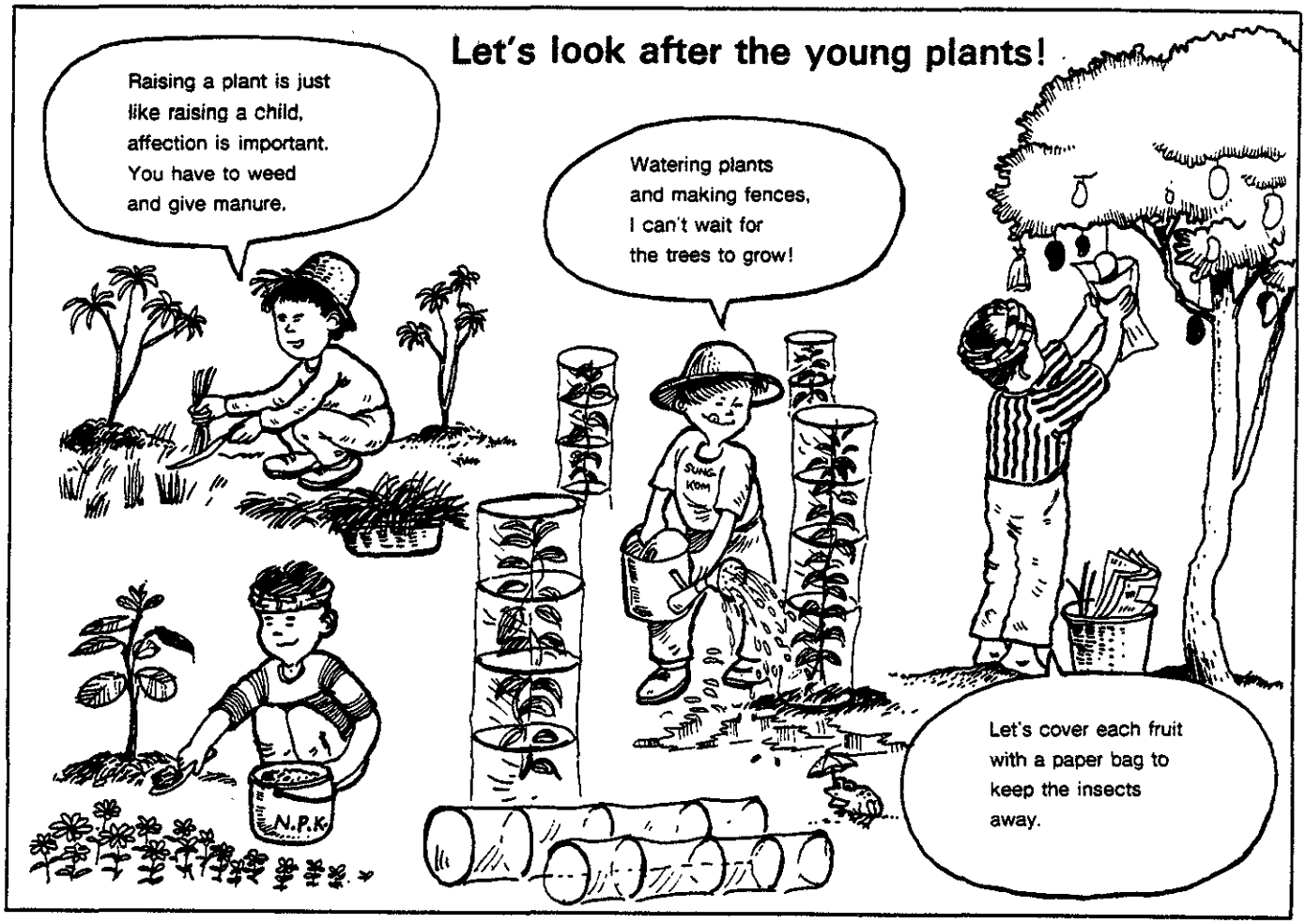
Oh, there are so different kinds of trees!

Use \ Time Required for Growth	one year	three years	five years
1. Fruit	Banana, Papaya		Coconut, Mango
2. Medicinal		Pomegranate	
3. Spices		Pepper, Clove	Cinnamon
4. Fodder			Mangrove

Use \ Time Required for Growth	five years	ten years
5. Industry 	Para rubber tree 	Pine tree
6. Fuel 	Eucalyptus	Acacia 
7. Timber 		Teak  Mahogany 



Let's look after the young plants!



LEUCAENA

The following information is reprinted from:
***Leucaena* produced by Rodale Institute for Rodale Press Inc., in cooperation with the Tanzanian Agricultural Research Organization.**
This is a pamphlet available from Rodale Institute at a unit price of US$0.50.

Leucaena (said: loo-SEE-nuh) is a fast-growing tree that is well-suited to tropical Africa. It can grow in acid soil, and at altitudes as high as 500 m above sea level.

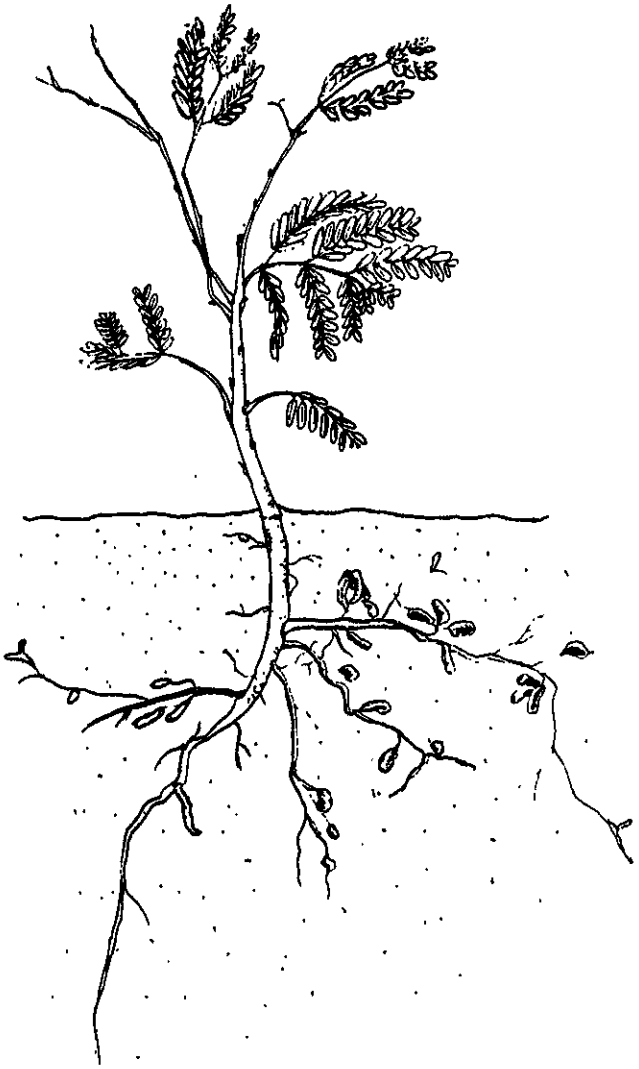
You will not have to fertilize Leucaena with nitrogen. Tiny creatures called Rhizobia, which are too small to be seen, live in the tree's roots and supply it with nitrogen from the air. Rhizobia do the same thing for beans. Such plants are called legumes, and actually add nitrogen to the soil.

Leucaena has a very long taproot that brings up moisture from deep in the ground. Because of this, it grows well with as little as 600 mm of rain per year.

Leucaena's leaves contain much nitrogen, and are a good "food source" both for the soil and for animals.

You can grow Leucaena from seeds or cuttings. When planting it on land where Leucaena is not already growing, mix a few clay pots full of soil from beneath a growing Leucaena tree with soil in the holes where the new trees will be. This will bring Rhizobia into contact with Leucaena's roots so that it can start making its own nitrogen. if there are enough Rhizobia, Leucaena can produce up to 500 kg of nitrogen per hectare each year. This is more than six times the amount of nitrogen needed to grow maize in Tanzania.

In acid soils, you may need to apply compost to provide minor plant foods.



How to Plant Leucaena from Seeds

1. Soak seeds for two to three minutes in water that is almost boiling - about 80°C., (see figure 1).
2. Plant seeds in a hole about 5 cm deep, (see figure 2). The distance between trees will depend on how you are going to use them. For details, see the sections on different ways to use Leucaena.
3. Try to keep weeds, animals and fire away from small trees.

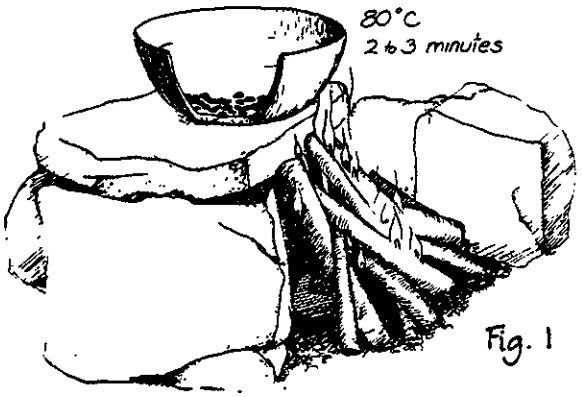


Fig. 1

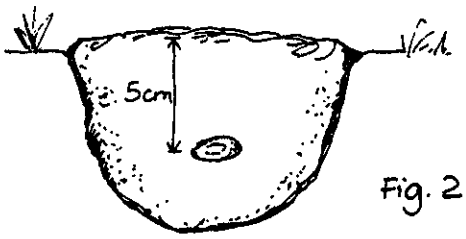


Fig. 2

How to Plant Leucaena from Cuttings

1. Cut branches 3 to 5 cm thick and at least 60 cm long from a healthy Leucaena tree at least two years old, (see figure 3).
2. Chop one end of each branch on a sharp angle so that you can push it into the ground easily.
3. Push each branch into the soil about 30 cm deep, (see figure 4). Remember to add soil from beneath a growing Leucaena tree if you are planting in a new area.

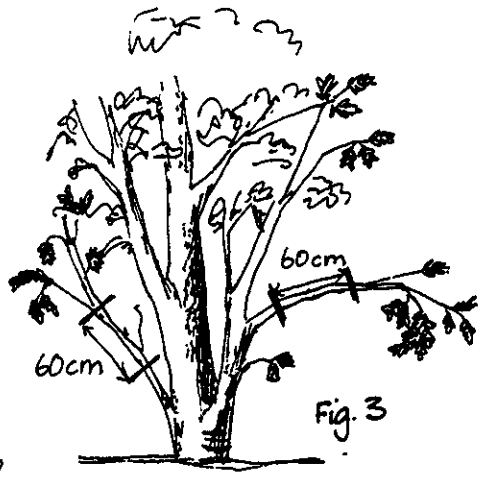


Fig. 3

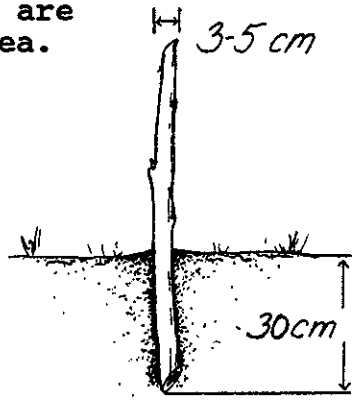


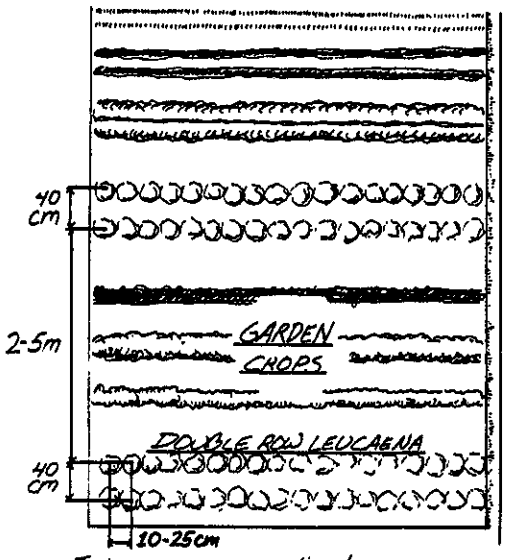
Fig. 4.

Leucaena as an Intercrop

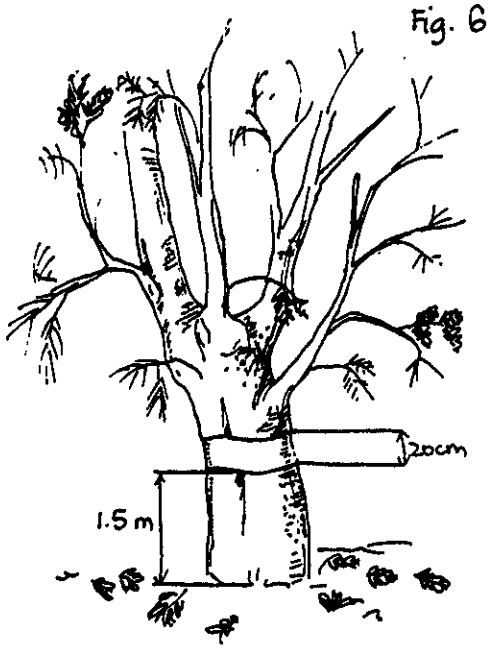
Between rows of food crops, you can plant Leucaena in narrow, double rows to add nitrogen to the soil, control erosion and shield the main crop from wind.

1. Plant seeds or cuttings in double rows that are 40 cm apart from each other, (see figure 5).
2. Each double row should be 2 to 5 m apart from the next double row.
3. Plant trees 10 to 25 cm apart within the rows.

When Leucaena trees are more than one year old, you can plant food crops in the 2 to 5 m between the double rows. First, you must cut the branches and treetops, leaving a main stem about 1 m high above the ground. To make sure branches regrow, do not cut them closer than 10 cm from the main stem. Cutting the branches and tops will keep Leucaena trees from shading the main crop.



Leucaena as a Green Manure



Leucaena's leaves and twigs are high in nitrogen and other plant foods. Trim the trees every three months during the rainy season and every four months during the dry season. Chop twigs and leaves, and mix them with soil immediately after cutting.

When the trees are more than two years old, you can make them drop leaves naturally, (figure 6). Using a knife or other cutting tool, remove a strip of bark 20 cm wide half-way around the main stem about 1.5 m above the ground. Leaves will dry and fall to the ground within one month. *Do not strip bark more than half-way around the main stem or the tree will die.*

Leucaena as a Forage Crop for Animals

Leucaena is a good food source for animals, but its leaves and seed pods contain a juice that causes health problems if the animals eat too much. Cows and sheep can eat a diet containing up to 50 percent Leucaena leaves, but swine should eat less than 20 percent and poultry, less than 10 percent.

Two Ways of Planting Leucaena for Forage

1. Plant trees about 1 m apart in a single row around grazing land. This "living fence" makes the land more productive, and lets the animals walk freely from one grazing are to another, (see figure 7).
2. Plant an entire field of Leucaena trees 1 m apart from each other. Allow animals to graze until about half of the leaves have been eaten from the trees. Trim the trees as you would if you were growing them as an intercrop, but do not cut the stem until it is at least 3 cm thick. if grazing is not heavy, you can use the leaves and branches as green manure and firewood, (see figure 8).

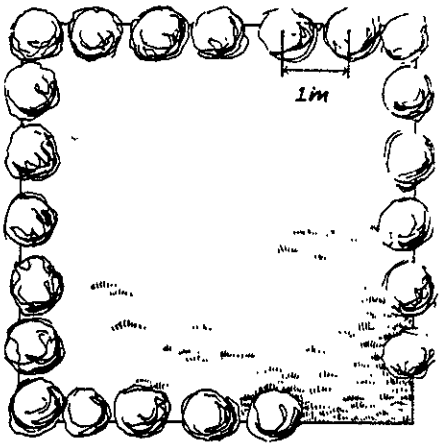


Fig.7

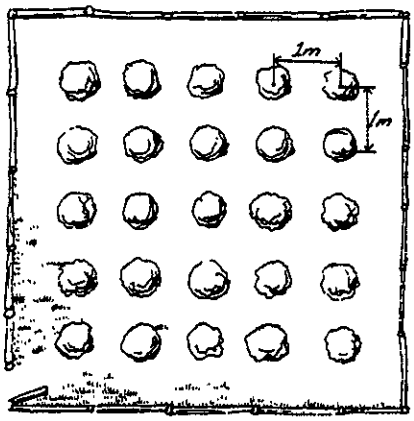
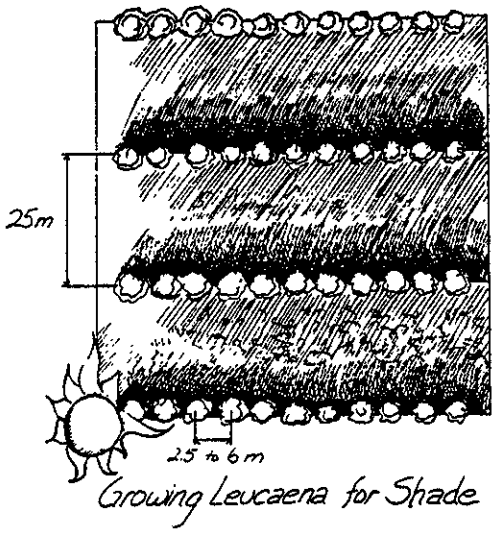


Fig.8

Leucaena as a Shade Tree

Leucaena makes an excellent shade tree for crops like cacao and coffee that do not grow well in direct sunlight. Plant the trees in rows that are 25 m apart from each other, (see figure 9). Plant trees 2.5 to 6 m apart within the rows. Trim trees for firewood and green manure after the main stem is 3 cm thick.



Growing Leucaena for Shade

Fig.9

Leucaena for Firewood

If you are growing Leucaena for firewood, plant the trees in rows that are 2 m apart from each other, (see figure 10). Plant trees 1 m apart within the rows.

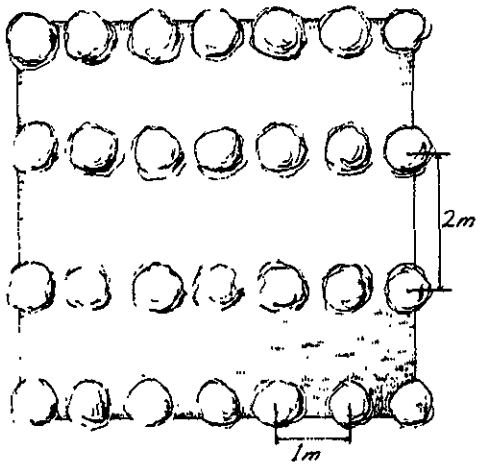


Fig.10

Growing Leucaena for Firewood

How to Grow Your Own Leucaena Seeds

1. Plant trees 3 m apart. On hillsides, plant in rows 5 m apart, with trees 2 m apart within the rows.
2. When trees are about two years old, seed pods will begin forming on the branches. pick the pods during the dry season when they have turned yellow. Be sure to gather them in the evening or early morning when they are damp. In midday, the pods will be dry and can break when picked.
3. Remove seeds from pods immediately after picking them. Dry the seeds in the sun for three days, then store them in jars or cans with lids, or a sackcloth hung in a dry place.
4. Trim the trees just as you would when using them as an intercrop. But try to trim them just before the rainy season so the seed pods will be ready to harvest at the beginning of the next dry season.

Leucaena grows quickly and will become a weed if you do not trim it regularly and harvest the mature seed pods. The small seeds are a healthy food for humans.

Although Leuacaena can grow in many types of soils and climates, it does best in rich, well-drained soils and in regions where there are at least 600 mm of rainfall per year.

Uses for Leucaena

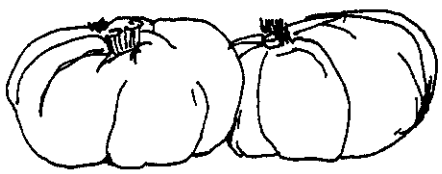
* Firewood and charcoal
* Erosion control on bare lands and hillsides
* Windbreaks
* Green manure
* Forage for animals
* Timber for building
* Soil improvement

Pumpkin

The information below is reprinted from: ***South Pacific Foods Leaflet 12*** **published by South Pacific Commission in 1985 and reprinted 1989**

The leaflet is the twelfth in a series devoted to the uses of local Pacific foods. Other leaflets available in the series describe Taro, Pawpaw, Mango, Guava, Cassava, Green Leaves, Banana, Coconut, Breadfruit, Pineapple and Citrus fruits. For more information, write to:
South Pacific Commission, B.P. D5, Noumea Cedex, NEW CALEDONIA

A valuable food



Pumpkin is an important food for many Pacific people. It is a very valuable food because most parts of the plant can be eaten and are rich in nutrients. Pumpkin is easy to grow and one plant in the garden can supply pumpkins and green leaves throughout the year.

Everyone should know how to grow, prepare and preserve local foods such as pumpkin. Eating locally grown foods can save money. Pumpkin is a protective food. It helps people stay healthy.

An easily grown plant

Pumpkins belong to the family with the scientific name *Cucurbitaceae*. These creeping vines do not need much looking after once they are planted. They can be grown throughout the Pacific — even on atolls.

Pumpkin plants grow easily from either seeds or cuttings with roots. There are many different varieties of pumpkin, which differ in flavour, texture, colour and storing quality. The best way to get the desired variety is to plant cuttings.

Pumpkins grow best in loose, rich soil. The site of an old rubbish heap is a good place for growing pumpkins. Kitchen scraps put round the plants will also add goodness to the soil. Brushing the flowers gently with a feather or brush will help to produce more pumpkins.

Health giving

Pumpkin leaves, fruit, flowers and seeds are all protective, health-giving foods. They contain vitamins and minerals the body needs to stay healthy.

The dark green pumpkin **leaves** are an excellent source of **Vitamin A.** The body needs Vitamin A for proper growth, healthy eyes and protection from disease. The leaves are also a good source of **calcium, Vitamin C, iron** and **protein.** Calcium helps to make strong bones and teeth.

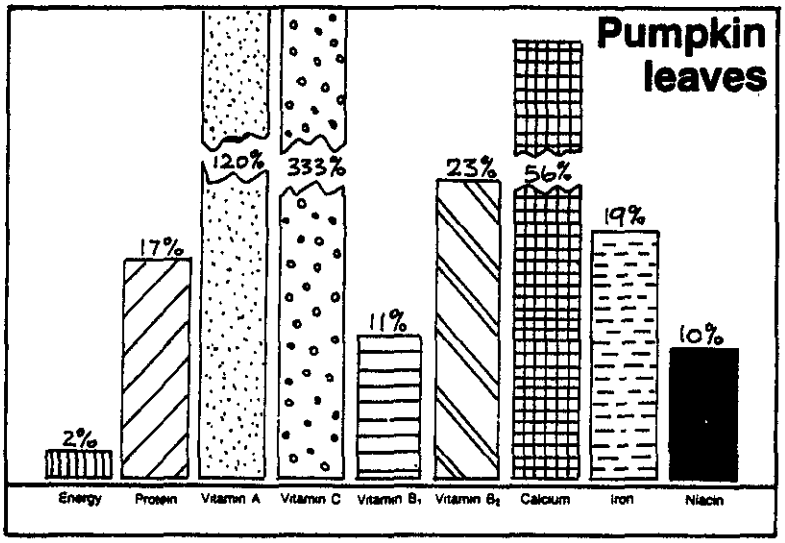
Vitamin C keeps the body tissues strong, helps the body use iron, and helps chemical actions in the body. Iron helps keep blood healthy, and the body needs protein to grow and stay healthy.

Looking at the bar graphs it is easy to see that pumpkin leaves have more food value than tinned peas. Pumpkin leaves have much more Vitamin A and Vitamin C. Tinned peas are much more expensive than pumpkin leaves and have to be imported. Eating vegetables grown near the home is healthier and will save you money.

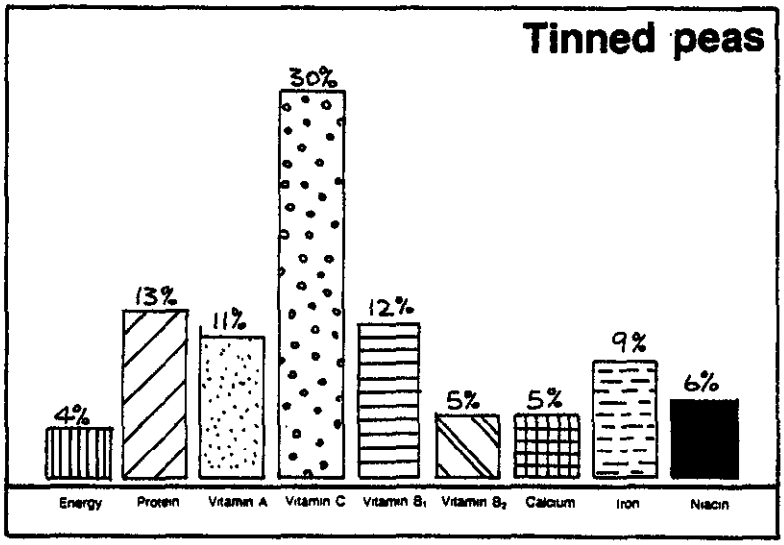
The **fruit** of the pumpkin is another health-giving food. It is an excellent source of **Vitamin A** and a good source of **Vitamin C.** Cooked, mashed pumpkin is an excellent food for babies.

Pumpkin **flowers** can also be eaten and are a good source of **Vitamin A.**

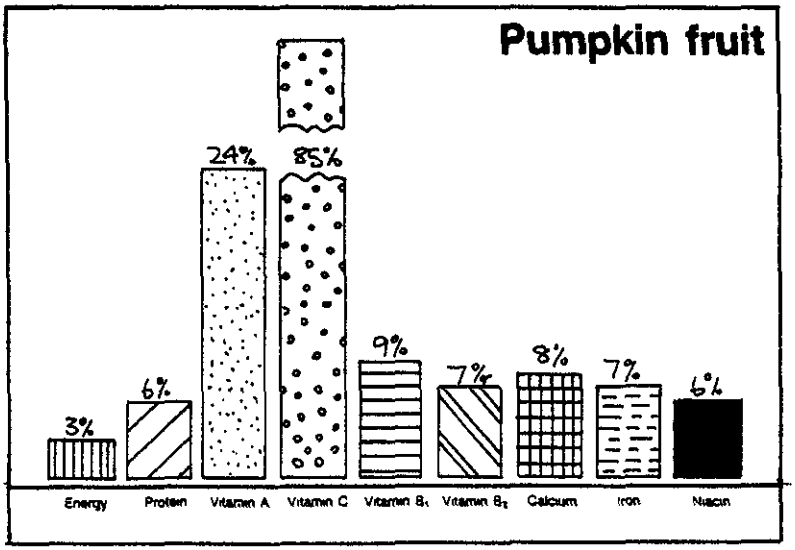
➡



Percentage of daily needs of an adult woman, filled by one serving (about ½ cup after cooking) of pumpkin leaves[1]



Percentage of daily needs of an adult woman, filled by one serving (about ½ cup) of tinned peas[2]



Percentage of daily needs of an adult woman, filled by one serving (about ½ cup after cooking) of pumpkin fruit[1]

1. From *Food composition tables for use in the Pacific Islands*. South Pacific Commission, 1983.
2. From *Metric tables of composition of Australian foods*. Commonwealth Department of Health, 1977

The most nutritious of all pumpkin foods are the seeds. They are an excellent source of **Vitamin A** and also **Vitamin B_1** (thiamin) and **niacin**. Vitamin B_1 and niacin help the body convert carbohydrate into energy and heat.

Uses

Most of the uses for pumpkin are for food and these are described in the next section. In some places pumpkin seeds are used to get rid of worms.

Preparation and cooking

The tender leaves and stems, flowers, fruit and seeds of pumpkin can all be eaten.

Leaves should be washed in clean water before cooking. Remove any tough stems. Place leaves in boiling water, cover and cook for about 5 to 10 minutes, until just tender. Eating green leaves with coconut cream or other fats helps the body to use the Vitamin A in the leaves. Pan-frying is also a good way to prepare pumpkin leaves. Heat a little cooking oil in a pot and add chopped garlic or ginger. Add cut up leaves, cover and cook for about ten minutes, shaking the pot often.

To cook the **tips** of the vines, scrape or peel off the hairy skin first. Boil in water or coconut cream until just tender, as for the leaves. The tips then can be made into a salad. Cool the cooked tips, chop them and flavour with lemon juice.

Before cooking pumpkin **flowers**, the centres of the flowers must be pulled out. These flowers are delicious fried in a little butter or cooking oil, or dipped into batter and then fried. They can also be added to fish and meat dishes.

Pumpkin **fruit** can be baked, steamed, boiled or fried. It is

delicious served as a vegetable or made into tasty curries, soups or desserts. Pumpkin has the best flavour when cooked in the skin. The skin of very young pumpkin can be eaten, but it is best to peel the skin off older ones.

Pumpkins can also be baked whole. Puncture the skin with a fork and bake it until it is soft. The cooking time will depend on the size of the pumpkin. When cooked, cut the pumpkin in half and scoop out the seeds before serving.

Another way to cook pumpkin whole is to cut the top off and scoop out the seeds. Stuff it with fresh or tinned meat or fish, and fresh vegetables, or coconut cream and onions. Replace the top and bake in an earth oven or a regular oven until cooked. Cut up the pumpkin and filling and serve hot.

The **seeds** are prepared by washing them carefully to remove the pulp. Then they can be boiled, toasted or dried in the sun. They make a delicious, cheap nutritious snack and are rich in protein and iron. They can also be fried in a little cooking oil and lightly salted. Do not throw away this valuable food.

Storage and preservation

Whole pumpkins keep better if picked leaving 5 cm (2 inches) of the stem on the fruit. Dry them in the sun for a few days, then store them in a dry, shady place. They should not be touching each other. Pumpkins can be stored this way for up to six months.

Pumpkins may be preserved by drying or freezing. **Drying** pumpkin must be done carefully in order to kill all the germs that would make it spoil. Split the pumpkin in half and remove the seeds. Remove the skin and cut the fruit into thin slices. Steam for about 6 minutes. Spread on a tray and dry in the sun or in a solar dryer until dry and brittle. This will take about 2 days. If flies are a problem, cover with netting. Pumpkin needs to be dried in hot sun so that it dries quickly before it spoils.

Freezing is another way of preserving pumpkins. Wash the pumpkin and cut it into pieces. Remove seeds, but do not peel. Cook until soft by boiling, steaming or baking. Scrape the pumpkin flesh from the skin and mash it well. Pack, seal and freeze immediately. Mashed pumpkin may be used later for baby foods, soups and breads.

Pumpkin recipes

Pasolo fish

Two servings:

1 fresh, cooked fish
Pumpkin leaves
1 coconut
1 onion, chopped
Salt to taste

1. Grate coconut and squeeze out the cream into a pot.
2. Add the chopped onion, and salt to taste.
3. Bring mixture to the boil.
4. Wash the pumpkin leaves. Wrap small pieces of fish in the leaves.
5. Add the fish parcels to the boiling coconut cream.
6. Cover with a lid and cook for 5 minutes.
7. Serve with cooked taro, cassava or breadfruit.

Pumpkin bread

1 kg wholemeal flour
1 teaspoon instant yeast
1 cup of cooked, mashed pumpkin
2 tablespoons toddy, golden syrup or honey
3⅓ cups lukewarm water or coconut cream

1. Mix toddy, syrup or honey with lukewarm water or coconut cream and mashed pumpkin.
2. Put flour into a bowl and mix in the instant yeast.
3. Make a well in the centre of the flour and pour in the lukewarm mixture.
4. Mix and work well into a soft moist dough.
5. Shape dough into rolls and put into greased baking tins.
6. Leave to rise for 10 to 15 minutes.
7. Bake in a moderate oven for 30 minutes or until bread sounds hollow when tapped.

Note: Shelled pumpkin seeds can be added to the dry flour and yeast mixture.

Pumpkin and custard

Six servings:

1 small pumpkin
2 cups milk
3 eggs
¼ cup sugar

1. Cut the top off the pumpkin. Scoop out the seeds.
2. Beat the eggs lightly and mix in the sugar.
3. Heat milk until it is just boiling. Add to the egg and sugar mixture. Mix well.
4. Pour the egg mixture into the pumpkin.
5. Replace top and bake in an earth oven or moderate oven (350°F or 180°C) for about 1 hour, until cooked.
6. Cool, slice and serve as a dessert.

Note: Sugar may be replaced by onion, green vegetable and a little salt to make this a savoury dish.

Savoury bananas

Four servings:

4 ripe cooking bananas
12 matchbox-sized pieces of pumpkin
2 spring onions
1 green pepper (optional)
4 serving pieces fresh fish
2 cups coconut cream

1. Put the fish pieces into a pot or baking dish.
2. Peel the bananas and cut lengthwise. Arrange on top of the fish.
3. Wash and chop the spring onions and green pepper. Sprinkle on top of the bananas.
4. Wash the pumpkin, cut into slices and add to the bananas.
5. Add coconut cream.
6. Cook for about 30 minutes or until the bananas are soft.
7. Serve hot.

Pumpkin drink

Two servings:

1 cup cooked, mashed pumpkin
1 cup coconut cream
1 cup cooking water from pumpkin
Sugar or toddy to taste

1. Prepare the pumpkin and leave to cool.
2. Mix all the ingredients well in a bowl or jug.
3. Cool and serve.

Chicken and pumpkin soup

Six servings:

2 tablespoons cooking oil
⅓ cup chopped onions
1 kg (2 lb) chicken
4 cups water
2 tomatoes, chopped
4 cups sliced and peeled pumpkin fruit
6 pumpkin tips
1 cup coconut cream
1 green pepper, sliced (optional)
3 tablespoons lemon juice (optional)
Salt to taste

1. Wash pumpkin tips, prepare and chop.
2. Fry onion in the cooking oil until tender.
3. Cut chicken into small pieces.
4. Add cut-up chicken to onion and cook for 10 minutes uncovered.
5. Add water, lemon juice and salt to taste.
6. Bring to the boil, lower heat and cook for 15 minutes, covered.
7. Add tomatoes, pumpkin, green pepper and pumpkin tips. Cook for 5 more minutes.
8. Add coconut cream. As soon as the mixture comes to the boil again, remove from heat.
9. Serve hot with cooked root crops or breadfruit.

Fried pumpkin flowers

Four servings:

3 cups pumpkin flowers (about 20 large ones)
1 fresh fish
1 medium onion
1 large tomato
1 tablespoon cooking oil
½ cup water or stock
Salt and pepper to taste

1. Clean the fish, remove all the bones and skin. Cut the fish into small pieces.
2. Peel and chop the onion. Wash and finely slice the tomato.
3. Remove the centres and stem from the pumpkin flowers. Wash the remaining flower petals well.
4. Heat cooking oil in a frying pan. Add the onion and cook until golden brown.
5. Add the tomato. When cooked add fish and cook for about 10 minutes.
6. Add the water or stock. When mixture begins to boil, add the pumpkin flowers and season with salt and pepper.
7. Serve hot with cooked breadfruit, banana or root crops.

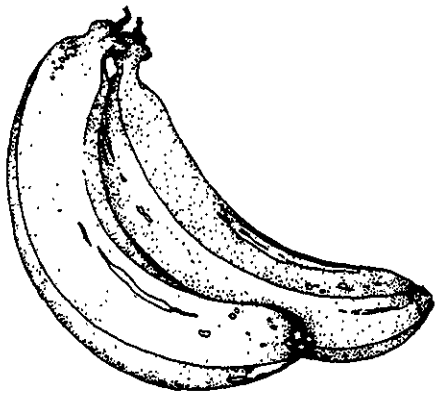
Note: Choose male flowers for this recipe so female flowers are left to develop fruit.

Banana

The information below is reprinted from: ***South Pacific Foods Leaflet 7*** **published by South Pacific Commission in 1983 and reprinted 1984, 1987.**

The leaflet is the seventh in a series devoted to the uses of local Pacific foods. Other leaflets available in the series describe Taro, Pawpaw, Mango, Guava, Cassava, Green Leaves, Coconut, Breadfruit, Pineapple, Citrus and Pumpkin. For more information, write to:
South Pacific Commission, B.P. D5, Noumea Cedex, NEW CALEDONIA

A tropical treat



Bananas are a good food for people living in the Pacific. They are covered by an easy-to-remove skin that keeps in the food value and keeps out germs that cause sickness.

These days there are many high-priced, imported snack foods in brightly coloured packages in stores. Bananas are also available, but in natural, easy-to-open packaging at an inexpensive price.

Easily grown and harvested, the banana plant gives many good tasting fruits if well cared for. The banana fruits can be easily prepared in many ways. Even the flower of the plant can be eaten. Best of all, bananas are available throughout the Pacific, in plantations, gardens, markets and stores.

Two kinds of bananas

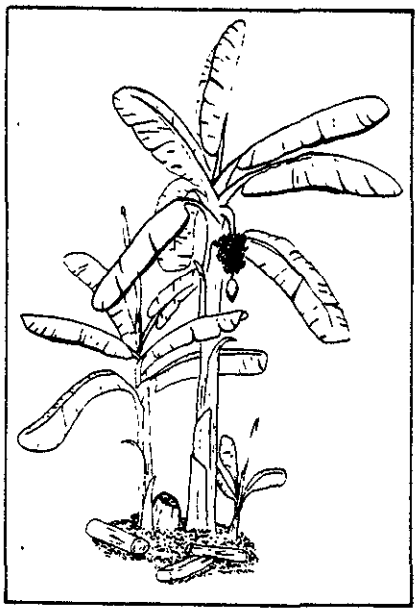
Banana plants belong to the family with the scientific name *Musa*. There are many varieties of bananas, all different in flavour and appearance, but there are two main kinds:

Eating bananas are the sweeter varieties. They are eaten raw when ripe.

Cooking bananas (sometimes called plantains) are the starchy varieties. They are cooked before eating, even when they are ripe. These varieties, the first ones in the Pacific, are an important staple food.

The banana plant grows to 3 to 8 metres (10 to 25 feet) from an underground stem called a **corm**.

The corm sends up a shoot every year, which dies after it flowers and fruits. The 'trunk' of the plant is really rolled leaf bases.



Banana plants should be thinned so that there is only one bearing shoot, one follower, and one new sucker.

Banana plants grow well throughout the South Pacific, even on most atolls. In order to bear large crops, banana plants must be properly looked after and must not be overcrowded. The illustration on the left shows how they should be thinned. They are grown by planting corms, or suckers, taken from the base of old plants.

About one year after planting, banana plants fruit. They may fruit at any time during the year, but they are more likely to fruit in warm weather. Bananas may be harvested when three-quarters of the fruit on the stem are full size. To ripen the bananas, hang the bunch in an airy place. Sometimes other ripening methods, such as burying or using chemicals, are used.

Energy in two forms

Bananas contain a lot of **energy**, which the body needs for warmth, work and play. This energy comes from the sugar and starch in the bananas.

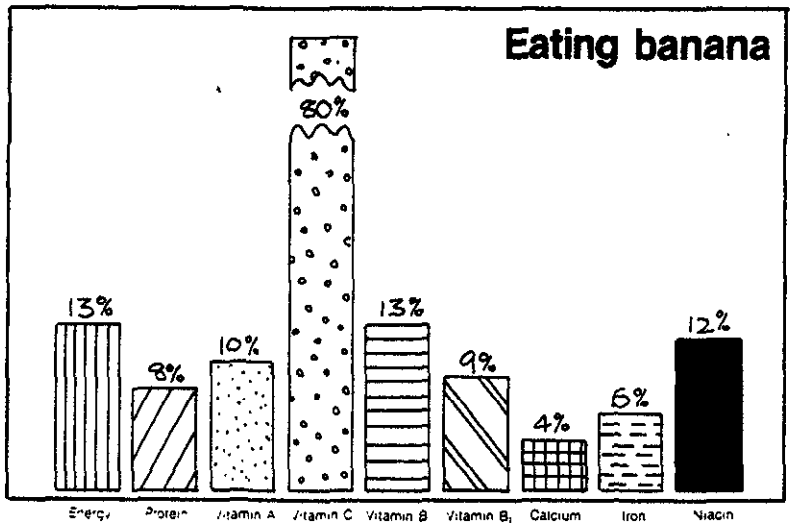
As the starch in green bananas is hard to digest, they must be cooked to be used by the body. As bananas ripen, the starch turns to sugar. Ripe bananas have the same energy value as green ones, but it is in sugar. Energy in ripe bananas is easily used by the body without cooking.

Bananas are a good source of ***Vitamin C***, *which keeps body* tissues strong, helps the body use iron, and aids chemical actions in the body. They are also a good source of **Vitamin A**, which is needed for proper growth, healthy eyes, and protection from disease.

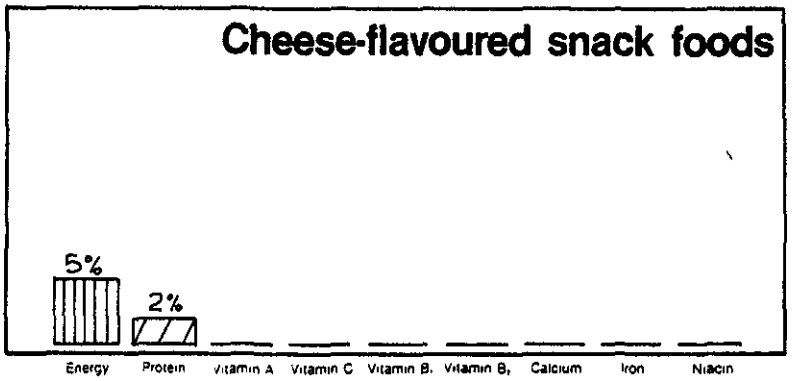
Bananas are an excellent source of minerals that are lost during diarrhoea. By eating bananas the lost nutrients are replaced.

The bar graphs show the food values of two foods that can be bought for the same price. Bananas have other nutrients in addition to energy and protein. Cheese-flavoured snack foods that are sold in brightly coloured packets have none of these important vitamins and minerals. Bananas are the better buy because they have more food value for the money spent.

The banana flower is a good source of Vitamin C and Vitamin A. It is a fair source of **calcium** and ***iron***, *which help make strong bones* and teeth (calcium) and help keep the blood healthy (iron).



Percentage of daily needs of an adult woman, filled by two medium bananas[1]



Percentage of daily needs of an adult woman, filled by one packet of cheese-flavoured snack foods[2]

1 From *Food composition tables for use in the Pacific Islands* South Pacific Commission, 1983.
2 From *Fiji Nutrition Newsletter* National Nutrition Committee. Volume 1, Number 2. p. 3

A weaning food

Ripe eating bananas are an excellent food for babies from 4-6 months on. They are very easy to digest and can supply the extra energy and vitamins that babies need. Making baby food at home with locally grown bananas is easy and saves money.

To prepare this baby food, peel the banana, remove any strings that may stick to it, and mash it well. Remember that a banana is protected from germs when it is in the skin. Using a clean cup and spoon helps to keep it germ free. Bananas prepared in this way can take the place of expensive cereal foods bought from the store.

Using bananas

Green bananas are used as starchy vegetables. They are not as nutritious as some starchy roots such as sweet potatoes or taro and should not take their place completely. They make a good starch for puddings. Green banana flour is used in the food industry.

Ripe bananas may be used in drinks, salads, meat dishes, sandwich fillings, cakes, or other desserts. Ripe eating bananas make a delicious snack. They are a good food for elderly or sick people because they are easily digested. When someone has diarrhoea, bananas should be eaten to replace nutrients that the body has lost.

Banana flowers are picked from the end of a bunch of bananas when the fruits are half grown. Removing the flower at this time will not hurt the fruit. Flowers from eating bananas have a bitter taste and should not be eaten. Only flowers from cooking varieties are eaten. They are used in meat, fish, or shellfish dishes.

Corms from a certain kind of banana that does not flower can be eaten. This kind grows in some places in the Pacific. The corm is eaten as a starchy vegetable.

Banana leaves are not eaten, but are used to wrap food. Use a clean, whole banana leaf and soften it by holding it over a flame. Cut the mid rib off the back so that the leaf lies flat. Cut the leaf to the size needed. After filling it with food, fold and tie with a mid rib from a coconut leaf.

Wrapping foods in banana leaves for school lunches or for selling at the market is cleaner than using newspapers. It is not as expensive as using imported foils or food wraps. A nutritious way to cook foods is to wrap them in banana leaves and steam or bake them in an earth oven.

Preparation and preservation

For easy peeling, green bananas are boiled, steamed, or baked until they are soft, and then peeled. Traditionally, they are cooked in earth ovens or over hot coals. Sometimes, peeled green bananas are soaked in salty water and then baked. Another cooking method is to bake them grated or sliced and wrapped in leaves with coconut cream. Fermented paste made from green bananas may be baked in earth ovens as a cake.

Ripe cooking bananas boiled with coconut syrup make a tasty sweet dish. A traditional chiefly drink in some Pacific countries is prepared by pounding ripe eating bananas and mixing them with lemon-leaf-scented coconut cream. Ripe eating bananas, mashed and cooked with starch, make a cake with a jelly-like texture.

To prepare banana flowers, remove the tough outer layers. Slice thinly into sections as an onion is sliced. Wash in salty water, kneading to wash out all of the sap. Rinse in fresh water and use in salads, soups, or other dishes.

To prepare dried bananas, use the following method:

Dried bananas:

1. Choose firm, ripe eating bananas. Peel.
2. Slice and lay on a frame stretched with cloth.
3. Cover with thin netting. Dry the bananas in the sun, turning them two or three times a day. When they are dry, they are brown, but not hard. Drying takes three to six days.
4. Pack in jars or wrap in banana leaves to keep out any moisture.

Dried bananas make a delicious and inexpensive snack. If dried correctly, none of the nutrients is lost. Selling dried bananas as snacks is a good way to make money using a local food. Dried bananas can also be soaked and cooked, or added to dishes such as porridge before cooking.

Banana recipes

Stuffed green bananas

Six to eight servings:

6 green cooking bananas
225 g (8 oz) raw minced meat
1 onion, chopped
Salt
1 egg, beaten

1. Without peeling, cut the bananas into halves along their length.
2. Scoop out the flesh with a spoon. Leave the peel boat-shaped.
3. Grate the banana flesh.
4. Mix the mince, chopped onion, and salt with the grated banana flesh. Add the beaten egg to bind the mixture.
5. Put the mixture back into the banana peels. Tie the halves together with string.
6. Steam for 25 minutes or bake in a moderate oven (180°C or 350°F) for 45 minutes.
7. Serve with gravy or a sauce made from cooked tomatoes, if desired.

Baked cooking banana and fish

Eight servings:

4 ripe cooking bananas
8 pieces of fish
1 onion, sliced
4 tomatoes (optional)
Coconut cream from 2 coconuts
Salt to taste

1. Peel bananas and slice.
2. Wrap the bananas and fish with the other ingredients in 4 banana leaf packages.
3. Place in a baking dish.
4. Bake in a moderate oven (180°C or 350°F) until the fish is tender (about 30 to 45 minutes).

Banana chips

Eight servings:

2 green cooking bananas
Oil for frying
Salt to taste

1. Pour oil into pot to heat.
2. Peel bananas and cut them into thin slices.
3. Put them on paper-covered plates and sprinkle with salt.
4. When oil is very hot, fry chips until they are a pale gold in colour.
5. Drain on paper. Serve at once.

Banana milk drink

One serving:

1 cup milk
1 ripe eating banana

1. Use fresh milk or prepare powdered milk by using 1 cup water to 4 tablespoons of milk powder.
2. Mash banana thoroughly.
3. Pour mashed banana into milk and stir well.
4. Serve in a glass.

Note: This is a good drink for babies and children. It is also a very refreshing drink for sick people.

Banana bread

Two loaves:

3½ cups flour
3 teaspoons baking powder
1 teaspoon salt
1 teaspoon baking soda
2 cups mashed, ripe eating bananas
2 tablespoons lemon juice
¾ cup butter or margarine
1½ cups sugar
3 eggs
¾ cup milk

1. Sift together flour, baking powder, salt, and baking soda. Set aside.
2. Mash bananas with a fork. Add lemon juice and mix. Be sure the bananas are mashed well.
3. Cream together the butter or margarine and sugar, until they are well mixed. Add eggs and beat thoroughly until light.
4. Add the sifted ingredients to the egg mixture in small amounts, adding a little of the milk each time. Beat well after each addition.
5. Fold in the banana mixture. Mix well.
6. Pour mixture into two greased loaf pans. Bake in a moderate oven (180°C or 350°F) for about 1 hour.
7. Cool and serve.

Note: Instead of baking, this bread can also be steamed using the following method:

1. Start water boiling in a large pot with stones or shells in the bottom.
2. Grease 2 large clean tin cans.
3. Pour bread mixture into cans, no more than half full.
4. Cover can tops with grease-proof paper or a leaf.
5. Put the cans in the pot, resting on the stones or shells. Cover the pot.
6. Steam the bread for 1 hour, or until a knife comes out dry after it is put into the bread.

Banana flower soup

Four servings:

2 cooking banana flowers
1 cup shelled shrimp or prawns
1 onion, sliced
4 tablespoons oil
2 cups water
4 cloves garlic, chopped (optional)
Lemon and salt to taste

1. Remove the tough covering of the flower. Slice across into thin pieces. Squeeze it with salt and rinse. Set aside.
2. Mix the shrimp or prawns with the sliced onion and lemon juice.
3. Fry the garlic in the oil. Add the shrimp mixture.
4. Add the water and continue cooking.
5. Add the flowers. Turn over constantly until tender. Season with salt.
6. Serve hot.

Banana rice

Six to eight servings:

2 cups rice uncooked
12 ripe eating bananas
1 coconut
Salt to taste

1. Clean rice.
2. Peel and slice bananas.
3. Put rice and bananas in a pot. Add water to 5 cm (2 inches) above the rice and boil gently until cooked.
4. Grate coconut, add a little water, and squeeze out the cream. Add salt to taste.
5. When rice is cooked, mix in the coconut cream.
6. Serve hot or cold with greens or other vegetables.

THE WINGED BEAN

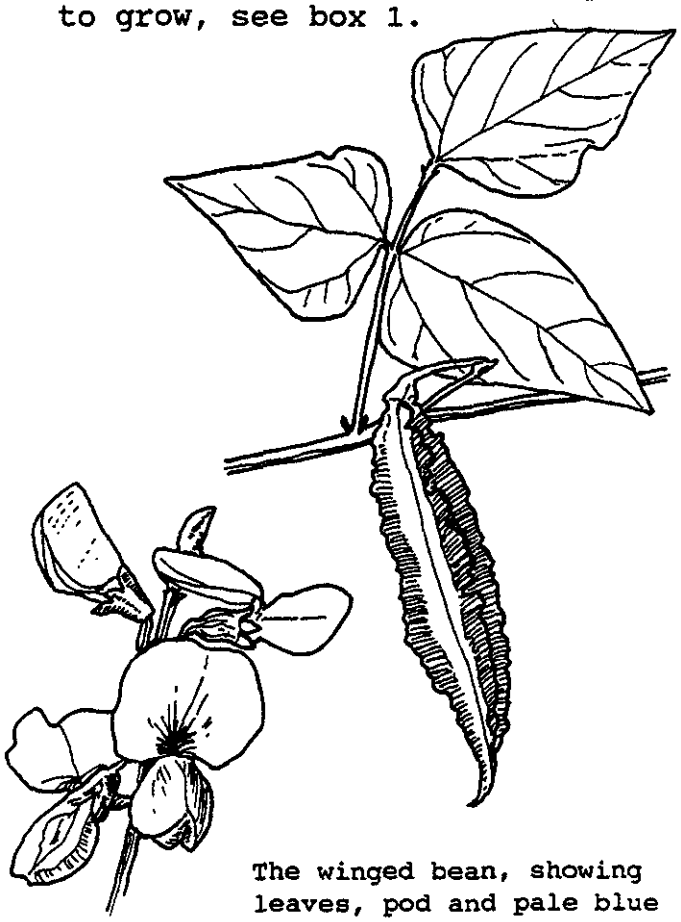
Winged bean (*Psophocarpus tetragonolobus*), also known as Goa bean, asparagus pea, four-angled bean, Kachang botor (Malaya), too-a poo (Thailand)

The winged bean is popularly called "supermarket on a stalk". Why? Because you can eat almost every part of it! The leaf, rich in vitamin A, tastes like spinach. The flowers, when fried in oil, taste like mushrooms. The young pods can be eaten in salads or cooked like green beans. They even taste like green beans, and the young seeds taste like peas. The tubers are more rich in protein than the potato, yam or cassava. They are peeled and can be boiled, fried, baked or roasted. Tasting slightly sweet and having the consistency of an apple, tubers are best eaten when they are as thick as a thumb. Old tubers get stringy and tasteless. The seeds provide high-quality protein,, and yield edible oil, although mature dried seeds are difficult to cook and are indigestible. In some respects, the winged bean is a rival to the soybean, which is difficult to grow in the humid tropics.

Like most legumes, the winged bean improves the soil in which it grows by taking nitrogen from the air. The winged bean plant makes a good cover crop or restorative fallow crop. The bean has other advantages, too. It grows is a small space. One hectare of this powerful climbing bean produces nourishment equal to five or six hectares of most other crops.

Although winged beans are native to the humid tropics, they grow well in drier regions if irrigated. Some varieties are drought resistant. The Efe pygmies of Zaire, for example, started growing winged beans in the early 1980's, and they found that, despite a lack of rainfall, they got a good crop their very first year.

Winged beans are suitable only for small-scale farming because its vines need stalking if high yields of pods and seeds are desired. The plant is relatively easy to grow, see box 1.



The winged bean, showing leaves, pod and pale blue flowers.

Box 1: Cultivation Tips
If you are growing winged beans for their pods and seeds,

* Plant at the beginning of the rainy season on flat ground;
* For seed production, place 3 seeds in holes 10 cm (24") between plants and 10 cm (24") between rows;
* For pod production, plant with 7.5 - 10 cm (18" - 24") between plants and 10 cm (24") to 20 cm (48") between rows.
* Seeds should be sown 2.5 cm (about 1") deep;
* Supports - e.g. bamboo poles, trellis or wire fence - are needed for vines to twine around.
* The first pods are ready to harvest 42 to 72 days after sowing. If beans are harvested continually, the plant will produce about 25 pods every 5 or 6 days for several weeks. If beans are allowed to mature and dry out, then new pods will not form. Mature seeds are normally produced 180 to 270 days after planting.

If you are growing winged beans for their tubers,

* Seeds are planted on ridges 10 cm (24") wide and 15 - 24 cm (6" - 10") high.
* Seeds are planted 5-7 cm (2" - 3") deep and 7-14 cm (3" - 6") apart.
* No supports are needed: plants are allowed to spread about on the ground, and will reach a height of 30 cm (about 1').
* Weed control is especially important for the first 3 to 5 weeks because seedlings grow very slowly at first.
* Tubers are mature for harvest 120 to 240 days after seeds are sown. They are best harvested when 2.5 - 4.5 cm (1" to 2") in diameter and 7 -12 cm. (3" to 5") in length. They are best dug out with a fork.

Source: **Education Concerns for Hunger Organization (ECHO Inc.) 17430 Durrance Rd., North Fort Myers USA**

One farmer joked, "Put it in the soil, put a stick next to it, and you can pick it - the leaf, that is - after three weeks." It's not quite so simple, but nevertheless, the only demands are weeding; replacing the stick the vine grows on; harvesting each stage at the right time. The plant is generally free of pests and diseases, but this is probably because it is grown in mixed market gardens or as a rotated crop.

The winged bean is sometimes treated like a perennial, and in some places produces a good yield for five years. In other parts of the world, it is better to replant every season. The pods mature unevenly, but it is very important to gather the "peas" from them at the proper time because these are the seeds to be planted the following season. Seeds may be stored for up to a year. Plants will also develop from tubers which are left in the ground. Winged beans are often interplanted with sweet potatoes, taro, bananas, sugar cane and other vegetable crops.

The bean can be made into a variety of dishes. It can be stew, soup or porridge, as well as a great substitute for miso, soya paste, popcorn, or tempeh (a fermented soya bean cake). A flour made from the seeds may also be used as a dry milk substitute for children suffering from Kwashiorkor. See box 2 for a way of cooking dried winged bean seeds.

So the winged bean is an extraordinary food plant.

Box 2: Cooking Dried Winged Bean Seeds

1. Measure the volume of the beans to be cooked.
2. Rinsed the beans, and add 5 times their volume of water.
3. To the water, add 1% sodium bicarbonate sold as soda or baking powder.
4. Boil the beans and simmer for 3 minutes.
5. Remove from the heat, and soak the beans in the solution overnight.
6. The next day, throw away the water, rinse beans twice with fresh water and boil them in double their volume of fresh water for 20 to 25 minutes.
7. Beans treated in this way are very soft. Even seed coats are pliable and edible. A few seeds may remain hard: these can be separated from the soft ones by means of a large mesh screen.

Beans, softened and cooked in this way, have a mild flavour and may be added to many traditional bean dishes.

Source: **Frankin W.Martin and Ruth Roberts**

But, perhaps, what is even more remarkable is that while this crop has been grown for many generations as a "poor man's crop" in South East Asia and Papua New Guinea, the winged bean has only recently attracted international attention. Now it is grown in more than 70 countries.

Sources:

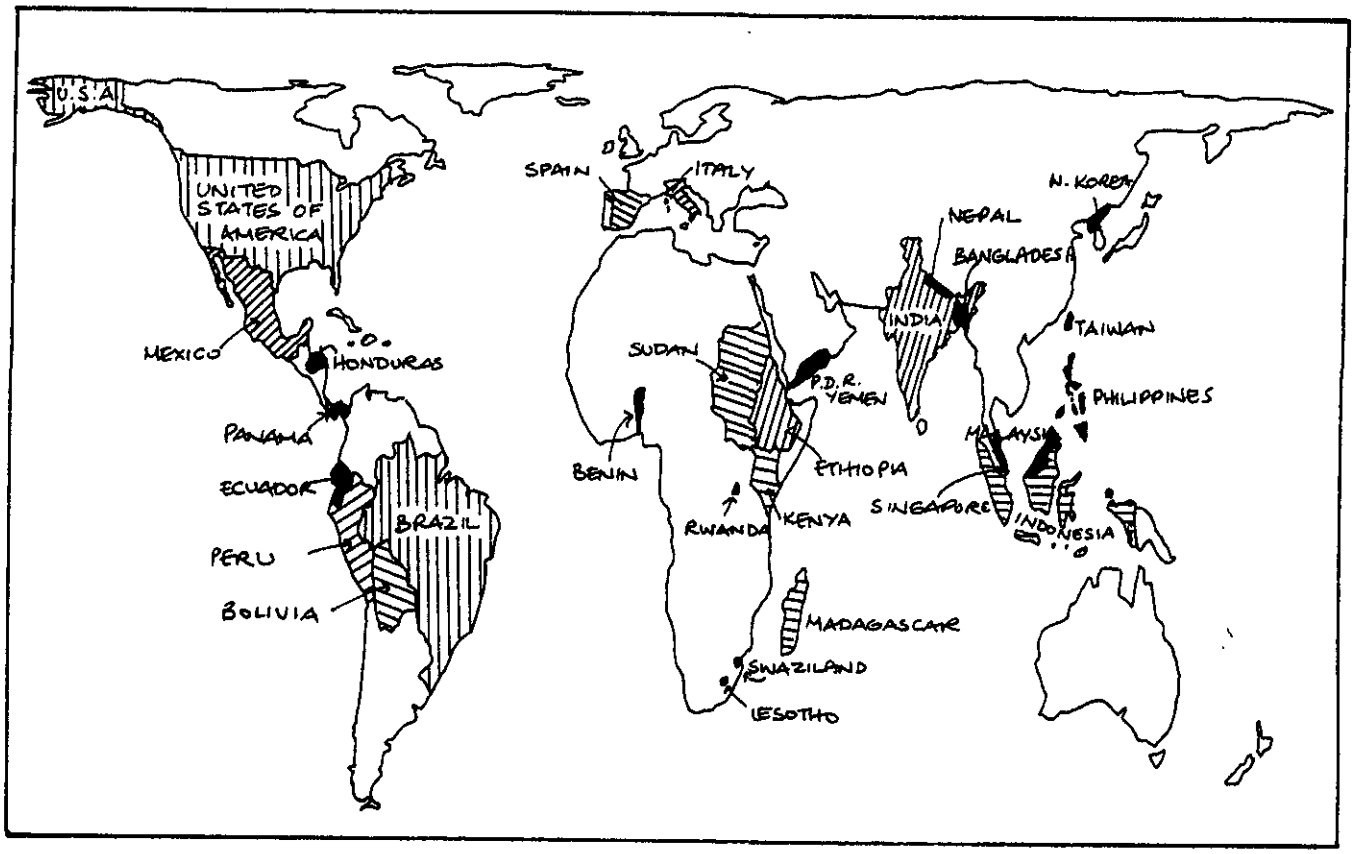
1. ***African Farmer*** **No. 2 Dec. 1989, published quarterly by The Hunger Project, Global Office, One Madison Avenue, New York, NY 10010 USA**
2. ***The Winged Bean*****, notes from ECHO Inc.** (for address, see above)
3. ***Green Inheritance*** **by Anthony Huxley published by William Collins Sons & Co Ltd., London 1984**

OUTREACH ISSUE NO. 71: CONTENTS

[Reading level: I=children (8-10 years); II=children (11-13 years) and adults with basic literacy; III=teachers and/or people with secondary education]

LOCATION MAP

The map below shows the location of places mentioned in issue no.71.



ACKNOWLEDGEMENTS

OUTREACH would like to thank Marion van Schaik from Save the Children and Sharon Kahkonen for providing a wealth of information and ideas for these OUTREACH packs on "Crops". Thanks also go to Asian Cultural Centre for UNESCO, Centre for Environment Education (India), Developing Countries Farm Radio Network, Rodale Institute, Save the Children, South Pacific Commission, Deutsches Zentrum fur Entwicklungstechnologien (GATE) and other contributors to these information packs.

CLASS/YOUTH GROUP ACTIVITY

FOOD ISSUES

The activity below is taken from:
***World Conservation Strategy: A Programme for Youth, Manual for Youth Environmental Projects*, prepared for IUCN Commission on Education by Klaus Berkmuller and Martha C. Monroe, in collaboration with the United Nations Environment Programme (UNEP) as a contribution to the International Youth Year.**
(Education, Training and Awareness Series No. 1)

For further information, contact:
International Union for Conservation of Nature and Natural Resources, (IUCN) Publication Services, Ave du Mont-Blanc, CH-1196 Gland, SWITZERLAND

Setting: Indoors
Time: One hour
Format: Small group discussion

Purpose: To recognize the complexity of food production and the effects of technology, to work with other participants to discover shared information, to improve listening skills, and to promote discussion in small groups.

Materials: One card per person.

Concepts: The group has to sort through confusing bits of information. These issues are highly condensed and simplified. By attempting to answer the question, "How can we best feed our people?" the group will probably realize that (a) technology can help, but has limitations; (b) food availability and distribution are influenced by politics and economics; and (c) there are no easy answers.

Procedure: Divide into groups of 3-4 people. Distribute the cards so that each group has a complete set. Read the rules and give each group 20 minutes to "solve" the problem. Allow sufficient time for the groups to share their solutions and problem solving experiences.

Rules:

1. Do not show your card to anyone.
2. Whoever has the question should read it first.
3. Read the information on your card out loud to your group. Read it again if asked.
4. Answer the question by reaching agreement in your group.

Some groups may decide there is no adequate answer and spend their time discussing the issue. That's fine. Other groups may decide they need to know more about this topic. That's fine too.

The questions below might help keep the discussion on track:

— Do you think that seed banks and genetic engineering can make up for the loss of genetic diversity in the wild? Should we reverse the trend toward larger monocultures and fewer crop varieties?

— Can modern agriculture, with its huge machines, super crops and potent chemicals, reduce hunger in the world? What might be other components of the hunger problem?

— Should people eat less meat, if the livestock grains could feed people?

— What are some of the advantages and disadvantages of modern agriculture?

Extensions: Your group can continue exploring food issues by: preparing and enjoying a nutritious vegetarian meal, touring a food-producing farm, tending an organic garden, providing workshops to teach others about food issues, etc.

FOOD ISSUES CARDS

CARD 1 1. Increase our use of pesticides to kill the insects that eat our crops. This will help provide more food for our people. 2. Goat meat is a more efficient energy source than beef. 3. If positive and negative factors are balanced, it is possible to use powerful tools wisely.	CARD 4 1. Grow more grain crops and raise less livestock to make more food energy available to people. Livestock require more energy in grain than they give in meat. 2. How can we best feed our people, now and in the future, without harming the life support systems? 3. Grow food on less fertile soil and in very dry areas.
CARD 2 1. We can use ponds and oceans to raise fish, algae and other foods. 2. Increasing our use of chemical fertilizers will make the land more productive. 3. Heavy machinery can compact the soil and harm its ability to hold water.	CARD 5 1. Chemical fertilizers cost money to import. Organic fertilizers (mulch, manure, cornstalks, etc.) enrich the soil and are available locally. 2. Increase the area of land under irrigation. 3. The more new strains we plant, the sooner we'll lose the genetic diversity from the wild plants.
CARD 3 1. Pesticides cost money to import and the improper application of these poisons can made people sick. 2. Good farmland should not be converted for housing and industrial development. 3. Breed strains of crops that are disease-resistant.	CARD 6 1. Over time, irrigation can build up toxic salts in the soil and deplete groundwater supplies. 2. Because of our increasing population, we will need to produce twice as much food in the year 2000. 3. Grow food crops instead of export crops like cocoa, coffee and tobacco.

UNDERSTANDING GENETIC DIVERSITY

The text below is taken from:
***World Conservation Strategy: A Programme for Youth, Manual for Youth Environmental Projects*, prepared for IUCN Commission on Education by Klaus Berkmuller and Martha C. Monroe, in collaboration with the United Nations Environment Programme (UNEP) as a contribution to the International Youth Year.**
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For further information, contact:
International Union for Conservation of Nature and Natural Resources, (IUCN) Publication Services, Ave du Mont-Blanc, CH-1196 Gland, SWITZERLAND

You may have heard the expression "gene pool". The gene pool is the total genetic diversity we have in the world. There are two types of genetic diversity: interspecific diversity and intraspecific diversity.

Interspecific diversity refers to the great variety of species, from the single-cell plankton to the more complex organisms. This type of diversity increases as new species evolve, but exceedingly slowly. Genetic diversity diminishes irrevocably with the extinction of every species.

Intraspecific diversity is the genetic variation present among the individuals within a species. Individuals of a species share many genetic characteristics, but they are not identical. This variety results in some individuals being better adapted to a changing environment than others. When populations are drastically reduced, much of this individual diversity and potential is lost.

A species is on the road to extinction when formerly large populations are fragmented into small populations, isolated from one another, as when forests are converted to farms, or when dams, roads and canals are constructed. A species is dangerously close to extinction if there is only one breeding population. The species hovers at the brink of extinction if the size of that breeding population is barely above the minimum necessary for survival. That minimum number depends on the species and its reproduction characteristics.

To break the trend of accelerating loss of genetic diversity, we must prevent the fragmentation of populations, and remove the pressure from already vulnerable populations.

There are ethical, ecological and economic reasons for wanting to preserve genetic diversity. We cannot replace species. Once lost, they are gone forever. Many species have economic value now, or might in the future. And, losing them could interfere with essential ecological processes. Every species has a function within its ecosystem, even if we cannot describe it.

Genetic diversity of domesticated species. Our crop plants and domesticated livestock were derived from their wild cousins — grasses, tubers, oxen, goats, etc. Generations of early farmers protected the varieties that grew well in their area and were able to survive climatic extremes and local pests. They planted a great number of different varieties and crops to ensure a productive harvest.

About a hundred years ago, seed companies and animal breeders began to create new strains of domesticated animals and plants by selecting and breeding varieties for fast growth, large size, and appealing color. More recently, qualities like ease of machine-harvesting, transport and storage, and resistance to disease, have been selected. Most of the world's agricultural products are produced with only a few high-yielding varieties of crops. Ninety-six percent of the U.S. garden pea crop comes from only two strains. Four varieties of potatoes make up over two-thirds of the U.S. potato crop. The entire U.S. soybean crop consists of the descendants of a mere six plants (*WCS* 3.3-6).

One problem with these super species is that the large monocultures may be susceptible to disease and insect attack, and they are less adaptable to a variety of environments. If a resistant virus or fungus attacked the U.S. soybean crop, for example, the entire crop could be destroyed. If the diversity of wild plants from which new genetic material can be obtained is not available, soybean farmers could suffer.

Thus, local strains or wild relatives are needed to breed disease resistance and other desired characteristics into commercial strains. The "miracle rice", for example, got its resistance to a serious disease common in Asia from a wild relative growing in India.

Genetic diversity of wild species. We are losing animal and plant species at an alarming rate. Historically, one species became extinct every 190 years. From now to the end of this century, the approximate rate of extinction is three species every hour. Human-caused extinctions are radically interfering with life-support systems. Habitat destruction and fragmentation are by far the most serious causes of extinction, but economic exploitation and the introduction of non-native species also affect wild populations.

Public attention has focused on the loss of wild species in the past few decades, but it has primarily been limited to impressive and appealing animals like pandas, whales or tigers. As a result, some (like the Arabian oryx) have been successfully propagated in zoos or effectively protected in national parks. Many other less dramatic species, although no less important, receive little attention or protection.

CLASS/YOUTH GROUP ACTIVITY

THE ITCH-BUG GOBBLER AND GENETIC VARIATION

The activity below is taken from:
***World Conservation Strategy: A Programme for Youth, Manual for Youth Environmental Projects*, prepared for IUCN Commission on Education by Klaus Berkmuller and Martha C. Monroe, in collaboration with the United Nations Environment Programme (UNEP) as a contribution to the International Youth Year. (Education, Training and Awareness Series No. 1)**

For further information, contact:
International Union for Conservation of Nature and Natural Resources, (IUCN) Publication Services, Ave du Mont-Blanc, CH-1196 Gland, SWITZERLAND

Setting: Indoors or outdoors (the names of the species have been invented.)
Time: 30-45 minutes
Format: Group simulation game

Purpose: To understand the importance of genetic variation and potential changes in a small population.

Materials: 200 pebbles or shells, a stick, five meters of rope, some paint. Paint 20 of the pebbles or shells — let's say red. Mark four of the painted ones with a dot.

Concepts: Intraspecific genetic diversity is the genetic variation within a species. The larger the population, the greater the probability that some individuals will deviate from the norm in various respects. If this difference is carried by the genetic material, it will be passed on to future generations.

In this simulation, populations of the nasty itch-bug are controlled by the itch-bug gobbler. The gobbler has, unfortunately, some potentially fatal weaknesses. It cannot fly and does not dare set foot on a road. When temperatures drop below 5°C most gobblers die. Only 10% of them are genetically equipped to survive lower temperatures. The population will not satisfactorily reproduce if the ratio of males to females is lower than 1:4.

The genetic variation in itch-bug gobblers is a tolerance of temperatures below 5°C. A reduction of population size (through road construction) followed by low temperatures can lead to local extinction.

Procedure

1. Form a circle with the rope. Scatter the pebbles or shells at random over the area of the circle. Stand the stick on end and let it fall across the circle.

2. Explain the each pebble represents a gobbler. The painted pebbles are the cold tolerant gobblers (10%). Of these, the ones with a dot are the males. The stick represents a road recently constructed through the population. If any gobblers were touched by the stick, they have been eliminated by road construction. Since gobblers can't cross the road, the populations are now separated.

3. Unusually cold weather settled into this valley. Ask the group: Will gobblers survive on both sides of the road, or will the itch-bugs on one side of the road become a problem?

4. To answer this question, have the group count the red pebbles on each side. You will need at least one dotted red pebble and four plain painted ones to form a reproducing population (remember the sex ratio). Other outcomes are: 1) With less than five red gobblers, the population dies of the cold, and 2) with more than five red gobblers, but no males, the population cannot reproduce.

5. Ask the group what they might suggest to restore or protect the gobbler population on both sides of the road. When would such measures be needed?

SEEDS - BREEDING EXTINCTION

The article below is adapted from: "Seeds - breeding extinction", prepared by the Rural Advancement Fund International, in *Development Forum* Volume xvii no 3 (May-June 1989)

The Rural Advancement Fund International (RAFI) is a non-governmental organization working for the conservation of genetic resources. Its activities include research, lobbying, public education and consulting on both policy and technical matters. For further information, contact:
RAFI, R.R. 1 (Beresford), Brandon, Manitoba, CANADA R7A 5YI or
RAFI, P.O.Box 1029, Pittsboro, North Carolina 27312 USA

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Thousands of different and genetically distinct varieties of our major crops are being cultivated by farmers around the world. These different types were developed over the years to be grown in different

environments and for different purposes.

But today, many of these unique varieties are disappearing and becoming extinct. The introduction of modern grain varieties in the Middle East led to the widespread disappearance of traditional varieties. African rice is nearly extinct in its native West African homelands. It is estimated that three-quarters of all vegetable varieties now grown in Europe will vanish in the next decade.

The rapid disappearance of so many grain and vegetable varieties has been described as a botanical holocaust. A variety of hybrid rice called 1R-36 now extends over 60% of the rice lands of South-East Asia where, only a few years go, thousands of varieties were common. Another strain, 1R-8, rules from the cool of Taiwan to the heat of Benin. Where 30,000 different varieties of rice grew a few years ago, Indian agronomists now expect that no more than a dozen will soon dominate three-quarters of the land.

To some the replacement of old with new is part of the march of progress. But more and more people are realizing the importance of preserving the traditional crop varieties. The Third World farmer who plants several different kinds of seed in a field is often sowing insurance against crop failure if one variety succumbs to a disease or a period of bad weather.

Generally speaking, genetic diversity in a crop safeguards its adaptation to different environments and growing conditions. The ability of a certain plant variety to withstand drought, grow in poor soil, resist an insect pest, give higher protein yields or just produce a better tasting food is passed on naturally by the variety's genes. It is the genetic material from all the different potatoes in the world that constitutes the raw material plant breeders use to breed new varieties of potatoes. Without this diversity, plant breeding would cease. Pests and diseases would have a stationary target to attack. Crop evolution would come to a standstill.

The value of genetic diversity to modern crops is difficult to exaggerate. Every wheat variety grown in Canada contains genes introduced in recent decades from up to 14 countries. The largest gene pool is in the Third World. Tomatoes could not be grown commercially in North America were it not for genes from wild tomato species in Central and South America. The world's leading hybrid grain sorghums are based upon Zera-Zera sorghums from Sudan and Ethiopia.

Third World genetic resources are important to Third World people, too. Traditional crop varieties are part of the whole farming system. Old varieties have adapted over centuries to local climates and conditions. The local farmers know how to grow these crops. When old varieties stopped being planted and become extinct, it is the local farming community that suffers.

Natural gene banks

In the last 30 years efforts have been made to collect specimens of diverse crops. They are stored under conditions of low temperature and low humidity in facilities called seed or **gene banks.** But gene banks cannot guarantee that genetic diversity is conserved. Equipment can fail. Technologies may not be adequate. More troubling is the fact that once stored, seeds are no longer evolving to adapt to farming conditions: they are just adapting to gene bank conditions.

So gene banks should be viewed as one - but not the only - solution. Farmers and gardeners can help by preserving all the different varieties of crops they grow. It is on small farms and in gardens - and in natural habitats - that evolution can continue.

Unlike the vast fields that modern agriculture has created with single crops stretching to the horizon, the family-sized gardens tend to grow a wide range of plants. In gardens, where herbs, root crops, fruits, flowering vines and hedge-plants intermingle, plants tend to use water, light and nutrients more efficiently. One kind of plant may harbour a predatory wasp which preys upon the pest of another, neighbouring plant. Another kind of flower may keep bees in an area until a second kind needs them to perform pollination. A mixture of plants may hide the most vulnerable one from pests that would easily destroy it in the open.

Some areas of the world are richer in species diversity than others. Perhaps, one half of the world's plant and animal species are located in tropical moist forests. The tiny nation of Panama contains more different kinds of living things than all of North America.

Agricultural scientists have long recognized that there are "centres of diversity" which are particularly rich in varieties of certain crops and their wild relatives. Usually, but not always, a crop's centre of diversity is the place where the crops originated. For example, potatoes originally grew in the Andes. It is in the Andes where potatoes have been cultivated for thousands of years that the crop has had the opportunity to develop the most diversity.

In early times, however, crops travelled with people. Often "secondary" centres of diversity sprang up over the course of hundreds or thousands of years far away from a crop's original homeland. Maize, for example, comes from Central America. But valuable diversity can now be found in Asia.

Crop evolution

A crop is always evolving. It finds new ways to fend off animals and the microorganisms that attack it. And pests are always trying to defeat a plant's defences.

But crop evolution is not just about plants and bugs. Its also about people.

Farmers notice things about their crops that others cannot see. Sometimes these qualities are very practical. The scientist who proudly

"discovered" that an Ethiopian sorghum he had collected had a high protein content and excellent baking qualities could have saved himself some time in the laboratory if only he had asked Ethiopian farmers about the variety. Their name for it was *sinde lemine* which translates as "why bother with wheat".

The crop diversity we all depend upon today was not created by people who were satisfied with a having the exact same variety everyone else had. Differences in plants were noticed and encouraged by people who appreciated and valued those differences, often for reasons we cannot understand today. Different cultures and different needs played an important role in creating diversity.

Until recent times every farmer was a plant breeder. From the dawn of agriculture 12,000 years ago until the 20th century, each farmer had to produce and save his/her own seed for sowing the next season. This contributed to genetic diversity as varieties adapted to specific growing conditions.

Today, seeds are a $13 billion a year business, and big multi-national corporations are involved in plant breeding. The number of plant breeders has been reduced from millions to a mere handful of specially-trained scientists employed by these corporations.

In the past 20 years, governments have become less involved in plant breeding, and giant petrochemical and drug companies are dominating the seed business. These companies have bought up hundreds of family-owned seed companies all over the world. One of the largest seed companies in the world is Royal Dutch/Shell.

Corporate takeover

These big companies are involved in the seed business because they can make lots of money, and the markets for seeds are the same as those for their crop chemicals. Another reason is that there is a possibility of linking chemical and seed development and marketing. Ceba-Geigy, for example, markets its own brand of sorghum seed which comes wrapped in three chemicals, one of which is to protect the seed from Ciba-Geigy's leading herbicide. Such marketing packages allow the company to sell more seed and more chemicals.

Through sheer size and economic power, the transnational corporations have come to dominate the commercial seed market. This is especially so in industrialized countries where laws give them strong (patent-like) controls over new varieties they develop. Often called "Plant Breeders Right", these laws allow corporations to own plant varieties and set the sale conditions for them. This has meant that the few companies big enough to have full-fledged breeding programmes obtain most of the patents, locking up the market on new seed varieties. Moreover, these same companies often stop offering traditional varieties because no patent-like control can be obtained over varieties that existed before the laws came into effect. This means many traditional varieties are

falling out of use. If they - and the centuries of plant breeding work that went into them - are to be preserved, farmers and gardeners will have to do it.

If the same kind of patent laws were introduced into the Third World, it would mean companies could control and market varieties of crops in the very countries which had donated the genetic material used to breed those varieties. As more and more patented varieties are imported to centres of crop diversity in the Third World, traditional varieties would vanish forever.

When traditional varieties become extinct, farming communities lose a bit of their history and culture, and the plant species loses some of its gene pool. The future farming generation loses some of its options, and the present generation gives up some of its independence because the farmers have to rely on outside sources of seeds and the chemicals needed to grow and protect them. Other problems arise. For example, seeds bred for large farmers in industrialized countries are rarely bred for drought resistance. Yet, the loss of a traditional quality like drought resistance in a crop can cause real hardship for many farmers.

Gene revolution

The widespread introduction of modern, high-yielding varieties since the 1950's has been called the "Green Revolution". Today, a new and more important revolution is beginning. It is the "Gene Revolution". Biotechnology and genetic engineering hold out the promise of significant alteration in virtually every crop.

Biotechnology will certainly bring about startling increases in crop yields. We can expect yield increases as high as 500% for some crops like palm oil and cassava. New coconut trees yielding over 1,000% more coconuts annually are possible. Such developments will have widespread impacts upon these industries, affecting supplies, price, the need for labour and land. Breakthroughs in one crop could dramatically affect the fate of similar crops.

Biotechnology will also produce new, previously unattainable pest- and disease-resistant crops. But all these developments may be at the cost of making crops genetically uniform, and causing the loss of presently used "primitive" and traditional varieties. One certainty is the breeding of crops more appropriate to the use of herbicides and other crop chemicals.

How biotechnology is used, what problems (and whose problems!) it is directed to solve, and who benefits from it will be decided by those who control the technology - and how strongly those who do not control it can influence those who do. Whatever happens, genetic resources must be preserved for several reasons: (1) to provide the raw materials for the good things biotechnology can produce; (2) to provide options and insurance against the bad effects biotechnology could have; (3) to give those people presently without power

(but with genetic resources) a greater voice in determining the direction biotechnology takes.

From millions of plant breeders to a few; from a public activity to a private one; from crop varieties owned by everyone or no-one to varieties and even individual genes patented by corporations; from a common heritage of mankind to the raw materials stockpiled in gene banks - the trend is one of lessening public ownership, control and participation in the conservation and breeding of plants.

Third World governments are becoming increasingly concerned about the loss of genetic diversity and the growing "privatization" of the resources, and they have begun important talks with the United Nations Food and Agriculture (FAO). Third World governments have called for the full and free exchange of all genetic resources and for an international system of gene banks under the auspices of the FAO. In 1983, they succeeded in establishing an FAO Commission on Plant Genetic Resources which for the first time has given governments the opportunity to sit down with each other and focus on the conservation, control and utilization of genetic resources.

There are also efforts to establish a World Gene Fund to support the conservation and development of seed resources within the Third World.

The reason for conflict over genetic resources is clear. Genetic resources are the only raw material in the world that is donated - largely by the poor to the rich. Over the last decade, more than 90% of seed collected has been from the Third World, but almost the same percentage has either gone to industrialized countries (where patent laws exist) or to the International Agricultural Research Centres (IARCs) located throughout Third World regions. In either case, seed has escaped the sovereign control of the donating country, and it is far out of reach of the farmers who created and sustained the diversity in the first place.

NGO PROFILE: SAN (SEEDS ACTION NETWORK)

The following text is taken from:
***Ecoforum* Volume 13 No. 2, October 1988.**
Ecoforum is published bi-monthly in English, Spanish and French by the **Environment Liaison Centre (ELC), P.O.Box 72461, Nairobi, KENYA**
The publication functions as a networking instrument for non-governmental organizations (NGOs) around the world to share information and strategies relating to environment and sustainable development. It also serves as a window on the United Nations Environment Programme.

Who controls plant breeding and who is taking care of the genes upon which the world's food security depends? This is a question that brought people from around the world together to form the Seeds Action Network International (SAN). SAN is a global network of NGOs and individuals working to prevent the erosion of genetic diversity and to promote popular control over genetic resources.

SAN noticed that while most of the world's plant genetic resources originated in the Third World, they are today controlled by the North. Northern multinational firms from the chemical, pharmaceutical and food processing sectors are the major commercial seed sources for the world's agriculture.

But the "seedsmen" of the North are not only using Third World genetic material to breed new plant varieties, they have been granted property protection for the varieties they

produce. That is, they "own" them.

This has created an ironic situation. While the new biotechnologies offer huge possibilities to improve small and marginalised farmers' crop production, they are used to worsen genetic erosion and to reinforce industry's power over the agricultural sector. People are losing control over a fundamental resource for development.

SAN, launched in 1985, is trying to fight this trend. By joining together under this wide umbrella coalition, SAN members are sharing experiences and forging common strategies. The goal is to develop cooperative initiatives for local conservation and community plant breeding — for improving grassroots control over genetic resources.

SAN members are working towards this goal by setting up community gene banks, initiating local seed exchange networks and lobbying political and legislative bodies. Since people — in their families, their villages and their local organisations — have cared for genetic diversity for millenia; people are the base of the strategy to conserve genetic resources.

SAN has a loose, decentralised structure in which active NGOs form regional SAN contact-points. These contact-points (listed in the box) are the hinges to the organisation. If you want to know more about SAN or about the issues, contact the group closest to you.

SAN CONTACT-POINTS

AFRICA
PAFATU (Pan-African Federation of Agricultural Trade Unions)
P.O. Box 495
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ELCI
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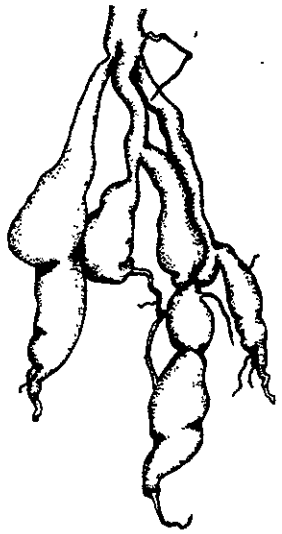
CANADA

WILD RELATIVES HELP OUT OUR FOOD SUPPLY

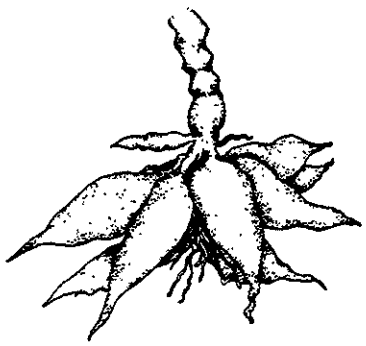
The sources for the material below are:
***Genes from the wild: using wild genetic resources for food and raw materials* by Robert and Christine Prescott-Allen (an Earthscan publication, published by the international Institute for Environment and Development, London 1983)**
***Saving the plants that save us*, a WWF publication for its Plants Campaign.**

Ever since people learned to farm, they have been using wild plants to improve their crops. Many fruits and vegetables have grown bigger, tastier, brighter, juicier or healthier by systematic cross-breeding with wild relatives.

1 Wild relatives are essential in developing resistance to all kinds of pests, parasites and diseases:



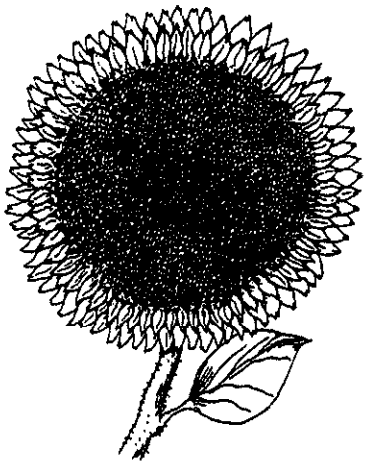
* The wild cassava (*Manihot glaziovii*) - left - is the only known source of resistance to the two most serious cassava diseases in Africa. Transfer of its genes to cultivated cassava - right - has increased yields of new cultivars by up to 18 times.



2. Wild relatives have increased yields of crops:

* Wild sugar species have helped double the cane yield of commercial growers.

* Wild species in sunflower breeding have helped raise yields by 20%.



cultivated sunflower

3. Wild relatives have extended the range of some crops:

* Specially developed salt-tolerant varieties of wheat, rice and alfalfa are already producing yields of similar nutritional value to those of traditional crops.

4. Wild relatives have raised the quality of many crops:

* The protein content of cassava has been raised.

* Pineapples have been made tastier - sweeter and more acidic.

* The fibres of cotton have been strengthened.

Plant explorers regularly find new 'wonder plants' in the wild, often in habitats that are in danger of being wiped out. These plants could greatly increase food production in areas which most need it.

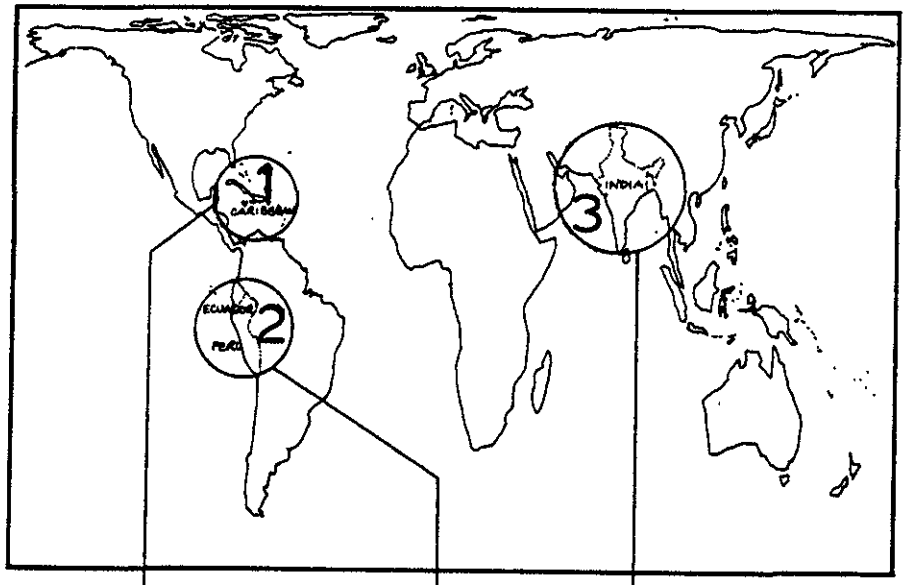
* The discovery of perennial maize, *Zea diploperennis*, in Western Mexico, has been claimed as "the botanical find of the century". Although it may be some time before we can take full advantage of the plant's perennial nature (our common corn has to be replanted each year), the discovery may result in greater yields, since the wild variety is resistant to several common diseases. It might also enable totally new areas to be opened up for maize production, since the new maize variety is resistant to cold and damp. It is a threatened species, discovered in a forested corner of Mexico that was scheduled to be cut down to make way for local settlers.

cultivated maize

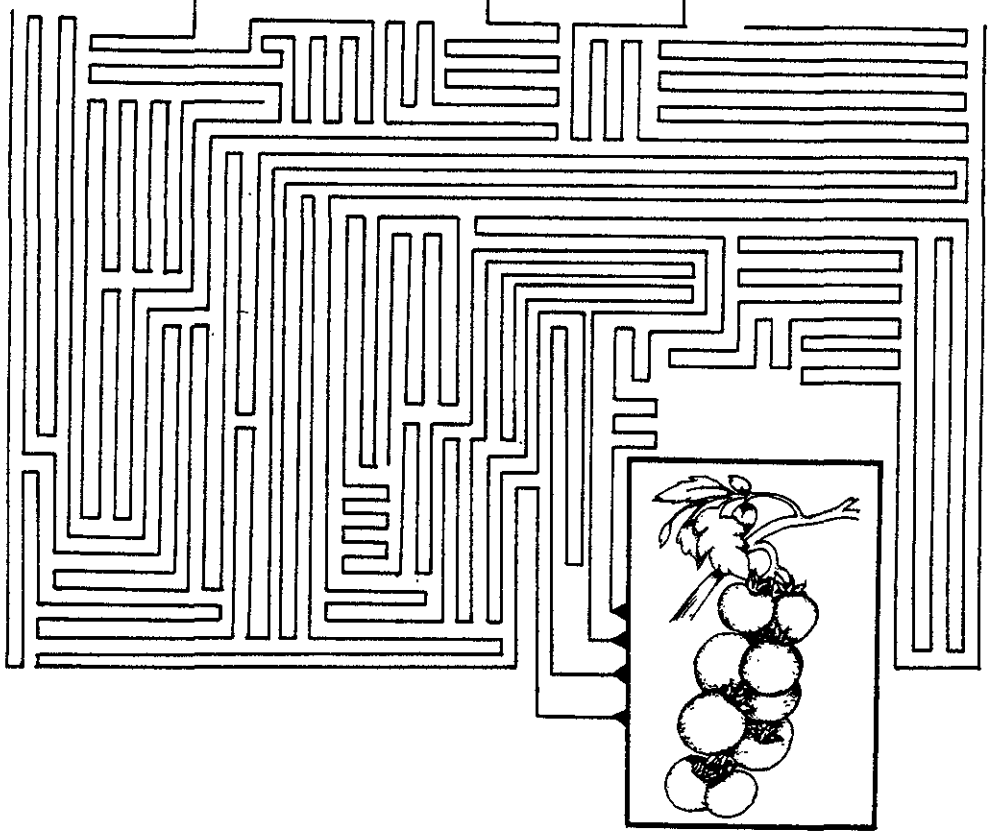
ACTIVITY

THE ORIGINS OF THE TOMATO

Many of the plants grown in your garden or on farms in your region are not native plants. They have been introduced from other countries. Follow the lines to find the home of the tomato plant:



1 - the Caribbean
2 - Ecuador and Peru
3 - India



(Answer: 2 Peru and Ecuador)

[NOTE: This activity may be adapted to feature a locally-grown crop. Here are two suggestions: mango (Mangifera indica) - India; oil palm (Elaeis guineensis) - tropical West Africa]

UNDEREXPLOITED PLANTS

The main reference source for this article is **"Biodiversity and underexploited species", the Editorial in *International Ag-Sieve* Vol II (6) published by Rodale Institute, 222 Main Street, Emmaus, PA 18098, USA**

Here are some interesting facts:

- Of the 20,000 species of grasses, we are using only seven species intensively as food crops. Among the underutilized grasses is Job's Tears (*Coix lachryma-jobi*), a very nutritious cereal which could replace wheat and rice in disease-prone areas. A few local strains exist, but no big effort has been made to develop it. The Australian grass, *Echinochloa turnerana*, can yield crops of good grain after a thorough initial watering, but it has never been domesticated.
- Banana, mango, papaya and pineapple are four tropical fruits that have been given attention worldwide. Yet there are over 3,000 other fruits that have considerable potential as food plants. Two examples are breadfruit and jackfruit which are quite widely grown in the tropics as subsistence crops. They are permanent plants rather than annual ones so, once established, need little attention.

The list of underutilized plants is lengthy. Yet while many people are working to protect underutilized plants, preservation is not enough. It is important to study the potential of cultivating these plants so that we know how to incorporate them into existing farming practices.

Recording local knowledge of uses and management of lesser known crops is also vital. Tragically, much of this information is being lost as native peoples are being forced to abandon their land and livelihoods. Population growth and poor use of land is doubly damaging: they destroy species as well as information resources on underexploited plants.

Information on how to realize the potential of underutilized plants must be made more readily available. Several organizations are involved in spreading this message. Some are described below:

EDUCATIONAL CONCERNS for HUNGER ORGANIZATIONS Inc. (ECHO)
This organization serves as an information source and seed bank. ECHO grows and distributes seeds of under-exploited food plants for the Third World. ECHO also provides information on how to prepare various food plants for human and animal consumption. ECHO serves as a pipeline, tapping information from many sources to bring the most useful information to people through its newsletters, *ECHO DEVELOPMENT NOTES* and *ECHO NEWS*. For more information, contact **Dr. Martin Price, Director, ECHO Inc.**
17430 Durrance Road, North Fort Myers, FL 33917 USA

INTERNATIONAL COVER CROPS CLEARINGHOUSE (CIDICCIO)
CIDICCIO conducts research on cover crops in the tropics as alternatives to fertilizers, as erosion control and as sources of food and fodder. Their research has focused on the velvet bean (*Mucuna pruiens*) For further information, contact
Milton B. Flores, CIDICCIO, Apartado 3385, Teucigalpa, HONDURAS

ANDEAN CROPS NETWORK
The Andean Crops Network was founded by the Instituto Boliviano de Tecnologia Agropecuaria in Ecuador. The members of this organization meet yearly to exchange scientific information and research results on Andean crops. A key researcher on quinoa (*Chenopodium quinua*) is Humberto Gandarillas. Write to: **Ing. Humberto Gandarillas, Instituto Boliviano de Technologia Agropecuaria, Castilla Postal 5783, La Paz, BOLIVIA**

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC)
IDRC's Crops and Animal Production Systems Division is involved in a variety of research efforts which include oilseed, roots and tubers, horticultural crops, perennials, grain legumes, cereals and Andean crops. IDRC's focus is worldwide. For more information, contact: **Nicolas Mateo, Associate Director, IDRC, Crops and Animals Production Systems, P.O.Box 101 Tanglin, SINGAPORE**

FOOD AND AGRICULTURE ORGANIZATION
This organization has a clearinghouse for information on germplasm. FAO's Seed Laboratory has distributed over 1 million samples of seeds. The Crops Ecology and Genetic Resources Service has been developing a global system to coordinate actions in the field of plant genetic resources. It has studied the conservation and use of *ex situ* and *in situ* storage , and its effect on biodiversity. Its International Network of Base Collections and the Global Information System on Plant Genetic Resources promote the free availability of germplasm and data of samples. For further information, contact:
FAO, Via Delle Terme di, Carracalla, Rome ITALY 00100

BRAZILIAN NGOS FIGHTING FOR LAND RIGHTS

FILM NEWS

The news item below is taken from:
***MOVING PICTURES BULLETIN* Issues 3 (September 1988)**
MOVING PICTURES BULLETIN is a quarterly guide to films on development and the environment produced by **Television Trust for the Environment (TVE), 46 Charlotte Street, London W1P 1LX United Kingdom**

As the struggle for agricultural land in Brazil intensifies, an association of doctors, journalists, lawyers and skilled craftsmen is using video to try to help small farmers fighting for environmental protection, land rights and better working conditions. Movimento Botucatuense Pro Vida also runs a seed exchange network, co-ordinating distribution and information about native crop seeds more suitable for local soils than the expensive hybrids offered by multinational organisations.

CONTACT: Movimento Botucatuense Pro Vida, Cx Postal 322, Cep 18.600, Botucatu-SP, Brazil. Tel: (0149) 22 6453

Sharing film and editing facilities with the Movimento Botucatuense, the Centro de Trabalho Indigenista (CTI) — the Indian Work Centre — is making video recordings of the Brazilian Indian population's tribal rituals and other celebrations as part of a process of cultural recovery — and to help in their fight for land rights. Set up by a group of anthropologists in 1979, the centre is currently trying to find funds to edit footage on the devastation caused by the Carajas mining operation.

CONTACT: Brian Hoeve, CTI, Rua Fidalga 548, Vila Madalena, São Paulo SP, Brazil. Tel: (11) 813 3450

The landless farmers

This article is reprinted from:
Development Forum Volume xvi no.6 (Nov.-Dec. 1988).
Development Forum is published six times a year in English, French and Spanish by the United Nations Department of Public Information for the Joint U.N. Information Committee.

A report from the Food and Agriculture Organization (FAO) warns: "Landlessness is emerging as possibly the single largest agrarian problem in the developing world, with possible explosive consequences for the future."

Over three-quarters of the world's population lives in the developing world, primarily in rural areas. At least 70 per cent of these are small farmers. Even with reasonable amounts of fertile land, most face serious obstacles—lack of appropriate technology and agricultural inputs, inadequate marketing facilities and poor community services such as sanitation, medical care and education. The result is widespread poverty and undernutrition, and all their attendant miseries. Those farmers who are virtually landless slip into even more abject poverty.

It is difficult to calculate just how many farmers are landless, in part because "landlessness" can cover a variety of cases. There are farming families who possess literally no land, often not even the ground where their huts stand; they make up the bulk of the agricultural wage labour force in many countries. Tenants and sharecroppers form another substantial group; they work the land owned by someone else, usually paying rent in the form of a sizeable proportion of the crops they raise. Others may be agricultural nomads, shifting cultivators who clear a piece of earth, till it and when it ceases to produce, move on in search of new plots. Probably the largest group are those who are functionally landless; they may own or have customary rights to a piece of land, but it is so small or of such poor quality that they cannot grow enough to feed or support their families. Or their land tenure may be meaningless without water rights, a situation not uncommon, especially in the Near East.

A further complication is that land tenure laws and practices vary enormously from country to country. In some societies, for example, women have no legal right to own land, although they may work it if their husbands are away or have died.

The causes of landlessness are almost as varied as the environment in which farmers live. The chief cause, though by no means universal, is population pressure on an inelastic supply of arable land. This is especially the case in most of Asia and much of the Near East. Population continues to grow, but the amount of fertile land remains the same; in some regions, the area of cultivable land may actually shrink as generations of use and misuse transform fertile soil into wasteland or as erosion, floods and other natural disasters sweep away topsoil. The result: farms either become progressively smaller and smaller or an increasing number of farmers become landless or both.

Traditional inheritance laws and customs may accelerate the division of farms into ever smaller plots, especially where these laws dictate that at the father's death, the land must be divided among all children. Some countries, like India, have tried to control sub-division by setting a limit on the size of a plot which can be divided; others have tried to restrict the number of heirs. These measures have helped to preserve a minimum holding, but at the price of increased absolute landlessness.

In many countries, colonial landholding patterns persist which exclude the small farmer from vast areas of land—most often the best land. For example, in Latin America as a whole, small farmers, who make up more than 50 per cent of the rural population, have less than one-fifth of all cultivated land; the remaining four-fifths is taken up by latifundias (large estates). In the Kingdom of Swaziland, whose population density is among the highest in Africa, 44 per cent of all arable land is still held by Title Deed from the 19th century by foreign companies that have established large plantations of sugar cane, pineapple, citrus, cotton and lumber; the rest—the poorest and least productive—is held in trust as Swazi Nation Land by the king to be shared among over 50,000 small homesteads.

Land tenure patterns favouring large farms can also be the result of deliberate government policy geared to developing cash crops for the export market.

Another cause of landlessness is poverty itself. Farmers who own land may be forced to sell part or all of it to repay debts, especially if they have been constrained to borrow from traders or money lenders who charge exorbitant interest. Where land can be bought and sold, large landowners may take every opportunity, legal and otherwise, to buy small farms to expand their holdings. Small farmers, struggling to maintain ever a bare subsistence level of living, can often be tempted to exchange what little long-term security their land can offer for immediate gain.

Although there is considerable variation from region to region and country to country throughout the Third World, the basic patterns and trends are similar: the vast majority of farmers cultivate small plots of land, often less than the minimum size required adequately to sustain a family; the average acreage is progressively shrinking, while the numbers of the landless are growing. In 1970, close to 70 per cent of all farms in Africa and Asia were smaller than two hectares. In 1980, the average smallholding in Ethiopia, the Yemen Arab Republic, the Republic of Korea and Bangladesh was half a hectare or less.

The problem of landlessness is less serious in Africa than in other continents, largely because of the prevailing customary tenure system on communal lands and because in many areas there are large tracts of potentially arable land still available. However, even in Africa, landlessness is growing as the population pressure increases—especially in Rwanda, Lesotho, central Kenya, central Madagascar and Swaziland.

The effects of landlessness are many, complex and serious. Where agriculture is the basic livelihood and where non-farm employment is limited—a situation found in most parts of the developing world—to be landless or virtually landless is to be cut off from the basic means of production and barred from access to essential materials and services. The result is poor or insufficient crop yields, accelerated environmental deterioration, chronic undernourishment and desperate poverty. Those with no access to any land at all live especially precarious lives, dependent for their survival on uncertain seasonal wage labour.

The most obvious consequence of landlessness or near landlessness is that farmers and their families cannot grow enough food or earn enough income to feed themselves adequately. If they are fortunate enough to be tenants or sharecroppers, they often lack the incentive to care for crops and the land properly, and may have to give up much of what they manage to grow to the owners. These farmers without tenure make up a sizeable proportion of the agricultural community in much of the Third World—in the rice lands of South and South-East Asia, tenants and sharecroppers occupy from 10-30 per cent of all holdings; 26 per cent in Syria and over 40 per cent in Egypt; while in a number of Latin American countries they account for over half of all small farms. Even in Africa, where tenancy and sharecropping are not common on communal lands, the pressures of population, increased private ownership and growing commercialization are causing them to appear.

Farmers who own a tiny plot of land are not much better off. Despite the fact that they may actually achieve higher yields per hectare than large farmers, primarily because they cultivate every square metre of their land and devote more man-hours per hectare on what land they have, their harvests are frequently too meagre to sustain a family. Like the farmer without title, they, too, may have difficulty gaining access to agricultural inputs and extension services, for many programmes are designed for large-scale operations.

Impelled by the demands of immediate survival, these farmers may reduce the length of fallow periods, with the inevitable result—the soil becomes exhausted, less productive, their chief resource progressively worthless. Out of desperation, many are forced to farm any land they can find, increasing marginal land, often in remote, inaccessible areas—steep slopes, rangeland, forests—where the soil is already fragile. They may till it for a period and then move on, leaving the depleted land to the invasion of useless weeds or the forces of erosion. Forests are cut and burned, vital watersheds exposed, delicate ecological systems destroyed. Out of need they may be compelled to leave their children a grim legacy—wasteland.

The landless and 'functionally landless farmers' problems do not end here. Without land, they have little or no collateral, and without collateral they are generally considered high credit risks by formal lending institutions and many rural credit programmes. Without credit, they are unable to buy good seed, fertilizers to enrich or revive the soil, and basic tools, or food to tide them over lean seasons. So they either go without, or they turn to local moneylenders, who not uncommonly charge 50 per cent interest or even more. If they are tenant farmers, these loans, understandably, rarely go toward improving land they do not own. If they hold a small farm, they may find that spiraling debt forces them to sell part or all of the land they do have—they watch, helpless, as their only asset shrinks or disappears completely.

One of the problems confronting small farm families in some parts of the developing world is the massive migration of males from the land in search of work in cities and industry. While landlessness is not the sole cause of this exodus, it is frequently a major factor. Out of pride, hope for a better life or frustration, men without land, or with land so limited in size or fertility that it cannot support a family, leave the farm for urban centres. Too often they discover that they have jumped from the frying pan of rural poverty into the fire of urban squalor and unemployment. If they are lucky enough to find work, it may be temporary or so poorly paid that they cannot afford to bring their families with them, while those left on the farm—women, children and the elderly—must do the best they can to grow what food the land and their labour will yield. The burden of farming thus falls on the women, who, because they are not the legal owners or because law or custom neglects or discriminates against them, may be denied access to materials and services which might be available to men.

Floods, earthquakes, droughts and other natural disasters affect everyone, but the landless, who are the most vulnerable, are usually the first to leave the devastated countryside for whatever relief towns may provide. They are also likely to become migrant farm labourers, moving from the less hospitable semi-arid, hilly or forest areas to fertile plains and coastal areas, or following the planting and harvesting seasons across the land. The landless, too, tend to make up the bulk of those who migrate, legally or illegally, welcome or not, across national borders, a phenomenon which can reach massive proportions, as it has in such countries as Swaziland, Lesotho and Mexico. Also many of the unskilled labourers employed in the oil rich countries of the Near East come from landless families of the neighbouring countries.

However hard the landless try, few can make substantial changes in their situation without assistance from governments, international agencies or non-governmental organizations. Not by way of handouts, charity or welfare, but through policies and programmes designed to eliminate or reduce the barriers they face, to create conditions which will permit them to use their talents and energy effectively, and give them realistic opportunities to help themselves.

There is no single recipe for the solution of the problems of the landless and functionally landless, if only because geographic situations are so diverse. However, there are a number of basic aspects which must be addressed. These have been clearly spelled out in the Strategy and Programme of Action adopted by the 1979 World Conference on Agrarian Reform and Rural Development. The WCARRD approach stresses the urgent need for national and international priorities and policies aimed at improving the productivity and enhancing the quality of life of all the rural poor. Since most of these are small farmers, many of whom are landless, the six areas where coordinated, sustained action is considered essential are particularly relevant to their situation:

- equitable access to land, water and other natural resources;
- access to agricultural inputs, markets and community services;
- education, training and extension;
- development of non-farm employment opportunities;
- participation of the poor themselves in the planning, implementing and assessing of programmes which affect their lives and livelihood; and
- full integration of women in all dimensions of rural development.

One of the obvious ways to reduce landlessness is for governments to enact or enforce comprehensive land reforms or settlement programmes aimed at a more equitable distribution of land. Such reforms are by no means simple as they frequently face strong opposition (or at best studied inertia) from established power groups. And simple land redistribution that leaves untouched the factors which lead to concentration of land or does nothing to enable small farmers to have a reasonable chance to make their land and labour productive and leaves them essentially as vulnerable and powerless as before, can only be a short-term solution.

Programmes, such as those in Malaysia and Indonesia, which aim at resettling the landless in undeveloped or reclaimed land can and have been effective, although clear-

ly they are only feasible in countries where cultivable land is abundant. Even in such countries, however, resettlement may have only limited success unless the new settlers are provided with basic infrastructures and services such as agricultural inputs, markets, health care, education and training, and credit. Relocation of communities and villages is an expensive, time-consuming process, something which most developing countries simply cannot afford on anything but a very limited scale.

Programmes to intensify and improve agricultural productivity through irrigation and easier access to basic inputs, technology, markets and extension services will benefit those who have access to some land, either as smallholders or tenants, enabling them to support their families on the limited land they can cultivate. Special attention is needed to ensure that women, both as heads of farm households and as working wives, are not neglected.

Since the landless are often forced to seek work off the farm, the availability of non-agricultural employment (and preferably self-employment) within the rural economy is crucial. Programmes aimed at broadening and diversifying the rural economy to include manufacturing, trade and services can not only provide the landless and the under-employed with greater income-earning opportunities, but can also enrich the entire community environment.

Rural credit programmes, if properly designed and operated so that they are accessible to the landless, can play a key role *in releasing their productive potential*. Small loans to individuals or groups, especially if they are accompanied by social support or rural development schemes, can often provide the capital and incentive which allow people to improve what land they have or to set themselves up in some kind of small business. Credit programmes such as the Small Farmer Development Project in Nepal and the Grameen Bank in Bangladesh have demonstrated that the poorest segments of the population can and will take advantage of savings and loan plans, can and will repay their loans at regular market interest rates, thus improving their incomes and self-reliance while at the same time permitting the lending operation to be financially viable and self-sustaining over the long run.

The task is enormous—complex, expensive in terms of time, energy, and money. But it is far less costly than millions of stunted and wasted lives. If all *those concerned with reducing human* suffering—governments, international agencies, non-governmental organizations and private individuals and, above all, the poor themselves—were to work together to transform WCARRD's words into reality, then farmers without land would not necessarily be people without hope. ▫

Comprehension questions for older students

1. What, according to an FAO report, might become "the single largest agrarian problem in the developing world"? (Landlessness)
2. Approximately what percentage of the world's population are small farmers? (70% x 75% = 53%)
3. What kinds of people may be described as landless? Are there landless families in your community?
4. Discuss the causes and effects of landlessness. Draw upon local examples if possible.
5. The Strategy and Programme of Action adopted by the 1979 World Conference on Agrarian Reform and Rural Development stresses the urgent need for national and international priorities and policies. Describe the actions that the WCARRD propose. Would any or all of these actions improve the landlessness situation in your community?

Extension

Consider land ownership in the area in which you live. Draw a map of your locality, and show land ownership patterns. Use the map and the following questions to help guide class discussion. Who owns most of the land? How much of the locality is public/communal lands? What is the average size of the farms? Is there a problem of land fragmentation (see page 19 for definition)? If so, is this a result of traditional customs of inheritance? What proportion of the land is farmed by sharecroppers? What can you find out about the history of landownership in your community? What crops are grown on the large estates and small family farms? Are these cash or subsistence crops? What is good about the present land ownership patterns? What problems are associated with the present patterns of land ownership? What land reforms, do you think, might resolve the problem? Consider the problems and opportunities your land reforms might present.

ACTIVITIES

LAND OWNERSHIP

The exercises below are reprinted from:
***Teaching Development Issues, Section 3: FOOD* published by and available from Development Education Project, c/o Manchester Polytechnic, 801 Wilmslow Road, Manchester M20 8RG, ENGLAND (copyright Development Education Project, 1986)**

Teaching Development Issues is an integrated set of seven course books which study the processes of development and underdevelopment. The books are structured to introduce a number of 'key issues' which allow teachers to extract material to suit their own work schedules. The books are designed on a double page system: the left-hand page is for the teacher, containing background notes and teaching ideas; the right-hand page contains copyright free student stimulus material. The books are best suited for secondary school students. While the publications are primarily directed at students in Britain, they do have application elsewhere. Other titles in the series include Perceptions, Colonialism, Health, Population Changes, Work, Aid and Development. The price of each publication is 3.00 plus postage, and 15.00 plus postage for the complete series.

The following exercises explore some of the problems associated with land ownership and the effects of inheritance.

Exercise 1

In an Indian village the land might be divided in the following way:
9 families have land of their own.
141 families own no land at all.
Of these 141 families, 30 are sharecroppers - they farm the land, but don't own it. Some of their harvest goes to pay the rent.

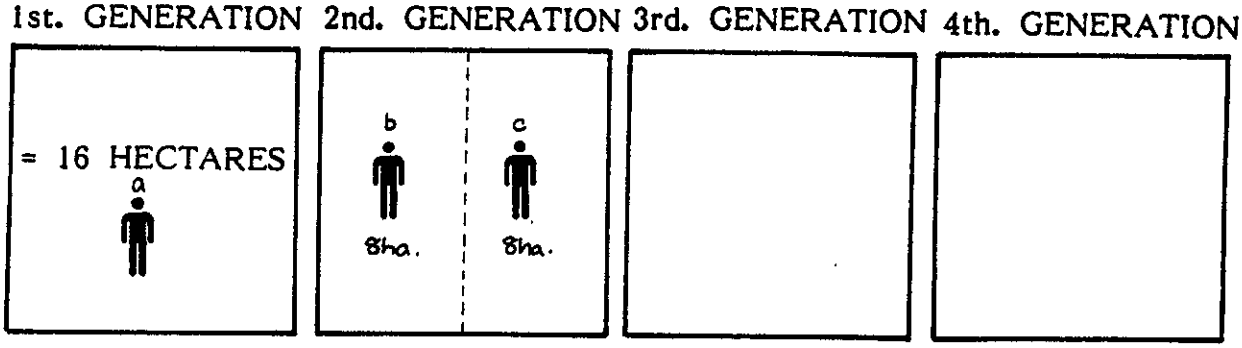
1. What % of the village families own their own land?
2. What work can the landless families find in the village, or what might they do?

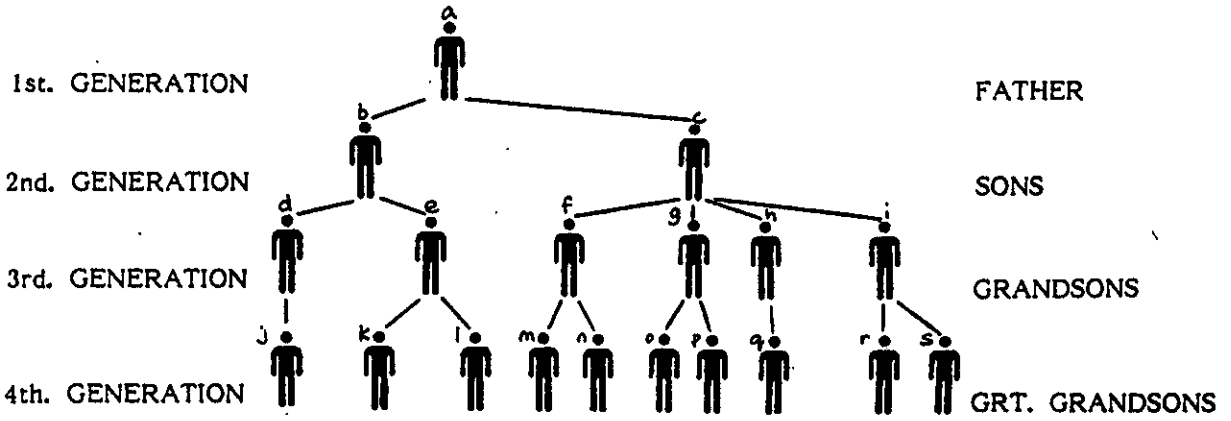
The land a family has is likely to be widely scattered around their village - this is called land fragmentation. This fragmentation is caused by the system of inheritance where land is divided between all sons when the father dies, by gifts of land given as dowry on marriages, or by forest clearance on land distant from the village.

3. Why do you think daughters don't inherit land? What do you think about this?
4. Does your family own land? Who, do you think, will inherit it?
5. If you owned land and had a son and daughter, to whom would you leave your land when you die? Why?

Exercise 2

To understand the effects of inheritance on the fragmentation of land carry out the following exercise. Draw four squares 4cm x 4cm on graph paper and label each square as shown below:

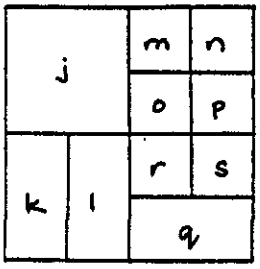




✸ **Divide up the squares in each generation according to the number of sons. Remember the inheritance is divided equally between each son. (The first step has been completed to help you.)**

a) How many plots of land are there by the fourth generation?
b) Calculate the average size of the plots for each generation.
c) If 2 hectares of land are required for each family, work out how many families have insufficient land in each generation.
d) Which families might have to sell their land and become landless labourers or migrate to the city?

ANSWER:
This diagram shows how the original plot of land would be divided after four generations (among the 10 great grandsons).



SCRIPT FOR CASETTE DRAMA/RADIO PROGRAMME

LET'S FORM A FARMERS' COOPERATIVE IN OUR VILLAGE

A cassette of the drama and permission to reproduce the script may be obtained by writing to:
Asian Cultural Centre for UNESCO (ACCU) No. 6, Fukuromachi, Shinjuku-ku, Tokyo, 162 JAPAN

The drama script is directed at neo-literates in rural areas. The drama hopes to provide entertainment while attain the following objectives:

1. To rouse the listeners' identification of their situation as well as attention for improvement of their lives;
2. To motivate listeners to organize a co-operative by introducing its role and how it can benefit them;
3. To show how to form a co-operative briefly.

NOTES FOR INSTRUCTORS:

<u>How to use the drama in an adult education class</u>

1. Introduce the play to the class, and invite eleven students to play the parts of the characters in the drama.
2. After acting out the drama in front of the rest of the class, ask each member of the class about the problems he/she is actually facing in the village that are similar to the problems presented in the drama. Ask them, too, how they felt about the co-operative.
3. Lead a discussion on what kinds of benefits the learners can get from a co-operative, and how it might be organized.
4. Reference material related to co-operatives should be handed over to the learners for further discussion.

NOTES FOR PRODUCERS:

<u>How to make a radio programme</u>

1. The programme should be adapted to suit local situations. You need to record various sound effects prior to making the programme. Use music that is appropriate for your audience.
2. Before presentation of the drama, some brief information about co-operatives should be given to the audience.
3. After the drama, questions such as how the audience felt, what kind of benefits may be obtained from a co-operative, how it can be organized etc., should be asked.
4. Reference material and contact organization/person related to co-operatives should be introduced for the audience's further action.

LET'S FORM A FARMERS' COOPERATIVE IN OUR VILLAGE

Script for Cassette Drama/Radio Programme

Cast: Agus *(a diligent farmer, aged 33, affectionate father to his daughter)*
Shillie *(Agus's daughter, a plucky girl aged 8)*
Roy *(an honest farmer, aged 35, Agus's next-door neighbour)*
Amir *(Roy's wife, a woman of firm character, aged 33)*
Sam *(a middleman, cunning but kind by nature, aged 45)*
Kasim *(an able staff member of the neighbouring village's co-op, aged 30)*
Ali *(a stingy and selfish farmer, aged 40)*
Village Chief *(a considerable old man, aged 60)*
Villager A *(aged around 30)*
Villager B *(aged around 30)*
Villager C *(aged around 40)*

Total: *11 casts*

Time: *17 minutes (five acts)*

ACT 1

(sound of thunderstorm. After a while, there is a violent banging on the door.)

Agus: Hey, Roy! Open the door! It's Agus, your next-door neighbour. My daughter, Shillie, she is in trouble. Please open the door, Roy. (the banging continues.)

Amir: (In a low but firm voice) Hey, Roy, wake up! (Pause) Somebody is banging on the door. Wake up, please!

Roy: (Yawning sleepily) What the dickens is going on at this time of the night? What's the matter? Who is it? (Sound of door opening, sound of thunder)

Agus: It's me, Agus! Shillie is injured! During the storm, a rafter fell from the ceiling onto her leg.

Roy: (Over Agus's panting) How is she, then? Where is she now?

Agus: (Still panting) She's at home, bleeding.

Amir: Did you try to stop the bleeding, Agus?

Agus: Oh, no! Not yet!

Roy: A doctor! Take her to a doctor immediately!

Amir: The most important thing is to stop the bleeding. Roy, I'll go to Shillie right now and tie her leg up tightly. Then, I'll take her to a doctor.

Roy: All right! I'll go to the doctor with you. Agus, let's hurry.

Agus: All right, but... I have no money to pay for a doctor. What shall I do? All my savings have gone because of the bad harvests for two years running. Will the doctor treat Shillie on credit? Can I pay him later?

Roy: I don't know. That's a problem. Money! We haven't got enough money to lend you, either.

Amir: This is no time to argue. I shall go to Shillie right a way and put on a bandage to stop the bleeding. Then we will go to the doctor if necessary. Roy, you look for the money. I have some money in my bag, you may take it. I'll go first!

Roy: (Pause) Oh, no! this is far from enough. Agus, you please go to attend Shillie, I will go to the neighbours and ask for some money from them.

Agus: (Nervously) Thanks, Roy. I really appreciate your help.

ACT 2

Narrator: The next morning after the fierce storm.....

(Sound of hammer bashing nails while birds are twittering)

Roy: (Entering) Good morning, Agus! It was a terrible night. How is Shillie?

Agus: Good morning, Roy! Thank you very much for last night. Shillie was very lucky to be able to see a doctor. I think she's all right now. Well, I don't remember so well, but how did you collect all that money? It was a lot.

Roy: Yes, we didn't have enough, so I asked around the neighbourhood. Well, we all have our hard times. But only Ali didn't lend me any. He's always like that. He's the only who's not cooperative.

Shillie: (From inside the house) Good morning, Uncle Roy!

Roy: Good morning, Shillie! Are you already up? How is your leg?

Shillie: It hurts a bit still, but I'm all right now. Thank you very much for last night, Uncle! On the way to the doctor, Auntie Amir kept encouraging me.

Roy: Was that so? Just rest well and get better soon.

Shillie: All right, Uncle!

Agus: Roy, talking about the money we borrowed last night...(pauses)... it seems that Shillie has survived because of the money collected from everybody. I couldn't do anything to save her by myself. In other words, their cooperation has saved Shillie's life. That's why I'd like to return the money as soon as possible.

Roy: That's all right, Agus. Everybody understands the situation well. You can pay them back after the harvest.

Amir: (entering) Good morning, Agus! How's Shillie?

Agus: Hello, Amir! Thank you very much for last night. Shillie is all right now.

Amir: That's wonderful! Everybody lent you some money. But think about the possibility of another accident like that happening in the near future!

Roy: Ah, a money lender might loan us some money, but in that case, we'll spend all our money just paying the interest. Nobody in the village has money to spare. (music in) Why is this village so poor?

Agus: We had bad harvests two years running. The others must have had a fairly good harvest last year. But they didn't seem to have gained much.

Amir: That's right. When there is a surplus harvest, the middlemen try to buy it up cheaply and their commission is very high.

Roy: We should think up a good idea.

(music out)

ACT 3

(Market noise)

Middleman Sam :

Hey! I made a lot of money today, buying tomatoes from Agus and Roy at 50 each and selling them at 70... I made 20 on each. That's because there weren't many tomatoes around in the market.

Kasim (a member of a farmers' cooperative in the next village):

Hello, Sam! You look as if you're doing very well. How can a middleman make so much money? How much did you pay for the tomatoes you bought today?

Sam: Don't talk like that, Kasim. We middlemen work independently, not like you people. So we have to have good days every now and then. But 20 is quite a lot, I must admit.

Kasim: 20? In that case, you must have bought all those tomatoes at 50 each! That's too much, Sam! In our co-op we pay at least 65 to the members if a product can be sold at 70.

Sam: Co-ops and middlemen are completely different. You can't compare them. You speak ill of me, but in my village farmers don't come to market to sell their crops themselves. It's a lot of work. Although the commission is a little high, I'm working for them. Bye, see you later. I am in a hurry.

Kasim: Bye. (Kasim says to himself) This guy is really cheating the people. This is why the village chief is interested in hearing about our co-op. I hope they can form a co-op soon.

ACT 4

Narrator: Several days have passed since the accident. In the village chief's house.

(Sound of crowd of people)

Village chief:

(Clears his throat) Ladies and gentlemen, thank you very much for gathering here today. You must all know that Agus's daughter, Shillie, was injured. After that stormy night, Agus, Roy and Amir came to visit me and talked about some of the problems we have in this village. Those problems concern the whole village. So, as village chief, I asked you all to gather here today.

All: Chief, we don't know what the problems are, but please cut the cackle. Time is money and I hate wasting it.

Chief: Listen, All! That's what I'm going to talk about; how to make more profit for the village as a whole. Agus, can you explain it, please?

Agus: Yes, chief! The first problem, as I know you all feel, is that the crops grown through the sweat of our labour are bought up by middlemen so cheaply. If we can deliver them directly to the market, our income will increase.

Amir: The another problem is that the prices of crops vary according to the season and if there is a big harvest in the wrong season, we have to sell them at incredibly low prices. So we have considered the possibility of large-scale storage.

Roy: Everybody, thank you very much for helping Shillie. There's another important thing. When somebody needs money urgently like in that case, it would be nice if there were some way that we could borrow money at low interest or without it, easily. If we could do that, we could pay for medical costs in emergencies and buy fertilisers and efficient agricultural machines and implements.

Villager A: That's a good idea.

Villager B: But who will deliver crops to the market directly, instead of the middlemen, and who can provide us with storage facilities?

Villager C: That's right. And also, where can we get money for the loan?

Amir: All the villagers can offer a little bit each.

Ali: You must be joking. I have no money to give away.

Chief: Listen, Ali! This idea is to profit all of us.

Roy: In order to solve these problems we all need to cooperate. Our combined effort will make us strong.

Chief: That's right. The next village has succeeded because of the farmers' cooperative. Today I invited one of the employees of this cooperative. Let me introduce Mr. Kasim. He works at the next village's cooperative.

Kasim: Good afternoon, ladies and gentlemen. The chief told me the story. We had the same problem in our village as you have now. But because of the cooperative, our lives have been much improved. When we set it up three years ago, there were some people who were against it. But gradually they came to understand the benefits of the cooperative and now all the villagers are members. I suppose it's easier to answer your questions than to make a long speech. Please ask me anything you like.

Villager A: Is it really true that a cooperative will give us a better life, Mr. Kasim?

Kasim: Yes. I think you'll have much more stability. For example, we buy crops from the members at much higher prices than the middlemen, and loan money when members are in trouble. We also sell seeds and fertilisers at much lower prices than the retailers. We can do this because we buy everything wholesale. There are various other activities for the members' benefit such as introducing effective farming methods. If a cooperative is well established, most of your problems will be solved.

Villager B: Sounds wonderful, but who will form a cooperative and how will they do it?

Kasim: All of you can donate some money to form one. All who give money will become members and you can select some committee members who will take responsibility for all the cooperative's activities. The use of capital and activities are determined at a general meeting where all the members are present. The profit will be distributed among the members according to the amount of money they invested.

Villager C: Can you explain it more plainly?

Kasim: Yes. In other words, you all give some money and think how to use it to improve your lives.

Chief: Thank you, Mr. Kasim. I expect everybody understood how the cooperative works.

(Sound of discussion)

Villager A: (As if talking to himself) Shall we try?

Villager B: Well, let's try...as hard as we can!

Villager C: We won't lose anything. It's worth a try.

(Sound of voices raised in approval)

Kasim: Well, chief, it seems you'll have a nice cooperative.

Chief: Thank you very much for your help. I feel a lot of energy being generated.

ACT 5

Narrator: A year has passed since the cooperative was formed.

(Sound of a tractor coming down a path between vegetable fields)

Sam: Hello, All! How is the harvest? I'm collecting from everybody. Recently the price of tomatoes has been up so I'm going to deliver them to the market as soon as possible.

All: Hello, Sam! I'm doing quite well today. Well, you seem to be well suited to co-op work. You look much better than before.

Sam: Ah, everybody says so. My life is much more stable and just the thought that I'm working for others makes me smile.

Shillie: (In a loud voice from the distance) Uncle Ali, there are a lot of tomatoes growing here, too.

Ali: I'm coming. Shillie. Thank you.

Sam: You've become very popular with the children.

Ali: Yes. I can't believe that I used to be so edgy. Since the establishment of the cooperative, I really feel that an individual's power is so weak. Because of the co-op, I can send my children to school and have continuous good harvests because I can use enough fertilisers.

Sam: Roy, Amir, and Agus are bringing some tomatoes. (After a short pause, in a loud voice) Hello! How's today's harvest?

Roy: (In a loud voice from the distance) Hello! It's great.

Agus: Wonderful! It's the best yet.

Amir: Sam, try to sell them for as much as possible. Tonight's festival really depends on you.

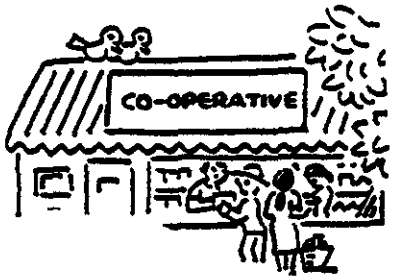
Sam: All right, Amir. I'll try my best, but watch out <u>you</u> don't become like a fat tomato!

(Everybody laughs)

(music in)

(music out)

END



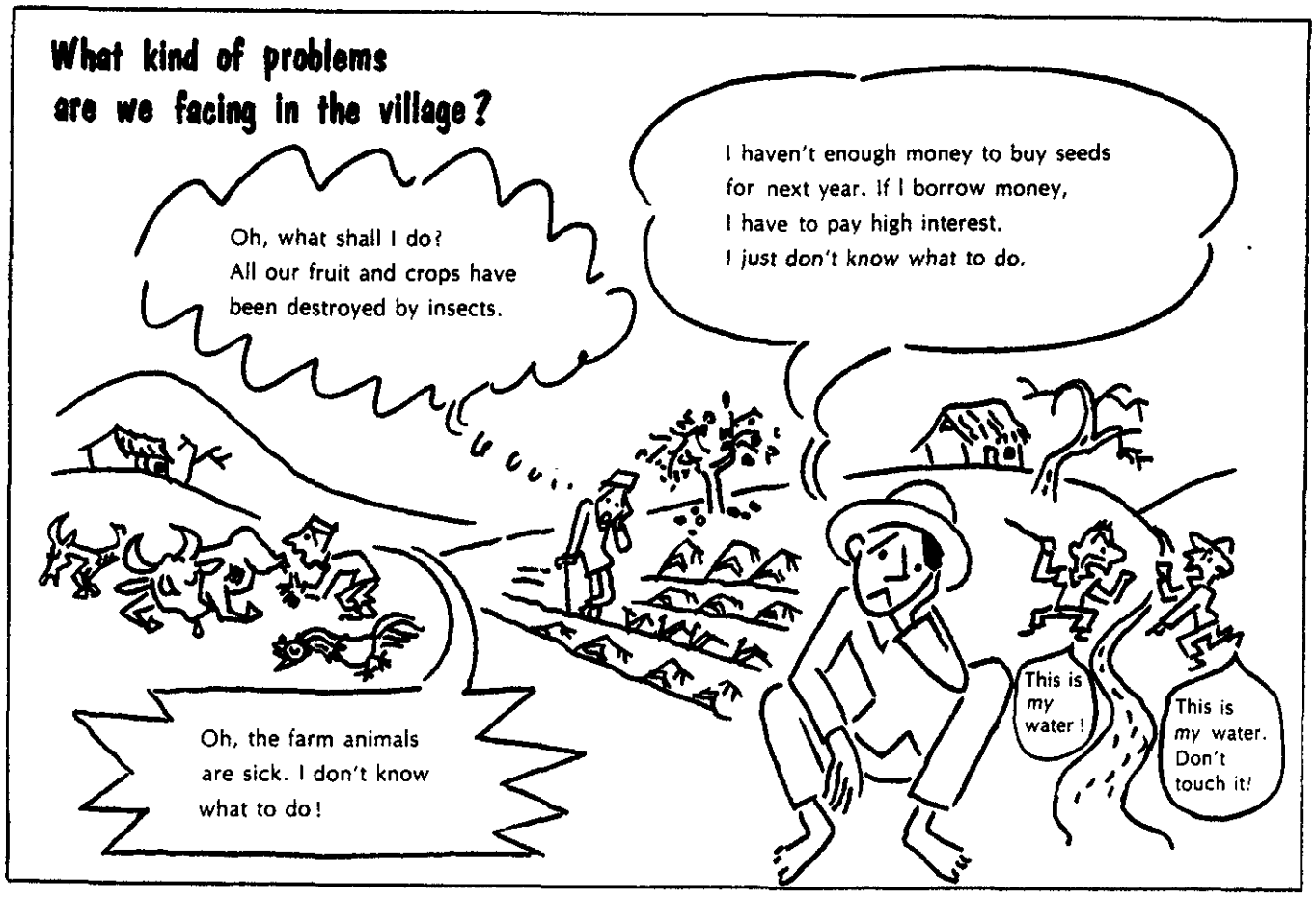
Let's Form a

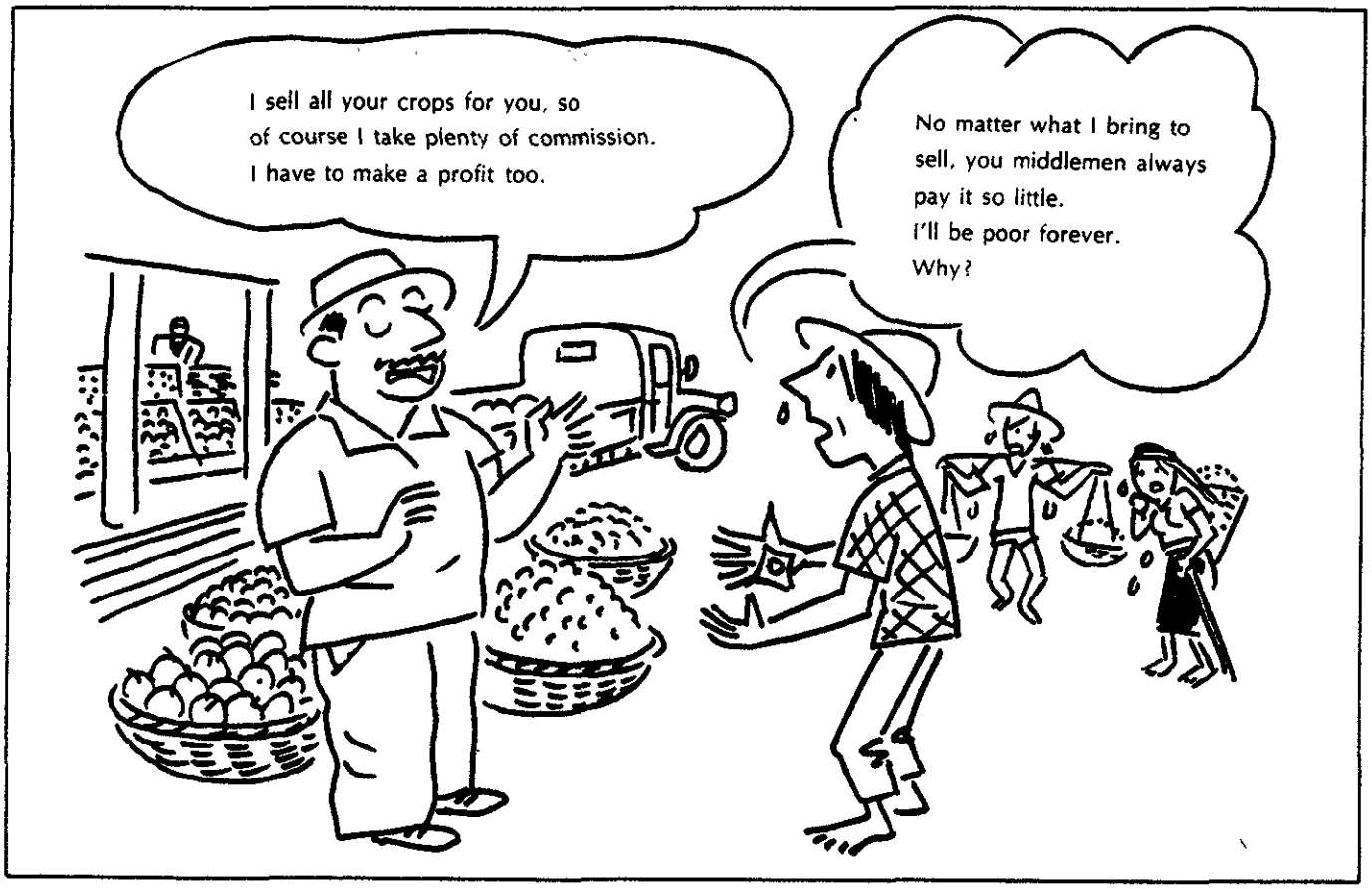
Co-operative for Better Life

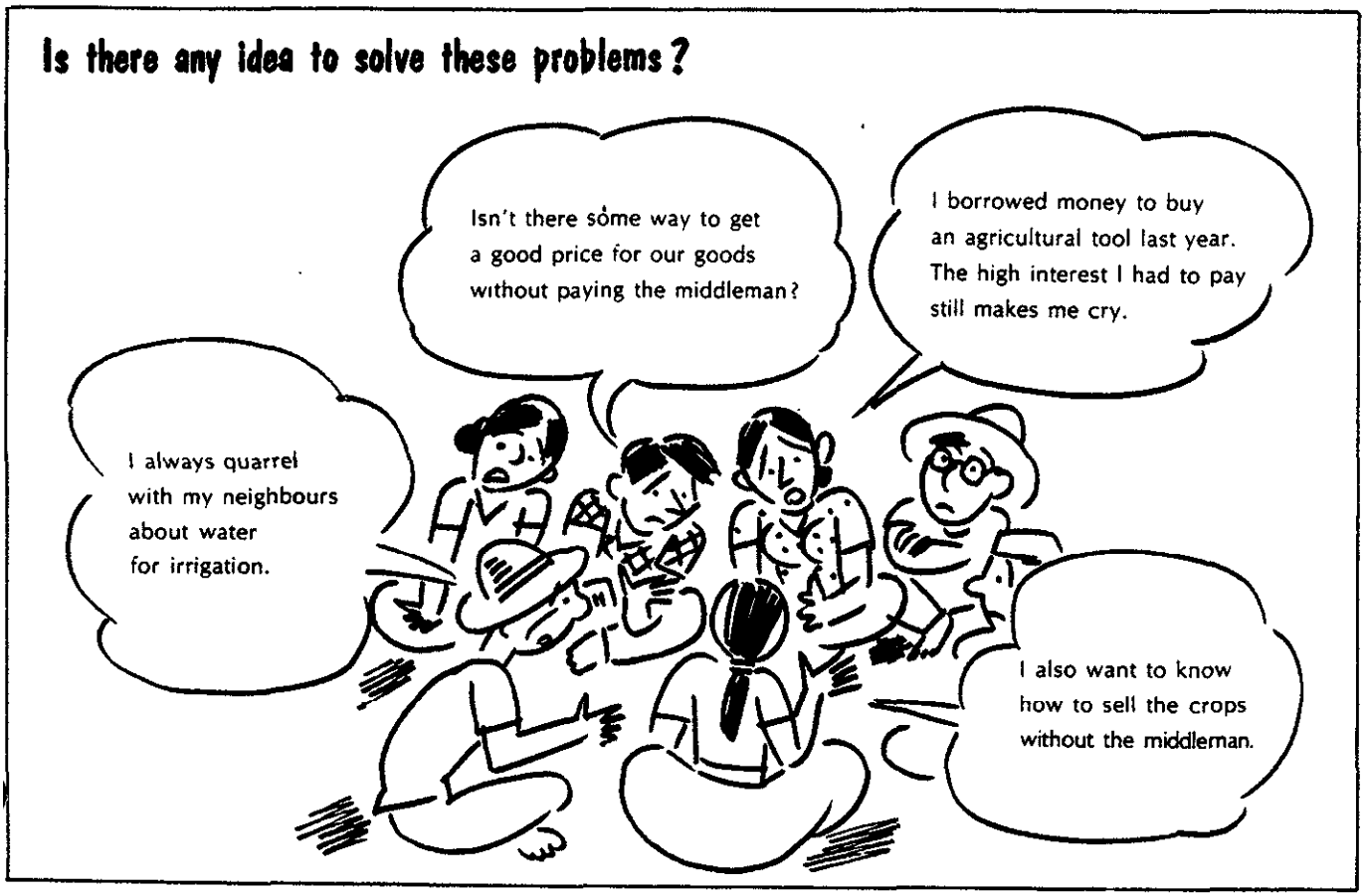
The booklet is directed at middle-level neo-literates in rural areas. The booklet has three objectives:

1. To create awareness of the importance of the co-operative in solving village problems;
2. To introduce the role of the co-operative and the benefits it can provide;
3. To show how to form a co-operative.

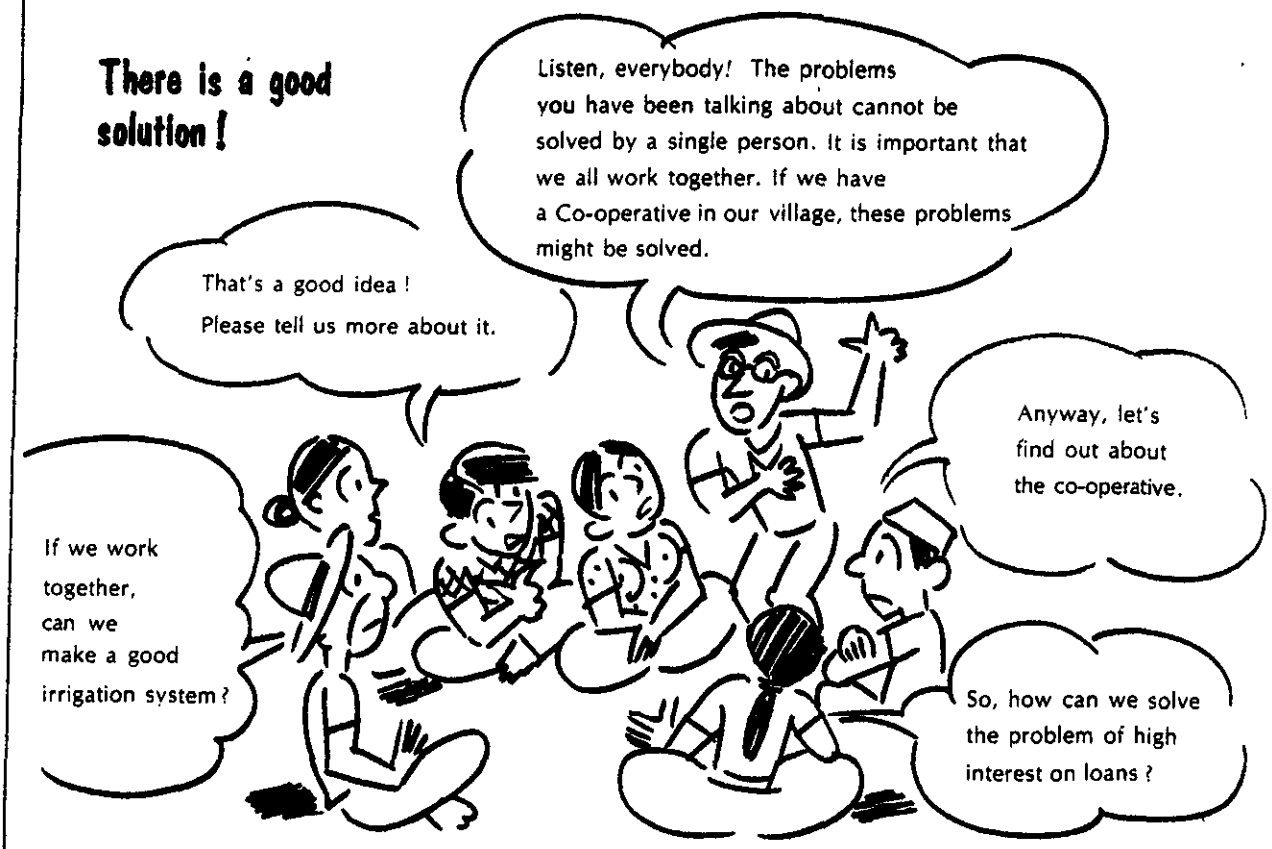
NOTE TO TEACHERS: Before learners read the information, ask about the problems they are facing in the village in everyday life. Then, distribute the booklets for the students to read. After everyone has read the information, ask the learners what kinds of benefits they can get from the co-operative. This is followed by discussion. Finally, inform the learners, in question-and-answer style, how to organize a co-operative.




I sell all your crops for you, so of course I take plenty of commission. I have to make a profit too.
No matter what I bring to sell, you middlemen always pay it so little. I'll be poor forever. Why?


Is there any idea to solve these problems?
Isn't there some way to get a good price for our goods without paying the middleman?
I borrowed money to buy an agricultural tool last year. The high interest I had to pay still makes me cry.
I always quarrel with my neighbours about water for irrigation.
I also want to know how to sell the crops without the middleman.

There is a good solution!

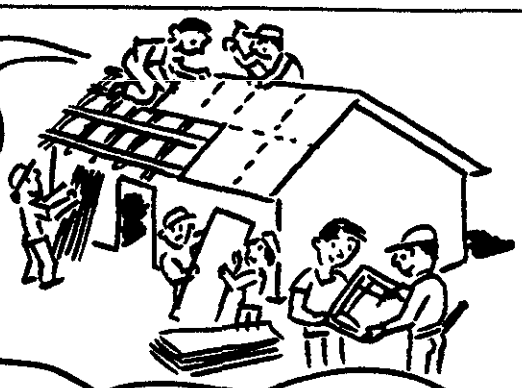


What is a Co-operative?

This is how it works.....

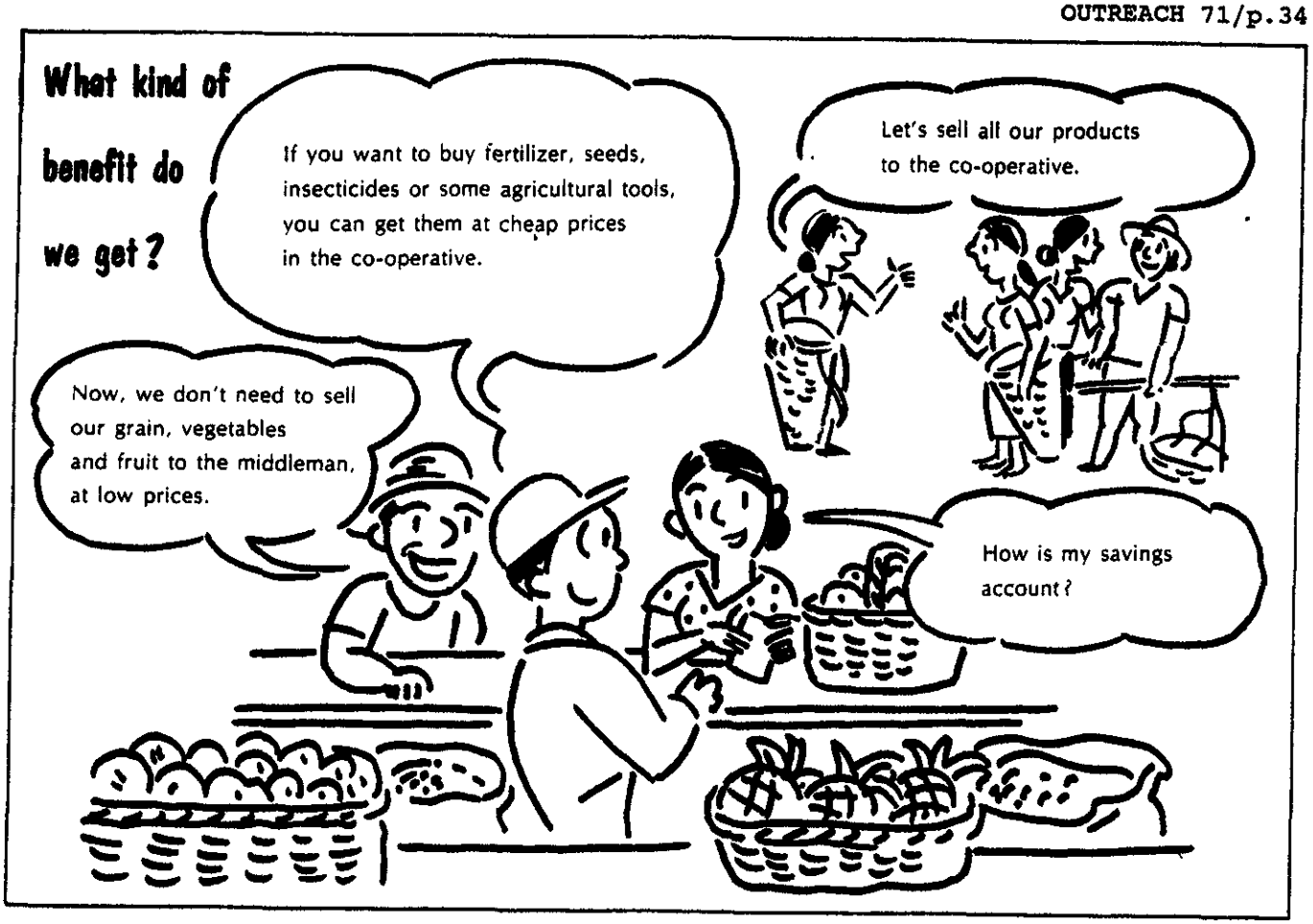
1. All the members are owners.
2. Members each contribute a small sum of money to run the co-operative.
3. Members work together to run the co-operative.
4. The co-operative provides fertilizers, seeds, machines for agriculture and other goods at low prices.
5. It also provides loans at low interest rates.
6. It buys the crops, vegetables and other goods which are produced by farmers, for a fair price.
7. It gives interest on savings, too.

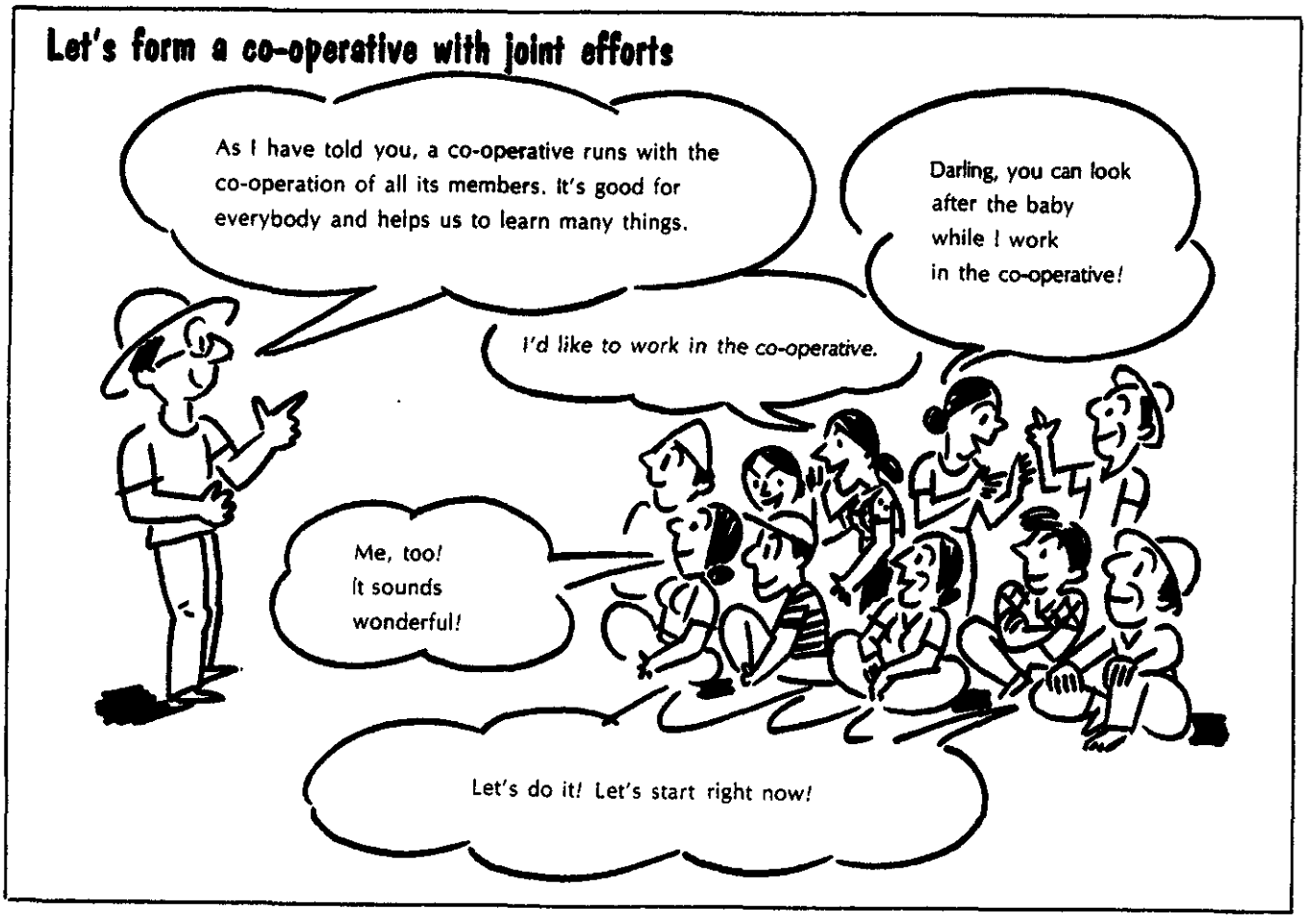
Our products can be stored safely and conveniently by making a co-operative store-house.



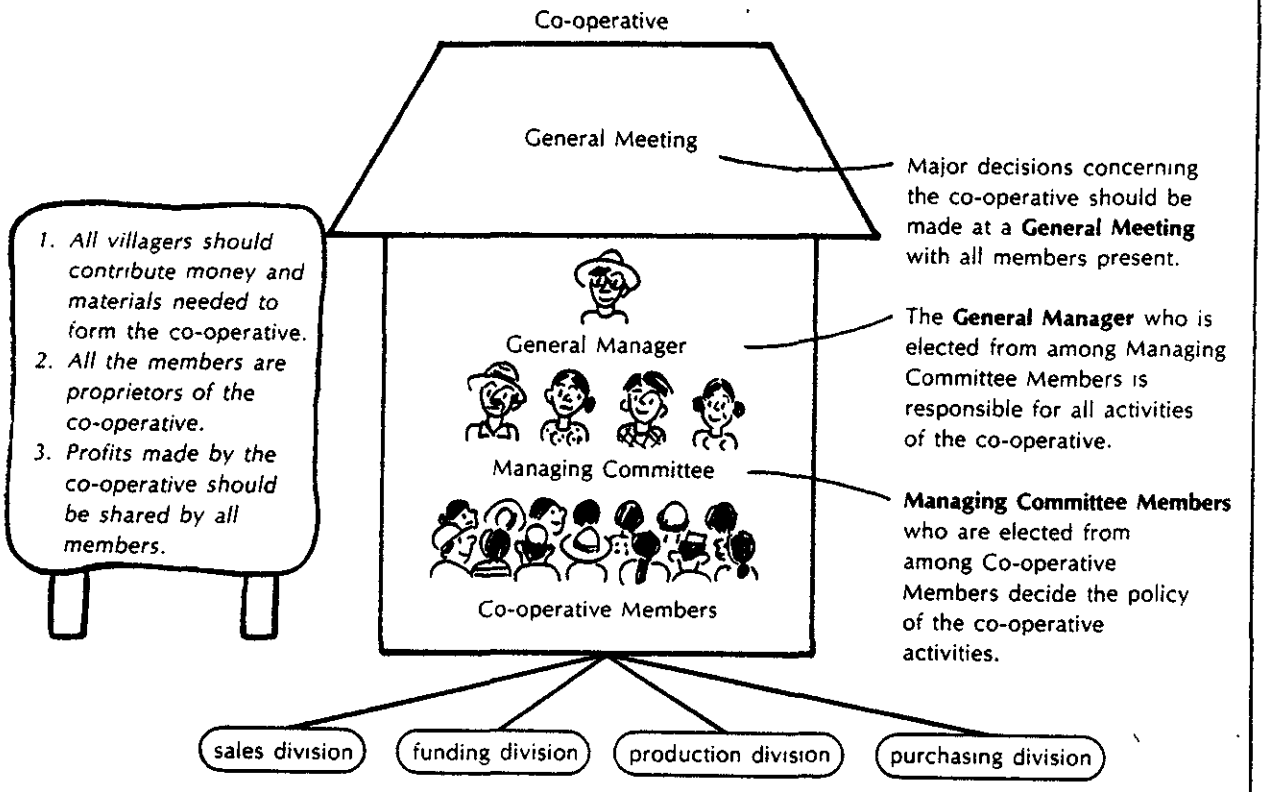
Experts at the co-operative teach us about better irrigation.
I don't have to quarrel with my neighbours any more.

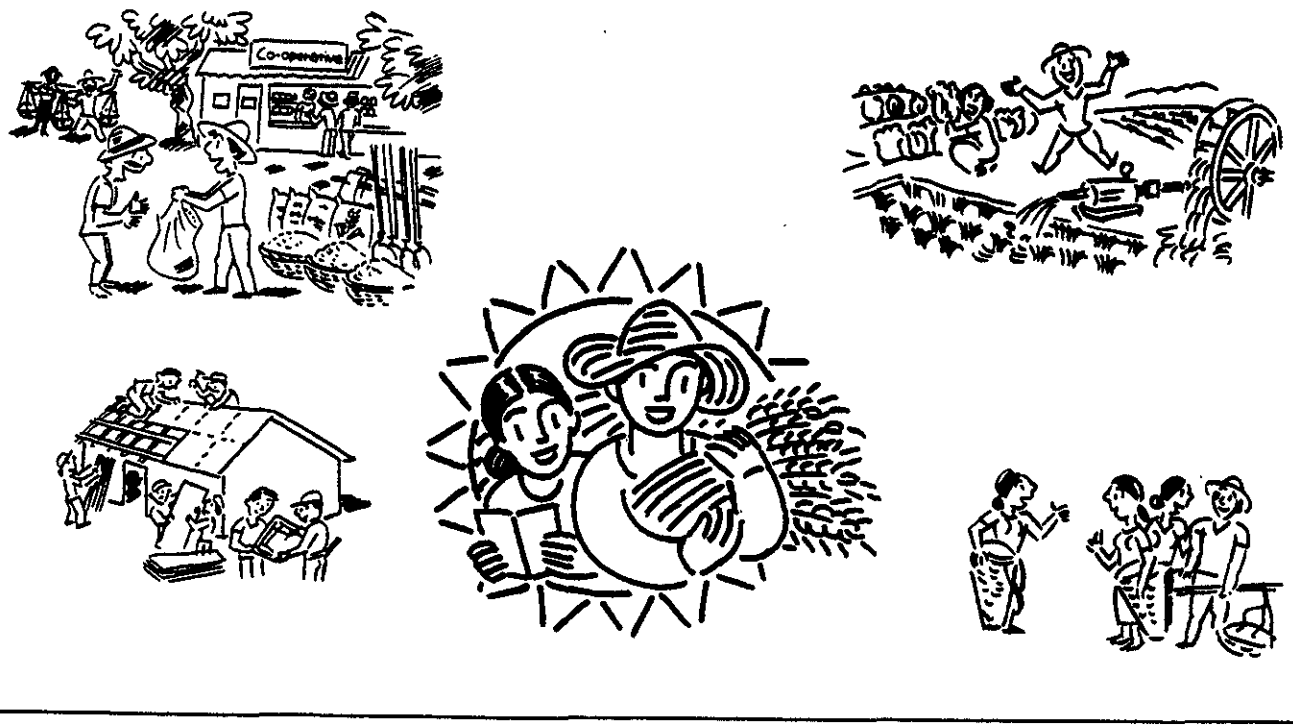
Loans are available at low interest from the co-operative for various purposes - for example, when a member of the family is sick.


What kind of benefit do we get?
If you want to buy fertilizer, seeds, insecticides or some agricultural tools, you can get them at cheap prices in the co-operative.
Let's sell all our products to the co-operative.
Now, we don't need to sell our grain, vegetables and fruit to the middleman, at low prices.
How is my savings account?


Let's form a co-operative with joint efforts
As I have told you, a co-operative runs with the co-operation of all its members. It's good for everybody and helps us to learn many things.
Darling, you can look after the baby while I work in the co-operative!
I'd like to work in the co-operative.
Me, too! It sounds wonderful!
Let's do it! Let's start right now!

How do we organize the Co-operative ?





Issue no. 72: Contents

page(s)

PART 1 (in this issue of OUTREACH)

Introducing the OUTREACH Learning-by-Doing Leaflets

The OUTREACH Learning-by-Doing leaflets have been especially designed for middle school and high school teachers in Third World countries. It has been recognised that good learning materials are scarce in many classrooms in the South. Textbooks are not always available. Those that are available are not always relevant to the most pressing problems in the Third World, including health and environmental problems and sustainable development. The purpose of the Learning-by-Doing leaflets is to help fill the needs, at least in small part, of middle school and high school teachers in the developing world by providing inexpensive, classroom-ready materials that will help to foster a scientific attitude in students. They are meant to supplement and enrich the science curriculum, not replace it, and they are meant to be used in any way that is most useful to the classroom teacher. In other words, they can be adapted, adopted or added to, in order to meet local needs. They may be used, copyright-free, for any non-profit purpose in Third World countries. The Learning-by-Doing leaflets will be published for profit in the North, and profits will be used for the further development and publication of leaflets on other topics for use in the South.

Fostering a scientific attitude

The philosophy behind the science leaflets is that science teaching should not be telling students what to think and believe. Rather, science teaching should foster a scientific attitude -- the attitude which appreciates the value of forming ideas based upon observations and reliably testing information, and being content to say, "I don't know" until the evidence is sufficient to answer the question. Science teaching should allow students to find out things for themselves through scientific inquiry. The Learning-by-Doing leaflets, as the name implies, include a variety of hands-on activities designed to foster a scientific attitude towards solving the most pressing health and environmental problems facing people the world over. This scientific attitude can be useful in all areas and levels of scholastic inquiry and for problem-solving in every day life as well.

Adaptable

Each leaflet is self-contained. Teachers can pick and choose the topics that they would like to cover to supplement their science programme and to help meet the curricular specifications of their local education ministries. In addition, each of the leaflets and accompanying teacher materials, provide a number of suggestions for additional, more in-depth activities, so that the leaflets are adaptable to a wide range of classroom levels, from primary school to high school.

The leaflets are adaptable in many different climatic and cultural situations, since their focus is on basic scientific principles and scientific inquiry. A particular technology may be appropriate in one area, but not in another. Therefore, the focus of the leaflets is not on providing information about specific technologies, such as how best to plant a specific crop. Rather, the leaflets provide some basic scientific information and the tools of scientific inquiry, which students can use to closely examine technologies being used in their own areas and to test and perhaps even improve upon these technologies.

Inexpensive

The contents of each Learning-by-Doing leaflet cover two sides of a sheet of paper. When folded down the middle, it becomes a four-page leaflet. The

materials required in the activities are readily available even in the most rural areas and are not costly.

Relevant

When engaged in the tasks outlined in the leaflets, the students are in contact with their surroundings directly, through the senses, because they deal with concrete things in the world around them. Moreover, the leaflets cover very practical problems in the students' own lives, especially those related to health, the environment and sustainable development. The students learn through their own investigations of real problems, which is as sound a basis for education as one could desire.

Motivational

Children the world over demonstrate a natural curiosity about the natural world around them. In their every day lives, children like to watch things grow and develop. They like to manipulate things and observe what happens. The Learning-by-Doing leaflets take advantage of the natural curiosity of children by focusing it towards learning how to solve practical environmental and health problems. Students are allowed to take an active learning role by actively constructing their own meanings in the classroom. When allowed to make discoveries on their own, students become excited about the learning process and are self-motivated to learn more on their own.

Inter-curricular

Teachers the world over complain that there is no time to teach science, since basic literacy is their main concern. The health and environmental problems that are the focus of the leaflets can be a suitable "unifying" subject in the classroom, as it has many links with other subjects. In the course of their investigations, students have many chances to practise simple calculations and to practise their reading, writing and speaking skills. They are also encouraged to tap into and build upon the knowledge of their elders, and to bring home and make practical use of what they have learned in the classroom.

Future issues of OUTREACH

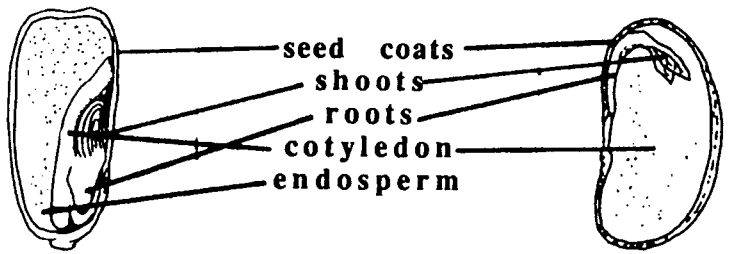
Outreach issues 72 and 73 comprise solely of Learning-by-Doing leaflets. Subsequent information packs will follow the usual format - a miscellany of materials focusing on a particular theme - but they will also include a selection of Learning-by-Doing leaflets that relate to the theme.

Do All Seeds Have the Same Basic Structure?

1. Soak different kinds of large seeds overnight, such as bean, corn, pea, pumpkin, sunflower and peanut seeds.

2. Remove the seedcoat from a corn seed and a bean seed. Try to find the parts of the seeds shown in the picture. Compare the corn seed to the bean seed. The corn seed has only one cotyledon, which is very small. Food for the developing corn seed is not stored in the cotyledon. The corn seed has a structure called an **endosperm** (EN-doe-sperm) which stores food for the developing seed.

a corn seed a bean seed



3. Plants are divided into two main groups, **monocotyledons** (MON-o-cot-el-ee-dons), or monocots, and **dicotyledons** (DI-cot-el-ee-dons), or dicots. "Mono-" means one and "di-" means two. Remove the seed coats from the other seeds and observe them carefully. Divide the seeds into two groups, monocots and dicots.

4. Place some soaked corn and bean seeds in a seed view jar. Watch them closely each day to see how they germinate. Draw what each kind of seed looks like each day for a week. What happens to the cotyledons of the bean seeds? What happens to the endosperm of the corn seeds?

OUTREACH pack 72 pp 3-4. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

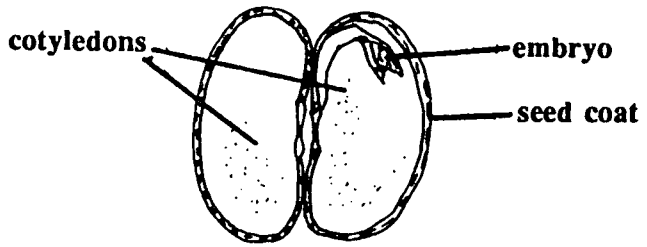
LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 1

What's in a Seed?

Did you ever wonder how a whole plant can grow from a tiny seed? If you look inside a seed, you will find out how this is possible. You will need: large bean seeds, such as lima or kidney beans and a glass of water.

1. Soak the bean seeds overnight. After soaking, carefully remove the outer **seed coat**. The seed coat is the tough skin that protects the seed.

2. The bean seed has two fleshy halves, called **cotyledons** (cot-el-LEE-dons). Carefully break open the two halves of the seed. If you look closely, you will see a tiny plant inside, called the **embryo** (EM-bree-o). Do you see the shoot? the root?



Does a Seed Need All Its Parts to Grow?

Will a seed germinate and grow without a seed coat? Will it grow without cotyledons? What do you think the cotyledons are for? Try this experiment to find out. *You will need: a glass or jar, paper towels, bean seeds* soaked overnight, a common pin, and water.

1. First you will need to make a seed view jar. Line a glass or jar with 2 or 3 thicknesses of paper towelling. Put about 1 inch (2.5 cm) of water in the bottom of the jar, and watch the paper soak up the water. To make sure the paper towel stays firmly against the jar, stuff crumpled, wet paper towels into the centre of the jar.

2. Place two bean seeds in the seed view jar, between the moist paper and the glass.

3. Carefully take the seed coats off two seeds. Place these seeds in the seed view jar.

4. Pull the seed coats off two more seeds. Break the seeds in half. Place the halves with embryos in the seed view jar.

5. Finally, break open two more seeds. Use the common pin to very carefully remove the embryos from the seeds. Place them in the seed view jar.

6. Watch the seeds for a week to see if the roots and shoots grow. Make sure the paper stays moist. Record your observations on a chart like the one shown on the next page. Based on your observations, what do you think the cotyledons are for?

Observations of Root and Shoot Growth in Dissected Bean Seeds

Date	Whole seed	No seed coat	No seed coat, one cotyledon	no seed coat, no cotyledons

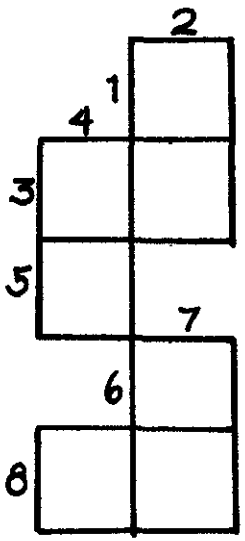
Figure out the answers to these questions to complete the crossnumber puzzle.

Across

1. The germination rate of a batch of seeds is 25%. 28 seeds have been planted. How many sprout?
3. The germination rate of a batch of seeds is 50%. 80 seeds have been planted. How many sprout?
5. Only 30 out of 600 seeds sprout. What is the germination percentage?
6. 200 seeds are planted and 16 sprout. What is the germination percentage?
8. The germination rate of a batch of seeds is 50%. If 15 sprouted, how many were planted in total?

Down

2. 20 seeds are planted and 14 sprout. What is the germination percentage?
4. 150 seeds are planted. If the germination rate is 30%, how many seeds sprouted?
7. The germination rate of a batch of seeds is 40%. How many must be planted to have 32 plants?



OUTREACH pack 72 pp 5-6. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

OUTREACH

LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 2

To Sprout or Not to Sprout

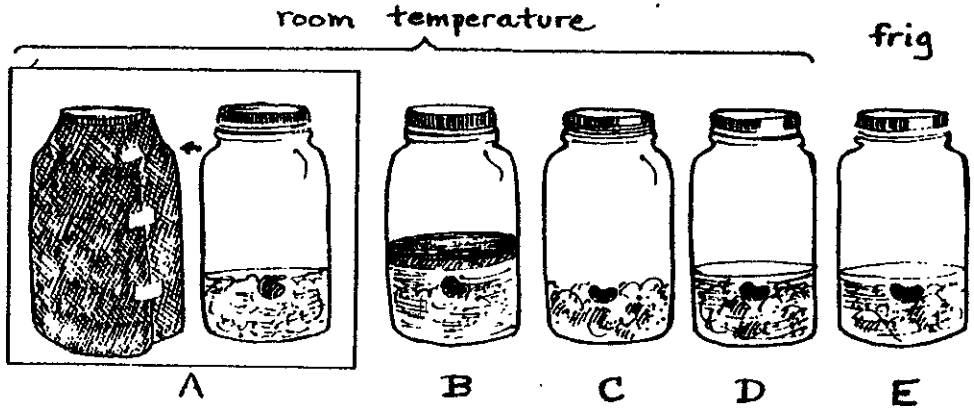
Will seeds germinate better in the dark or in light? Will they germinate without air? Do they need water to germinate? Do this experiment to find out. You will need: 5 jars, 15 seeds of the same type, cotton wool or paper towels, a little oil, and black paper.

1. Stuff cotton at the bottom of each jar. Place three seeds, such as bean seeds, on the cotton in each jar.

2. Label the jars A, B, C, D, E and F to correspond to the following treatments:

A wet the cotton, cover jar with dark paper
B wet the cotton, pour water and a little oil into jar
C do not wet the cotton
D wet the cotton, keep at room temperature
E wet the cotton, place in the refrigerator

Keep jars A through D at room temperature. Look at the jars daily to see how many seeds are germinating. Keep a daily record of your observations.



When you have finished your experiment, answer the questions below.

1. What would happen if seeds were planted in soil where there is no air?

2. What would happen if seeds were planted in soil where there is no water?

3. Do seeds need light to germinate?

4. What would happen if seeds were planted in very cold soil?

After answering these questions, provide the seeds in all five jars with the conditions that you think are necessary for germination. In this way, you can prove that the seeds failed to sprout before because they did not have right conditions to germinate, not because they were bad seeds.

How Can You Find Out How Good Your Seeds Are?

Before planting seeds it is a good idea to find out how good they are. Sometimes seeds are harvested, dried or stored improperly, so they are no longer able to germinate. For example, simply dropping bean seeds on the ground can damage them enough so that they can no longer germinate! If only half of the seeds you are planting are likely to grow, then it is a good idea to plant twice as many as you would if they were all good. Otherwise you will have a very sparse stand of crops.

A week or so before you decide to plant, you should test your seeds to find out how many will actually germinate. Here is how you can do this. You will need:

a damp cloth or paper
seeds
a rubberband or string
a glass
water

1. Place the seeds between two pieces of damp paper or wrap them tightly in a damp cloth. Make sure the seeds are placed half an inch (1.2 cm) or more apart.

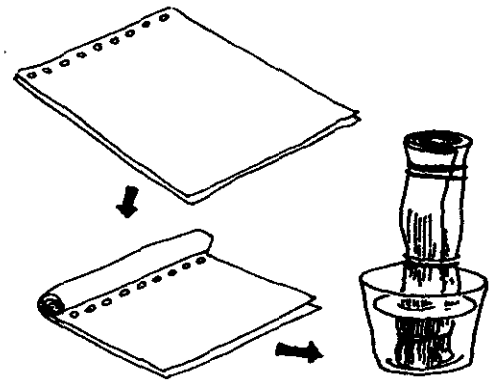
2. Roll the seeds and the material tightly, and tie with a rubberband or string.

3. Place the roll in a glass with an inch(2.5 cm) of water and keep in a warm place. Add water when needed.

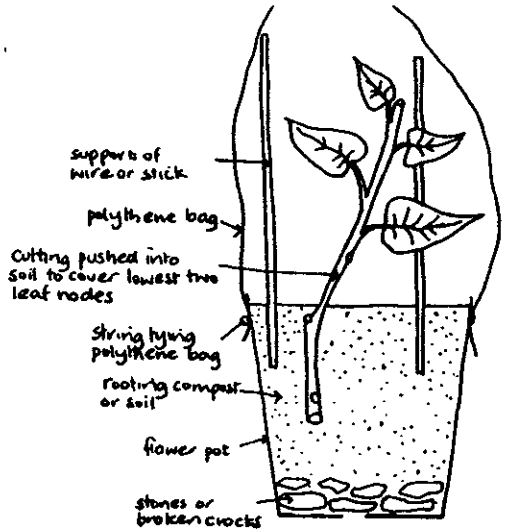
4. Take a look in a week and see what has happened. How many seeds have germinated?

5. Divide the number of seeds that have sprouted by the total number of seeds and multiply by 100. The answer is the germination percentage. For example:

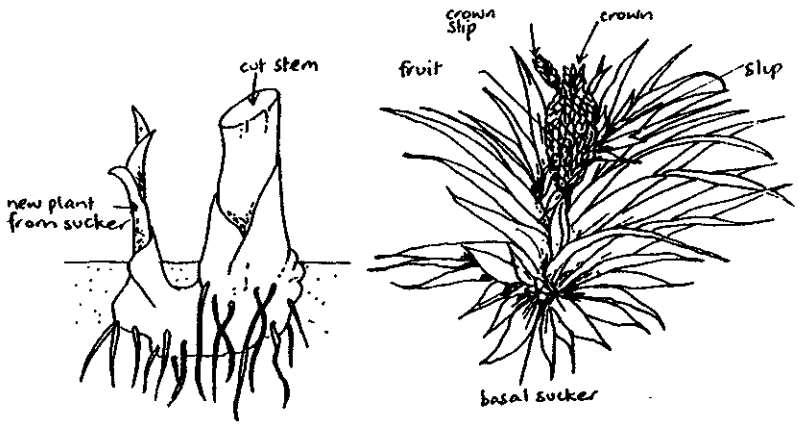
$$\frac{\text{10 seeds sprouted}}{\text{25 seeds in total}} \times 100\% = .4 \times 100\% = 40\% \text{ germination rate}$$



7. Sweet potatoes also grow from stems. The soft stems are used for cuttings (this year's growth). Stem cuttings can be various lengths, from 1-3 feet (30 to 90 cm) long. Try rooting a cutting in a pot of compost, using the method shown here. Also try planting sweet potato cuttings in the garden. Plant them in rows one metre apart with cuttings a half metre apart.



8. Pineapple and banana plants can be grown from **suckers**. The suckers are cut from healthy, high-yielding mother plants. They are planted in holes filled with compost. Pineapples can also be grown from crowns and slips. Try growing a pineapple plant in a pot from one of these parts.



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OUTREACH

LEARNING-BY-DOING

HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS

LEAFLET NO. 3

New Plants from Old

Plants not only grow from seeds. Some grow from roots, stems and leaves as well. These activities will show you how.

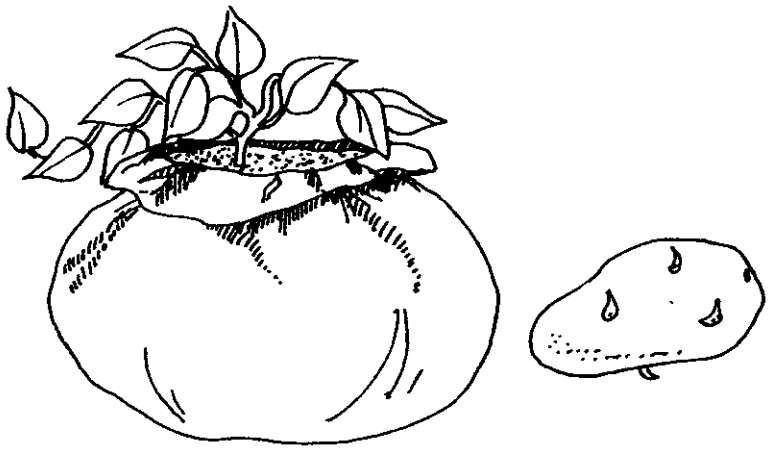
Growing plants from roots

1. Carrots, radishes and beets have thick roots where food is stored. These plants can use their stored food to sprout and grow. To see how this happens, get a pan and punch holes in the bottom for drainage. Fill with soil. Place some carrot tops in the soil and cover with small stones. Keep the soil moist. Soon shoots will appear. In time, the carrot plants will produce delicate, white flowers called Queen Anne's Lace.

Growing plants from underground stems

2. Onions store their food in bulbs. Bulbs are actually stems that grow underground. Put an onion bulb at the top of a glass jar full of water. Watch how it grows new shoots.

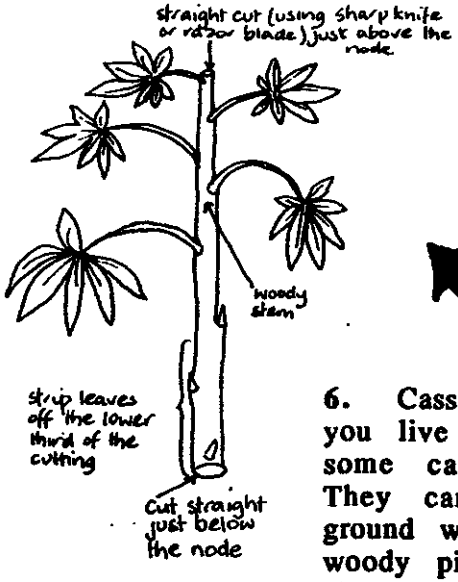
3. Irish potatoes store their food in tubers, which are also underground stems. To see how this happens, fill a two-gallon plastic bag with soil mix. Plant a seed potato (with buds called eyes) about four inches deep. Keep the bag watered, but be careful not to overwater. The vines will grow out of the bag and the potato will eventually blossom. When in full bloom, tear open the bag carefully and find the potatoes that have grown inside.

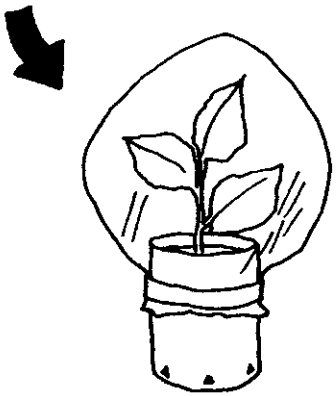


Growing plants from stems and leaves

4. Many different kinds of plants can be started from stem cuttings. Put a variety of stems in jars of water and observe which ones form roots. Try both hard-wood cuttings (such as Hibiscus) and soft-wood cuttings (such as Begonia, Impatiens and Coleus). Can you see new root hairs? Plant the cuttings in potting soil or compost. Do the rooted cuttings continue to grow when planted in soil?

5. Try rooting some soft-wood cuttings in compost. Find small containers, such as tin cans, and punch holes in the bottom for drainage. Fill with compost. Moisten the compost and make a hole in it with your finger for each cutting. Take three to four inch stem cuttings of Begonias, Impatiens or Coleus. Cut just below a leaf and remove leaves from the lower half of each cutting. Also try single leaf cuttings of African violets or Snake Plants. Place each cutting in the hole and firm the compost around it. Put a clear plastic bag over the cutting. Keep the cutting out of direct sun with the plastic bag over it for about one week. No additional water should be needed. Then remove the plastic bag.





6. Cassavas grow from stem cuttings. If you live in a warm climate, try planting some cassava cuttings in your garden. They can be planted directly into the ground without rooting them first. Cut a woody piece of stem (last year's growth) about 12-18 inches (30-45 cm) long. Use a sharp knife or razor blade to cut the stem cleanly, straight across. Cut the bottom end just below a **node** (the place where a leaf is attached to the stem). Cut the top end just above a node. Strip the leaves off the lower third of the cutting. Stick the cutting into the ground about half way at a 45 degree angle. Space the cuttings about one metre apart.

Try This

Good farmers are good scientists. They are very observant and keep a close watch on their crops. They constantly look for and try new ways of doing things. For instance, they may notice that a particular plant has certain characteristics that might be desirable. It might be insect and disease-free, when all the other plants are infested. They save the seeds from this plant and try planting them during the next growing season. Then they watch the plants from these seeds to see if they too are insect and disease-free. Good farmers also try different cultivation techniques to find out what works best for their own plot of land.

You can learn to be a good scientist (and a good farmer) by learning to do experiments on your own. Think of a practical problem that you would like to solve. Then design an experiment to help you solve the problem. Here is a list of suggested problems that you might try to solve. Also try to think of your own ideas for experiments, which would help you to grow better crops in your area.

1. Would seedlings grow better in the direct sun or in partial shade?

2. Would seedlings grow better if fresh manure (not rotted) were added to the soil?

3. Would seedlings grow better if ashes were added to the soil?

4. Would seedlings grow well in soil from the garden?

5. Would seedlings grow well in compost?

6. Find a knowledgeable farmer or nursery grower, or contact the Ministry of Agriculture or Cooperative Extension Service. Interview them about new technologies for growing vegetables in your area. Find out what kinds of experiments they conduct and what they have learned from these experiments.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES
FOR YOUNG SCIENTISTS
LEAFLET NO. 4

How to Please Your Plants

Many people believe you must be born with a "green thumb", a natural talent for growing plants, in order to be a successful gardener. In fact, anyone can learn to grow healthy plants. Plants have some basic needs. Once you understand what these needs are and how to provide them, you can turn your own thumb green!

In this activity you will find out what plants need to grow. You will need: 10 containers of the same size, such as milk cartons or tin cans; potting soil or compost mixed with sand; 20 seeds of the same type (for example, beans); water; chart for the wall; and paper strips.

1. Punch three or four holes in the bottom of the containers for drainage. Label the containers A, B, C, D and E. There should be two containers for each treatment (i.e. two A's, etc).

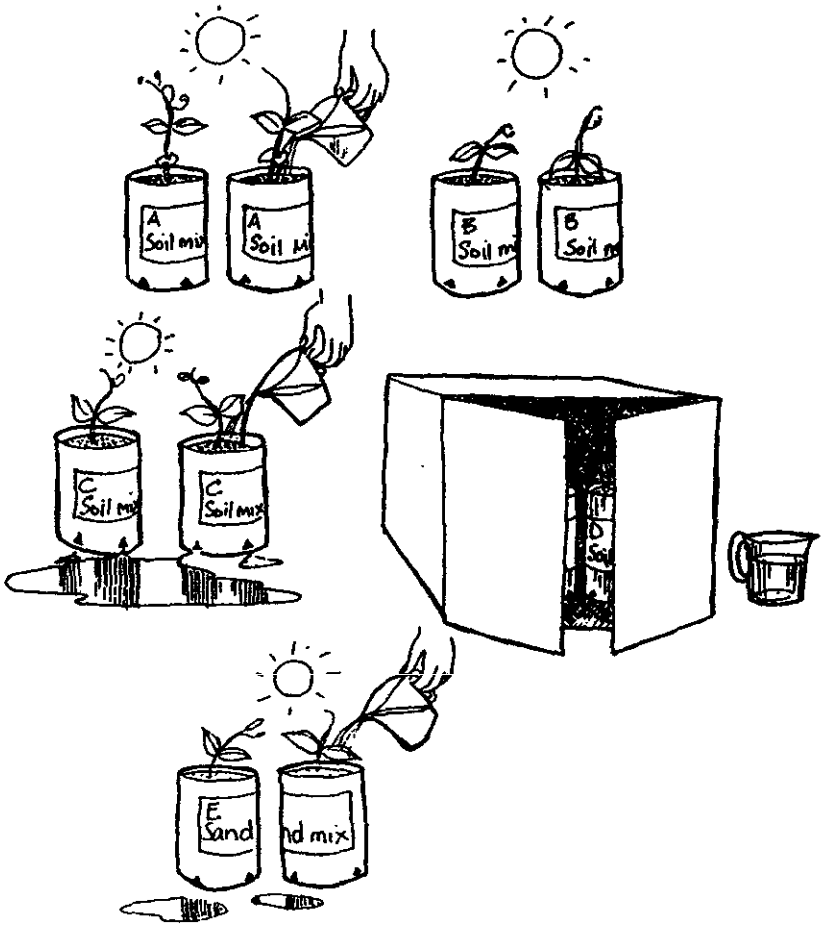
2. Fill containers A, B, C and D with potting soil. Fill the two E containers with sand.

3. Plant two seeds in each container. Keep the soil moist but not soggy. After the seeds have germinated, place the containers in the window where they will receive sunlight.

4. Allow the plants to grow until they have a few leaves (a week or so). Then pinch out the weaker plant in each container. (Do not pull it out, since this might disturb the roots of the plant remaining.)

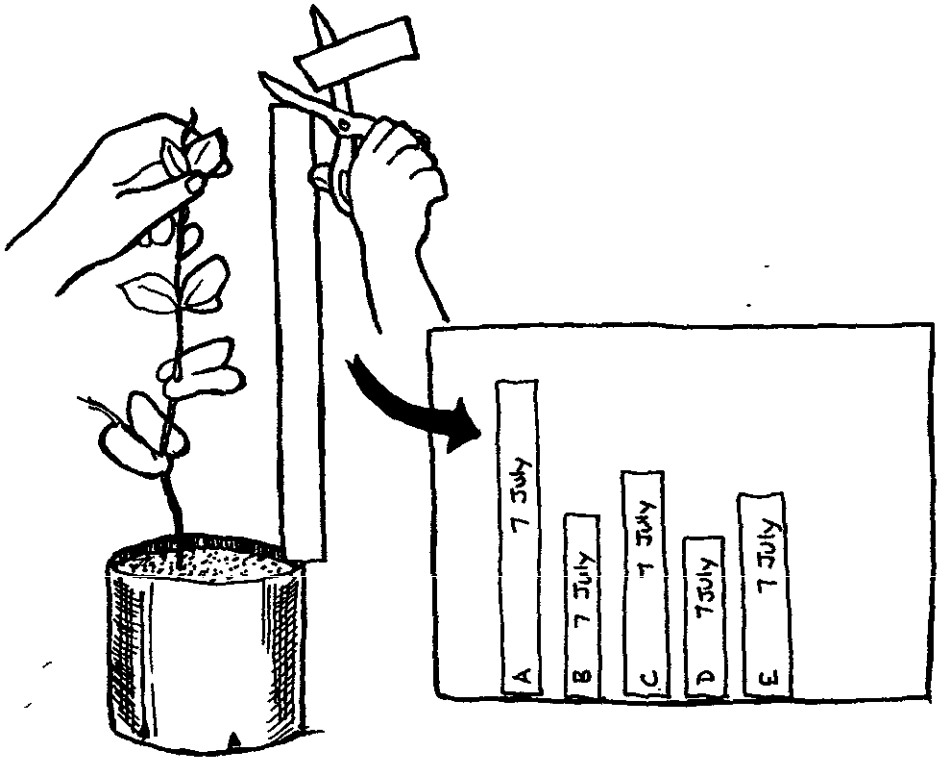
5. Subject the plants to the following conditions:

Plant A: water when dry, keep in light
Plant B: do not water; keep in light
Plant C: over-water so the soil stays soggy; keep in light
Plant D: water when dry, keep in dark
Plant E: water when dry, keep in light (in sand rather than soil mix)



6. For each of the five environmental conditions to which the plants are subjected, keep a "paper strip graph" of growth. About twice each week, cut paper strips so that they are the same height as the plants. Write the date and treatment on the strips and paste to the chart.

7. After about 3-4 weeks of growth, compare the paper strip graphs and discuss the results. What does a plant need in order to grow well? Draw a wall chart of a plant and its basic requirements.



Soil pH

You should also test the pH, or acidity, of your soil. Soil pH affects the availability of nutrients to your crops. Even if all the required plant nutrients are present in the soil, plants will not be able to utilize them if the pH of the soil is too high or too low. Most crops like a pH between 6.5 and 6.8. (See "Sweet 'n Sour Soil" for information on what soil pH is, how to test pH and how to change soil pH.)

Drainage

To test soil drainage, fill the hole that you have dug with water. The water should disappear within 30-60 minutes. If it does not, then you may have a drainage problem that should be dealt with. If you live in a humid region, you may need to plant your crops on raised beds.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 5

Be a Soil Detective

Soil is one of the most important, yet least understood factors determining the success or failure of a garden. Most gardeners do not pay enough attention to their soil, perhaps because the important plant processes that take place there are underground, hidden from view. Before beginning a garden, you should find out several things about your soil. This will take a bit of detective work, so sharpen up your eyes and put on your thinking caps!

Depth

Dig a hole about two to three feet (.6 to 1 m) deep. You should be able to see two distinct layers of soil -- a dark-coloured surface soil and a lighter-coloured subsoil. These layers have been produced by the longtime effects of the climate and plants acting on mineral matter. Generally the lower layers of soil have more clay and less organic matter than the top layer. If you do not see any distinct layers, then the soil has probably been moved about and mixed up not long ago. If there is only a thin layer of soil over rocks, then there is only a small space for roots and water storage. You will only be able to grow drought-resistant plants with shallow roots.

Texture

Scoop up a handful of surface soil. Do the "squeeze test" to determine the texture. Texture is the size of the soil particles in your soil. Sand particles are largest, loam particles are intermediate in size, and clay particles are smallest. Which of these soils is most like yours?

A. **Sandy** soil feels harsh and gritty. The particles do not hold together when squeezed, even when wet.

B. **Sandy loam** soil feels gritty. The particles do hold together when squeezed.

C. **Clay** soil feels greasy when wet. It can be squeezed against your hand into a smooth smear.

D. **Silt loams** make a rough and broken smear.

E. **Loams** make a very rough smear.

Try This

Here is another test you can do to determine the amount of sand, loam and clay particles in your soil.

1. Put a cup of the soil in a jar. Add water to fill the jar.

2. Put on the lid and shake vigorously.

3. Put the jar in a place where it will not be disturbed for 24 hours or more. Look at the layers of different size soil particles (the heaviest sand particles settle first and the clay particles settle last).

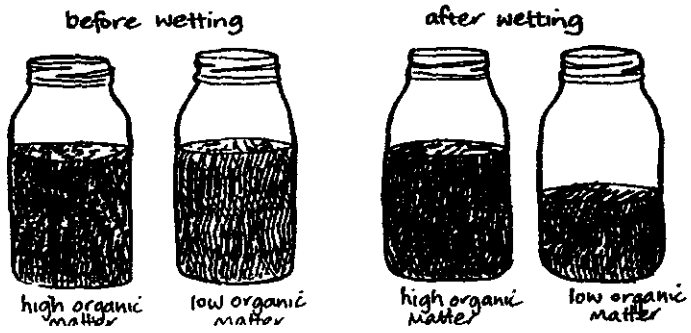
If your soil is a sandy loam, loam or silt loam, then you are in luck. These soil textures are the easiest to handle. They drain efficiently but not too quickly. Sandy soils do not hold water. Clay soils hold tightly to water and form hard clods if stirred or walked on when wet. Since the spaces between clay particles are very small, there is not enough air in the soil for root growth. You will have to put a little more effort into making sandy and clay soils productive.

Organic Matter Content

Next look at the colour of your soil. Colour can tell you a lot about the amount of organic matter present. A healthy soil has a high organic matter content. Organic matter improves the structure and texture of soil and the ability of the soil to retain nutrients and moisture. If your soil is dark brown, then it probably has a good supply of organic matter. If you are in a humid region and the soil is yellow, then it is probably low in organic matter and nutrients. If you live in a dry region and your soil is white, then the soil is probably low in organic matter, and also too salty or basic for most plants.

Try This

Another test for organic matter content is to place a cupful of soil in a jar. Mark the level of the soil on the jar. Then pour water into the jar. Shake to mix the soil and water together. Let it sit until the soil particles have settled. If your soil contains a lot of organic matter, then the volume of the soil will not change after wetting. If your soil does not contain a lot of organic matter, then you will need to add some. (See Learning Leaflets entitled, "Gold for Your Garden" on how to make compost.)



Suppose your soil is too basic, which is more likely if you live in a dry region. Simply irrigating your soil and adding organic matter can help raise the pH. You can also add substances that are acidic, such as coffee grounds or cottonseed meal.

Try This Try this experiment to see the effects of adding different substances to your soil.

1. Add some garden soil to several one-gallon containers, such as metal cans. Be sure to punch holes in the bottoms of the containers for drainage.

2. Use red cabbage water to test the pH of the soil. Then add different amounts of wood ashes, egg shells, coffee grounds or cottonseed meal to each container. For example, add one-quarter cup of wood ashes to one container and one-half cup to a second; add one-quarter cup of coffee grounds to a third container and half a cup to a fourth container. Mix the substances that you add to each container into the soil.

3. After a couple of days, test the pH of the soil in each container.

4. Plant some seeds, such as radish seeds or bean seeds in each container. Keep a record of how they grow.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 6

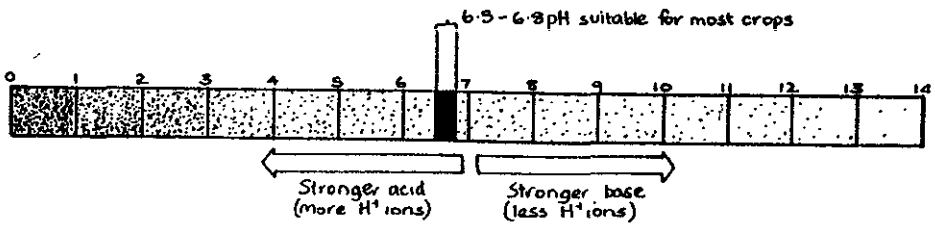
Sweet 'n Sour Soil

Your soil has adequate nutrients and a good texture. Still, your plants are not growing well. What could be wrong? Perhaps the pH of your soil is too low or too high. What does that mean? How can the pH of soil be determined? In this leaflet you will find out.

What is pH?

A system called pH is used to express how acidic or basic a substance is. The pH scale goes from 0 to 14. The lower the pH, the more acidic the solution. The higher the pH, the more basic the solution. The midpoint, pH 7, is neutral. Pure water, which is neutral, has a pH of 7. A pH below 7 indicates a substance is an acid. Acids taste sour. A pH above 7 indicates a substance is a base. Bases taste bitter. Does a solution of baking soda and water have a pH above or below 7? What about a vinegar and water? **Caution**: never touch or taste unknown substances to find out what they are.

pH Scale



How can you measure the pH of a substance?

Some dyes change colour according to the acidity present. These dyes can be used to test the pH of a substance. Litmus paper is one such dye. It turns pink in the presence of an acid and blue in the presence of a base. Red cabbage water is another such dye. To make this indicator, simply boil about two cups of red cabbage leaves in a cup of water for about five minutes. Keep the pot covered during boiling. Pour off and save the cabbage water.

Try This Test some or all of these substances with the red cabbage water: lemons (pH 2.3), vinegar (pH 2.8), soft drinks (pH 3.0), oranges (pH 3.5), tomatoes (pH 4.2), bananas (pH 4.6), bread (pH 5.5), milk (pH 6.5), pure water (pH 7), eggs (pH 7.8). Make a chart like the one below. Record the colour change for each substance. Use colour pencils, crayons or paints, if you wish, to indicate the colour change for each pH value listed.

Substance	pH	Colour Change
lemons		
vinegar		
soft drinks		
oranges		
tomatoes		
milk		
bread		
pure water		
eggs		

How do you test soil pH?

The level of a soil's acidity is important because it affects the availability of nutrients to crops. Slightly acidic soil (6.5 - 6.8) is best for most vegetable crops. The first step in finding out your soil's pH is to get a good soil sample. You need a small bag and a spoon or trowel. To get an average measurement of pH, randomly take soil samples from all over the garden, from 6-7 different spots. Each sample should be taken from a 6-inch (15-cm) depth, since the soil is slightly more acidic at the surface, where there is more organic matter. Close the bag and shake to mix the soil together. Spread out your soil sample and dry it in the sun or in a warm place before testing it.

Use red cabbage water to get a rough estimate of soil pH. Place about a half teaspoon of your mixed soil sample on a white plate. Add the cabbage water drop by drop until the soil is just saturated. Do not flood the soil. Move the plate slightly from side to side for about one minute to allow the cabbage water to react with the soil. Then tip the plate so that a drop of the cabbage water will flow from the soil. Note the colour of this cabbage water. Red indicates your soil is too acidic; blue or green indicates it is too basic; purple or slightly bluish-purple indicates it is just about right.

Try This Get a soil sample from your garden and test the pH. Also get soil samples from several other spots around the school and test the pH of each.

How can soil pH be changed?

Suppose you test your soil and find that it is too acidic, which is more likely if you live in a humid region. The most effective way to raise the pH of your soil is to add lime. One common source of lime is limestone. This is a rock that is mined from the earth and then crushed. If you cannot get limestone, there are other sources of lime you can use. Ground or burned seashells or eggshells are one source of lime. Wood ashes can also be used as a liming material. The finer the size of the lime particles, the more quickly it will react with the soil.

Cause and Effect Relationships

Listed below are some of the causes and effects which lead to soil erosion. Write and illustrate each of these statements on a small piece of paper. Arrange these pieces of paper on a large sheet of paper. Draw arrows to show the cause and effect relationships (the arrows should point from the causes to the effects). There can be more than one arrow from a cause, or to an effect. For example, an increase in population leads to cutting more wood for fuel, grazing more animals and cultivating more crops. Draw an arrow from "Population increases rapidly" to each of these three statements. Note that the effects can also be causes of other effects. For example, cutting more wood, grazing more animals, and cultivating more crops leads to more and more soil being laid bare.

Population increases rapidly.

More woodlands are cut for fuel, until fuel wood becomes scarce.

More goats and other animals graze on land.

More land is cultivated for growing crops.

More and more land is laid bare.

Since there is no wood available, crop residues and dung are burned for cooking.

Soil is deprived of soil nutrients and organic matter.

Rain beats down harder on soil, since there are no plants to break the force of raindrops.

Soil becomes more compact.

More rainfall runs off and less seeps in the soil.

More soil erodes.

Water table falls, and there is less moisture for plants.

OUTREACH pack 72 pp 15-16. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH

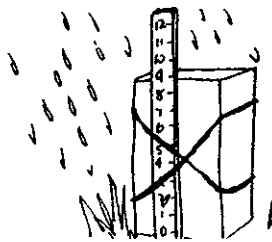
LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 7

Soil on the Move

Erosion is slowly reducing the productivity of the world's croplands. Each year, 25 billion tons of topsoil are washed away from croplands and into the oceans! What causes soil erosion? How can it be stopped? Do these activities to find out more about soil erosion.

How does rain stir up the soil?

1. Paint several sticks white, and mark off the sticks in inches, from 1 to 12 (or in centimetres, from 0 to 30 cm). Mud splashes will show plainly against the white sticks. Secure each stick in an upright position by means of a brick and rubber band, as shown in the picture. Place the sticks in different areas, such as in the garden on bare soil, in the garden on a mulched area, in a grassy area, under a tree, and in a sandy area. After a rainstorm, note the height to which mud has been splashed on each stick. Make a chart or a paper strip graph to record your observations. Repeat the activity during other rainstorms to see if all rainstorms produce the same effects. In which area was soil stirred up the most? Where would erosion be most likely to happen? Why?



2. After a heavy rain, examine the soil surface under a mulch and compare it to a bare soil surface. How does mulching keep the soil from getting compacted? How does mulch keep the soil from eroding?

Where does the soil go?

Take water samples from various places, such as streams and ditches before and after a heavy rain. Collect the water samples in jars and label the jars with the location from which the samples were taken. Let the jars stand for several hours until the sediment has settled out. Compare the amount of sediment in each jar. How does the amount of sediment in a stream before a storm compare to the amount after a rainstorm? Repeat the activity during other rainstorms. Where is the most soil erosion occurring? Why?

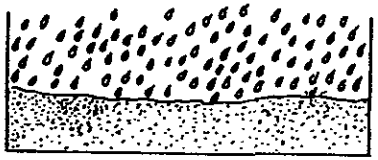
How does wind cause erosion?

1. Get some shallow pie tins. Fill one with sand, one with garden soil, and a third with flour (flour has the same texture as dry clay particles). Place the tins 7 yards (about 7 metres) from an electric fan which is directed toward the tins. Use a large piece of cardboard for a fan if an electric fan is not available. Move each pan toward the blowing fan until there is a slight movement in the material. Which moves at the least distance? Which moves at the farthest distance? Why? Which is most likely to be eroded by wind?

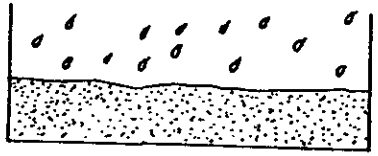
2. Design a way to stop the wind erosion, for example by building some kind of barrier or by covering the soil with something. How can wind erosion be stopped in a garden?

Based on what you have learned by doing these activities, look at each pair of weather conditions below and choose which would cause more erosion (all other things being equal).

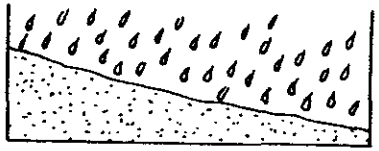
a. a heavy rain



a light rain



b. rain on a bare slope

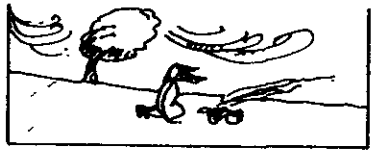


rain on a grassy slope

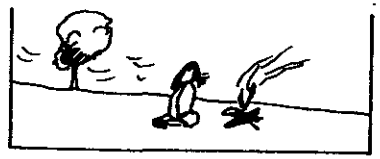
c. rain on mulched garden

rain on unmulched garden

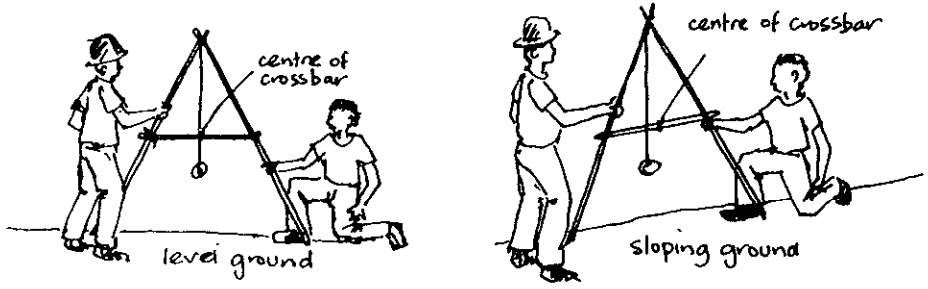
d. strong winds



light breezes



plumb line will hang straight down. (Be careful not to push either leg into the ground.) Mark the position of the two legs with stakes. Then keep one leg fixed and pivot the other around it. Adjust the position of the second leg until the plumb line hangs straight down again and mark its position with another stake. Continue marking the contour in this way all the way across the side of the slope.



How can you stop erosion where you live?

1. Look in your school yard or garden for places where running water has caused damage. Decide upon a means for preventing the erosion and carry it out.

2. Look at the farms and gardens near your home or school. How many fields are losing good soil? Do people use contour ploughing or terraces? Do they use strips of grass or trees? Have you seen deep gullies dug by heavy rains? Try to put some wood and stones near the top to stop the water. Do the same thing farther down.

3. Think of ways to keep the soil in your garden covered as much as possible. For example, use mulch around growing crops. Consider planting cover crops, such as legumes that can be turned into the soil when you are not growing other crops. Cover crops not only prevent erosion, but also add valuable organic matter to your soil. Consider intercropping shallow-rooted crops with deep, fibrous-rooted crops, especially on steep slopes.

OUTREACH pack 72 pp 17-18. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

OUTREACH

LEARNING-BY-DOING

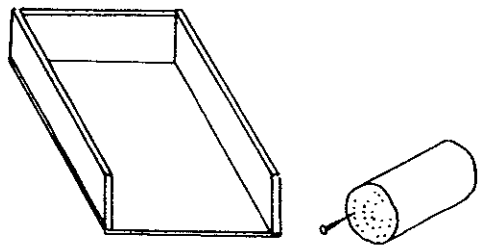
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS

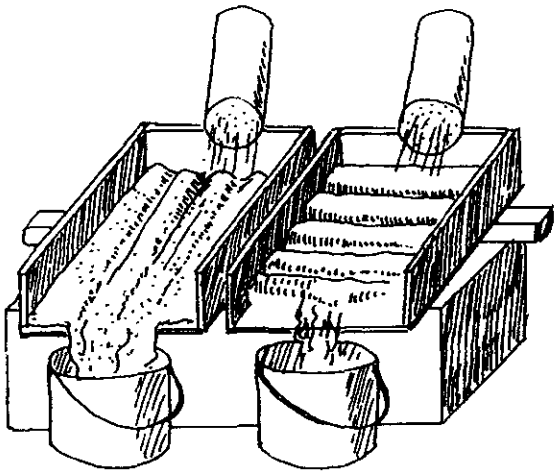
LEAFLET NO. 8

Saving Soil on a Slope

A farmer cleared a new plot on a steep slope and planted his crops there. After three years there was no topsoil or water left on his plot! Why did this happen? What could this unfortunate farmer have done differently? Try this experiment to find out what causes soil erosion on a steep slope and how this erosion can be stopped.

1. Construct a box to test soil erosion on a steep slope as shown in the diagram. Use a flat box or tray two feet by one foot (about 60 cm by 30 cm). Cut a piece out of one end of the box and fill it with soil. Pat down the soil. Raise the box about 2 inches (5 cm) at one end so it is tilted. Place a pail or glass jar with a funnel at the other end to collect the run-off water. Use a nail to make holes in a tin can to make a watering can.





2. Pretend your fingers are a plough and make lines that run up and down the slope. Use the watering can to sprinkle water on the soil and watch what happens. Now mix the soil again and pat it down. Use your fingers to plough across the slope (contour ploughing). Sprinkle the same amount of water as before and watch what happens. Which time did the water run down faster? Which time was more soil moved? Should you make the rows in a garden going up and down a slope or across a slope? Why?

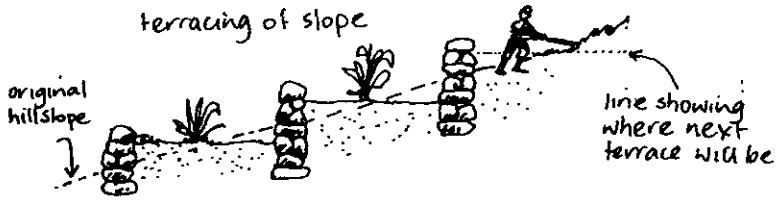
3. Fill the boxes again with loose soil. Water them with the sprinkling can until well-defined gulleys are formed by the running water. Block the gulleys at intervals with small stones and twigs. Water the soil again and observe the effect of blocking the gullies.

4. Try other methods of preventing erosion on a slope, such as covering the soil with a mulch. Also try planting grass seed in the box. When the grass has developed a network of roots, see if the roots can hold the soil when it is watered. Try building terraces, like the ones in the diagram, to slow the flow of water. Watch what happens to the water in each case. In which model does the most water sink into the soil? In which model does the most water run off?

5. Try the above experiments again, but this time raise the box to different heights. What happens as the water runs down faster? Which method is most effective in holding the water as the slope gets steeper?

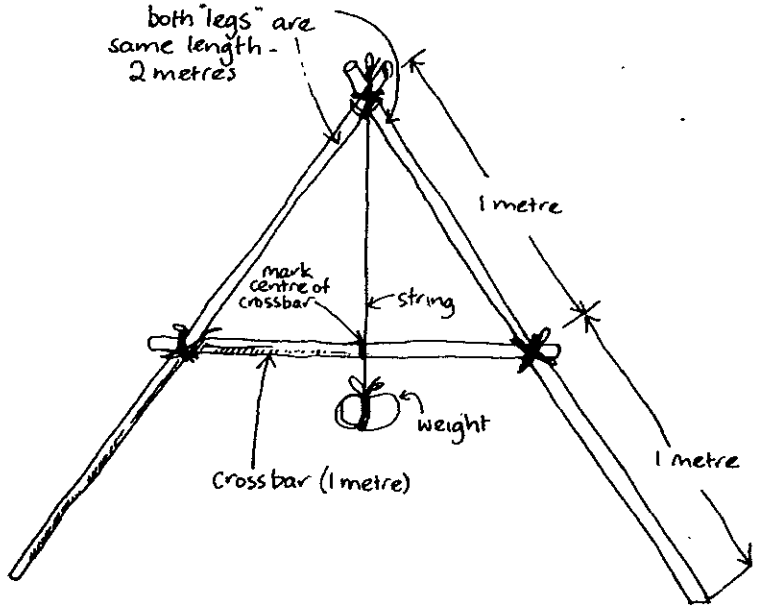
6. Try the experiments again, but this time compare the effects of erosion on loamy soil versus clay soil versus sandy soil. Which soil erodes the most? Which erodes least?

7. Based on the results of your experiments, draw a poster illustrating how to prevent erosion on a steep slope.



How do you plant on the contour?

If your garden is on a slope, use this method to mark places at the same level along the slope so that rows can be planted along this contour. This method can also be used to build terraces. You need two 2-yard (or 2-metre) sticks and one yard (or metre) stick, string and a weight. Tie the sticks together as shown in the diagram. Make sure the two side legs are exactly the same length. Mark the third stick at the exact center. Use the string and weight to make a plumb line. When the two side legs are on the same level, then the



When is the Compost Ready?

The more ideal the conditions you provide for the microbes, the faster the decay process. It could take from several weeks to several months to finish the composting. You will know the compost is ready when it has shrunk to about one-third the original size, is dark brown in colour, has a crumbly consistency, and has a nice, earthy odour.

Try This

1. Get a one-gallon capacity container, some garden soil, vegetable scraps chopped into small pieces, and some leaves or grass clippings. Build a mini-compost pile in the container by layering the materials as follows: 1 inch (2.5 cm) of soil, 3-4 inches (7.5-10 cm) of leaves or grass clippings, 1-2 inches (2.5-5 cm) of vegetables scraps. Repeat the layering, ending with an inch (2.5 cm) of soil on top. Mix the piles once a week. Add water to keep moist. Check the pile every week. What happens to the materials? Try planting seeds in the finished compost.

2. Set up several mini-compost piles to test the effect of different conditions on composting. For example, try keeping one pile soggy, another dry, and another moist. Try adding all materials high in nitrogen in one and all materials high in carbon in another. Try turning one and not another. Try adding wood ashes to one, and not the other.

3. To see how compost affects soil, punch several holes along the bottom edge of four equal-sized cans. Add one cup of each of the following soils to the cans: A. clay soil; B. sandy soil; C. half clay soil and half compost, mixed well; D. half sandy soil and half compost, mixed well. Place a dish under each can to catch water. Then fill the cans to the top with water. Watch what happens to the water. Which soil soaks up the most water? Which soil does the water drain through fastest? Slowest? Make mud pies out of each kind of soil and put in a warm place to dry for several hours. Which soil dries fastest? Slowest? After the soils are dry, look at soil structure. How does compost change the sand? the clay?

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 9

Brown Gold for your Garden

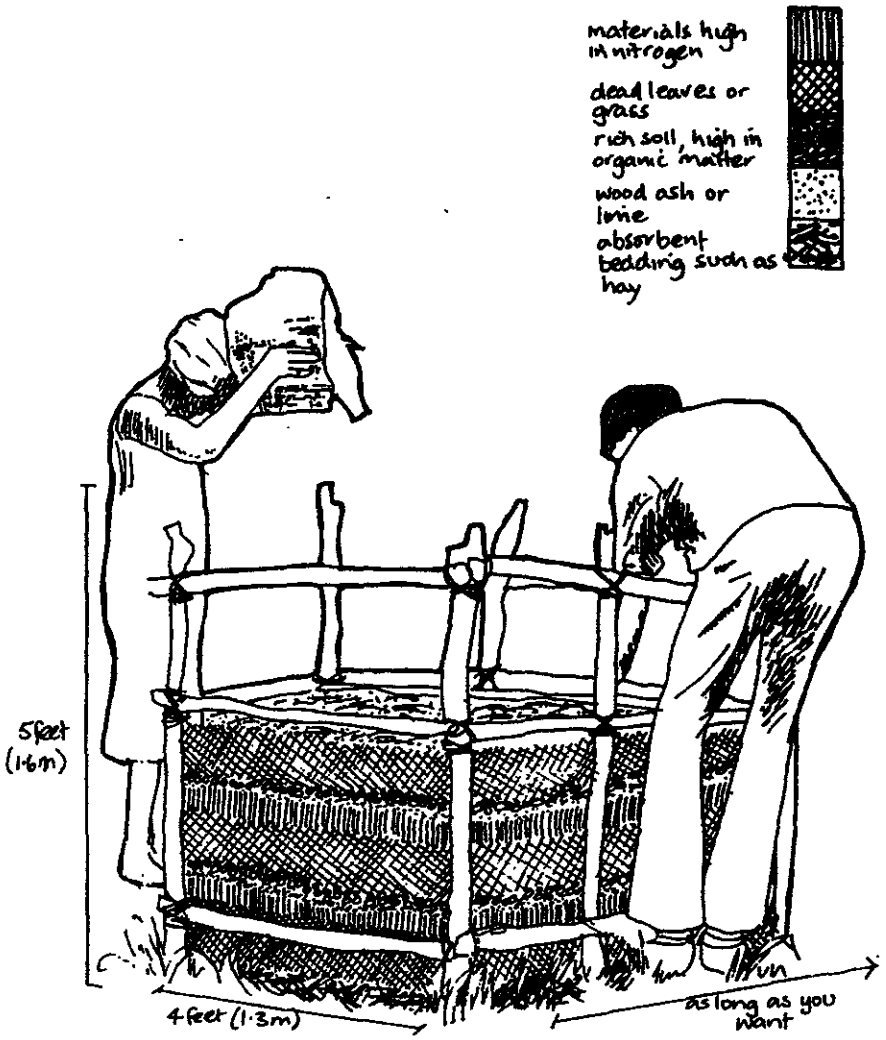
Take a close look at the soil on a forest floor or under a grassy field. What colour is it? It is dark brown because it is very high in organic matter. Look at the soil closely. Can you find the partial remains of dead plants and animals? Where did they come from? Leaves fall to the ground. When animals and plants die, they also fall to the ground. Then microbes, tiny living things that can only be seen with a microscope, begin to decay the dead plant and animal remains. The microbes convert them into rich soil high in nutrients. Plants use the nutrients to grow and multiply, and the cycle continues...

In a compost pile, microbes carry on the very same decay process that takes place in nature. However, in a good compost pile, microbes are provided with ideal conditions for growth. Like other living things, microbes need food, air, water and a warm enough temperature. If all of these needs are provided, the microbes grow and multiply quickly. As they do, they quickly convert the vegetable scraps, manure, leaves and other stuff that you throw into the pile into rich, dark brown, sweet-smelling compost, worth its weight in gold for your garden! Do these activities to learn how to make and care for a compost pile.

How do you build a compost pile?

First decide whether to build the pile above ground or in a shallow pit. If the weather is very dry, then dig a shallow pit, about 4 feet (1.3 m) wide and one to two feet (30 to 60 cm) deep in a well-drained area. This will keep the compost pile from getting too dry. If the weather is very wet, then put four corner posts in the ground, four feet (1.3 m) apart, to contain the compost pile. Putting the pile above ground will keep it from getting too wet.

Once you have selected and prepared the site, make a compost "sandwich" like the one shown here. The pile should be about four feet (1.3 m) wide and five feet (1.6 m) high. If it is begger than this, then air will not get to the center. If it is smaller, then it may dry out too fast. Six inches (15 cm) of dead leaves or grass to every two inches (5 cm) of materials high in nitrogen provides a balanced diet for your microbes. Materials high in nitrogen include vegetable and fruit scraps, dead legumes (like peas and beans), and animal manure.



How do you care for the compost pile?

The better you take care of the compost pile, the faster the compost will be ready. The most important thing to remember is that microbes need both air and water to grow and multiply. For an ideal compost pile, follow these tips:

* In very wet weather, cover the heap to keep the rain out
* In very dry weather, put a thin layer of soil on the outside of the heap to keep the moisture in
* For 2 to 3 days after it is built, use a fine spray to wet the pile
* Shape the top of the pile like a dish to catch water and stop it from washing down the sides
* Place absorbent bedding, such as hay, at the bottom of the pile to catch the nutrients
* Turn the pile once a week to make sure it gets enough air (if it begins to smell, it does not have enough air, so turn it even more often)

How do you know if the microbes are working? After two to three days, stick your hand in the pile. If the pile is big enough, it should feel warm. (The pile needs to be 4 feet (1.3 M) across and 5 feet (1.6 m) high to generate this internal rise in temperature.) As the pile heats up, the microbes begin to grow and multiply faster. The growth of microbes nearly doubles for every 18°F (10°C) rise in temperature, up to 170°F (77°C). Thus, this rise in temperature shortens the composting time.

* If you live in a **hot and wet climate** and plant one crop of corn per year, try planting velvetbean one or two weeks after corn. Prune the bean as described above. After harvesting your corn, leave the bean growing on the field until it dries out naturally. Grow jackbean or lablab with it to provide shade during drier months until another crop is planted. If you plant two crops of corn per year, then plant the first crop of velvetbean as described above. Before you plant your second corn crop, chop the bean down. Then plant your corn and one or two weeks later, plant the bean between rows.

* If you grow **sorghum**, try intercropping with lablab beans. If your soil is poor, try jackbean rather than lablab, or velvetbean and jackbean together.

* If you live at an **altitude above 1,700 meters**, try planting choreque (*Lathyrus nigrivalvis*) one month after you plant your corn. It will produce better the second year than the first.

* If you grow **coffee or orange trees**, jackbeans grown under and around the trees will increase their growth and provide fodder for animals as well.

2. Interview local farmers to find out if they use cover crops, and if so, how they cultivate them. If possible, get a few seeds of locally grown cover crops and try them out on small plots.

3. Try growing cover crops on otherwise fallow land. Try planting a cover crop on one fallow plot of land and not on another. Compare the soil texture and subsequent crop yields of the two plots. Jackbean and lablab grow year after year, and protect the soil from being dried out by wind and sun during the dry season. If fields are laying fallow, then planting a cover crop can shorten the fallow period. To plant velvetbean, simply cut the weeds, then broadcast the velvetbean seeds onto the land or plant them with a dibble.

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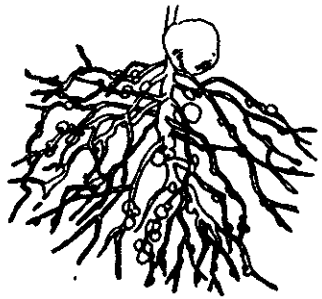
LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 10

Cover Crops

You can improve the fertility of your soil and increase your grain yields by more than three times without the use of commercial fertilizers or compost. At the same time, you can grow nutritious fodder for animals and high protein food for humans without any extra land. Sound too good to be true? Try growing cover crops and see for yourself! **Cover crops** are legumes that are grown to cover and protect the soil, and to add nitrogen and organic matter for improving its fertility. Legumes have **nodules** on their roots, where **Rhizobia** bacteria live. Rhizobia take nitrogen from the air that is otherwise unavailable to plants and convert it to forms plants can use.

Try This Carefully pull up a legume and examine the roots. Look for the pinkish nodules, where the Rhizobia bacteria live.



Why use cover crops?

* Cover crops can add large quantities of nitrogen (over 200 kilograms/hectare) and organic matter (up to 30 tons/hectare or more) to the soil.

* Since the cover crops grow where they are needed, they present no transportation problems, as do compost and chemical fertilizers.

* Cover crops, while they are growing, can provide a natural protection of the soil from the intense rays of the sun and from wind and water erosion.

* Cover crops can provide high protein fodder for animals, which can be especially valuable during dry seasons.

* In many cases, cover crops can provide human food, including edible beans, peas and pods.

* Some cover crops, when intercropped with grain, can control weeds at the same time as they add nutrients and organic matter to the soil.

What characteristics does a good cover crop have?

* It produces large amounts of green matter.

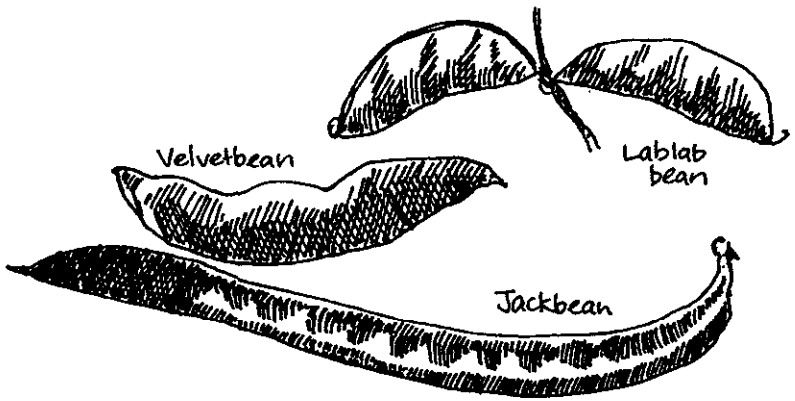
* It grows vigorously in poor soils without the addition of fertilizer.

* It requires a minimum of soil preparation, and it can be planted with a dibble stick or by broadcasting.

* It has few natural enemies and does not require pesticides.

* If it is being used as an intercrop, it is shade resistant. If it will be growing during the dry season, it is drought-resistant.

* It fixes large amounts of nitrogen, thereby increasing yields of subsequent crops.



Try This

1. Intercropping (planting between rows of other crops) is one way to cultivate cover crops. Try small plots of different legumes to find out what works best for your area. Compare the soil texture and grain yields of the plots that are intercropped with cover crops to plots that are not intercropped. The legume you should use depends on the climate of your area and/or the type of crops you grow. Which of the following applies to your area?

* If you live in a **cool climate**, try planting one crop of velvetbean (*Stizolobium mucuna*) per year at the same time as corn or a couple of weeks later. Plant 8 - 10 seeds per square metre. If the velvetbean starts to cover the corn, prune it to slow its growth and to make it spread out and smother weeds instead of climbing the cornstalks.

* If you live in a **hot and dry climate** and your soil is fertile, try planting one crop of lablab beans (*Lablab prurien*) between rows of grain. Lablab can be fed to animals. You can also try planting jackbean (*Canavalia esiformis*) or velvetbean. To control damage to velvetbeans from leaf-cutter ants, jackbean can be mixed with velvetbean.

TEACHER'S NOTES FOR LEARNING-BY-DOING LEAFLETS ON CROPS

INTRODUCTION

On the average, families in the developing world spend at least 75% of their income on food. The home garden is a viable method whereby families can inexpensively help meet daily nutritional needs. Hence, this first series of 25 Learning-by-Doing science leaflets focuses on home gardening. The leaflets are divided into five sections: (I) Learning About Plants, (II) Soil, (III) Planning, Preparing for and Planting Your Garden, (IV) Garden Care and (V) Harvesting and Preparing Your Crops. This OUTREACH pac includes sections I-II and the next pac includes sections III-V.

TEACHER'S NOTES FOR I. LEARNING ABOUT PLANTS

In this section, students will gain a basic understanding of how plants can be propagated both sexually ("What's in a Seed?" and "To Sprout or Not to Sprout?") and asexually ("New Plants from Old"). In addition, they will learn about the basic needs of plants ("How to Please Your Plants"). All of the activities are also meant to introduce students to experimental methods.

#1 What's in a Seed?

Teaching Tips

Caution students to dissect the seeds very carefully, so they do not damage the embryo or detach it from the cotyledons.

Experimental Results

The seed coat protects the seed so that the tender root and shoot are not damaged. If the beans are dissected carefully so the embryos are not damaged or separated from the cotyledons, then the seeds without a seed coat or with only one cotyledon should sprout. However, the beans with only one cotyledon will not grow as fast as those with two. The beans will not sprout at all if both cotyledons are removed, since the cotyledons contain the food energy needed by the growing sprout. Once the sprouts break through the surface of the ground, they can use sunlight to make their own food.

Beans, peas, and peanuts are dicots. Corn, pumpkins, and sunflowers are monocots.

The cotyledons of the bean sprout emerge from the soil with the growing shoot. It is gradually consumed as the bean sprout emerges. The cotyledons and endosperm of the corn sprout stay in the soil. Not much of the corn seed's endosperm is consumed until after the shoot has emerged.

Going Further

See OUTREACH pac #67, pp. 15-16 for more hands-on activities to learn more about seeds. Learning-by-Doing Leaflet #16, "Your Garden Debut," discusses how seeds should be planted in a garden.

#2 To Sprout or Not to Sprout

Teaching Tips

Discuss with students the need to subject several seeds to each treatment in order to reach valid conclusions. If there were only one seed in a treatment and it fails to sprout, you would not be able to tell whether it did not sprout because of the treatment or because it was simply an inviable seed.

Experimental Results

The seeds in jar A should sprout, since seeds do not need light to germinate. The seeds in jar B will not sprout, since they do not have air. The seeds in jar C will not sprout, since they do not have water. The seeds in jar D will sprout, since seeds will sprout either with or without light. The seeds in Jar E will not sprout since bean seeds do not sprout at cold temperatures.

Answers to Questions

1. Seeds cannot germinate without air.
2. Seeds cannot germinate without water.
3. Seeds do not need light to germinate, since they can use the food stored in the seed to sprout.
4. Seeds planted in very cold soil will not germinate. They will rest until the soil gets warmer.

Crossnumber Puzzle

Across

1. 7
3. 40
5. 5
6. 8
8. 30

Down

2. 70
4. 45
7. 80

Going Further

See OUTREACH pac #67, pp. 17-18 for hands-on activities to discover how deep seeds should be planted and what temperatures seeds need to germinate. See pp. 19-21 for a radio scripts on how to test your seeds' germination percentages and how to grow your own carrot seeds.

#3 New Plants From Old

Teaching Tips

When rooting cuttings, use a loose, light-weight soil mix or compost. Cuttings will not root well in soil that is simply dug up from the garden and put in a pot, since the soil will get packed together when watered in the pot and get too dense. (The Learning Leaflet entitled "Brown Gold for Your Garden" gives information on how to make compost.)

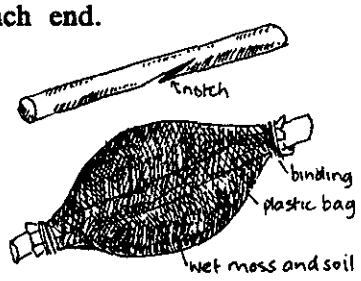
Going Further

See OUTREACH pac#67, pp. 6-13 for various hands-on and paper-and-pencil activities on plant parts.

Encourage students to root cuttings of ornamental plants and food plants not only for the school garden, but also for their home gardens.

Have students experiment to find the best soil mix for rooting cuttings. For example, have them try pure compost versus compost mixed with different amounts of washed sand versus pure sand.

Teach students how to propagate plants by layering, a method of starting a new plant from a stem while it is still attached to a plant. Try layering a Bougainvillea plant. Bend a branch to the ground and make a cut on the underside at the point where it touches the soil. Peg it down with a forked stake, and cover with rich soil and mulch to keep it moist. In time, roots will form and the section of stem may be cut off to form a new plant. Another way to layer a plant is shown below. Make a notch in a stem. Enclose the stem section in a plastic bag. Pack wet compost into the bag and tie the bag at each end.



#4 How to Please Your Plants

Teaching Tips

The purpose of this experiment is not only to teach students about the basic needs of plants, but also to introduce them to experimental techniques, which they can use to find the answers to any practical problem related to growing crops. Ask the students why it would be better to include several plants in each of their treatment groups (some of the plants might not grow well not because of the experimental treatment, but because of other reasons. For example, they may be weak plants or they may have been attacked by insects or diseases). Encourage the students to design experiments, and if possible, carry them out, to answer the problems posed under "Try This." It would also be helpful to have a knowledgeable farmer who likes to try new agricultural techniques, or a cooperative extension agent speak to the students and show them the experiments that they are carrying out.

Experimental Results

Plant A, which is provided with ideal conditions for growth, should grow tallest and bushiest. Plant B, which has been over-watered, should not grow as tall as Plant A, and its leaves should appear yellowish. The roots should appear water-logged, and perhaps they will be partly decomposed. Plant C, which has been deprived of light, should not grow very much and should appear very light green in colour. Plant E, which has been grown in sand, should not be as tall as plant A, because it has been repeatedly subjected to drying since sand cannot hold water.

TEACHER'S NOTES FOR II. SOIL

The secret to a productive garden is productive soil, yet often the soil is overlooked. As a result, its productivity is reduced by erosion and by decreasing amounts of organic matter and soil nutrients. In this section, students learn how to analyze their soil ("Be a Soil Detective"), how to measure and correct soil pH ("Sweet 'n Sour Soil"), the causes and prevention of soil erosion ("Soil on the Move" and "Saving Soil on a Slope"), and how to add fertilizer and organic matter to the soil ("Brown Gold for Your Garden" and "Cover Crops").

Going Further
The handout entitled "Six Steps to a Better Soil," which can be found at the end of the teacher's notes for this section, provides an overview of the soil section. You may wish to simply read it for your own benefit, or you can also reproduce it for your students.

#5 Be a Soil Detective

Teaching Tips
This leaflet provides an overview of how to analyze soil, which is necessary before any steps can be taken to improve the soil for growing crops. Perhaps the students could be assigned to teams to perform the tests described. Then they can compare their findings with the rest of the class.

Going Further
See also OUTREACH pac #68, pp. 1-3 on what makes up soil; 5-6 on soil texturing by hand; 10-11 on analyzing soil; 16-17 on water in soil.

6 Sweet 'n Sour Soil

Teaching Tips
Assign students to teams to complete the experiments. Then the different teams can compare their results. If your soil is acidic, see "Soil pH" at the end of this section recommendations for liming.

Experimental Results
Red cabbage water should give a rough indication of soil pH (red = too acidic; blue or green = too basic; purple or bluish-purple = just about right).

Going Further
The handout entitled "Soil pH," which can be found at the end of this section, provides a more in-depth, theoretical explanation of soil pH for higher-level students.

#7 Soil on the Move

Experimental Results
How does rain stir up soil? 1. During very heavy rainstorms more soil will be splashed up than during light drizzles. More soil will splash up in areas with bare soil that is very loose. More erosion is

also likely to happen in these areas. Less soil will splash up in areas where the soil is covered with a mulch or with growing plants.

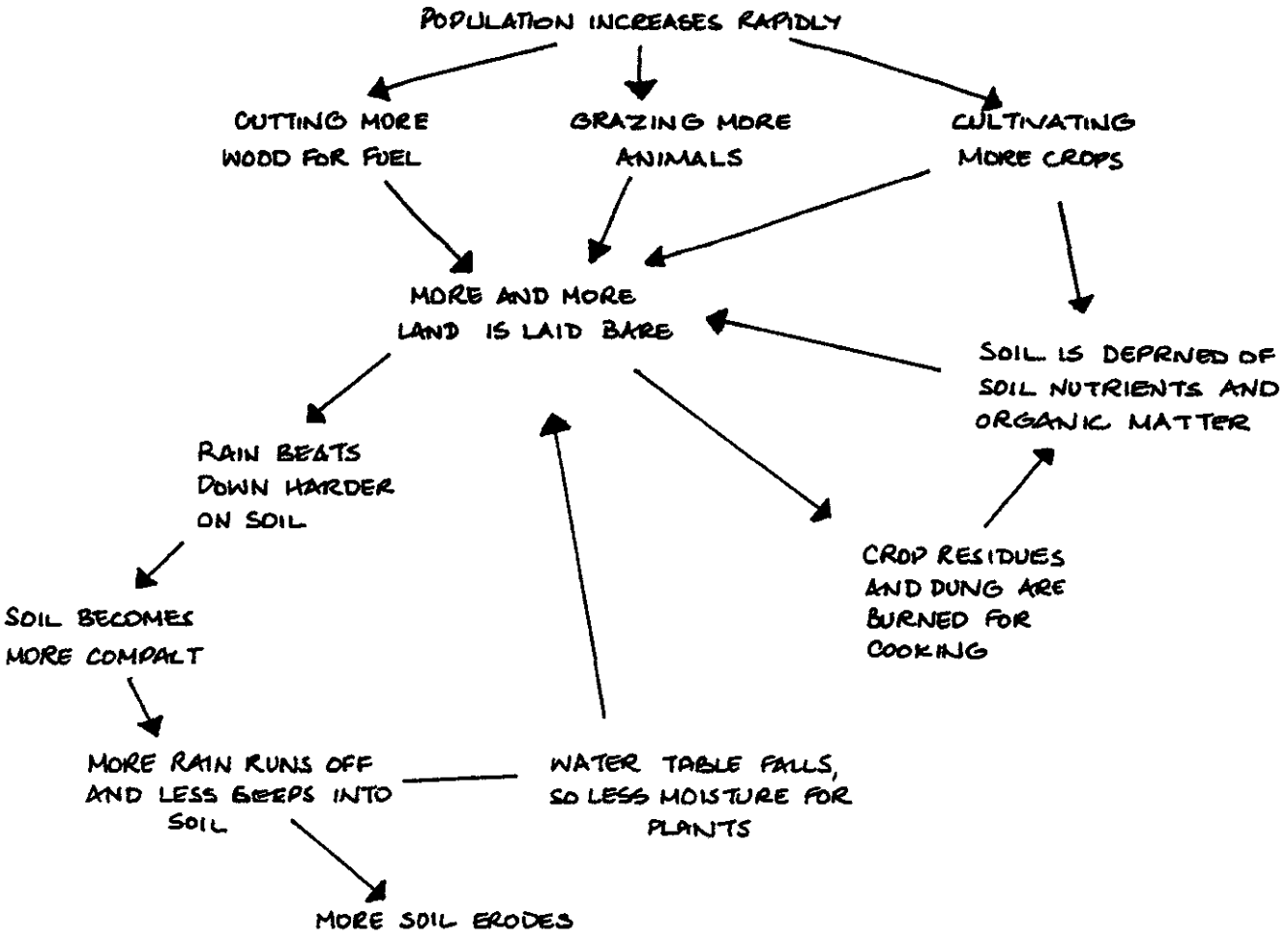
Where does the soil go? There will be more sediments in streams after a rainstorm. The streams with the most sediments are being fed by run-off from areas that are being eroded, perhaps because they are bare.

How does wind cause erosion? 1. The flour moves when the fan is farthest away, since the flour particles are smallest and lightest. Clay particles, if they are dry, are most likely to be eroded by wind. 2. Placing a barrier between the fan and the pans will stop the wind erosion. In a garden, a wind break can be built or trees and bushes can be planted to break the wind.

Answers to Questions

The conditions which cause the most erosion are: a. a heavy rain; b. rain on a bare slope; c. rain on an unmulched garden; d. strong winds.

Some of the cause and effect relationships that can be drawn are shown below.



#8 Saving Soil on a Slope

Teaching Tips
Students should be given the opportunity to put into practice what they learn about preventing erosion. Divide students into teams to research and carry out the practical applications suggested under "How can you stop erosion where you live?"

Experimental Results
When you plough up and down the slope, water will run down faster and move more soil. When planting a garden on a slope, you should make the rows going across the slope rather than up and down the slope to slow down erosion. Blocking gullies will slow down any further erosion. Mulching or planting grass on a slope will also slow down erosion. The steeper the slope, the faster water will run down and the faster the soil is eroded. Building terraces is the most effective way to slow down erosion on a very steep slope. Clay soil erodes the most, since it does not easily absorb water, so water must run over the surface instead. As water runs over the surface, it can easily carry away small clay particles.

Going Farther
See also OUTREACH pac #68, pp. 18-19 on managing the slope.

#9 Brown Gold for Your Garden

Teaching Tips
If you do not have the materials or space necessary to build a full size compost pile, carry out suggested activity #1 under "Try This." This will give students the practical experience of composting on a small scale, which will help them to set up a compost pile at home. Suggested activity #3 is a dramatic demonstration of the beneficial effects of compost of clay soil and sandy soil. Compost added to clay soil makes it lighter and looser. Compost added to sandy soil enables it to hold more water.

Going Farther
See also OUTREACH pac #68, pp. 4, 14-15 on organic matter in soil and composting.

#10 Cover Crops

Teaching Tips
Intercropping versus not intercropping provides an opportunity to practice experimental techniques. Students may discover and demonstrate intercropping techniques that are currently not being used to the fullest advantage in your locale. Have the students design and carry out an experiment to test the possible advantages of growing cover crops in your area.

Going Farther
See also OUTREACH pac #69, pp. 4-8 on intercropping.

Six Steps to a Better Soil

Most crops like a rich, loamy soil. However, more often than not, we have soil that is less than ideal and we must make the best of it. Usually soil is too sandy or too clayey; too wet or too dry; and too poor in nutrients for good gardens. Don't despair! Good garden soil can be made from it. This does not take a lot of money, but it may take some work. For a start, follow these six steps to a better soil.

1. Add Organic Matter

Probably the single most important thing you can do to improve your soil is to add organic matter -- the decayed remains of plants and animals. In nature, organic matter is constantly being added to the soil. You can see this happening in a forest or on a grassy plain. Dead leaves and other plant and animal material fall to the ground. Microbes in the soil, tiny living things such as bacteria and fungi, decay the plant and animal matter to form a top layer of dark brown soil rich in organic matter. If you look closely at this topsoil, you can see bits and pieces of plants and animals. Eventually, organic matter is broken down further by microbes into nutrients that plants can use.

Adding organic matter to your garden improves the soil for growing crops in a number of ways. Just as in nature, organic matter promotes the activity of living microbes. If organic matter is continually present, then the microbes are also always there, providing nutrients to plants. Organic matter also acts as a buffer, protecting the soil against extremes of pH and temperature.

In sandy soils, organic matter acts like a sponge, holding water and nutrients in place so plant roots can get at them. In clay soils, organic matter helps to clump clay particles together. As the organic matter decomposes, various substances are formed that cement the clay particles together into clumps, allowing water to sink through and air to circulate.

There are several ways to add organic matter to soil. One way is to make a compost pile. (See Learning Leaflet entitled "Brown Gold for Your Garden".) Another source of organic matter is to plant crops that improve the soil, such as legumes. (See Learning Leaflet entitled "Cover Crops.")

2. Prevent erosion

The slope of the surface soil can affect drainage and erosion. If your soil lets water pass through quickly, then it can be cultivated even on fairly steep slopes. Remember to always make rows going across rather than up and down a slope. This is called **contour ploughing.** If your soil does not drain rapidly, then you should build small terraces to slow down the runoff water. Terraces will give your soil more time to absorb water and prevent it from washing away.

If your garden is in a windy spot, then exposing the bare soil to the wind can lead to wind erosion. If water is available and the soil is suitable, plant trees to prevent wind erosion. (See Learning Leaflets entitled "Soil on the Move" and "Saving Soil on a Slope.")

3. Avoid Compacting the Soil

Good soil has a granular structure that permits easy drainage of water, good circulation of air, and root development. Soil structure can be destroyed if the soil is worked when it is too wet or too dry. Check the soil first before working. A handful of soil should just crumble after being squeezed into a ball. Keep working of soil to a minimum. Walk as little as possible over areas where crops are planted. If you must walk across the garden, lay down broad boards to walk on. Putting mulch, a layer of leaves, sawdust or other matter, around your plants can also help keep your soil granular. Mulching helps prevent crusting of the soil during heavy rains, and also supresses weed growth so that the soil will not need as much tilling. However, mulches such as sawdust and leaves should be at least partially decomposed before being used as a mulch so that they do not deprive your plants of nitrogen. (See "Much Ado About Mulch.")

4. Spading

The purpose of spading is to develop and maintain good soil structure and to get rid of weeds. Be sure your soil is not too wet or dry before beginning. Deep, fertile, granular soil may not have to be tilled very much, but usually some tillage is necessary. Spading by itself will do little good. When the soil is wet again, it will settle back together unless organic matter is added. You should work lots of organic matter into the soil while spading. Lime can also be added to the soil at this time, if needed. The surface soil (darker in colour) should be spaded to a depth of about 5 inches in dry sites and 7 or 8 inches in moist ones. Spading of subsoil (lighter in colour) is usually necessary for good, deep rooting. Do not mix the subsoil with the topsoil. Spade each layer separately. (See "Preparing Your Garden for Planting.")

5. Rotate crops

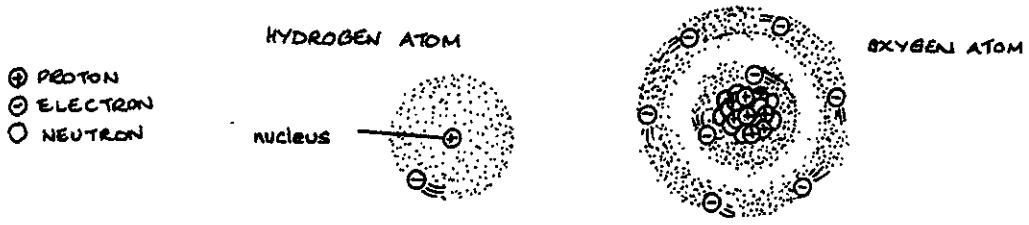
Every plant you grow demands something different from the soil. Keep changing the layout of your garden so that the corn you grew is followed by beans, tomatoes by melons, and so on. In this way, the soil will not completely lose any one nutrient in any one place. This also helps control diseases and insect pests. (See Learning Leaflet entitled "Planting Plans.")

6. Adjust soil pH

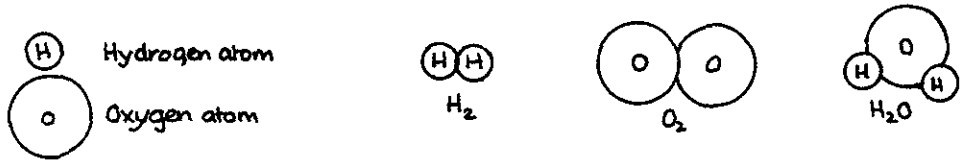
Alkaline soils occur mainly in dry areas and acid mainly in wet areas. Most crops prefer a slightly acidic pH, from 6.5 to 6.8. Test your soil pH and make adjustments if necessary. (See Learning Leaflet entitled "Sweet 'n Sour Soil.")

Soil pH

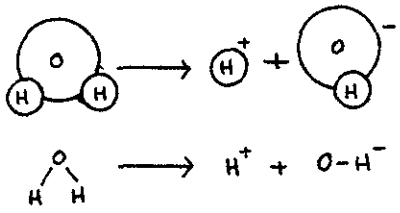
To understand pH, you need to know some chemistry. In the scientist's model of matter, everything is made of **atoms**. Atoms are made up of a **nucleus**, which contains positively charged **protons** and neutral **neutrons**. Negatively charged **electrons** spin around the nucleus of the atom. There are 107 different kinds of atoms. Each different kind of atom has a certain number of protons and an equal number of electrons. For example, a hydrogen atom has one proton and one electron. An oxygen atom has eight protons and eight electrons. The equal and opposite charges of the protons and electrons balance each other, so that atoms by themselves have no net charge. They are said to be neutral.



Most atoms do not usually occur by themselves in nature. They are usually joined together to form different kinds of molecules. For example, two hydrogen atoms could be joined together to form H_2, hydrogen gas. Two oxygen atoms could be joined together to form O_2, oxygen gas. Water molecules are made up of two hydrogen (H) atoms joined together with one oxygen (O) atom. The chemical formula for water is HOH or H_2O.



Not all the water molecules in a glass of water are joined together. A few of the water molecules are broken up into two parts -- **H ions** (H^+) and **hydroxyl ions** (OH^-). As you can see, the H ion has a net positive charge of +1. This is because it has one proton and no electrons. It's electron was "borrowed" by the hydroxyl ion, which now has eight protons and nine electrons, and a net negative charge of -1.



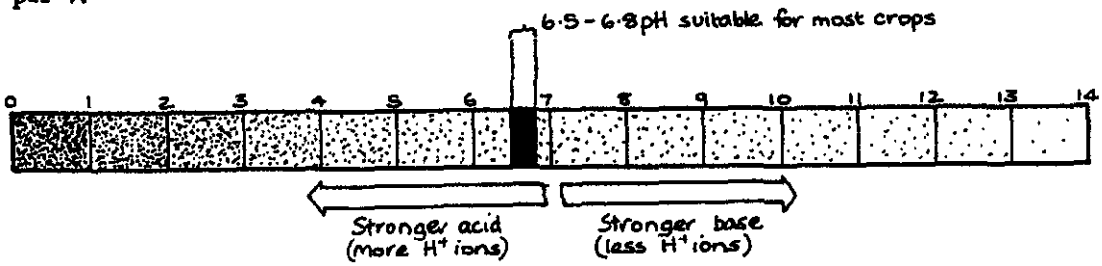
There are equal numbers of H^+ and OH^- ions in pure water. However, when some substances are added to water, they dissolve to form a **solution**. Some solutions, such as vinegar or sulfuric acid in

water, have more H^+ ions than OH^- ions. When there is an excess of H^+ ions, the solution is said to be **acidic**. Acidic solutions taste sour. Some solutions, such as baking soda or lye in water, have an excess of OH^- ions. These solutions are said to be **basic** or **alkaline**. Basic solutions taste bitter. **CAUTION: Never touch or taste unknown solutions. Strong acids, such as sulfuric acid, and strong bases, such as lye, can cause severe burns and even death.**

What is pH?

A system called pH is used to express the acidity or alkalinity of solutions. The pH scale goes from 0 to 14. The midpoint, pH 7, is neutral. Pure water, which is neutral, has a pH of 7. A pH below 7 indicates an acid solution. A pH above 7 indicates a basic solution.

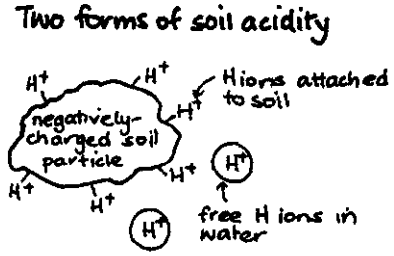
The lower the pH, the more acidic the solution. Each pH value indicates a concentration of H^+ ions 10 times greater than the pH value after it. Thus, a solution of pH 5 has ten times more H+ ions than a solution of pH 6, and 100 times more H+ ions than a solution of pH 7.



What is soil pH?

When you test the pH of soil, you are testing the number of hydrogen ions that are dissolved in soil water. However, hydrogen ions do not only exist as free ions dissolved in soil water. H^+ ions are also attached to tiny, negatively-charged soil particles. As soil water becomes less acidic, that is, as H^+ ions are removed from the soil water, *then the H^+ ions attached to soil particles are released into soil water.* Therefore, the acidity of a soil is composed of two parts:

1. active acidity, made up of H^+ ions in soil water; and
2. potential acidity, H^+ ions held to tiny soil particles.



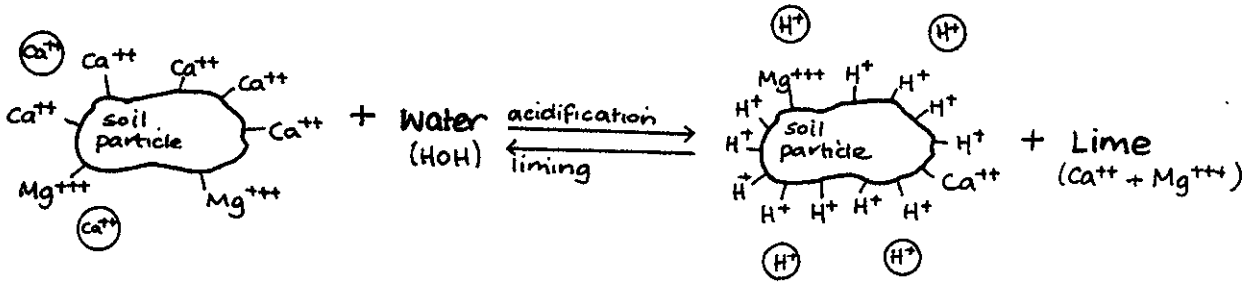
Not all soil particles are negatively charged. Only very tiny clay particles and pieces of organic matter (from dead plants and animals) are negatively charged. Therefore, it follows that fine-textured soils that are high in organic matter can have a higher potential acidity than sandy soils with low clay and organic matter content.

How do soils become basic or acidic?

The rock material from which soil is made usually contains tiny soil particles that are not saturated with H^+ ions, but with other positively charged ions, mostly calcium (Ca^{++}) and magnesium (Mg^{+++}). Through the centuries during which soil development takes place, H^+ ions are gradually carried downward by rainwater seeping into the soil. The Ca^{++} and Mg^{+++} ions are washed away. The H^+ ions replace the Ca^{++} and Mg^{+++} ions on the surfaces of tiny soil particles. The number of positive charges on each soil particle stays the same. Read the diagram below from right to left to see how this happens.

The more rain water moving through the soil, the faster the process of acidification. Therefore, soils found in humid regions are generally more acidic than those in other regions. Acidic soils are rarely found in arid regions. Also, since sandy soils hold smaller amounts of ions, they become acidic more quickly than clay soils when it rains.

When lime is added to soil, the pH is raised, that is, the soil becomes more basic. The process of raising the pH of soil is the opposite of the process of lowering the pH. Lime, which forms calcium and sometimes magnesium ions when dissolved in water, is added to the soil. The H+ ions on the surfaces of the tiny soil particles are replaced by calcium and magnesium ions. The H^+ ions are washed away. Read the diagram below from left to right to see how this happens.



How does soil pH affect plants?

The level of a soil's acidity is important because it affects the availability of nutrients to crops. Slightly acidic soil (6.5 - 6.8) is best for most vegetable crops.

To be available to plants, nutrients must be dissolved in soil water. Soil pH affects the solubility of these nutrients. For example, if the soil is too acidic, too many of some nutrients, such as aluminum, iron, manganese, copper and zinc, are dissolved in soil water. They become toxic (poisonous) to plants. If the soil is too basic, then not enough of these nutrients are in the soil water, so plants become undernourished.

The soil contains atoms of other essential nutrients, such as nitrogen, phosphorus and sulphur. However, they are parts of complex molecules which the plants cannot use until they are broken down. Bacteria in soil break down these complex molecules into

simpler forms that plants can use. If the soil is too acidic, these bacteria do not grow as rapidly. Raising the pH of the soil speeds up the growth of bacteria so more nutrients become available to plants.

How can soil pH be changed?

Suppose you test your soil and find that it is too acidic. The most effective way to raise the pH of your soil is to add lime. One common source of lime is limestone. This is a rock that is mined from the earth and then crushed. Try adding 2-3 pounds (2.5 - 4 cups) of limestone per 100 square feet. Work it into the top six inches of soil. After a couple of days, retest your soil pH. If still acidic, repeat the liming procedure. (See chart below for liming recommendations.)

Limestone requirements in tons per acre for soils of the warm-temperate and tropical regions **

Soil type	pH 4.5 to 5.5*	pH 5.5 to 6.5*
sand and loamy sand	.3	.4
sandy loam	.5	.7
loam	.8	1.0
silt loam	1.2	1.4
clay loam	1.5	2.0
muck with no clay/sand	3.3	3.8

* if soils are unusually low in organic matter, reduce by 25%; if soils are unusually high in organic matter increase by 25%

**from USDA Handbook No. 18, p. 237; tons per acre can be converted to pounds per 100 square feet by multiplying by 4.6

If you cannot get limestone, there are other sources of lime you can use. Ground or burned seashells or eggshells are one source of lime. Wood ashes can also be used as a liming material (they are 30-70% as effective as limestone). Coal ash has little or no liming value, but can improve the physical condition of your soil. The finer the size of the lime particles, the more quickly it will react with the soil. The lime should be mixed uniformly with the surface layer of soil. Mixing is necessary since the lime moves downward through the soil very slowly.

The frequency of liming depends on climate, soil and cropping practices. Test the pH of your soil before each planting. Soils with little organic matter in humid regions will need to be limed more often than heavy soils with lots of organic matter, which may only need lime once every few years.

CAUTION: Sandy and highly-weathered soils in humid regions with little organic matter can easily be over-limed. Adding organic matter can help prevent this. Use what you have learned about soil chemistry to explain why this is so.

If your soil is too basic, which is more likely if you live in an arid climate, then simply irrigating your soil will help lower its pH. Some of the excess Ca^{++} and Mg^{+++} ions are leached away with the water and replaced with H^{+} ions. Also, adding organic matter to the soil will lower the pH, since more soil particles will be available to which H^{+} ions can attach themselves. Coffee grounds and cottonseed meal can help lower pH since they are acidic. If the soil is extremely basic, you may need to add agricultural sulphur. Ask an extension agent for recommendations.

Composting

To make compost successfully, you must provide an ideal home for microbes such as fungi (molds), algae, bacteria and protozoa, so they can grow and multiply. Of course, you cannot see your tiny "tenants" unless you have a microscope to magnify them, but they are there in very great numbers. Pick up a handful of compost, and you are *holding more microbes than there are people on the earth.* In fact, a million million friendly microbes, more or less, are present in a cupful of compost! Though you can't see them, you know they are there, growing and multiplying, for right before your eyes they transform the vegetable scraps, manure, weeds and other stuff that you throw into the pile into rich, dark brown, sweet-smelling compost, worth its weight in gold for your garden!

How do you make a home for billions of microbes? They have four basic needs: 1. plenty of air; 2. adequate moisture; 3. a balanced diet; and 4. temperatures on the hot side.

Air

Why do microbes need air? Microbes need air to grow and multiply, and to finish the compost in a minimum of time. If your compost heap gets soggy or too compacted, then microbes do not get enough air. Bacteria that do not require air take over. Then only partial decay takes place, and products such as sulphur compounds result. Many of these products have offensive odours If your compost pile has sufficient air, it should not have an odour.

How can you insure that microbes will get enough air? The amount of air the microbes get depends on the height of the pile, how often the pile is turned, the moisture content, and the size of the air spaces within the heap. To provide enough air, the heap should be about 5 feet high and 4 feet wide so air can penetrate to the bottom. Make the heap as long as needed for the amount of material you have. The pile should be turned every third day for the first couple of weeks, and then at least once every second week. If the pile gets too soggy or compacted, then the microbes do not get enough air. The heap can be loosened and dried by turning it.

Coarse materials, like cornstalks, cause large air spaces and too much air, resulting in rapid loss of moisture and heat from the heap. They should be cut into pieces no bigger than 6 inches in length. (Chopping or shredding materials will speed decompostion as well, since there will be more surface area exposed to microbes.) Fine materials, such as sawdust, may not get enough air. They should be mixed with coarser materials. Materials like leaves and straw are the right size for composting.

Moisture

Microbes cannot do their work if the compost pile is too wet or too dry. How much water do the microbes need? Water should be applied when the pile is built up and for two or three days after the pile is built. Use a fine spray to wet the pile. The pile should be moist, not soggy. Do not let water run out at the bottom of the pile, since nutrients will be lost. Shape the top of the pile like a shallow dish to prevent rainwater from washing down the sides. Cover the pile during heavy or extended rains. Place absorbent bedding such as hay beneath the pile to catch the nutrients. Fresh green materials, such as grass clippings, contain too much water for composting. Let them wilt before piling or mix with about one-third their weight of

dry material. If the pile becomes soggy, turn and loosen the heap. Small heaps will dry out more quickly. Add water to them as needed. If the weather is very dry, a thin layer of soil on the outside of the heap will help retain moisture. Building the compost heap in a shallow pit will do the same, but the pit should be in a well-drained place so the compost does not get soggy.

A Balanced Diet

Like humans, microbes need a balanced diet. They need organic materials high in carbon for energy to carry out their life processes. Materials that are high in carbon include straw, leaves and sawdust. They also need materials high in nitrogen, out of which they make more of themselves. Materials high in nitrogen include animal manure, seaweed, vegetable scraps and legumes (pea or bean plants, for example). Ideally, the ratio of materials high in carbon to those high in nitrogen should be 3 to 1.

How do you get a 3 to 1 carbon to nitrogen ratio? To set up these ideal proportions in your compost heap, layer the heap like a sandwich. Start with a six inch layer of carbon materials, and on top of this add a two inch layer of nitrogen materials. Add a layer of soil on top of this to insure that plenty of microbes are present. A dusting of lime, such as wood ashes, will help to keep the pile from getting too acidic. Microbes do not work as well when the materials get too acidic. Repeat these layers until the pile is about five feet high. You can put poles or even a wire fence around the pile to keep it in place. The first time you turn the pile, of course, the layers will disappear. Don't worry. The only reason for making the layers is to get the right ratio of carbon to nitrogen.

Temperature

To speed decay, the compost heap should be allowed to heat up. How hot is hot enough? The growth of microbes nearly doubles for every 18^{o} F rise in temperature, up to 170^{o} F. How do you heat up the pile? If the pile is big enough, at least 4 feet in diameter and 5 feet high, then the microbes will generate their own heat. If the pile feels warm, then you know that composting is happening. Heat shortens the time needed for decay. Heat also kills plant diseases and weed seeds, however, you should not count on all of them being killed. The ones on the outside of the pile might not be subjected to enough heat to kill them. Do not add weeds that have gone to seed or diseased plants to the pile.

The Finished Compost

How long does it take before the compost is ready? The more ideal the conditions you provide for the microbes, the faster the decay process. It could take from several weeks to several months to finish the composting. How do you know when it's ready? You will know the compost is ready when it has shrunk to about one-third the original size, is dark brown in colour, has a crumbly consistency, and has a pleasant, earthy odour.

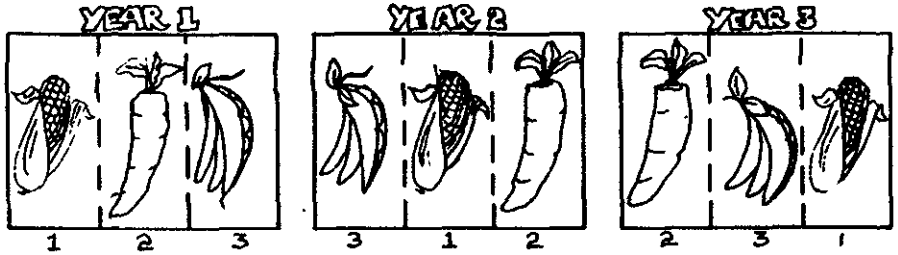
How much should you put in the garden? Ideally, you should add five gallons on compost for every square metre of soil surface in your garden. Thoroughly mix it in with the top 6 to 8 inches of soil. If you do not have enough organic matter to spread over the entire garden, then use it just where you are planting your crops.

Issue no. 73: Contents page(s)

PART 2 (in this issue of OUTREACH)

* **Interplant** quick-growing crops among slower-growing ones. The fast-growing crops are out of the way before the longer-growing crops need the space. For example, plant lettuce between rambling vegetables such as squash and tomatoes, and harvest the lettuce before the vining vegetables spread.

* Practise **crop rotation.** Try to avoid growing the same kinds of crop in the same location more often than once every three years. Rotation should be by families of crops, for example, legumes (peas and beans), cucurbits (pumpkins, gourds, and melons), and corn. Crop rotation prevents some diseases and insect pests from living over from one planting to the next. Also, different crops take up different nutrients. Root crops, such as carrots and turnips, require a lot of potassium. Leaf crops, such as spinach and lettuce, as well as corn, require a lot of nitrogen. Beans and other legumes add nitrogen to the soil. Below is a sample crop rotation plan for a family garden.



1 The heavy feeders : cabbage, corn, lettuce, melons, spinach, squash, tomatoes
2 The light feeders : carrots, onions, peppers
3 The soil builders : beans of all kinds, peas

Try This

Make a plan on paper that includes the vegetables you intend to plant, where and when. The plan should show the location of each crop, the amount to be planted on each date, and the spacing required for each crop. Your drawing should be in scale. For example, one cm on the plan could represent 20 cm. Incorporate principles of interplanting, interval planting and crop rotation in your plans.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 11

Planting Plans

A successful garden requires careful planning. You must decide where to plant, what to plant, when to plant and how to plant your garden.

Where to plant

When choosing a site for your garden, there are five questions you should ask:

1. Does the site get enough direct sun each day? Fruit crops, such as corn, beans, melons, squash, tomatoes and peppers, need at least six hours of sun per day. Leafy crops, such as spinach and lettuce, need less sun.

2. What kind of soil does the site have? Plants need a rich loam with good drainage, rather than a clay soil with poor drainage.

3. Is the site near a source of water? Most vegetables are shallow-rooted and need regular watering, especially during dry seasons.

4. Is the site near the house? You can keep better track of what is happening in your garden if it is nearby. You are more likely to catch and correct little problems before they become big problems.

5. Is the site protected from the wind and from animals?

Try This

Go outside and scout out the most ideal spot for a garden. Remember, it is not always possible to find a perfect spot for a garden. You may need to make some compromises. Make sure your site has enough sun each day. You may need to check the site several

times during the day to find out how many hours of sun it gets. Also remember that some problems can be corrected. For example, a poor garden soil can be improved. You can plant trees or bushes to serve as a wind break or as a fence to keep out animals.

What to Plant

a. First you must decide how big you want to make your garden. A small plot that is easy to tend is better than a huge plot that requires more time than you have. As a rule of thumb, every 11 x 16 feet (10 x 15 metres) of well-tended garden should provide enough vegetables for 2-3 people.

b. You must decide what crops to plant and when to plant them. Choose vegetables and fruits that are easy to grow, that are adapted to your area, that are disease-resistant and that yield well. Take into consideration the nutritive value of different vegetables.

Try This

Interview local farmers who grow vegetables and fruits in your area. If possible, also interview an extension agent or someone at a local agricultural college about what crops and varieties grow best in your area. Ask the following questions: What crops and crop varieties can be grown in this area? Are the seeds planted directly in the ground or are they transplanted? How much space does the crop require between plants and between rows? What dates should they be planted? Based on the information you have gathered, make a chart listing the crops and varieties you would like to plant in a family garden, the spacing required for each crop, when each crop should be planted and other useful growing information.

How to plant

Keep the following points in mind when designing your garden:

* Plant crops that span more than one growing season to one side of the garden so they do not interfere with the rest of the garden.

* To minimize shading effects, plant low-growing crops along one side of the garden and the tall-growing crops along the other side.

* Decide whether to plant in rows or in blocks. The advantage of growing plants in single-file is that hoeing or tilling for weed control is easier when vegetables are in rows, rather than in beds. Also, if your soil is marginal, it may be better to plant your vegetables farther apart. If planting in rows, run rows north and south to insure even exposure to the sun in all the rows. If your garden soil is rich, you can get away with planting crops closer together in blocks. The advantage of this method is that after one or two initial weedings, your vegetable plants will shade out weeds. Also, less growing space will be wasted on paths between rows. If your soil does not drain well and you are growing during the rainy season, then you may need to plant your vegetables in raised beds about 12 cm high..

* If planting corn, plant several short rows in a block rather than a couple of long rows. Each kernel of corn must be pollinated before it will fill out. Planting in blocks results in better pollination and ear fill-out.

* If space is at a premium, plan on making use of vertical space. Train cucumbers, melons and gourds and climbing beans on a trellis. Stake and prune tomatoes so they grow upwards.

* Do not plant too much of any one crop at one time, especially if they must be eaten fresh and cannot be stored. To provide fresh vegetables over a long period of time, make **interval plantings** of any one vegetable every 10 to 14 days. Interval planting works particularly well for crops such as beans and corn that have a short harvesting period.

How should green-leaved vegetables be cooked?

Green-leaved vegetables are usually boiled or steamed. This is a good practice since boiling or steaming gets rid of harmful germs. Also, if the leaves contain poisonous or irritating substances, heating destroys them. However, some nutrients, such as vitamin C, are destroyed by heating. Others, such as the B vitamins, tend to be leached out into the cooking water. Therefore, it is a good idea to boil in as little water as possible and to cook as briefly as possible (three to five minutes). Get the water boiling before adding the leafy vegetables. If greens are added to soups or stews, then the vitamins that leach into the cooking water are not lost.

Try This

1. Try boiling a green-leaved vegetable for a short time (3-5 minutes) versus for a long time (over 20 minutes). Compare the taste, texture and appearance of the vegetables. Which do you like better? Which do you think is more nutritious?

2. Interview your parents, grandparents or other elders to find out how greens are cooked in your area. Write down the recipes and put them together to make a cookbook. Have a cooking contest to see who can prepare the most delicious dish of vegetable greens.

3. Here is one recipe from Southeast Asia for a green-leaved vegetable:
Wash five cups of greens and place in a pot with little or no water. Cook 3-5 minutes, covered, until tender but not mushy. Combine a quarter cup of vinegar, one tablespoon sugar and a quarter teaspoon salt and pour over greens. Garnish with tomato or hard-boiled egg if desired.

OUTREACH pack 73 pp 5-6. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING

HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS

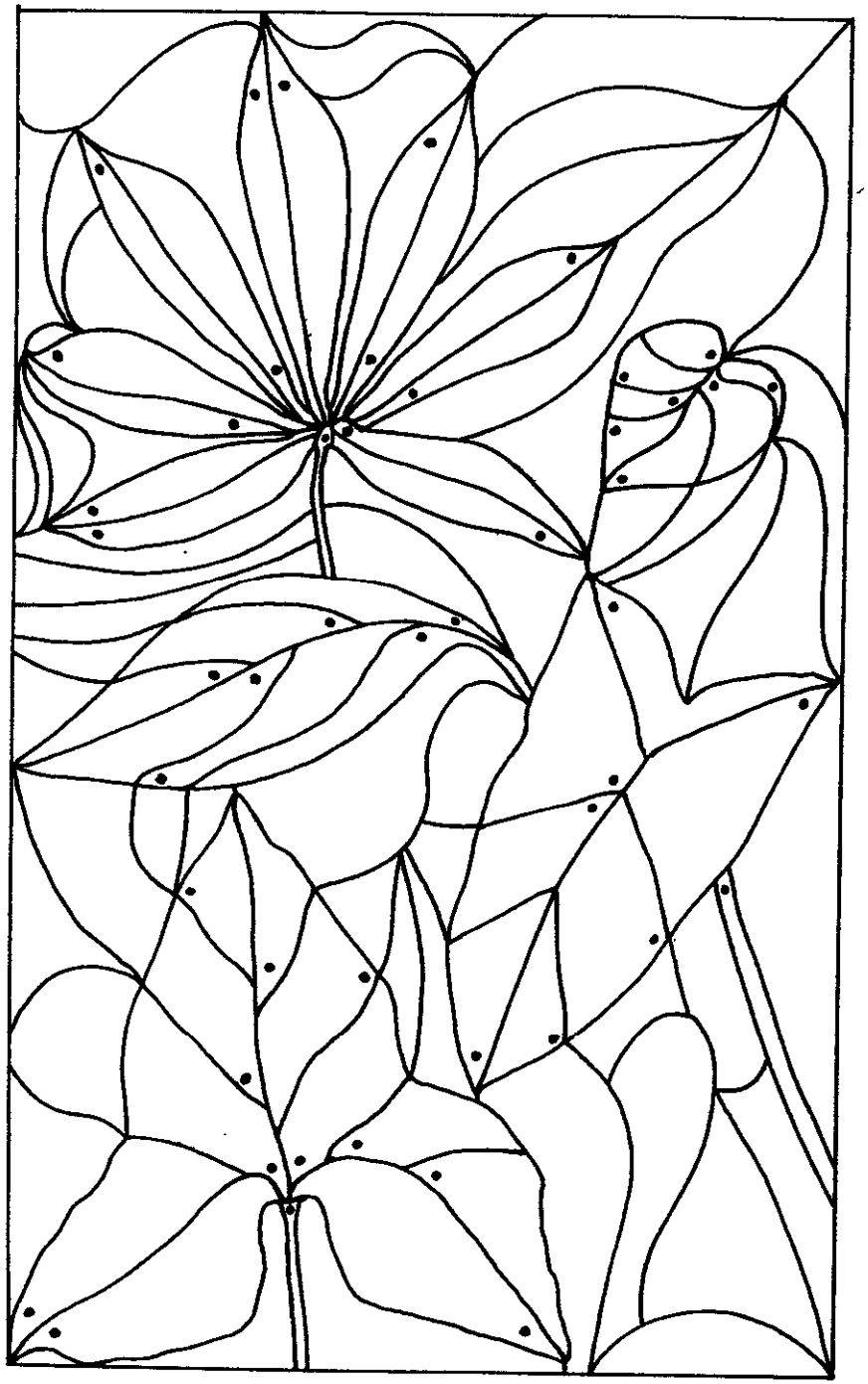
LEAFLET NO. 12

Eat a Green Plant Today

Green-leaved vegetables should be a part of everyone's diet. They contain vitamins and minerals that are essential for good health. Dark green leaves are especially high in vitamin A. Green leaves also contain vitamin C, the B vitamins, iron, calcium and phosphorus. Green-leaved vegetables add bulk to the diet as well, which is important for regulating the digestive track.

Green-leaved vegetables are eaten all over the world. In Africa, 500 or more different kinds of greens are eaten. Africans usually add greens to soups and stews. In Southeast Asia a wide variety of greens are used to add diversity to many different dishes. Unfortunately, in Central and South America the custom of eating many different types of greens has died out, perhaps as a reaction to the views of those who looked down on local customs. In western countries, many greens that were traditional in other countries are now being enthusiastically adopted. For example, in the United States, many home gardeners now plant New Zealand spinach in their gardens. This green is preferred over other spinach greens because it does not go to seed in hot weather and because it can be harvested continually.

Hidden in the puzzle on the next page are five different kinds of leaves that are used as vegetables in the tropics. Colour all the dotted sections to discover five leaves that are commonly grown in the tropics. Do you recognize any of them? List the ones you know by name.



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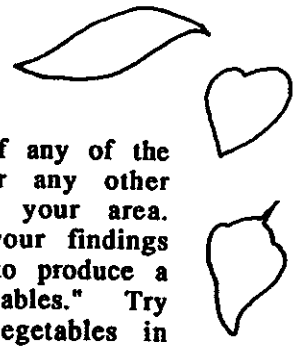
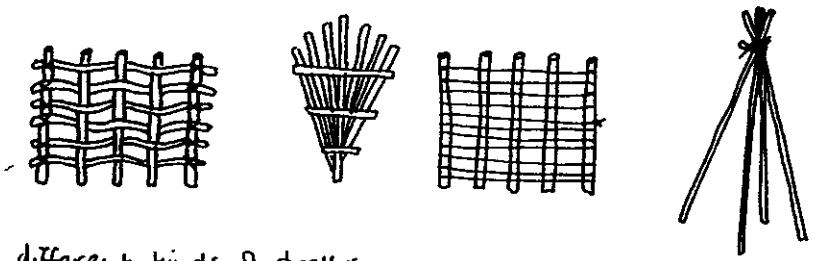


1. Interview local people to find out if any of the green-leaved vegetables shown here or any other green-leaved vegetables are grown in your area. Find out how they are grown. Put your findings together with those of your classmates to produce a "Growers Manual for Green-leaved Vegetables." Try growing some of these green-leaved vegetables in your garden.

2. Find out if local people harvest greens from the wild. Ask someone who knows about wild greens to take you on a collecting trip. Find out all you can about when and how wild greens can be harvested and how they are traditionally prepared. Collect some seeds from wild greens. Try growing the seeds in your home or school garden.

3. Some green-leaved vegetables, such as Ceylon spinach or water spinach, are vining plants. Try growing these vining plants and training them to trellises. Trellises are especially useful if space is at a premium. By training the vines to grow upward, you can make use of vertical space rather than taking up valuable ground space in the garden. Trellises also keep the plants cleaner, thus preventing rot. Trellises can be built in a number of ways. They can be built from thin strips of wood that are woven together in an open pattern of squares. They could also be built from tree branches stuck into the ground and tied together.



different kinds of trellises.

Planting and Thinning

Before planting, make sure you punch holes for drainage in the containers and add gravel to the bottom. Then fill the containers to the brim with the growing mix. Thoroughly water the mix until water begins to drain out of the drainage holes. Sow the seeds at the correct depth. Place the containers out of the direct sun so that the growing media stays moist to insure good seed germination. Once the seedlings come up, move the containers to a sunny spot. Make sure you thin out your seedlings so that your plants have enough room to grow.

Watering

If your containers are outside, then the sun and wind are constantly drying them out. Check your plants for wilting at least once a day and twice on hot, dry days. Feel the soil to see whether it is moist but not soggy. When you water, water thoroughly so that the excess runs out the bottom.

Sunlight

It is vitally important to put your vegetables in a place where they will receive enough sun. Tomatoes, peppers, beans, eggplant, squashes, and cucumbers need at least 6 hours of full sunlight per day. Leafy vegetables such as lettuce and spinach require less light.

Try This

Try planting a container garden at school or at home. Be sure to provide your plants with adequate light, water and nutrients. Keep a record of their light, water and nutrient needs, their growth and yields. Determine which vegetables grow best in containers.

OUTREACH pack 73 pp 7-8. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbo, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING

HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS

LEAFLET NO. 13

Container Gardening

Would you like to have a garden, but you can't because you live in the city where there is no room for one? If you have a roof-top, a windowsill, patio or just a doorstep, you can grow vegetables in containers. Anything that can grow in a garden can also be grown in a container. Just provide your plants with a few basic needs -- a suitable container, a growing media, nutrients, water, and light, and watch them sprout and grow!

Containers

Containers for your plants must:

* be big enough to support your plants when they are fully grown;
* hold soil and
* have adequate drainage.

Anything and everything that fulfills these basic requirements can be used. Use your imagination! Look for discarded containers that could serve this purpose, such as milk cartons, tin cans, cement blocks, fish or vegetable cartons, or even plastic bags.

Whatever you use for a container, drainage is extremely important. Be sure that there are adequate holes along the bottom sides of your containers. Put some gravel at the bottom of the containers, up to the level of the drainage holes. Keep the containers up on slats, bricks or blocks so that excess water can drain off freely.

Containers	Capacity	What can be grown
large tin cans, milk cartons, flower pots, plastic jugs	2-20 quarts	peppers, beans, herbs, dwarf tomatoes, 2-3 lettuce or amaranth
buckets and garbage cans, tomatoes, wooden packing crates, old tires	40-80 quarts	squash, cucumbers New Zealand spinach, pole beans

* Note: It is possible, but not really worthwhile to grow sweet corn in containers, since a very large container would be needed for the two or three poorly-filled ears of corn that would result. Dwarf varieties of vegetables such as squash and tomatoes developed for growing in small spaces may be available in your area.

Growing media

Soil dug up from the ground cannot be used in a container because it it too heavy. The particles are too small, so the soil gets too compacted in the container when it is watered. Soil must be porous in order to support plants, since plants require both the air and water which fill the pore spaces. A good growing media consists of well-rotted compost lightened with washed sand. If the compost is acidic, add wood ashes to sweeten it. (To learn how to make compost, see "Brown Gold for Your Garden.") This mix will provide your vegetables with the nutrients they need and will stay porous, even when watered. If the growing media is to be used for more than one crop, then add supplemental nutrients, such as well-rotted manure or commercial fertilizer.

Nutrients

While your plants are growing, you may wish to give them an extra booster of liquid fertilizer every 3 to 4 weeks. Plants absorb nutrients more quickly when they are dissolved in water than when they are in solid form. To make manure tea, fill a burlap bag with about 15 pounds (7 kilograms) of fresh manure. Tie the bag tightly at the top. Fill a 20-quart bucket with water and drop the tea bag in and leave for about 10 days. Be careful when lifting the bag out. Wet manure is heavy! The water should be the colour of black coffee. You can make compost tea by mixing a large shovelful of compost with 8 quarts of water. Let it stand 4 days and strain through a mesh screen. Apply about a half litre of either liquid fertilizer to the base of each plant.

crops need 4-5 weeks. Tomatoes, peppers and eggplants need 5-7 weeks. Do not let the transplants get too old. The smaller the transplant, the easier it is to transplant and the quicker its recovery from transplanting. However, tomato seedlings are too small to be transplanted without being damaged until 5 weeks old. After 7 weeks, tomato seedlings start to get too old for transplanting.

A week to ten days before transplanting, cut the soil to the full depth of the roots around each plant with a sharp knife. This cuts each plant's roots, confining them to a square of soil. In 7-10 days, the new side roots are formed so that the plants do not suffer serious setbacks when transplanted.

Harden the transplants by gradually witholding water. The seedlings should wilt for a short time, but should not be allowed to wilt permanently. This causes the plant tissue to become thicker and harder, hence the term **hardening**. This helps the seedling recover once transplanted.

The best time to set out transplants is just before or after a rain, as long as the soil is not too wet. If the weather is hot and dry, transplant in the late afternoon. Holes for the transplants should be dug in rows at the recommended spacing. Place some compost in each hole. The seedling should be at the same depth as it was in the seedbed. Set the transplants in the field with the soil cube intact. If available, add a cup of fertilizer dissolved in water. (Soak some manure and wood ashes in water for a few days.) Otherwise, just add a cup of water.

Try This

1. Try different methods of preparing the seedbed. For example, try sterilizing versus not sterilizing the soil in the seedbed. Try a seedbed in the sun versus one in the shade. Try using compost versus not using compost in the seedbed.

2. Try different methods of planting the seedbed. For example, try scattering seeds in the seedbed versus planting the seeds in rows 5-7 cm apart. Try thinning versus not thinning the seedlings once they have come up.

3. Try different methods of transplanting the seedlings. For example, try transplanting tomatoes when they are 4, 6, 8 and 10 weeks old. Compare the yields of the plants. Try transplanting in the morning versus the evening.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES
FOR YOUNG SCIENTISTS
LEAFLET NO. 14

Bringing Up Baby Plants

What vegetables should be transplanted?

It is not worth the effort to transplant all kinds of vegetables. Some will do better if they are direct-seeded into the garden. For example, some vegetables, such as corn, okra, legumes (beans and peas) and the cucurbits (cucumbers, squash and melons) are very slow at growing new roots. The top of the plant cannot start growing until the broken roots have been replaced. This stop in growth is never corrected and greatly reduces the yield of the plant. Some vegetables, such as carrots, beets and radishes produce a long tap root. If the tap root is damaged, which is difficult to prevent when transplanting, then the broken tap root causes an odd-shaped, small root. Some vegetables, such as sweet corn, legumes, and radishes, germinate rapidly and the seedlings grow quickly. This makes them easier to direct seed than crops that germinate and grow slowly over the first few weeks.

Tomatoes, eggplant, peppers and cole crops such as cabbage rapidly grow new roots. They have root systems with lots of branches. They also germinate and grow slowly in the first few weeks, which means the seeds must be kept under conditions favorable for germination over a much longer period of time. These vegetables should be transplanted rather than direct-seeded into the garden.

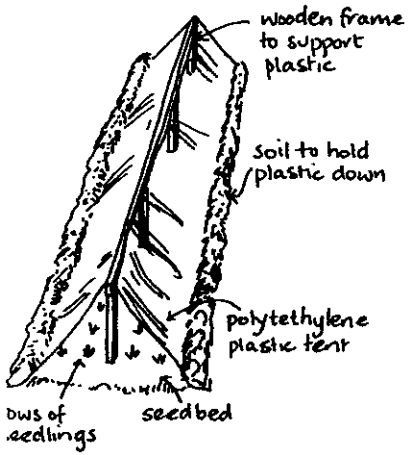
Preparing the seedbed

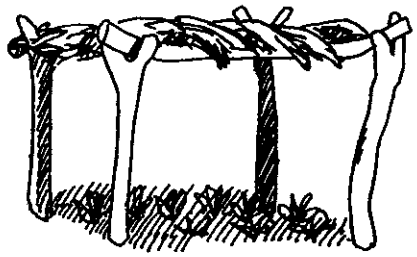
Baby plants are fragile. They have a better chance of survival if provided with ideal conditions for growth. These ideal conditions can be provided in a specially prepared **seedbed**. A seedbed is an outdoor area set aside for growing vegetable seedlings.

The seedbed should be in a sunny spot. Seedlings grown in full sunlight are stronger. They will need more water than seedlings grown in the shade, but are less likely to be damaged by the sun after being transplanted.

The seedbed should be thoroughly spaded, and lots of compost should be added. Sterilize the surface soil by moistening it and burning straw over it. Once sterilized, the soil should not be worked, except for raking off debris. Working will bring unsterilized soil to the surface. Therefore, work the bed thoroughly **before** burning the straw. When the bed is cool, plant seeds at once. If more than a day passes between sterilizing and planting, the seedbed should be sterilized again.

In the seedbed, rows should be 2-3 inches (5-7 cm) apart. In each 2-3 inch (5-7 cm) length of row, plant 2-3 seeds, depending on the germination percentage of the seeds. (Be sure to test germination % before planting the seeds.) To speed germination, you can cover the seedlings with a plastic tent. The tent keeps the seedbed moist and warm. It also protects the seedbed from beating rains. If plastic is not available, build a wooden frame over the seedbed and cover with palm leaves or other materials to protect from heavy rains.





After the seedlings have two leaves, thin to one seedling per 2 inches (5 cm). When thinning, pinch the seedlings out rather than pulling them up so that the roots of the remaining seeds are not damaged.

Watering

Be sure to water the seeds carefully before the seedlings come up. Do not let the soil dry out. Use a fine sprinkler to water. If the water stream is too hard, it will beat down the soil, pack it, and wash the top layers of soil along with the seeds. You can make a fine stream of water by putting your finger on the nozzle of a hose. If you do not have a hose, a regular watering can may be used if the soil surface is protected. Place a double layer of cloth such as burlap over the soil surface before watering. Pull off the cloth after each watering.

After emergence, water the seedlings carefully so that you do not knock them over. During heavy rains, protect the seedlings by building a wooden frame over them and covering the frame with palm leaves or other available material. Water thoroughly once or twice a day rather than only wetting soil surface a dozen times. Thorough wetting promotes deep root development. Shallow watering allows root development only at the soil surface.

Damping-off

One of the most common problems in growing transplants is damping-off. This is a seedling disease caused by several different bacteria. It can occur before or after the seedling comes up and has one or two leaves. When it occurs after the seedling comes up, the seedling becomes water-soaked at the point of contact with the soil and falls over.

To prevent damping-off:

- sterilize your soil;
- avoid contaminating the soil by using clean tools;
- sow seeds in rows to allow air to move freely between the rows and dry the soil surface;
- do not sow the seeds too thickly;
- keep the seedlings in full sunlight and do not over-water so they do not get too spindly; and
- water thoroughly in the morning so the surface of the soil dries before nightfall.

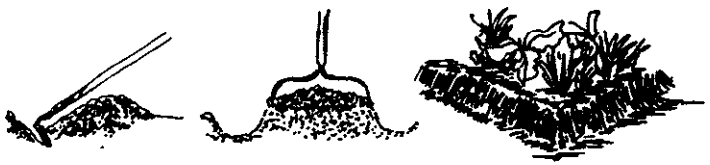
Planting out

Your seedlings should be ready for transplanting in 3-7 weeks. Lettuce needs only 3 weeks. Cabbage and other cole

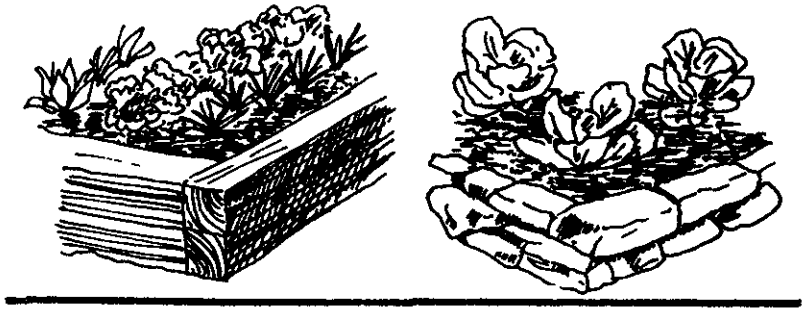
Planting in Beds

If you have only a limited amount of organic matter, you may prefer to plant your crops in small beds about 18 inches wide. Prepare the soil in the beds by double spading and adding organic matter, in the same way as described above.

If you live in a very wet area and your soil drains poorly, you should prepare raised beds for your vegetables. Prepare the soil under the raised beds in the same way, only pile the soil up into beds about 6 inches (15-20 cm) high and 18-24 inches (46-61 cm) wide, with trenches between them.



Raised beds can also be used to create a garden in an "ungardenable" spot, like on pavement, or in an empty lot, or in poor soil. To build a raised bed in such a place, loosen the soil to a depth of 2 feet (61 cm) and improve with large amounts of compost or well-rotted manure. The soil should be raised about 4-6 inches (10-15 cm) above ground level. Make the beds narrow enough so you can reach your plants from both sides without stepping into the beds. To keep the soil in place, you can enclose your raised beds with stones, cement blocks, bricks or wooden planks .



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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 15

Preparing Your Garden for Planting

Clearing the area

If you are preparing a new garden plot, the first step is to clear the area. Start by removing any rocks and other large debris from the surface. If there are woody plants growing, cut them down and grub out the roots. Also cut the tall weeds and grass. Once the vegetation is down to a fairly manageable level, you can remove the sod. If you leave it in, the grass roots will create weed problems later. Slice down through the sod and skim it off with a spade. Don't go deeply; you only want to remove the sod and about an inch of roots. Do not leave the sod on the soil surface or shallowly buried or some of it will reroot. Bury it at least 12 inches deep or stack it in piles to decay.

An easier way to clear the garden is to cover it completely with a mulch, such as black and white newspapers with a layer of soil on top, a season before you intend to plant. The plants under the mulch will die and can be spaded into the soil the following season.

Spading

Although spading is a lot of work, your plants will love you for it! The purpose of spading is to control weeds and to create and maintain a deep zone of fertile, porous soil. Organic matter and other soil amendments should be mixed into the soil at the same time that the soil is spaded. Simply

spading a heavy soil will do little good, since the soil particles will settle back together again after a heavy rain.

If your soil is already deep and fertile, it does not have to be spaded very much. However, most soils need some spading and a lot of organic matter worked in, not just once but often. Organic matter is constantly being broken down by soil microbes and being used up by plants. This happens especially quickly in hot, humid weather. If crop residues are entirely removed from the garden, then that is all the more reason to add organic matter back to the soil before replanting.

Try This

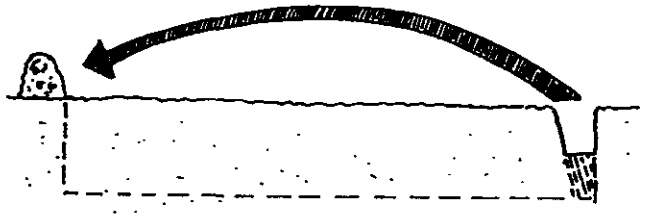
1. **Before beginning, test your soil to be sure it is dry enough.** A handful of soil should easily crumble in your hand after being formed into a ball and squeezed. Working wet soil will destroy its structure, and it will take years of careful handling to produce a good soil structure again. *On the other hand, if your soil is too dry, then it may* be too hard to cultivate. Water the soil well and then let it dry for a couple of days before digging.

2. To figure out what type of spading is best for your garden, dig a hole two feet deep. Do you see a 7 inch layer of topsoil which is darker in colour overlying a clayey subsoil that goes to a depth of 20 inches? The topsoil is darker because it contains a lot of organic matter and the subsoil usually contains more clay, which has been washed down from the topsoil. If you do see distinct layers, then the two top layers should be spaded separately and not mixed with one another. Spading two layers of soil separately is called **double spading.** Read the instructions below to find out *how to do double spading. If you do not see any distinct* layers of soil, which is rare, then you can simply spade the soil deeply.

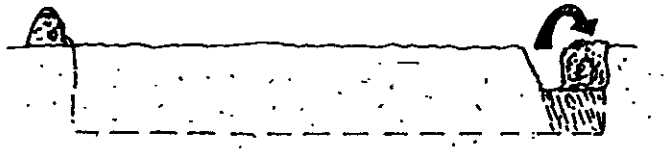
Double Spading

1. Start at one end of the garden and remove a two to three foot strip of surface soil and carry it over to the far side.

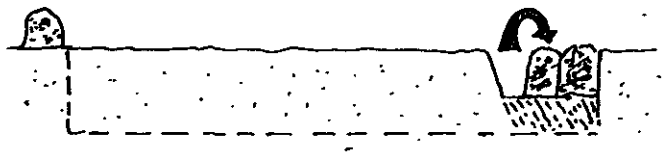
2. Then spade down into the subsoil for another foot or so. Mix organic matter into the subsoil. Also add lime, if needed.



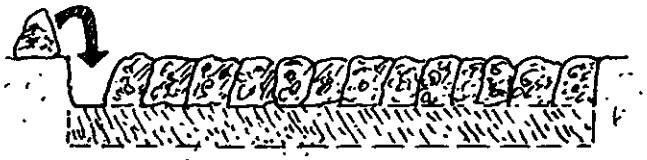
3. Next spade the surface soil from the next strip over the first strip, and at the same time mix in organic matter.



4. The newly-uncovered subsoil is spaded, and so on across the entire plot.



5. Put the surface soil from the first strip into the last strip.



Try This

Try storing seeds in different places. For example, put one some seeds in a cool, dry place and some in a warm, moist place. After several months, compare the germination percentages of the two groups of seeds.

Setting out transplants

Transplant on a cloudy day, in the late afternoon when the sun's rays are weakest. Make sure your transplants have been hardened off first. (See "Bringing Up Baby Plants.") First loosen the soil and dig as many holes as you need at the correct depth and spacing. The transplants should be at the same depth as they were before being transplanted. Add water to the holes if the soil is dry. Gently handle your transplants by the leaves, not by the stems. Never pull transplants up by their leaves or stems. Pry them up from underneath, being careful not to disturb the root systems. If your transplants are in flats, pots or packs, gently tap the bottom to loosen the plants and release them into your other waiting hand. The roots should be surrounded by soil. Bare roots will quickly dry out. Gently lower the plant into the hole and fill in soil around the roots. Press the soil around the transplant to remove air pockets. Water with weak manure tea or fish emulsion. You may need to keep the transplants out of the direct sun for a couple of days until they get used to their new home and establish some new roots. Make tents out of newspapers or wide leaves around the transplants and support with rocks.

Watering

Water your seedbeds and transplants carefully. Use a gentle stream of water. A strong stream of water can wash the seeds out of the seedbed and damage transplants. Keep seedbeds moist but not soggy until seeds germinate. If the weather is dry, water seeded areas and transplants as needed.

Try This

Compare the germination and resulting stand of a row of seeds watered properly versus a row of seeds not watered before emerging, or a row of seeds watered with a strong stream of water.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES
FOR YOUNG SCIENTISTS
LEAFLET NO. 16

Your Garden Debut

You have prepared your garden soil by spading it and adding organic matter. You have tested the pH of the soil and if necessary, you have corrected it. You have tested your seeds for percent germination. Your transplants are ready to set out. It is the right time of year to start planting and the soil is not too wet or too dry to work. If animals are a potential problem, you have protected your garden by building or growing a fence around it. You have a carefully thought out planting plan in hand. You are finally ready to make your garden debut!

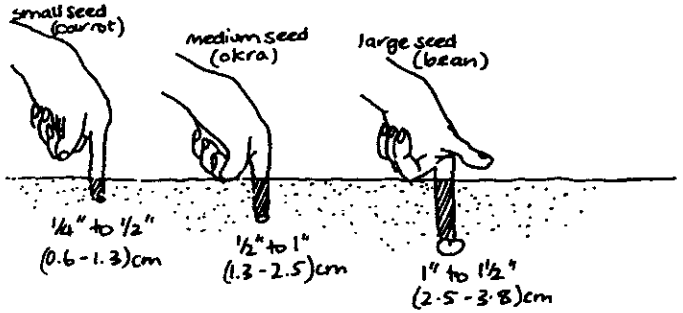
Marking rows or beds

Before planting your seeds and seedlings, mark the placement of rows or beds within the garden. A string tied between two stakes makes it easy to lay out straight rows and beds. It is important to make the rows straight to insure your plants will have enough room to grow. Otherwise, your rows might get too close together in some places. Besides, a garden with straight rows is much easier to cultivate and looks neater. To mark a single row, first carefully measure the distance between the row you are planting and the row next to it. Mark the row with a stake at each end. Tie a string between the stakes. To mark a wide planting bed, run two strings along the outside edges of the bed. Smooth the soil in the bed until it's level.

Just before sowing your seeds, loosen the soil where you will plant to a 6" (15 cm) depth. Rake over the area to make a smooth planting surface. Do not walk over the area where you will be planting. Stay in the pathways between rows or beds. Compacting the soil will make it difficult for your seedlings to emerge or to send down their roots.

Planting seeds

Be sure to plant your seeds at the proper depth. If they are planted too deeply, they will use up their supply of stored nutrients before they can push their way to the surface. If they are planted too shallowly, they may dry out or be washed away by rain. A good rule of thumb is to plant seeds two to three times their diameter.



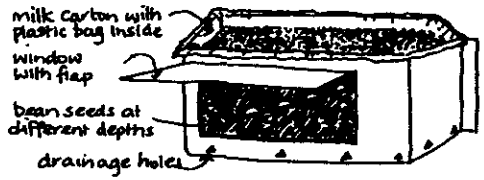
To make a shallow furrow, lay a rake or hoe or the side of a board on the ground underneath the string marking your row, and press it into the soil. To make a deeper furrow, drag the corner of a hoe across the soil surface, using the string as a guideline. Sprinkle seeds at the correct distance apart. Use a hoe to cover the seeds with soil and gently pat down the soil. Large seeds such as beans are easy to space at precise intervals, but even spacing of small seeds, such as carrots, can be a real challenge. One trick is to mix these tiny seeds with some fine sand, then sprinkle this mixture into the furrow. Sprinkle a little soil over the seeds and gently pat down. If your seeds have a low germination percentage, then plant them more thickly than you want the final spacing of the crops to be.

To plant in beds, sprinkle seeds over the entire bed. For beans, try to land seeds 1 1/2 to 2 inches (4-6 cm) apart. For smaller crops, try to land the seeds 1/2 to 1 inch (1-2.5 cm) apart. Pat the seeds down. Pull soil up and then smooth it over the seeds to the same depth everywhere. Pat the soil down again.

Planting in hills or groups is recommended for vining crops like cucumbers and squash. Loosen the soil well in a 3-foot- (90-cm-) diameter area, add compost or well-rotted manure if required, and level the area. Plant five or six seeds close together. Keep the two strongest seedlings and thin out the rest. Planting in raised hills is a good idea during the rainy season, especially if your soil is heavy. Hills drain better than level ground.

Try This

1. Make a seed view box by cutting a window out of one side of a water-proof container, such as a milk carton. Line the container with clear plastic and punch drainage holes along the bottom edge. Plant different kinds of seeds, such as beans and carrot seeds, at different depths next to the window. Keep the soil mix moist but not soggy. Observe what happens to the seeds planted at each depth.



2. Try planting vining crops in several different ways. For example, try planting in beds, hills and rows. You could also try training vining crops on trellises.

Saving leftover seeds

You can save seeds for succession planting later in the season or for planting the following year. You can also collect and save your own seed from plants you grow. Put them in jars in a cool, dry place. Make sure they are labeled. If you are uncertain about the viability of saved seeds, you can always run a germination test before planting. (See "To Sprout or Not to Sprout.")

- Put the water where your plants most need it, at their roots. Apply water at ground level rather than from above. A lot of water is lost, through evaporation, when using overhead sprinklers.

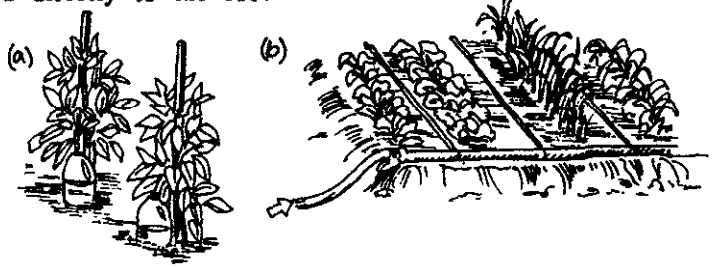
Try This

1. Get two cans of the same size. Punch holes in the bottom. Fill one with compost or well-rotted manure and the other with soil. Add water to each can, 100 ml at a time. Which one can absorb more water?

2. If water must be conserved in your area, try mulching one plot of vegetables and not mulching another plot of the same kind of vegetables. Compare how much water each plot requires.

3. Try watering in the morning versus in the afternoon, and compare how much water is needed to wet the soil to a 6 " depth.

4. Try one of these ground-watering techniques: (a) Punch holes in large tin cans or plastic jugs or other containers. Bury them in the ground next to your plants that need a lot of water, such as melons and cucumbers, and fill with water. The water will seep through the holes and reach the roots, where it is most needed. Compare the growth of plants watered in this way to the growth of plants watered from above. (b) Drip or trickle irrigation is a method of watering that puts water exactly where it is needed. Quite simply, drip irrigation systems are tubes with tiny holes in them which leak a small, steady amount of water. You can build your own system by punching tiny holes in a plastic or rubber hose. The tubes are laid on the ground right next to your plants, so that water can be applied directly to the root zone.



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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 17

Water: Not Too Much and Not Too Little

Vegetables are 80-94% water. It is easy to understand, then, why it is vital to supply your vegetables with ample water. Vegetables need water throughout their growth, but there are certain critical times when lack of water is most harmful. For most vegetables, the most critical time is right after planting, during seed germination or when young transplants are set out. Seeds need adequate moisture in order to germinate. Once they have germinated, the tender young sprouts dry out quickly if they do not get enough water. When transplants are set out, they need to establish their roots in their new environment before they can take up water and nutrients. Other critical times are when plants are flowering, and in the case of fruit vegetables, when their fruit is developing, or in the case of root vegetables, when their roots are getting fat.

How much water do vegetables need?

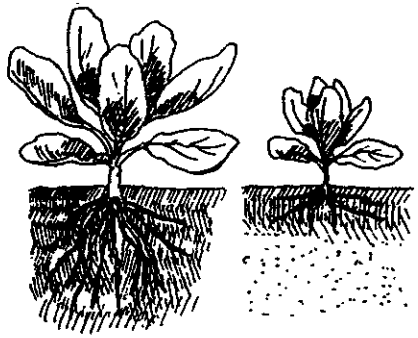
As a rule of thumb, vegetables need about 1" of rain water per week. In hot, dry climates they need 1 1/2 " of water per week because of faster evaporation. There are a number of ways to gauge whether your vegetables are getting too much, too little, or just the right amount of water. (1) Wilting is a sign that your crops need water or that they have too much. However, much damage has already been done to the plants if they have already started to wilt. (2) You can use your fingers to determine when to water. Dig down several inches into the soil. If the soil feels dry to the touch 3-4" down, then it is time to water. (3) You can measure how much rain your garden is getting with a rain gauge. If you do not get 1" each week (1 1/2 " in hot, dry climates), then you must supply the water that is missing.

Try This

Make some simple rain gauges to measure how much water your vegetables get each week. The rain gauges can be made from any container that has no lip and straight sides. For example, tin cans or plastic jugs with the tops cut off can be used. Bury your rain gauges in different places around the garden so that the tops are a few centimetres above ground. Use a ruler to measure how much it has rained after each rainfall and then empty the cans. Keep a record of how much water your garden gets each week.

How should vegetables be watered?

If you must water your garden, a basic rule is **more water, less often.** If you only give your garden a light sprinkling each day, then the roots grow closer to the surface in search of water. When the roots are close to the surface, they are more likely to be damaged by lack of water and the heat of the sun. Deep watering on the other hand, *sends roots downward.* Wet the soil thoroughly, to a least a 6" depth. After you think you have given the garden enough water, dig a hole to check.



Try This

Plant some beans in two different containers with drainage holes. After the seedlings have emerged, water one container by sprinkling a little water on it each day. Water the other container each time the soil has become dry to a 3-4 " depth. Water thoroughly, until water comes out the drainage holes. Compare the growth of the two plants. Carefully remove the beans from their containers and compare the root systems.

How can you prevent your vegetables from getting too much water?

Too much water is as bad as not enough. If the soil becomes water-logged, then the plants' roots will suffocate. Make sure your soil has sufficient drainage. In very wet climates, it may be better to plant vegetables on raised beds, especially if the soil does not drain properly.

How can water be conserved?

In many places, fresh water is a precious commodity. To help make the best use of available water, follow these water-saving suggestions:

* Add organic matter to the soil so it can hold more water.

* Mulch your garden to stifle water-stealing weeds and slow down evaporation of water from the soil.

* Water in the early morning when less of the water will evaporate, rather than watering in the heat of the day.

Try This

1. Fill two containers with soil. Put a mulch on one and not on the other. Water both containers thoroughly and place in the sun. After a few hours, remove the mulch and check the moisture content and surface structure of the soil in both containers.

2. Try mulching versus not mulching plots of different kinds of vegetables. Compare quality and yields of vegetables from each of the plots.

3. Check out possible sources of mulching materials in your area. Are there tobacco or sugar cane farms or processing plants in your area? Do you live near the sea where seaweed is plentiful? Are there lumber mills nearby? Can you obtain nutshells or cottonseed hulls, or cacao hulls from nearby farms or processing plants?

4. Compare the effectiveness of different mulching materials on different crops. Are some materials better than others?

OUTREACH pack 73 pp 17-18. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 18

Much Ado About Mulch

Why mulch?

A mulch is simply a blanket of some material, such as compost, leaves or straw, laid down around your plants. The virtues of mulching are many and varied:

* mulches block light, and therefore stifle weeds which compete with your plants for water and nutrients;
* mulches prevent hard, pounding rains from creating a hard, crusty soil surface, and so water seeps into the soil rather than running off and eroding the soil;
* mulches conserve soil moisture by reducing evaporation;
* mulches act as insulation, keeping the soil around plant roots cool and moist;
* mulches add nutrients and organic matter to the soil as they decompose;
* mulches prevent vegetables from rotting, as they might if they were on the ground;
* mulches keep your vegetables clean by preventing soil from splashing up.

When should you mulch?

Mulch as soon as the garden is planted! Remember that a lot of damage is done to soil when it is bare. The heat of the sun will bake it and rain and wind will erode it away. Mulch garden pathways and barespots first. Wait until vegetable plants are at least 4" high before pulling a mulch up to them, since they will be difficult to spot under a mulch. Keep adding mulch as it decays.

What should you use for a mulch?

Almost any biodegradable material can be used as mulch when applied at the proper depth. As a rule of thumb, the finer the mulch, the thinner the layers need to be. The chart on the next two pages gives some suggestions for materials to use as a mulch.

Material	Thickness	Comments
aged animal manure	2-3" deep	do not use fresh, since it will burn plants; will improve soil and nourish plants
compost	4" deep	be sure it does not contain weed seeds or plant diseases; will improve soil and nourish plants
grass clippings	2" deep	mix with other materials to prevent packing down; will add organic matter to soil; do not use grass that has been sprayed with herbicides
peanut, cottonseed or cacao bean hulls	4" deep with 2" soil on top to keep in place	high in nutrients; decays rapidly to form rich humus
dried leaves	6" deep with 2" soil on top	best to compost before using, since fresh leaves may pack down and also steal nutrients from soil while rotting
newspapers	5-6 pages or 4-6" with 2" soil on top if shredded;	slightly basic; do not use coloured paper which is toxic
washed seaweed	4-6" deep	leave outside in a number of rains to wash off salt
ground corn cobs, sugar cane wastes, tobacco stems	3-4 " deep	can obtain from farms and processors; must be ground or shredded
straw	6-8" deep	if lower leaves of plants begin to yellow, add extra nitrogen to plants while straw is decaying
sawdust, bark chips	2-5 " deep	if lower leaves yellow, add nitrogen

5. At harvest time (one and a half to three months after seeding, depending on the vegetable), compare the quality and quantity of vegetables harvested from the thinned versus the unthinned plots. What conclusions can you draw?

Try This

1. Set up some trial plots in your school garden to find out the ideal spacing for different kinds of vegetables. For example, try planting tomatoes one-half foot, one foot or two feet (15 cm, 30 cm or 60 cm) apart. You might also try staking tomatoes so that they grow upwards versus not staking them. Compare the yields and quality of vegetables for each trial plot.

2. An alternative to planting vegetables in rows is to scatter them in beds. Experiment to find out which type of planting yields the most and best quality crops.

OUTREACH pack 73 pp 19-20. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES
FOR YOUNG SCIENTISTS
LEAFLET NO. 19

Less is More

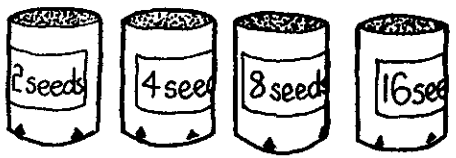
What happens to plants when they do not have enough room to grow? Try this simple experiment to find out. You will need:

four small containers of the same size (plastic cups,10 ounce cans or 1/2 pint milk cartons)
bean seeds
potting soil

1. Punch about four holes along the bottom edge of the containers so that excess water can drain out. Use a can opener to punch holes in metal cans.

2. Fill the containers to the top with potting soil. Sprinkle the potting soil with water to moisten it.

3. Plant a different number of seeds in each container and label the containers, as shown here
Make a hole for each bean seed with your thumb. A good "rule of thumb" is to plant a seed at a depth about 3 times its size.

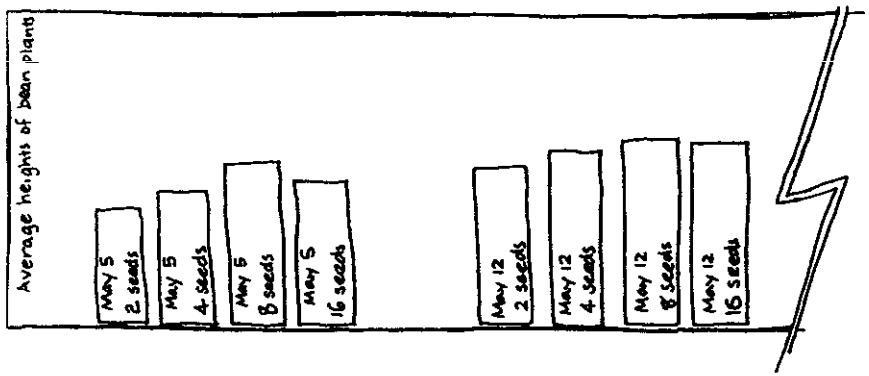


4. After the seeds have germinated, place the containers in a window or outdoors where they will get some sunlight each day. Keep the soil moist but not soggy.

5. Watch how the plants grow until they are 12 inches high. Count the number of leaves on the plants each week. Note the general appearance of the plants. At the end of the experiment pull out the plants and compare their root systems. Write down your observations on a chart. The chart could have these headings:

Treatment	*Date*	*Appearance*	*Number of Leaves*

Record the height of the plants once each week by cutting paper strips so they are the same height as the plants. Write the date on the strips and glue on paper to make a graph, like the one shown here.



Why Thin Out Seedlings?

Many vegetables, such as lettuce, carrots and beets, are seeded directly into the ground. When the seedlings are about an inch (2.5 cm) high, they must be thinned out. This is a very difficult task for most gardeners. They feel it is a shame to pull up and throw away perfectly healthy plants. However, later on they will feel even more sorry if they do not thin out their seedlings when they are small. Try this experiment in your school garden to find out what happens when vegetables are not thinned.

1. Before planting your seeds, be sure to prepare the soil well.

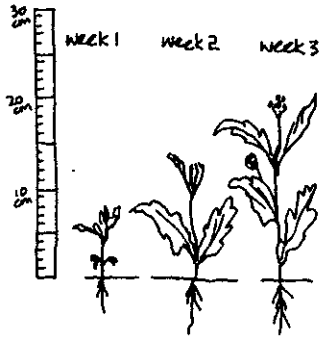
2. Beets, carrots, leaf lettuce and onions should be planted in rows about one foot (30.5 cm) apart. Mark off a row with string attached to sticks at both ends of the row. Draw a sharp stick along the earth next to the string to make a furrow (shallow ditch).

3. Mix the seeds with sand to prevent seeding too thickly. Sprinkle seeds from your hand evenly along the length of the furrow. Sprinkle soil over the seeds and firm it around the seeds. Be sure not to plant the seeds too deep. Be sure the soil stays moist but not soggy so that the seeds will sprout well.

4. When the seedlings are about one inch (2.5 cm) high, they are ready to be thinned. Very carefully pull out the excess plants. Try not to disturb the root systems of the plants that are left. Beets should be thinned to 2 inches(5 cm), leaf lettuce to 4-6 inches (10-15 cm), onions to 2-3 inches (5-7.5 cm), and carrots to 1 inch (2.5 cm). Leave a two foot (60 cm) section of each row unthinned.

How fast do weeds grow?

1. Record the rate of growth of several different weed plants. Leave a small plot in your garden completely alone. Put a marker with an identification number on it next to *several different kinds of weeds.* About twice each week, record the height of these weeds on a chart like the one shown below. Also record how long it takes before flowers and seeds form. You could also draw pictures of how the weeds grow and change and what the flowers and seed heads look like.



WEED No. 6

Date	Height	Remarks
Nov 1	8cm	Cotyledons still green
Nov 8	14cm	Four true leaves formed
Nov 15	20cm	Flower shoots forming

2. Collect the seed heads from each plant. Calculate how many seeds a single plant can produce. Draw the seed heads and paste some of the seeds on the drawings.

How can you keep your garden weed-free?

1. Based on what you have learned about weed seeds, how do you think you can prevent them from spreading?

2. How do you think you could prevent weed seeds already in the soil from coming up? (Hint: How could you deprive them of one of their basic needs without also depriving your vegetables of this need?)

3. If weeds do come up, is it better to pull them out when they are small or when they get bigger? Why? Try pulling up a small weed and a large weed. Which is easier to pull?

OUTREACH pack 73 pp 21-22. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 20

Weeds, Weeds, Weeds

A weed is a plant that grows where it is not wanted. Weeds in a vegetable garden rob your plants of light, nutrients and water. Weeds can also harbor harmful insects and diseases. Thus, weeds can greatly reduce your garden's yields. Do these activities to find out more about weeds and how to control them.

Where do weeds come from?

1. Take some soil samples from the garden. Search the soil carefully for weed seeds. If available, use a hand lens.

2. Place some of the soil in a large square container with holes punched in the bottom. Water the soil for a few days until some weed seeds germinate.

3. Count the number of weed plants that come up. Measure the area of the soil surface in the container. Then calculate the number of weed seeds per square yard (or per square meter) in your garden.

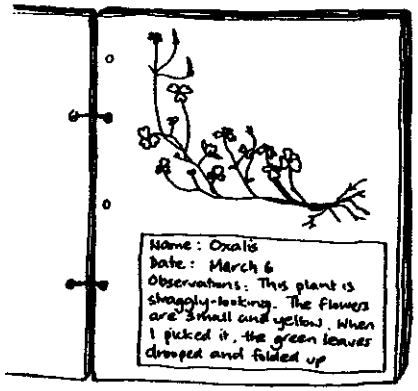
What weeds grow in your garden?

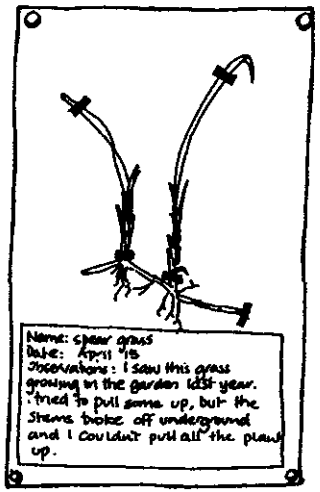
1. Make a collection of weeds that grow in your garden. Carefully pull up as *many different kinds of weeds as* you can find.

2. Place each different kind of weed between sheets of newspaper. Write a label for each weed specimen telling: where it was found, its name (if known), the date, any observations you can make about the weed, for example, was it difficult to pull because of a long root? Are there lots of this type of weed in the garden? Is it flowering? Does it have a seed head?

3. To press the weed specimens, pile up the layers of newspapers with weeds between them. Put them in a dry place and put some heavy books, rocks or other weights on top. Leave them undistrubed for a couple of weeks, or until the weeds are dry.

4. Paste or wire the pressed weeds and their labels on to cardboard. The weed collection can be displayed in the classroom or bound into a book. To make a book, punch holes at the left edge of each cardboard and thread a string through the holes and tie.





How do weed seeds get spread?

1. Collect different kinds of weed seeds. Glue them on to cardboard or paper.

2. Examine each type of seed carefully. How do you think they are spread? Can they be blown by the wind? Can they get stuck on clothes or animal fur? Are they eaten by birds?

3. Look at the pictures below. How do you think each type of weed is spread?

8. Look for insects that are interacting with other insects. For example, can you find any aphids? Are there any other insects, such as ants or lady bird beetles, around the aphids? If so, what are they doing? Lady bird beetles prey upon aphids. Ants feed upon the honey dew that aphids produce. In return, the aphids are protected from other insects by the ants. Aphids are harmful to plants because they suck juices from the plant. They can also spread plant diseases. Which of these three insects are helpful to your plants?

Controlling Insect Pests

Insect pests are difficult to control once they strike. Keeping your plants healthy by giving them adequate nutrients and water is your first line of defence. If your plants are healthy, they will be better able to withstand the onslaught of insects.

Some pests can be reduced by intercropping and crop rotation. When intercropping is practiced, the crops seem to act as barriers for each other, making it more difficult for pests that attack just one kind of crop to spread from plant to plant. Intercropping beans with corn decreases the number of army-worms and leaf-hoppers by 25 to 40 per cent. Crop rotation prevents some harmful insects from living over from one planting to the next.

Not all insects should be considered harmful. Some insects that visit your garden can be very helpful. For example, lady bird beetles should be welcomed into your garden because they eat aphids. The adults eat 40-50 insects each day and the larvae eat even more. Honey bees pollinate flowers as they search for pollen and nectar.

Getting rid of harmful insects is no easy task. Chewing insects, such as butterfly and moth larvae and beetles, can be picked off by hand. Check your plants daily for these intruders. It is important to get rid of them as soon as possible. Drop them in kerosene or smash them between rocks. Also encourage insect-eating birds to help you protrol the garden against harmful larvae. Aphids and scale insects are more difficult to get rid of without the use of **insecticides** (chemicals that kill insects). You can try spraying them with a soap solution. A soap solution will kill aphids and scale insects, which have soft bodies, but will not harm lady bird beetles.

OUTREACH pack 73 pp 23-24. Other Learning-by-Doing leaflets and information packs are available from Dr. James Connor, OUTREACH Director, 200 East Building, New York University, New York NY 10003, USA or R. Lumbe, OUTREACH Co-ordinator, Information & Public Affairs, UNEP, P.O.Box 30552, Nairobi, KENYA

LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 21

Insect Visitors

Many different kinds of insects visit a garden. Some can be very helpful and others are quite harmful. It is important to know which insects you should welcome to your garden and which you should not.

What kinds of insects visit your garden?

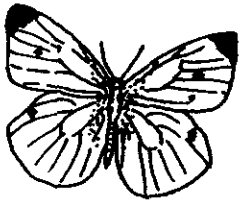
1. Go out to your garden. Look for evidence of insect visitors. For example, can you find chewed leaves, rolled leaves, insect nests or insect eggs? Display your collection of insect evidence in the classroom.

2. How many different kinds of insects can you find in your garden? Can you find a beetle, a grasshopper, a butterfly, a fly, an ant and a bee? Can you identify any of the insects that you find?

3. Catch an insect in a jar. Punch air holes in the lid of the jar and perhaps add a bit of plant matter to provide moisture and food. Describe your insect. What is its colour, size and shape? Draw your insect. Sketch details as accurately as you can. Take 5 minutes to watch how your insect moves and what it does. Compare your insect to someone else's. Tell how they are alike. Tell how they are different.

4. Read the descriptions of some common garden insects on the next page . Match each description with the correct picture. Can you find any of these insects in your garden?

Praying Mantis
About 2 in. (5 cm) long; forelegs, held often as though in prayer, used to grasp prey; hind legs well-developed for walking and leaping; eat harmful insects



Locust
Long narrow body; wings extending beyond body; hind legs suitable for jumping great distances, even without the help of wings; eat grasses and cereals

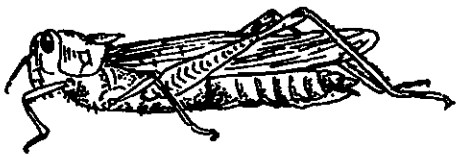
Aphid
From 1/25 - 1/5 in. (1-5 mm) long; tubes at rear secrete honeydew eaten by ants; suck juices from plants

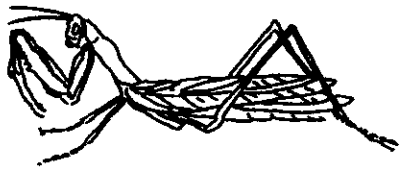
Cabbage Butterfly
Wing span to 2 in. (5 cm); white wings with black spots; eat cabbage

Lady Bird Beetle
About 1/4 in. (6mm) long; looks like a small split pea; usually red or yellow with black spots; eat harmful insects such as aphids

Honey Bee
1/2 - 1 in. (1.2-2.5 cm) long; usually black and golden yellow; wings seem small for such a large, plump insect; eats honey and pollen

Mealy Bug
About 1/4 in. (6mm) long; looks like a cottony waxy spot; light gray or white; sucks juices from plants

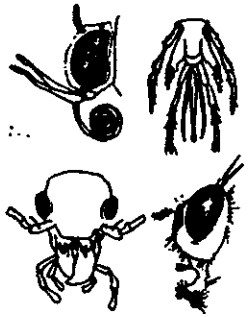




5. Have you seen cabbage butterflies in your garden? If so, look on cabbage leaves for little yellow eggs, or little green worms (called **larvae**) or cocoons (called **pupae**), like the ones shown here. The eggs, larvae, pupae and butterflies are different stages in the life cycle of the same insect, the cabbage butterfly. Beetles, moths, flies, bees and ants also have four stages in their life cycles. Other insects, such as grasshoppers, bugs and aphids, simply hatch from eggs and gradually grow bigger. The young insects look very similar to the adult, only smaller. Look for young insects in your garden. What are they eating? Place some leaves with the insects on them in a large jar. Also place some twigs in the jar. Fix a cheesecloth or old stocking over the mouth of the jar. Continue to feed the larvae the same kind of leaves on which they were found. Keep the jar clean. Observe the changes the insect undergoes. Draw a picture of each stage of the insect's life cycle. Record the date when each drawing was made.

What are the insects in your garden doing?

6. Find an insect in your garden that is eating. Look closely at its mouthparts. Use a hand lens, if available. Does the insect use its mouthparts to bite, to chew or to suck? Compare the insect's mouthparts to those shown in the picture. Which kind of mouthparts does your insect have? How are its mouthparts adapted for the kind of food it eats?



7. Find an insect in your garden that is seeking shelter. Is the insect **camouflaged**? In other words, is the insect disguised or concealed by its colour or shape? Can you find a moth that has wings which look like tree bark? Can you find a green bug or grasshopper that looks like a leaf or mud? How does camouflage help the insect to survive?

How do you prevent plant diseases?

7. Diseases caused by microbes are difficult to control once they strike. "An ounce of prevention is worth a pound of cure" is certainly true in the case of plant diseases. Just as a healthy person can quickly and easily shake off many of the infections that may attack him or her, so a healthy plant can better withstand the onslaughts of disease. Grow all your plants so that they remain strong and healthy all their lives.

It is also important to keep disease germs away from your plants as much as possible by practicing good garden hygiene at all times. Read the gardening tips below. Make a poster illustrating these tips. Explain how each tip prevents the spread of plant diseases. Be sure to keep these tips in mind when gardening!

* Use disease-resistant plant varieties, if available.

* Control insect pests, since some can spread diseases.

* Burn diseased plants.

* Use healthy seeds and plant parts that are used for propagating new plants.

* Clear away decaying plant matter and throw on a compost pile.

* Keep the garden free of weeds, which can harbor plant diseases.

* Rotate crops so that the same kind of plants are not grown in the same spots year after year.

* Try intercropping one kind of plant between another so that the disease organisms cannot spread as easily.

* Plant in fertile, well-drained and well-prepared soil

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 22

Plant Diseases

Go to the garden and find a plant which looks diseased. Carefully examine the diseased leaves. What do you see? What do you think is the cause of the disease? Could it be a lack of nutrients? Is the plant infected by a fungus, bacteria or virus? There are many different causes of plant diseases. To be a good plant doctor, you must learn to make careful observations in order to make correct diagnoses.

Nutritional Deficiencies

1. Grow some corn in four plots of soil that has not been cultivated for some time. After the plants have emerged, add fertilizer to the corn plants in the four plots as follows:

(a) fertilizer containing nitrogen and phosphorus,
(b) fertilizer containing phosphorus and potassium,
(c) fertilizer containing nitrogen and potassium, and
(d) fertilizer containing nitrogen, phosphorus and potassium.

To prevent burning the plants, sprinkle the fertilizers at the recommended rates at least six inches (15 cm) from the plants.

What happens to the corn plants that lack nitrogen? Potassium? Phosphorus? Label each of the symptoms below with the correct nutritional deficiency:

Stunted growth, yellow leaves and stems _____

Stunted root growth, red leaves, and delayed flowering and fruiting _____

Brown leaf tips, leaves covered with brown spots, margins of older leaves crinkled _____

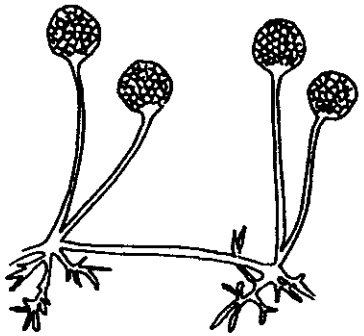
2. Plant a root crop such as carrots or cassava in two plots. Sprinkle wood ashes on one plot and not the other. Compare the yields from the two plots. Which mineral do wood ashes supply?

Diseases caused by microbes

3. Put some large seeds, such as garden peas or beans, on some dry clean cotton wool. Place them in a dry sealed jar. Dab some moist cotton wool in soil. Place some seeds and the moist cotton wool in a second sealed jar. Observe signs of moulds on the seeds. How should seeds be stored?

4. Find some seeds that look infected with a disease. Place them on moist cotton wool in a sealed jar. What happens to the seeds. Should diseased seeds be planted?

5. Try growing some moulds in jars. Place moist bread, cheese and jam in jars. Place some dry bread in another jar. Do moulds grow better when moist or dry? Look at the moulds through a hand lens. Can you find the spore-bearing parts, like those shown in the picture? When spores land on a food source, they begin to grow. How can diseases caused by moulds be spread?



6. Below are some common plant diseases caused by microbes, including fungi, bacteria and viruses. Which of these diseases have infected the plants in the drawings? Can you find any of these diseases in your garden?

a. **Rust** -- bright orange circular spots on leaves

b. **Downy mildew** -- grayish patches of furry growth

c. **Powdery mildew** -- white, powdery growth on leaves

d. **Damping off** -- young plants rot at or below the soil

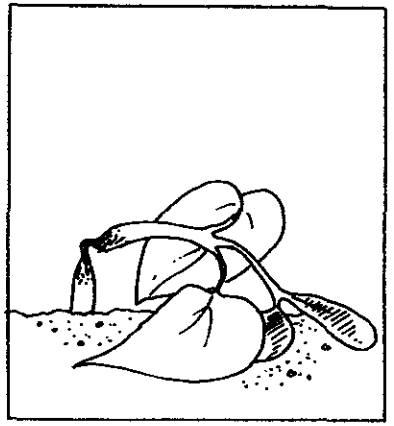
e. **Clubroot** -- roots swollen; growth stunted and plant wilts

f. **Bacterial Wilt** -- all the leaves of cucumbers, squash or melons wilt and die; if wilted stem cut, threads of white ooze can be seen

g. **Tobacco Mosaic Virus** -- mosaic pattern of light green and yellow patches on leaves

h. **Smut** -- large boils appear, swell and burst, emitting sooty spores

i. **Bacterial blight** -- water-soaked spots on fruit, stems and leaves; creamy ooze may appear during wet weather



Try This

1. If you have planted all your vegetables at the same time, it may be difficult to keep up with your harvest. One good way to make it easier to keep up with your vegetable harvest is use **sucession planting**. Try planting beans or leafy vegetables several weeks in a row, rather than only once. This will give you two or three smaller, more manageable crops of vegetables instead of one large crop. Smaller harvests will allow you to pick all your vegetables as they reach their prime.

2. Perishable vegetables, such as tomatoes, carrots, peppers, greens and beans, should not be allowed to stand around. Be gentle with your harvested vegetables. Remove dirt by wiping with a clean cloth. Avoid bruising or crushing. Do not leave your harvested vegetables in the sun. Place some of these vegetables in the sun for a day and observe how they change. Compare what happens to bruised or dirty vegetables versus clean, uninjured vegetables. Draw a poster to summarize your observations.

3. Try different varieties of vegetables and keep track of the yields harvested from each variety. For example compare the yields from two different kinds of pumpkins.

4. Compare the net yields from the same variety of vegetable harvested when they are small versus when they are over-mature. For example, harvest half a row of beans when they are young and the other half a row only after the seeds are swollen and compare the yields.

5. Go out to the garden each day to look for vegetables that are ready for harvest. Explain why or why not different vegetables are ready to be harvested.

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 23

Harvesting Your Rewards

If you take good care of your garden, you will be rewarded with a bountiful harvest. Do you know when and how to harvest your vegetables to maximize your rewards? Answer these questions "true" or "false" to test your knowledge of harvesting.

1. The biggest vegetables are the best.

2. If you harvest cucumbers when they are small, you will get a smaller total yield from each plant.

3. Tomatoes taste better when they are allowed to ripen on the vine.

4. Melons should not be harvested until they are fully mature.

5. Snap beans reach their peak in flavour and nutritional value when they are still young and tender.

Read the harvesting tips on the next two pages to find the correct answers to these questions.

Pumpkin

LET ME REACH FULL SIZE BEFORE BEING PICKED. PICK ME TOO EARLY – AND I'LL TASTE LIKE CARDBOARD!

CUT HERE (A FRUIT WITHOUT A STEM WILL NOT STORE WELL)

PICK ME WHEN I HAVE A HARD RIND. YOU CAN WAIT TILL THE VINE DIES BACK AND THE STALKS DRY OUT. STORE ME IN A COOL, DRY PLACE AND I'LL KEEP FRESH FOR SEVERAL WEEKS.

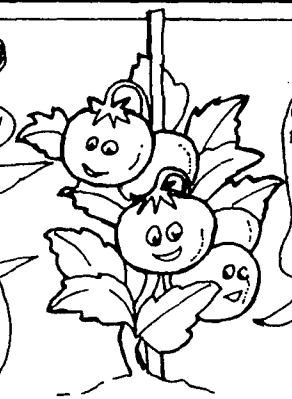
Cucumber

IF I'M LEFT ON THE VINE UNTIL I GET VERY BIG, THEN THE PLANT WILL PRODUCE ONLY A FEW BIG OVER-RIPE FRUITS

IF CUCUMBERS ARE HARVESTED ABOUT EVERY OTHER DAY, WHEN WE ARE YOUNG AND THE SEEDS ARE SOFT, THEN THE PLANT WILL PRODUCE MORE AND MORE FRUITS.

REMOVE OVER-AGED FRUITS FROM THE VINE TO ALLOW NEW FLOWERS AND FRUITS TO DEVELOP.

Tomato



PICK ME WHEN I'M FULLY RED – I TASTE BETTER WHEN RIPENED ON THE VINE.

DURING HOT WEATHER TOMATOES SHOULD BE HARVESTED AT LEAST TWICE A WEEK, ONCE HARVESTED, DON'T KEEP US STANDING AROUND.

CUT OR SNAP ME FROM THE PLANT. DON'T PULL TOO HARD – YOU MIGHT HURT THE PLANT.

Cabbage

PICK ME WHEN MY HEART FEELS FIRM.

DON'T LEAVE ME TOO LONG BEFORE HARVESTING BECAUSE MY HEAD WILL SPLIT AND I'LL GO TO SEED!

ONCE PICKED, I CAN BE KEPT FRESH FOR SEVERAL WEEKS IF STORED IN A COOL PLACE. OR YOU MAY WANT TO 'DRY' ME FOR FUTURE USE

Sweet Corn

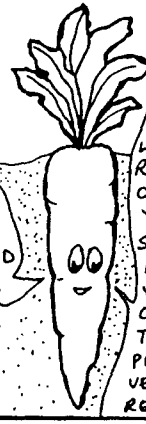
I SHOULD BE HARVESTED WHEN MY SILKS ARE DRY AND BROWN. CAREFULLY LOOK AT A FEW EARS BY OPENING A SMALL WINDOW ON THE SIDE OF THE EAR.

SWEET CORN QUICKLY PASSES ITS PRIME EATING STAGE, SO CHECK IT DAILY. IF LEFT TOO LATE, SOME OF ITS SUGARS TURN TO STARCH AND IT LOSES ITS SWEET TASTE.

IT IS BEST TO PICK ME JUST BEFORE EATING SINCE SOME OF THE SUGAR CHANGES TO STARCH IF LET TO SIT IN THE HEAT.

EACH CORN STALK SHOULD PRODUCE TWO EARS OF CORN. USE TWO HANDS WHEN HARVESTING THE FIRST EAR BENDING THE STALK COULD INTERFERE WITH THE GROWTH OF THE SECOND EAR.

Root crops



MOST ROOT CROPS ARE BETTER IF HARVESTED WHEN THEY ARE STILL SMALL. IF BEETS, CASSAVA OR CARROTS LIKE ME BECOME TOO OLD, WE'LL LOSE OUR FLAVOUR AND GET TOUGH AND WOODY.

ONE GENERAL TIP – IF CROPS SUCH AS BEANS OR LEAFY VEGETABLES ARE PLANTED SEVERAL WEEKS IN A ROW RATHER THAN ONLY ONCE, THIS WILL GIVE YOU TWO OR THREE SMALLER, MORE MANAGEABLE CROPS OF VEGETABLES INSTEAD OF ONE LARGE CROP. THEN, YOU'LL BE ABLE TO PICK ALL YOUR VEGETABLES AS THEY REACH THEIR PRIME.

Try This

Steam different kinds of vegetables as described and over-boil the same vegetables. Compare the colour, texture, and taste of the steamed versus the boiled vegetables.

Stir-frying

Stir-frying is an Oriental cooking technique that is another good way to preserve the nutrients in vegetables. The vegetables are cut into small pieces just before cooking and then fried in oil over high heat for a very short time. Coating the vegetables with oil seals in the flavour and natural juices and seals out air to preserve vitamin content. The vegetables cook quickly, often in two to three minutes, so fewer vitamins are lost by heating. No vitamins or minerals are lost by dissolving in water since the vegetables are never in contact with water. Usually a combination of vegetables are fried, starting with the hardest, such as onions, and ending with those that cook fastest, such as greens.

Try This

Try this stir-fry recipe: *Stir-fry 2 onions, 3 cloves of garlic, and 1/2 teaspoon rosemary in oil until onions start to brown. (Fresh ginger or some other local herb can be substituted for rosemary.) Stir in hard vegetables, such as carrots, broccoli and cauliflower. Put the cover on and cook about 6 minutes, until the vegetables are half-done. Add soy sauce or salt. Add soft vegetables such as spinach leaves and green peppers. As soon as these are slightly wilted, serve the stir-fry on a baked potato or with rice.*

Stewing

Stews containing vegetables and meat or beans are traditional in many different cultures. One good way to conserve the nutrients in stews is to cook the meat or beans separately, since they usually need to be cooked for a long time over a low heat. Cook the vegetables separately and add them, along with the cooking water, at the last minute. If you do not throw away the cooking liquid, then you keep most of the nutrients you started with. When herbs or spices are added, you have a delicious, nutritious one-dish meal!

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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES
FOR YOUNG SCIENTISTS
LEAFLET NO. 24

Vegetable Cookery

To cook vegetables well, you should know their nutritional value and the cooking techniques that preserve the most nutrients. Vegetables are important in your diet because they provide carbohydrates, fibre and an assortment of essential vitamins and minerals. Dark green vegetables are especially high in vitamins A, C, E, K and some of the B vitamins. Vitamin A is also found in yellow vegetables, like pumpkin and sweet potatoes.

The carbohydrates in vegetables give you a steady supply of energy for thinking, working and playing. Fibre cannot be digested but it is important for keeping your digestive system healthy. It provides bulk that keeps the digestive tract working normally. Minerals are needed for the growth of bones, teeth, blood cells and other body cells. Vitamins are needed to promote growth and other body activities. Your body cannot use nutrients such as carbohydrates and proteins without the essential vitamins.

How should vegetables be cooked to preserve their nutrients?

The vitamins and minerals in vegetables can easily be destroyed with improper cooking. Some vitamins, such as vitamin C, can be destroyed simply when vegetables are exposed to air and light. Vitamin C and the B vitamins, along with important minerals, can be lost in soaking or cooking water, since they dissolve in water. Prolonged heating also causes loss of vitamins and minerals. Explain why each of the cooking tips on the next page should be followed.

Vegetable Cooking Tips

* cook vegetables when they are fresh and chop them right before cooking, not hours ahead of time

* do not soak vegetables before cooking and cook in as little water as possible

* cook for as short a time as possible (only for a few minutes, just until they are tender)

* do not put the vegetables in the pot until the water is boiling

* save boiling water to add to stews and gravies

* do not add salt, which draws out juices, to the cooking water

The chart below gives the vitamin C content in milligrams of different vegetables when they are raw, steamed or boiled. Read the chart to answer the following questions.

1. Which has more vitamin C, a cup of raw spinach or a cup of raw squash?

2. Which have more vitamin C, boiled vegetables or steamed vegetables?

3. Which have more vitamin C, raw vegetables or steamed vegetables?

4. What cooking method destroys the most vitamin C?

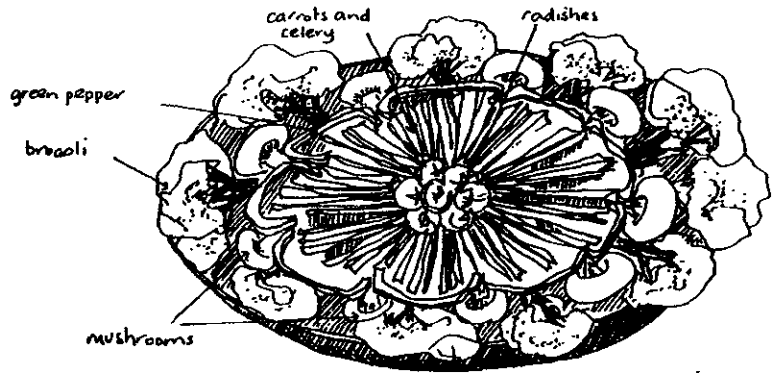
Vitamin C Content (mg.) of Vegetables

Vegetables	*Amount*	*Raw*	*Steamed*	*Boiled*
wax beans	*1/2 cup*	*27.3*	*20.4*	*12.3*
onions	*1/4 cup*	*6.9*	*4.6*	*2.5*
spinach	*1 cup*	*49.6*	*31.8*	*22.3*
squash	*1/2 cup*	*10.5*	*8.0*	*6.3*

Eating vegetables raw

Many vegetables can be eaten raw. Uncooked vegetables are very nutritious. They can be delicious in salads or on relish trays.

Try making a relish tray of raw, cut up vegetables. Cut up a variety of vegetables of many different colours, such as green peppers, tomatoes, radishes, carrots, cucumbers and celery. Arrange the vegetables on a plate in an attractive way. For example, make the plate look like a flower by arranging the vegetables in concentric circles. A dip for the vegetables can be made out of one mashed avocado, 1-2 cloves garlic, lemon juice, 1/2 teaspoon cumin and a pinch of salt.



Steaming

Steaming vegetables is a good way to preserve their nutrients. Steam is very hot, so vegetables cook quickly. The vegetables are not in contact with water, so nutrients are not lost in the cooking water. Also, the air in the pot is replaced by steam. Therefore fewer nutrients are lost by the vegetables contacting air.

Vegetables that contain a lot of water, such as tomatoes, greens, and cabbage, can be steamed in a covered pot in just the water that clings to them after washing. Add a few more tablespoons of water to create steam to vegetables that are denser, such as carrots or broccoli.

Vegetables can also be put in a bamboo or metal steaming basket and steamed over boiling water in a covered pot. If you do not have a steaming basket, you could improvise one, for example by placing a basket on top of stones. For added flavour, put a sliver of garlic or onion in the steaming water.

* Pears should be washed thoroughly and cut in half lenghwise. It is not necessary to remove the peel or core. Put them on the trays cut surface up, and expose to sun and wind for about 1-2 days. Then keep them in a shady, windy place for a few days until dry. Properly dried pears should be flat and fleshy but not mushy.

* Bananas should be cut into small pieces or split lengthwise. Use a knife that is not made of iron to prevent staining. Place the cut pieces on trays and allow to remain in the sun for one or two days.

* Guavas should be quartered and seeded, then placed on trays, cut surface up.

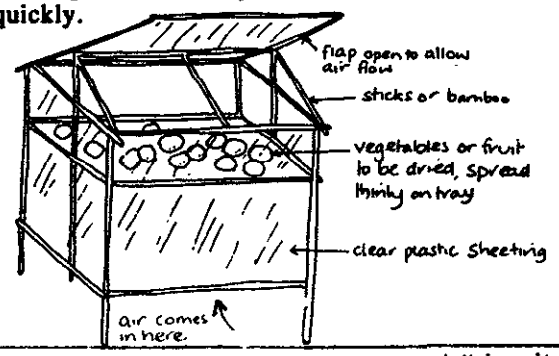
How to dry herbs

When at their peak, pick the herbs in the early morning or in the evening during dry, sunny weather. Rinse, shake and dry gently. Spread out on a cloth to dry. Form into bunches and hang in a dry, well-ventilated place, not in the sun. When dry, remove the leaves from the stalks, and store in airtight containers.

Try This

1. Try drying fruits and vegetables in different places to see what works best. Compare the time it takes to dry them in a sunny, windy spot; a shady, windy spot; a sunny spot with no wind; and a shady spot with no wind. You could also try drying wet cloths in each of these places.

2. Try building a solar dryer, like the one shown here. The temperatures inside the drier will rise 10°C to 15°C higher than the outside temperature, so your fruits and vegetables will dry more quickly.



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LEARNING-BY-DOING
HEALTH & ENVIRONMENTAL ACTIVITIES FOR YOUNG SCIENTISTS
LEAFLET NO. 25

Try Drying

Drying is the oldest and simplest form of food preservation. Drying removes the moisture from fruits and vegetables so there is little chance that bacteria can grow and cause decay. Dried fruits and vegetables are very nutritious since most of their nutrients are preserved when they are dried. Dried fruits and vegetables are delicious, too! Dried vegetables make a tasty addition to soups or stews. Dried fruits are delicious eaten just as they are. They can also be stewed.

General Drying Tips

* Drying fruits and vegetables requires two things -- heat and moving air. Warm air takes up more moisture than cool air. Moving air carries moisture away. Thus, fruits and vegetables dry well in the sun during hot dry weather, especially if it is breezy as well. Be sure to bring the fruits and vegetables in if it rains, and bring them in overnight so they do not get wet.

* Select only good-quality fruits and vegetables. If they have started to rot or are over-ripe, then the decay process will continue after they have been dried.

* Only prepare as much as you can dry at any one time. Otherwise, the extras will decay while waiting to be dried.

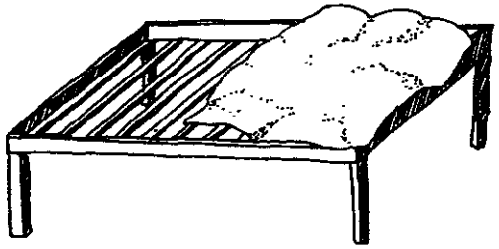
* The smaller the pieces of fruits and vegetables, the faster they will dry. They should be uniform in size so they will dry evenly. Turning them often will insure that they dry evenly.

* Allow dried fruits and vegetables to cool for several hours before storing. Once dried, they should be guarded against rodents, insects and moisture. Store in clean, dry containers in a dark, dry place. Jars with the lids work well.

What you will need

For sun-drying, you will need a slatted tray so that the air can get to all sides of the fruits and vegetables. The tray should be placed about a foot above the ground. Cover the tray with a cloth that has an open weave, like muslin or cheese cloth. Also cover the fruits and vegetables with loose cloth during drying, so flies or birds cannot land on them. Put the trays in a place that is not dusty. Fruits and vegetables must be exposed to the action of the sun and winds until dry, in some cases for a few days.

Use a clean knife not made of iron for cutting so the fruits and vegetables do not get stained.



How to Dry Vegetables

Vegetables should be dried when they are in their prime. Prepare them for drying as soon as possible after picking. Practically all vegetables should be **blanched** (precooked in boiling water or steam) before drying begins. Blanching serves several functions: (1) it helps preserve vitamins during drying; (2) it improves the colour of the vegetables; (3) it softens the vegetables, thus increasing the drying rate; (4) it kills bacteria; (5) it kills the vegetable tissue, preventing certain chemical changes from taking place during drying which may give the vegetables a bad taste; (6) it cuts down on the time required to cook the dried vegetables for eating. Immediately after blanching, the vegetables should be dipped in cold water to cool them thoroughly before drying.

Drying may take from one to several days, depending on the weather. You will know your vegetables are dry enough when no moisture can be squeezed from them when they are pinched between the thumb and finger, or if the soft pulp cannot be pressed out from a cut.

Try drying some of these vegetables:

* Sweet corn is one of the easiest vegetables to dry. Blanch the husked ears in water for 10 minutes and then thoroughly cool in cold water. Cut the kernels from the cob and spread on the drying trays.

* Cut snap beans into 1-inch (2.5-cm) pieces and boil in as little water as possible for 10 minutes.

* Root crops such as carrots and beets should be scrubbed clean, skinned, and cut into small cubes. Blanch for 3 to 5 minutes, cool in cold water and spread on drying trays.

* Cut cabbage into 1/4-inch (.6-cm) strips and blanch in steam for 5-6 minutes.

* Wash celery and cut into 1/2-inch (1.2-cm) lengths and blanch in steam for 8-10 minutes.

* Cut squash and pumpkins into one inch pieces and blanch for about 4 minutes.

* Onions and peppers, including chili peppers, do not need to be blanched. Wash and cut into 1/4-inch (.6-cm) slices for drying.

How to dry fruits

Different fruits are prepared for drying in different ways. Most do not need blanching. Try drying some of these fruits:

* Peel and core apples and cut into slices 1/4 inch (.6 cm) thick. Drop the slices in a salt solution (1 tablespoon of salt per quart of water) to prevent darkening. When the fruit is all prepared, rinse with clear water and place on the drying trays.

TEACHER'S NOTES FOR
III. PLANNING, PREPARING FOR AND PLANTING YOUR GARDEN

In this section, students research and plan how, when and where to plant a garden and what garden crops they might consider planting ("Planting Plans"). For those who do not have room for a garden, there is a special leaflet on container gardening ("Container Gardening"). There is also a leaflet on cultivating greens, since they are easy to grow and since they provide many important vitamins and minerals, as well as bulk, to the diet ("Eat a Green Plant Today"). This section also covers preparations for planting, including how to raise transplants ("Bringing Up Baby Plants") and how to clear and prepare the garden plot ("Preparing Your Garden for Planting"). It also covers how to layout and plant the garden ("Your Garden Debut").

11 Planting Plans

Going Further
For other crops that the students might consider planting, including leucaena, pumpkin, banana and winged beans, see OUTREACH pac #70, pp. 18-33.

Teaching Tips
The activities in this leaflet provide students with the opportunity to carry out the research necessary to determine where to plant, what to plant, when to plant and how to plant a garden. First they are asked to scout out the most ideal spot for a garden, based on a list of criteria. Then they are asked to find out information from local farmers and/or extension agents about what crops are most suitable to their area and how they should be cultivated. Then they are asked to design a garden, based on a list of criteria. The sample garden plans, at the end of the teacher's notes for this section, will give students a better idea of how to draw a garden plan in scale.

Going Further
Also see OUTREACH pac #67, p. 2 on interviewing a crop, #69, p. 8 on a mapwork exercise and #71, p. 14 on underexploited plants.

12 Eat a Green Plant Today

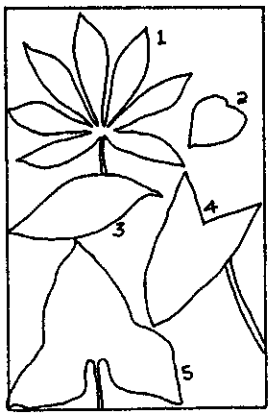
Teaching Tips
This leaflet highlights the importance of green leaves in the diet, and encourages students to consider cultivating them in the home garden. Students are asked to find out from their elders how greens are traditionally grown and cooked in their area, since this important information is being lost in many areas of the world.

Going Further
The hand-out entitled "Green-leaved Vegetables, " which can be found at the end of the teacher's notes for this section, gives specific

growing information about some of the green-leaved vegetables that can easily be grown in a wide range of climatic conditions.

Answers to Questions
The plant leaves in the picture puzzle are identified here.

1. Cassava
2. Ceylon or Indian Spinach
3. Chinese Spinach (Amaranthus spp)
4. Cocoyam
5. Swamp taro



13 Container Gardening

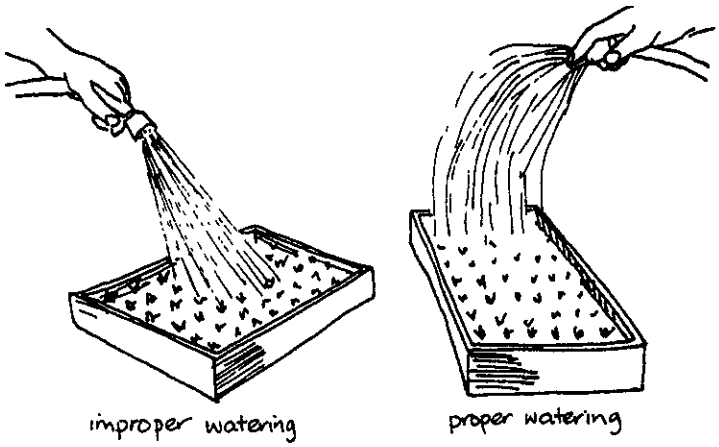
Teaching Tips
This leaflet explains how to provide plants in containers with all of their basic needs. It explains what to use for containers, what to use for a growing media, how to fertilize, how to plant and thin, how to water and how much sun is required. Container gardening is especially suitable for students in urban areas. Container gardening might also be considered if there is no room for a school garden. Students would gain some hands-on gardening experience that could be useful for cultivating a regular garden at home.

Going Further
See also OUTREACH pac # 69, pp. 10-11 on hydroponic gardening in an urban setting.

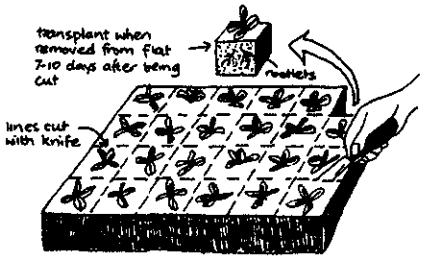
14 Bringing Up Baby Plants

This leaflet describes the seedbed method of growing transplants, a method which is most suitable for tropical areas. Encourage students to do some experiments to discover the best methods for raising transplants in your area, as suggested under "Try This."

Teaching Tips
Be sure students water the seedlings properly, with a fine stream of water.

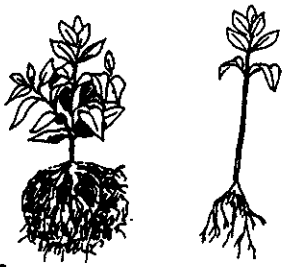


If planting seedlings in a seedbed, be sure to cut the soil between the transplants 7-10 days before transplanting.



If planting seedlings in individual pots, be sure students remove the transplants carefully at the time of transplanting. Demonstrate how to hold the pot upside down while supporting the soil with one hand. Tap the bottom of the pot with the other hand until the transplant, with soil attached, fall out.

If transplants have been raised correctly, then they should be short and stocky with lots of leaves, rather than stringy, with few leaves. The roots should have lots of soil attached; they should not be bare.



Experimental Results

1. The seedlings in the unsterilized seedbed will be more prone to damping-off. The seedlings grown in the shade will be more likely to wilt permanently once they are transplanted to the field. The seedlings in the seedbed without compost will not have enough nutrients and the soil will not be loose enough for them to grow a good root system.
2. The seedbed in which seeds have been scattered will be more difficult to thin and the transplants will be more difficult to separate. If the seedlings are not thinned, then the result will be many stringy, weak transplants.
3. The yields of the tomato plants should decrease with age of seedlings at time of transplanting.

Going Further

The hand-out entitled "The Seedbox Method of Growing Transplants," which can be found at the end of the teacher's notes for this section, describes the seedbox method. This method requires more labour and materials, but is a much more fool-proof method of raising transplants than the seedbed method.

15 Preparing Your Garden for Planting

Teaching Tips

Planting in beds is especially suitable for a school garden, since the garden is likely to be heavily trafficked by the many students who will be working there. The padding of many little (and big) feet can unneccessarily compact the soil and ruin its structure. Make wide paths between the beds, and make the beds narrow enough so the children can reach to the middle without stepping into the beds. If compost is scarce, then it can be concentrated in the beds, rather than being scattered throughout the garden.

Clearing the plot for the garden and spading the soil can be difficult tasks, more suitable for older children. To make working the soil and weeding much easier throughout the growing season, be sure to add lots of compost to the soil. It is better to prepare a small plot well with lots of compost than to spread out your compost too thinly. Difficult weeding and undernourished crops can quickly discourage novice gardeners.

16 Your Garden Debut

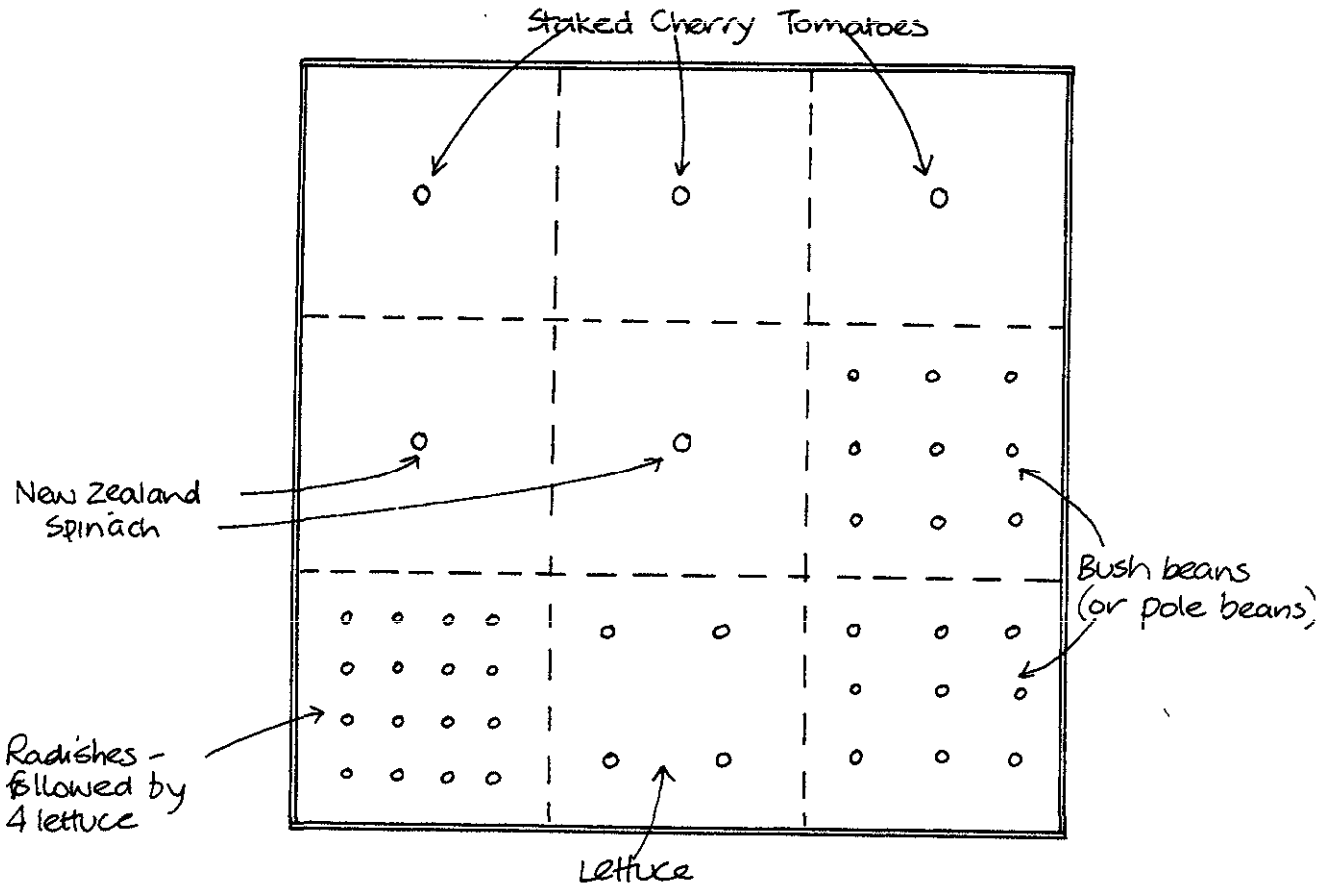
Teaching Tips

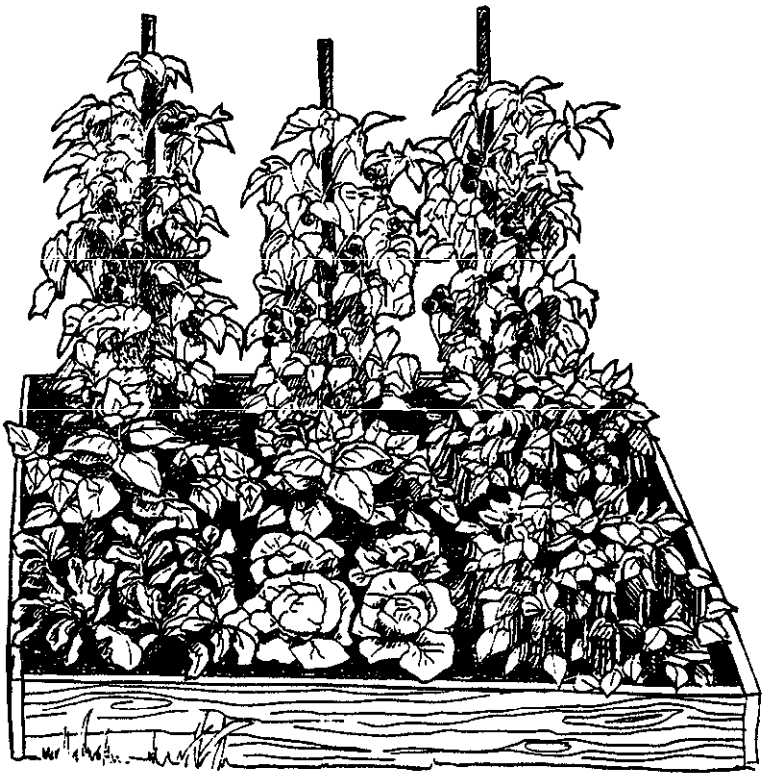
Be sure your students have finished all the necessary preparation, as described in the introduction to this leaflet, before making their garden debut. You may wish to have students practice measuring rows and planting seeds on large sheets of brown paper before going out to the garden. Be sure they know how far apart and how deep to plant the seeds before going out to the garden.

Going Further

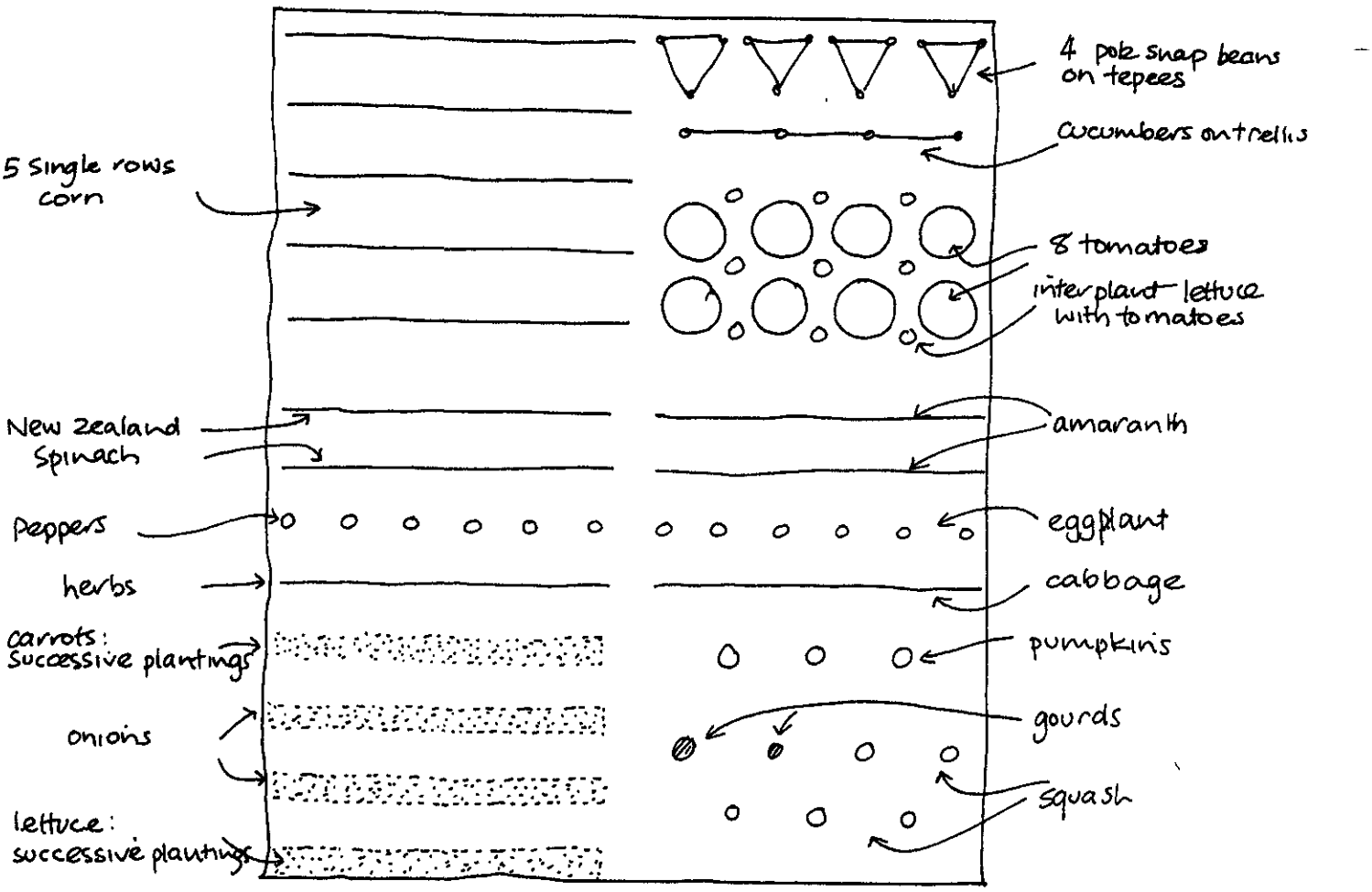
See OUTREACH pac #69, pp. 2-3 on gardening measuring machines and pp. 11-16, which is a radio script on boosting vegetable production

Sample Garden Plan for 3-foot square/1-metre square Plot

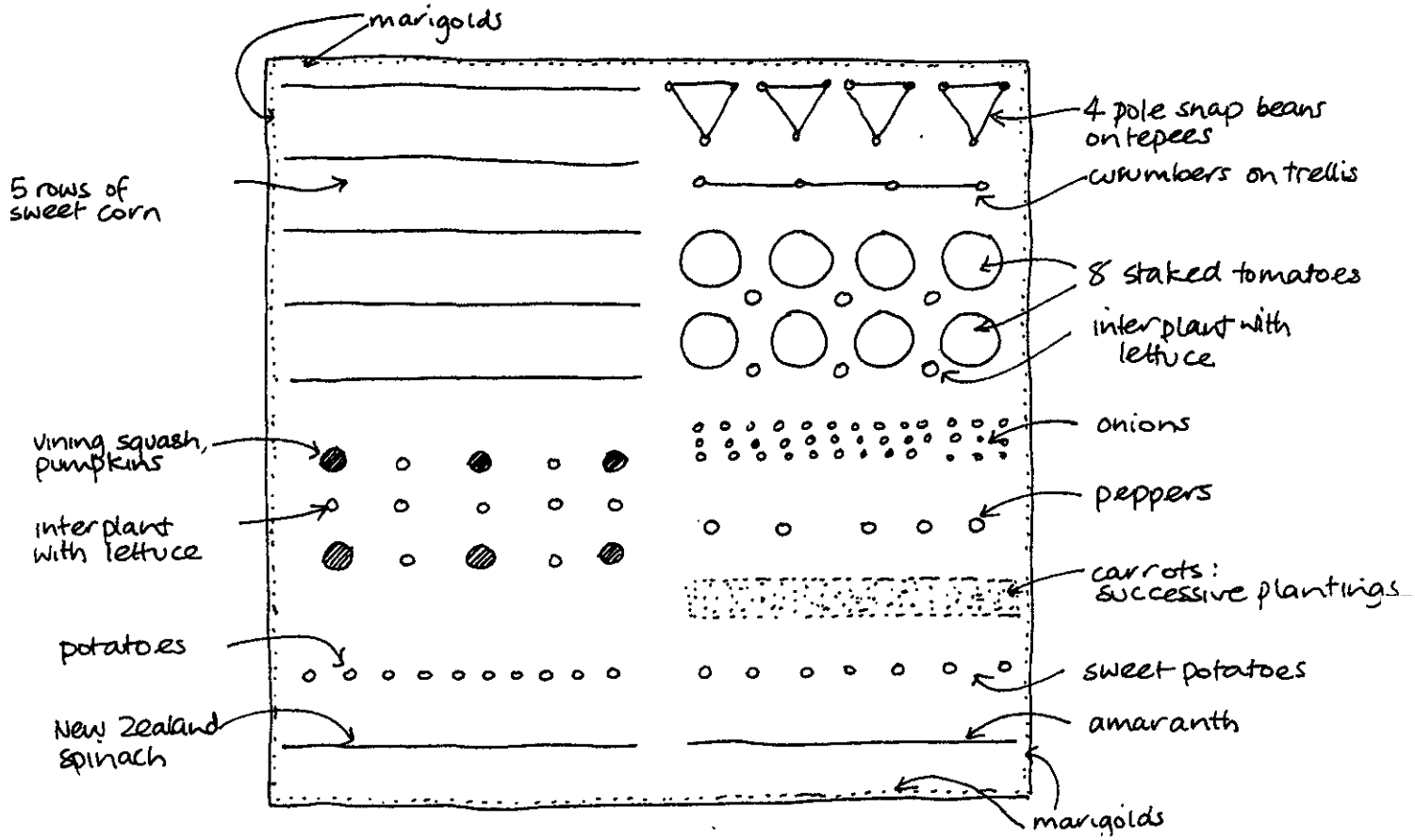




Sample Garden Plan for 25-foot by 30-foot (7.75 metre by 9.1 metre) Plot



Sample Garden Plan for 25-foot square (7.75 metre square) Plot



Green-leaved Vegetables

Here are some green-leaved vegetables that are available thoughout the tropics, are easy to cultivate, have high yields and taste good!

Amaranthus gangeticus L.

Common names: Amaranth, Jacob's coat, rangasak, lal sak, bayam, puteh, Chinese spinach, bush greens, pigweed, lulitis, tampala

Uses: Amaranth is grown in both tropical and temperate regions. It is usually eaten as greens, but some yield seeds of high food value which are eaten as grain in Mexico and Central America. Amaranth is very high in vitamin A, and also contains vitamin C, calcium and iron.

Cultivation: Amaranth is an annual that can be harvested 30 days after sowing, when about two feet (15-20 cm) high. The upper portions can be cut every 2-3 weeks. Amaranth grows best in light, sandy, well-drained and fertile soils. Broadcast the seeds very thinly. (Seeds saved from the previous crop can be used.) Be sure to thin the seedlings so that the remaining plants are 3-6 inches apart. The plants grow rapidly and thus require ample water. They benefit from extra fertilizer ((wel-rotted compost or manure) during the growing season, since they require a lot of nitrogen.

Tetragonia tetragonoides (Pall.)

Common names: New Zealand spinach, aizoaceae, kabak

Uses: This plant is a native to New Zealand but has been widely introduced into tropical, subtropical and temperate areas. It is becoming more and more popular in the United States since it can be harvested all summer long. Unlike regular spinach, it does not bolt (flower and go to seed rather than continuing to produce leaves) during the hot months. In the tropics, it does best at elevations of 600 meters or more. New Zealand spinach is rich in iron and a very good source of calcium and phosphorus. The young leaves and three inches of the stem are eaten, usually as a spinach dish.

Cultivation: New Zealand spinach has a dense growth habit, thus a few plants will suffice for a family. It can either be planted from cuttings, which root in damp sand, or from seeds. Soak the seeds 24 hours before planting. Plant 35-50 cm apart in beds one metre wide. Fertile, sandy, well-drained soil is best. New Zealand spinach is drought-resistant and immune to most insects and diseases. Since it needs a lot of nitrogen for good growth, give it a good application of manure. New Zealand spinach can be harvested continually over many months. When growth is unsatisfactory, pull out the old mat of plants. There will be new seedlings underneath the old plants.

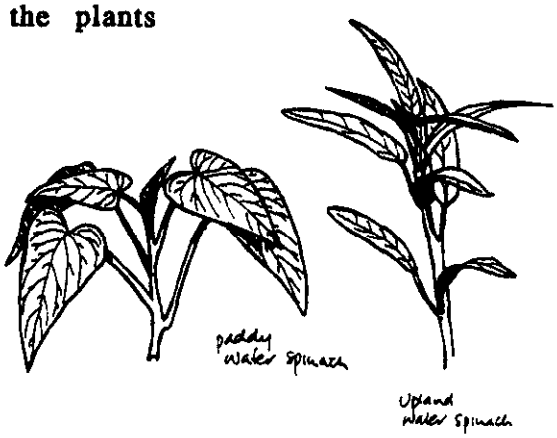
Basella rubra L.

Common names: Ceylon spinach, Malabar nightshade, libato, gendola, remayong, jinga, pak prang, puty, purai

Uses: This plant, probably Indian in origin, is widely cultivated in the tropics of Africa, Asia and the New World. It is a good source of vitamins A and C, calcium and iron. The leaves are used uncooked in salads or they can be cooked in a stew or with other vegetables. The cooked leaves are used as a safe and mild laxative. The red berries can be used as a dye to colour foods like jellies.

Cultivation: Basella is a trailing or climbing perennial vine that is well worth growing since it is very prolific and requires little attention besides adequate watering and frequent harvesting. With proper care and enough nutrients, basella can be maintained and harvested continually. It is almost completely free of disease and insect pests and can also grow in a variety of soils and climates. However, sandy loam seems to be the best soil for growing Basella. Seeds can be sown directly or vines can be grown from stem cuttings. If starting from cuttings, keep them well-watered until roots and buds are well-developed. Plant 8-9 inches apart at the foot of a trellis that is 3 to 6 feet high, or plant one and a half feet apart in beds where they can sprawl over the ground. In Southeast Asia, Basella is planted in hills, with 4-7 cuttings per hill and 25-30 cm between hills. Using a trellis is beneficial during the rainy season, since this will prolong the life of the plants and induce growth of lateral stems. Three months after planting, the leaves and about 3-5 inches of stem can be harvested weekly. Frequent harvesting keeps the plants bushy.

Impomoea aquatica Forsk.



Common names: Water spinach, swamp cabbage, kangkong, pitcher vegetable

Uses: This plant, related to the sweet potato, is found in tropical Africa and Asia, through Malaysia to Australia. It is usually cooked with various dishes or simply blanched and served with spices or sauces. The young tips can also be eaten in salads. The parts not suitable for human consumption are used as animal feed. It is an excellent source of vitamin A, and is also fairly rich in vitamin C, calcium, potassium and phosphorus.

Cultivation: Water spinach is a perennial that can grow in a wide variety of soils. However, it grows best on rice fields with clayey soil rich in organic matter, well-provided with water. It is relatively free from serious attacks by diseases and insects. There are two main types of water spinach, upland (dry) and paddy (swamp) forms. For paddy forms, long cuttings (30 cm) are planted in mud and kept moist. As the vines grow, the paddies are flooded to a depth of 15-20 centimeters. Harvest begins after 30 days. For upland forms, the plants are spaced 12 cm apart in raised beds 60-100 cm wide. They can also be direct-seeded. Upland forms require large amounts of water and weeds must be controlled. Mulching with rice straw can control weeds and help conserve moisture. If the vines are trained to trellises, the leaves can be harvested continually, starting six weeks after planting.

The Seedbox Method of Raising Transplants

The most fail-proof method of raising transplants is to use seedboxes. Seedboxes are filled with soil that is free of weed seeds, insects and plant diseases. The soil provides excellent drainage and adequate air space, and remains moist after watering. The soil remains loose rather than becoming compacted when watered. However, it is not so coarse that it does not cling to the roots of the transplants during transplanting. The soil mix also has adequate nutrients so that your transplants grow up strong.

Ingredients for the Soil Mix

To create the right texture for your soil mix, use the following ingredients for each cubic metre of mix:

one part sand (if using seashore sand, wash it well, since it may be too salty)

one part compost

one part garden soil

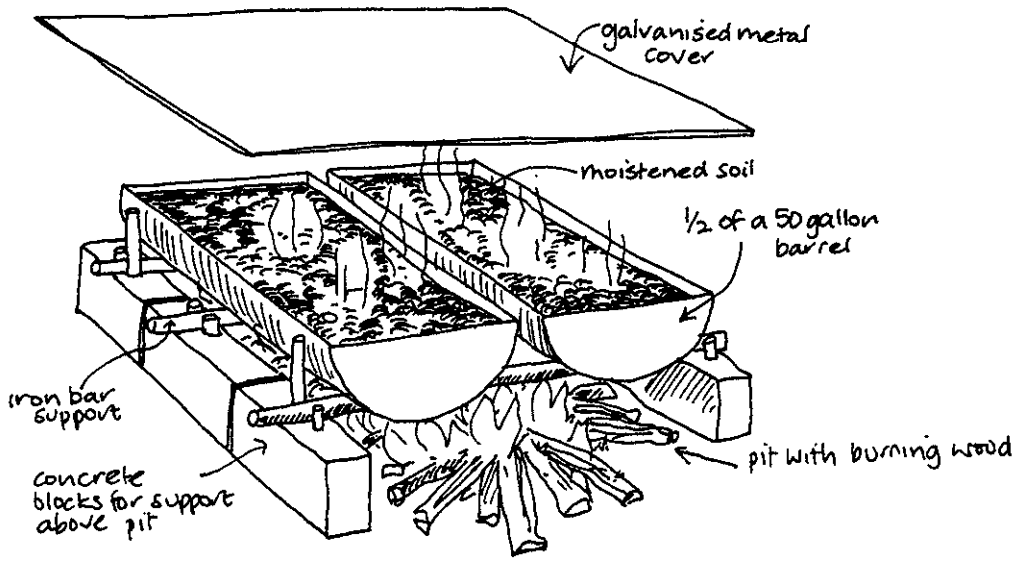
one liter of all-purpose fertilizer, such as 12-24-12

one liter of 20 percent superphosphate

You may need to modify the mixture to suit the texture of your garden soil. If your garden soil is a sandy loam, for example, less sand should be added.

Sterilizing the Mix

To get rid of weed seeds, insects and plant diseases, the soil must be sterilized. Heating sterilizes the soil. One method of sterlizing soil is shown in the diagram. Cut a 50-gallon metal barrel in half. Use concrete blocks and iron bars to support the barrel halves over the fire pit. Fill the half barrels with soil mix and moisten. Make holes in the soil with a rake handle and sprinkle the soil with water until thoroughly damp, but not soaked. Wet soil heats up much faster than dry, and the steam helps to sterilize the soil. The moisture also prevents burning the organic matter out of the soil. Cover the soil with old galvanized metal sheets to retain the heat that reaches the top of the soil. Start the fire in the pit. Heat the soil until it starts steaming, and continue to heat for about one hour.



Planting in seedboxes

Before planting your seeds, test them for percent germination. (See Learning Leaflet entitled, "To Sprout or Not to Sprout.") Once you have tested your seeds for percent germination and prepared your seedbed, you are ready to plant your seeds. A good seedbox size is 33 cm by 50 cm by 7 cm deep. Wash the seedboxes with a brush and hot, soapy water to get rid of diseases. After the seedboxes are filled with soil, the soil should be firmed around the edges and leveled. Do not pack the soil into the seedboxes. It will settle after some watering.

When planting in a seedbox, each 33 cm by 50 cm box should hold about 48 seedlings (eight rows of six plants each). Do not sow the seeds too deep (.3-.6 cm is about right). Two or more seeds should be sown at each spot, or more if the seeds have a low germination percentage. Thin the seedlings to one per spot when the seedlings have the first true leaf. Keep the seedboxes on wooden planks to keep them off the soil surface.

TEACHER'S NOTES FOR
IV. GARDEN CARE

In this section the students will study some basic garden care, including watering ("Water: Not too Much and Not too Little"), mulching ("Much Ado About Mulch"), thinning ("Less Is More"), and garden pests ("Weeds, Weeds, Weeds," "Insect Visitors," and "Plant Diseases"). Keep in mind that the emphasis is on learning about vegetable plants and how they interact with other living things in the garden environment, rather than on trying to produce the greatest possible yields in the garden. By carrying out some of the suggested experiments, you will have to sacrifice greater potential crop yields, but in return your students will have the opportunity to see dramatic demonstrations of the consequences of poor versus proper gardening practices. Their impressions of these demonstrations may stay with them for a lifetime. Studying the biology of weeds, insects and microbes will lead to more rational approaches to the control of garden pests.

17 Water: Not too Much and Not too Little

Teaching Tips

Keeping track of how much it rains each week is a good lead-in to learning more about weather. Students could keep a bar graph of how much it rains each week. They could also keep a daily record of cloud types, wind direction and temperature. They may eventually be able to recognise certain patterns, for example, do certain cloud types or wind directions precede certain weather conditions?

Experimental Results

1. The well-rotted compost or manure should hold more water than soil alone. One of the advantages of adding compost to soil is that it increases the water holding capacity of the soil.
2. The mulched plot should require much less water, since mulches prevent water from evaporating from the soil.
3. Less water should be required in the cool of the morning, when less evaporation is taking place.
4. a. Note: The jug method of irrigation will work best if the jug has an air-tight cap. Prick a few small holes into the jug along the top. Air will slowly seep into the holes to replace the water slowly seeping from the jug into the soil. b. Note: The drip irrigation system can be gravity-fed from a rain barrel placed at just the right height above the ground, so that the water does not seep out too slowly or too quickly.

Going Further

See OUTREACH pac #68, pp. 16-17 and 22-23 on irrigation systems, including watering plants with pots and p. 30, which is an experiment on plant's water loss.

18 Much Ado About Mulch

Teaching Tips

Mulching is well worth the effort, since it will save students a lot of weeding, cultivating and watering work, and since it will improve vegetable yields and quality.

Experimental Results

1. The mulched soil should have more moisture and be softer.
2. Not only should the yields be greater on the mulched plots, but the plots should also have fewer weeds and require less weeding.
3. Students should be able to find some sources of mulching material in your area. If nothing else is available, use shredded newspapers.
4. Some mulching materials, such as sawdust and wood chips, steal nitrogen from the soil while they are decomposing. They should not be used on crops that require a lot of nitrogen, such as corn and other grains.

19 Less is More

Teaching Tips

Encourage students to design and carry out the experiments suggested under "Try This," perhaps as independent study projects.

Experimental Results

The plants that are crowded will grow long and stringy since they will be reaching for light. The plants that are not crowded will be shorter and stockier and they will have many more leaves. In the same way, a tree in a forest grows much taller and thinner than a tree in the middle of a field.

Your students may wonder, "Why pull up perfectly good plants?" Leaving one section of a row of various crops unthinned will provide a dramatic demonstration of the necessity of thinning seedlings, which is a difficult job for novice gardeners. The unthinned plants will eventually crowd each other out. The quality and quantity of vegetables from the unthinned plots well be drastically lower than that in the thinnned plots.

20 Weeds, Weeds, Weeds

Teaching Tips

The activities suggested in this leaflet will help students better understand where weeds come from, why they sprout up so quickly in a garden and how they can be controlled. By studying weeds more closely, students will learn to recognise them by sight, and they will know something about their growing habits, even if they do not know their common names. You may be able to acquire weed identification literature for your area from your local cooperative extension service, ministry of agriculture or agricultural college.

Answers to Questions

1. Do not let any weeds go to seed. Pull the weeds before they form seed heads and put them in a compost pile.
2. Mulch the soil with straw, dead weeds, wood chips or black plastic.

3. The earlier the weeds are pulled, the easier it is to pull them. Also, the roots of your vegetables are not injured when they are pulled early. Finally, the weeds do not get a change to go to seed.

Going Further
See OUTREACH pac #68, pp. 6-7 on weed work and p. 29 on growing lemon grass to prevent weeds

21 Insect Visitors

Teaching Tips
In this leaflet, students must make careful observations and record their observations in drawings and by taking notes. This will help them to develop an attitude of appreciation for insects and an understanding of where each insect fits into the ecosystem. This understanding will lead to a more rational approach to insect control. Wholesale spraying may kill harmful insects, but it will kill their natural predators as well. The harmful insects may then return in greater numbers than before. By watching and studying insects more closely, students will begin to understand their habits and learn how they can be controlled most effectively, using biological controls as well as insecticides, without harming the environment.

Answers to Questions
4. The insects pictured on the second page, from top to bottom, are: cabbage butterfly, lady bird beetle, honey bee, mealy bug, aphid, grasshopper (left), and praying manis (right).
5. The students could try to raise other moths or butterflies if there are no cabbage butterflies in your area.
6. The mouthparts pictured are sucking (top left), piercing (top right), chewing (bottom left), and lapping (bottom right). Moths and butterflies have sucking mouthparts, with which they suck nectar out of flowers. Aphids and leafhoppers have piercing mouthparts, with which they pierce through plants to suck their juices. Beetles and many different kinds of larvae have chewing mouthparts, with which they can chew plants. Flies have lapping mouthparts, with which they lap up foods.
7. Students should be able to find many examples of camouflaged insects in the garden or on trees.
8. Ants and aphids are harmful to your plants and lady bird beetles are helpful.

Going Further
See OUTREACH pac #68, p. 7 on insect pests, p. 28 on pesticides and p. 29 on marigolds for deterring nematodes (actually, nematodes are worms, not insects).

Some plants are known to drive away harmful insects. Find out if there are some in your area and do the following experiments: Plant two plots of a crop that is usually attacked by insects. Cultivate the crop as usual. On one plot interplant the insect-repelling plant with the crop. On the other plot do not interplant. Observe the growth of the crop in the two plots, signs of insect attack during growth, and the yield of the two plots.

Interested students could put together and exhibit of camouflaged insects, for example, a moth against tree bark or a green leaf hopper on a green stem.

22 Plant Diseases

Answers to Questions

1. Corn plants that lack nitrogen will have stunted growth, yellow leaves and stems.

Plants that lack phosphorus will have stunted roots, red leaves and delayed flowering and fruiting.

Plants that lack potassium will have brown leaf tips, leaves covered with brown spots, and margins of older leaves crinkled.

2. Wood ashes provide phosphorus.
3. Seeds should be stored in a cool, dry place.
4. Diseased seeds should not be planted, since they can spread diseases to other plants.
5. Moulds grow better in the presence of moisture. Diseases are spread by spores, which can travel through the air and land on other plants.

The diseases pictured are bacterial wilt and damping-off.

Going Further

See OUTREACH pac #68, p.30 which is a radio script on fruit and vegetable soft rot.

Teaching Tips

Contact your local extension agent, agricultural college or ministry of agriculture to find out about diseases that are common in your area and recommendations for controlling these dieseases. Find out if disease-resistant varieties have been developed for your area.

Studying plant diseases that appear in your garden is a good lead-in to the study of microbiology. Students will be motivated to find out more about what microbes are and how they cause diseases. Plant diseases caused by microbes could be compared to human diseases caused by microbes. If at all possible, obtain a microscope so that students can actually see and study these invisible microscopic life forms more closely.

TEACHER'S NOTES FOR
V. HARVESTING AND PREPARING YOUR CROPS

In this section, students learn about when to harvest vegetables ("Harvesting Your Rewards"), how to cook vegetables to preserve the most nutrients ("Vegetable Cookery"), and how to dry both fruits and vegetables ("Try Drying").

23 Harvesting Your Rewards

Answers to Questions

1. False. For some vegetables, biggest and oldest does not necessarily mean best. 2. False. Harvesting when they are smaller does not necessarily mean you will get a smaller total yields from your vegetable plants. By constantly picking the fruit while they are young, the plants can continue to produce new flowers and fruits. 3. True. Tomatoes should be allowed to ripen on the vine to maximize flavour and nutritional value. 4. True. If pumpkins, squash, and melons are harvested too early, they will not taste as good and will have fewer nutrients. 5. Vegetables such as beans, leafy vegetables and cucumbers reach their peak in flavour and nutritional value when they are still young and tender. As they grow older and larger, their quality begins to lessen.

Experimental Results

1. Succession planting can be especially helpful to the home gardener. An alternative to succesion planting is to plant vegetables that can be harvested over long periods of time, for example, pole beans rather than bush beans. Another alternative is to plant several varieties that require different growing times, for example, early sweet corn and late sweet corn.
2. Allowing vegetables to sit around results in a decrease in quality. Greens start to wilt, beans go limp, carrots dry out, peppers lose their crunch. More important, the vegetables begin to lose their vitamins with exposure to air. Bruised vegetables will rot quickly, especially if left in the sun.
3. Variety trials can give you important information about what varieties are best suited to your area. Tell students to keep track of yield, as well as overall quality of the different varieties being compared. For example, some varieties may have high yields but they may not taste as good as other varieties. Also check with your local extension service, agricultural college or ministry of education to find out if they carry out variety trials in your area.
4. This experiment is a good demonstration of the fact that biggest does not always mean best. Some vegetables, if they are harvested when they are young, have a better quality and the plants continue to produce more. If they are harvested when they are old, then the plants only produce a few, over-mature vegetables. Cucumbers and beans work especially well for this demonstration.
5. Have the students scout for vegetables that are ready for harvest and report their findings to the class. When all of the students have agreed on what to harvest, then assign students to do the harvesting.

Going Further

See OUTREACH pac # 70, pp. 9-10, which is a cartoon on how food spoils and pp. 1-8, which is a radio script on storing grain and vegetable seeds.

Also see the hand-out at the end of this section entitled "When Should Vegetables Be Harvested?"

24 Vegetable Cookery

Teaching Tips

The purpose of the activities in this leaflet is to make students more aware of the nutritional value of vegetables and how they can be prepared to preserve the most nutrients. Students may not be used to eating vegetables prepared in the most nutritious ways. For example, in many cultures, vegetables are over-boiled so that a lot of their nutrients are lost. Have the students discuss how vegetables are prepared in their own homes, and what practices they could introduce into their households to improve the eating habits of their families. Perhaps they could put together a cook book featuring healthful vegetable recipes.

Answers to Questions

1. A cup of raw spinach has more vitamin C than a cup of squash.
2. Steamed vegetables have more vitamin C than boiled.
3. Raw vegetables have more vitamin C than steamed.
4. Boiling destroys the most vitamin C, because boiling requires the longest cooking time and because vitamins are lost in the cooking water.

25 Try Drying

Teaching Tips

If you have a bumper crop of fruits or vegetables all at once, then you will have the opportunity to demonstrate to students how they can be dried. If your area is not hot and dry enough, then try the solar dryer pictured on the last page. If people living in the area dry fruits and vegetables, have the students find out what drying techniques they use.

HAND-OUT

When Should Vegetables Be Harvested?

Cucurbits

Squash, melons and pumpkins must be allowed to reach full size before being harvested. If picked too early, they will taste like cardboard. Squash and pumpkins should be harvested when they have developed a hard rind and the appropriate colour. You can wait until the vine dies back and the stalks dry out before picking pumpkins and squash. Cut the stem from the vine, since fruit without a stem will not store well. Keep in a cool, dry place.

Muskmelons are ripe when the the colour between the netting changes from green to tan or yellow. The melon should come off the vine with a gentle pull. Watermelons are ripe when the colour of the rind where it touches the ground is yellow or cream-coloured. Try thumping the watermelon with your finger. It should not have a metallic ring, but a dull thud, like the sound made when thumping your shoe.

If cucumbers are left on the vine until they get very big, then the plant will only produce a few big, over-ripe fruits. If the cucumbers are harvested about every other day, when they are young and the seeds are soft, then the plant will continue to produce more and more fruit. Remove over-aged fruit from the vine to allow new flowers and fruits to develop.

Onions

Onions should not be picked until the necks have dried and the tops have fallen over. After pulling, leave the bulbs in the sun for 7-10 days for further curing. Then cut off the tops and roots.

The Cabbage Family

Cabbages can be harvested when the heart feels firm. Do not leave them too long before harvesting, since eventually their heads will split and they will go to seed. If you have many plants that were all planted at the same time, you may find that you suddenly have lots of cabbage all at once. You may want to dry some for future use. (See Learning Leaflet entitled, "Try Drying.")

Cut the central head of broccoli when the buds are still compact. More side shoots will form after the main head is cut, giving you many weeks of harvest. Cut the stems at an angle to prevent rotting.

The Nightshade Family

Tomatoes, peppers and eggplants should be picked when fully ripe. Pick tomatoes when fully red, as they taste best when ripened on the vine. During hot weather, they should be harvested at least twice a week. Cut or snap the fruit from the plant. Do not pull too hard since this might injure the plants.

Potatoes can be dug a few weeks after flowering if the lower leaves have begun to turn yellow. Lift the crop with a garden fork inserted well below the potatoes. Use damaged potatoes immediately. Store others in a dry dark place. If exposed to sunlight, the skins will produce a poisonous green substance.

Sweet corn

Sweet corn should be harvested when the silks are dry and brown. Carefully look at a few ears by opening a small window on the side of the ear. Sweet corn quickly passes its prime eating stage, so it should be checked daily. If allowed to pass the prime eating stage, some of its sugars turn to starch and the corn loses its sweet taste. It is best to harvest sweet corn just before eating, since some of the sugar changes to starch if it is allowed to sit at high temperatures. Each corn stalk should produce two ears of corn. Use two hands when harvesting the first ear. Bending the stalk could interfere with the development of the second ear.

Legumes

Snap beans are at their best when the pods are tender and fleshy. When the beans inside the pods turn plump, the pods become stringy and tough.

One of the advantages of pigeon peas is that they continue to produce pods for extended periods of time. They can be harvested when the seeds are still green and eaten as peas. They can also be harvested when the seeds are mature, and stored and eaten like dried beans.

Leafy vegetables

Leafy vegetables are crisp when young, but grow fibrous and tough with age. Many leafy vegetables, such as amaranth, New Zealand spinach, mustard greens and collards, can be harvested over a long period of time. If you keep harvesting the tips of the shoots, they will continue to produce more.

Root crops

Most root crops are also better if harvested when they are still small. When beets, cassava or carrots become too old, they lose flavour and get tough and woody.