OUTREACH

INFORMATION FOR
EDUCATORS AND COMMUNICATORS

TVE WWF

BIODIVERSITY SERIES

sample pages from OUTREACH Packs on

GENETIC DIVERSITY AND FOOD CROPS

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This Biodiversity Series is dedicated to
International Biodiversity Observation Year 2001-2002,
an Initiative of DIVERSITAS

WHAT IS OUTREACH?

OUTREACH is a non-profit environmental and health education service whose goal is to help improve the lifestyles and the environment of children and the poor in the developing world. It does this by supporting community-based health and environmental programs in developing countries through the provision of learning materials, and by increasing awareness in the industrialized world of global environmental and health issues, particularly as they affect developing countries.

OUTREACH is a project of the Television Trust for the Environment (TVE), and is based at the offices of TVE USA. An independent, non-profit organization based in London, TVE was set up in 1984 by the United Nations Environment Programme, WWF and Central Television (now Carlton) to raise awareness of all aspects of the environment, social issues, human rights and development through broadcast television and video. The main focus of TVE is to reach out to people through moving images. OUTREACH complements this work by providing learning materials for educational institutions, community groups and local media in Africa, Asia and Latin America.

OUTREACH EDUCATIONAL RESOURCES

What makes OUTREACH materials special is summarized in the chart below.

OUTREACH learning materials:

- **Develop basic skills**: The Activity Guides and Communication Aids assist students in practicing basic literacy, mathematics and social skills, and they help students understand basic scientific concepts;
- **Develop problem-solving skills**: The activities do not tell students what to think and believe. Students observe, hypothesize, experiment, classify, gather data, infer, communicate, and so learn how to solve problems themselves through scientific inquiry;
- **Help community development:** The Activity Guides empower people to examine environmental and health issues in their own communities, and explore ways for community groups to address them.

The materials are:

- **Practical:** They focus on solutions to various everyday problems related to health, the environment and sustainable development;
- **Appropriate:** The classroom-ready Activity Guides are especially designed to meet the needs of teachers in the developing world - only inexpensive and readily available equipment is required, and teaching tips are included;
- **Adaptable:** The materials can be easily adapted, adopted and added to, in order to suit many different climatic, cultural and environmental conditions;
- **Suitable for different media:** The Communications Aids especially provide opportunities to focus on the issues in a variety of media - through the radio, newspapers, television, workshops, children's comics, drama and puppetry;
- **Copyright-free for non-profit, educational purposes in developing countries.** Copyright restrictions may also be waived for commercial publishers marketing educational materials in developing countries, provided written permission is first granted;
- **Free-of-charge** to members of the OUTREACH Network, which includes over 900 radio broadcasters, journalists, community workers, curriculum developers, representatives of non-governmental organizations and teacher trainers, mainly in Africa, Asia and the Pacific, Latin America and the Caribbean.

OUTREACH produces two types of learning materials: **Issue packs** which help young people in developing countries recognize and understand environmental and health issues in their locality, and **Solution packs**, which help young people take actions to improve health and environmental conditions.

EXCERPTS FROM RECENT OUTREACH EDUCATIONAL MATERIALS

The following pages include excerpts from the following OUTREACH packs:

Issue pack: Genetic Diversity and Food Crops

This pack looks at farmers' contributions to crop diversity; scientific breeding methods; impact of new biotechnologies upon crop diversity; *ex situ* and *in situ* conservation. Activity Guides and teachers' notes help students explore classical genetics, genetic diversity (focusing on local crop diversity), plant breeding, and genetic engineering.

Solution pack: Preserving Genetic Diversity in Crop Plants

Students learn how to select and save seeds and other practical techniques for preserving the genetic diversity of local crop plants.

Solution Pack: Breeding Your Own Crops

Students learn more sophisticated breeding methods, such as making hybrid crosses in order to create new varieties.

While the subject matter of the OUTREACH packs on Genetic Diversity and Food Crops is more suitable for secondary level students, there are some materials directed at primary school students. These three packs form part of the OUTREACH series on Biodiversity. Subsequent packs will explore species and ecosystem diversity. These packs will probably contain more primary level activities. The approach adopted in forthcoming issues will be similar to the one adopted in issues on Genetic Diversity and Food Crops. It will be people-centred, with an emphasis on the practical importance of protecting species and ecosystems, and practical ways that individuals and communities can work towards conserving species and ecosystems.

FUTURE PLANS

Over the next two years OUTREACH plans to work towards meeting its long-term goal by achieving the following objectives:

1. To complete the Biodiversity Series by producing 9 more copyright-free educational publications on Biodiversity that support community-based educational programs for youth in developing countries.
2. To establish a website in order to make OUTREACH materials more readily accessible to communicators and educators in the existing OUTREACH Network that have Internet access, and to extend the reach of OUTREACH to include more organizations involved in education and communication in the developing world.
3. To continue to make printed OUTREACH materials available to eligible communicators and educators in low- and middle-income countries that do not have Internet access, focusing primarily on developing the Network in sub-Saharan Africa.
4. To launch a web-based interactive magazine for 10-14 year olds, that will be posted 3 times a year, to help increase global awareness of critical environmental and health issues facing developing nations.
5. To use the website to facilitate fund-raising efforts for OUTREACH's educational programs in developing countries.

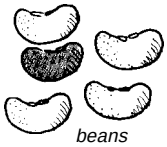
If you are interested in helping to support the OUTREACH project, or would like to learn more about it, please write to:

OUTREACH at TVE USA, P.O. Box 820, Shelburne, VT 05482, USA

or send an e-mail to **tveusa@together.net**

WHY CROP DIVERSITY IS IMPORTANT TO TODAY'S SMALL-SCALE FARMERS AND THEIR FAMILIES

body-building foods

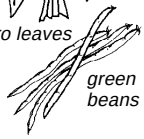


beans

protective foods

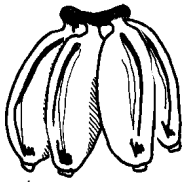
mango

taro leaves

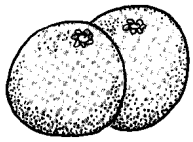


green beans

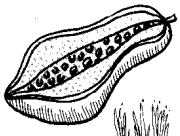
pumpkin leaves



bananas



oranges



pawpaw (papaya)

carrots
tomatoes

green pepper

Today, for many small-scale farmers, growing many different crops and crop varieties means improving their chances of having enough food to meet their needs.

By growing many different crops, farmers get foods that provide energy; foods that help their children grow; foods that keep their families strong and healthy. Different varieties may have different flavours or different cooking qualities. Some varieties of a particular crop may be good to eat right away, while other varieties may be easier to store, and eat later on. By planting varieties that mature at different times, farming families have food supplies for eating and for selling over a longer period of time.

Different crops and crop varieties need different growing conditions. Some crops grow well in dry soils, while others will die if they don't get water. Not all the land that a farmer works is likely to be the same. Perhaps, one field slopes steeply and is exposed to strong winds, while another field has fertile soil and receives plenty of sunshine. A single variety of a single crop is unlikely to suit both growing conditions. So farmers are more likely to have better harvests if they vary their crops.

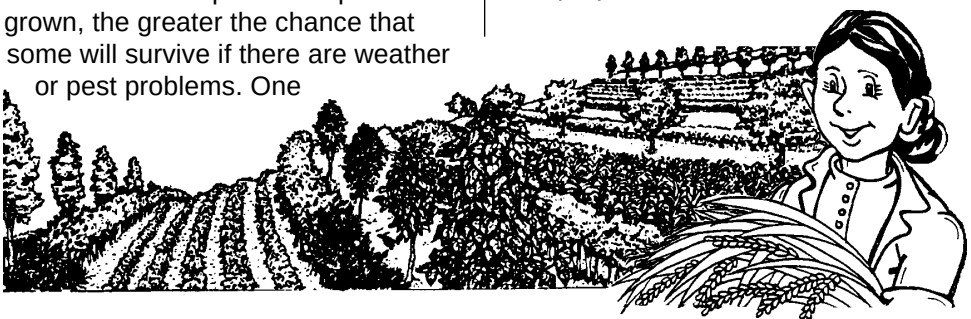
Varieties of crops that have been grown by local farmers for generation after generation are well suited to local weather conditions and soils. They are likely to be able to resist diseases and pests that are common in the region. These varieties will grow and produce a crop even if the farmer does not use chemical pesticides or fertilizers.

The more crops and crop varieties grown, the greater the chance that some will survive if there are weather or pest problems. One type of crop may get damaged if the weather gets very dry, or there's heavy rain or frost. But there's a good chance others will survive. Suppose several varieties of a crop are planted, each maturing at different times. If there is an early drought, the early variety may produce very little, but the late variety will be able to produce a crop when there are late rains.

Most insect pests and diseases attack only certain kinds of crops. They spread more quickly if a large area is planted with a single kind of crop. When farmers grow small areas or rows mixed with other crops, it's not so easy for pests to spread and cause damage. Different varieties of crops have different abilities to tolerate pests and diseases. If a farmer grows several varieties of a particular crop, they stand a better chance of reducing the damage from a pest outbreak.

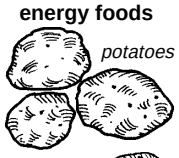
By growing several different crops, farmers have greater protection against low prices in the market. If they cannot get a good price for one crop, then they can harvest and sell other crops, too.

It is important to continue planting traditional varieties of crops, which have evolved to suit local growing conditions and cultures. Today's farmers are benefiting from the wealth of knowledge handed down by their parents, their grandparents and ancestors. But today's farmers need to be able to protect that legacy, and add to it. They can draw on the knowledge of their forefathers, experiment for themselves, and draw upon modern science to grow new crops that serve their purposes.

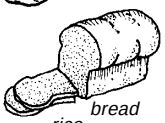


For a fertile soil and a reliable harvest, grow a variety of crops.

energy foods



potatoes



bread

rice

vegetable oil

sugar cane

sweet potato

taro

coconut cream

cassava

yam

For healthy lives, eat a variety of foods.

Adapted from "Grow many different crops and crop varieties", *Developing Countries Farm Radio Network (DCFRN) pack 18 item 5.* For further information contact: DCFRN, 416 Moore Avenue, Suite 101, Toronto, Canada M4G 1C9 tel: (416) 971-6333; fax: (416) 971-5299; website http://www.web.net/-dcfrn

SCRIPT FOR CHILDREN

SUGGESTIONS FOR USE:
Teachers, youth leaders: *As a play for students to read/perform as part of project work on agrobiodiversity and food supply; as a play for youth to perform for the local community or farmers' group in order to stimulate discussion on pest control and diversification of crops.*
Radio producers: *As the basis of a radio script to stimulate discussion on pest control and diversification of crops.*

Why Diversify?

This script describes some of the problems of monocultures and why it is important to promote agrobiodiversity. Adapt the script by including specific bugs that are pests in your area, and by describing local farming methods that encourage agrobiodiversity.

Characters:

3 bug pests;

a toad;

an insect-eating bird;

praying mantis (non-speaking part).

Scene 1: In a farmer's field

Bug 1: Stems, stems, and more juicy stems to eat!

Bug 2: We've never had it so good!

Bug 1: True! Once there were many different plants growing here, and all kinds of creatures living among them. But now the farmer plants just one crop, and it's our favourite food!

Bug 2: It's not just our favourite, it's our *only* food, and we can feast on it until harvest-time!

Bug 1: By then, there won't be much left for the farmer!

(Bug 1 and Bug 2 snigger.)

Bug 3: You don't think he'll let us get away with eating all his crops, do you? After all, he started growing a single crop because he thought it was the best way to grow more food. You know, people have to eat, too.

Bug 1: What can he do to stop us?

Bug 2: *(soberly)* Uh-oh, he could spray poison. He's done it before, and he could do it again.

Bug 1: But remember the stories about what happened the last time he sprayed?

Bug 3: They nearly wiped out our population!

Bug 1: *Nearly*. That's right. But *not all* of our relatives died, did they? Otherwise we wouldn't be around to tell the tale! The spray didn't kill some of our kin. They survived to have offspring who were immune to the poison, too.

Bug 2: True. And the poison killed a lot of insects that feed on us. With fewer enemies around and with lots of food available, our population grew really fast!

Bug 1: So what if the farmer does spray the crops with a new poison. It may kill many of us, but it's not likely to kill all of us!

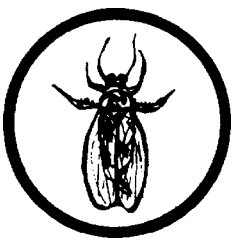
Bug 2: And it might harm our enemies, too!

Bug 3: You know, spraying pesticides is not the only trick the farmer can play on us, though.There are lots of ways he can kill us, or make our lives miserable!

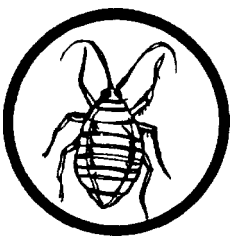
Bug 1: Like what?

Bug 3: I was talking to a beetle the other day. He had

Some harmful insects:



Fruit Fly



Aphid

Cutworm

Shoot and Fruit Borer/Stem Borer

come from the neighbour's farm, and he was very unhappy.

Bug 2: What was up?

Bug 3: Apparently, the farmer there is doing all kinds of things to make it hard for our kind to find food, or even survive!

Bug 1: *(worried)* What kinds of things?

Bug 3: Well, for one thing he's tried to trick pests by moving his crops every planting season, instead of planting them on the same land every year.

Bug 1: *(puzzled)* Moving his crops?

Bug 3: Yeah. Apparently a few years ago, the farmer divided the land into several sections. In each section he grew a different crop plant. Then, the following year, he grew the crop plants in different sections. So where he had grown a grain crop in the first year, he grew, say, sweet potato in the following year, and then beans the year after. It's called crop rotation.

Bug 2: Oh, I see! That could be big trouble for us! Imagine! There you are, feeding on your favourite crop plant, and laying your eggs in the ground so that your offspring will have a ready food supply. What a shock the larvae must have when they emerge from their eggs and find there's nothing to eat!

Bug 3: Yeah, all the bugs are complaining about it! What's more, the farmer is planting not just one variety of each crop plant. He's planting lots of different varieties.

Bug 1: What's the point of that?

Bug 3: Lots of reasons. For one thing, he's probably hedging his bets in case of bad weather or an outbreak of disease. Some varieties will survive better in a drought. Others are more resistant to diseases. And he's also done it because of pests like us. We find some crop varieties tasty, but other varieties are not appetizing at all.

Bug 1: This is not good news!

Bug 3: I'm worried our farmer will hear about these tricks, too.

Bug 2: I think we should find out more about these threats. I'm going over to that farm to see for myself!

Bug 3: Let's all go.

Scene 2: On The Neighbouring Farm

Bug 1: Goodness, this field is nothing like ours! There's all kinds of different crops growing here!

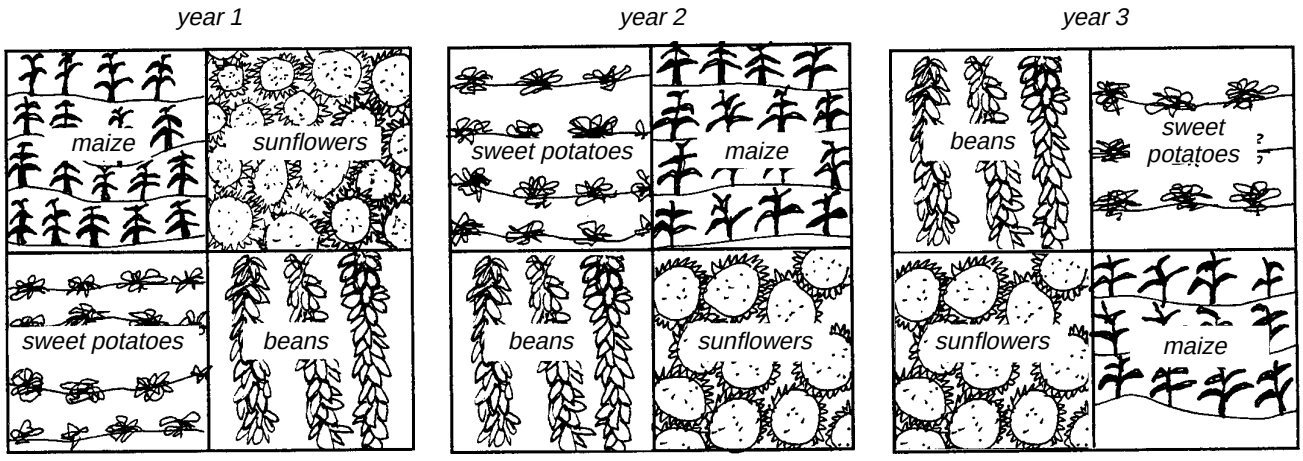
Bug 2: Yeah, there's rows of tall crops growing in the sun, short crops growing in the shade, and medium-sized plants, too!

Bug 1: And just look at all the different insects and other creatures! This is more like what life's like in wild places beyond the field boundaries. Quite a multi-cultural experience!

Bug 3: The beetle was telling me about this. He said the farmer called this type of farming, intercropping. The farmer realises that in wild places, where there is a lot of diversity of plants and animals, there are fewer big outbreaks of diseases and pests. So, he thinks if he makes his fields more diverse, then he'll have fewer problems with pests and diseases. Unfortunately, he's probably right.

Bug 1: Why?

Crop rotation



Bug 3: Just like the beetle said, when farmers start intercropping or increasing diversity in their fields, it means there are fewer plants to suit the particular needs of pests like us. And our food is much harder to find.

Bug 2: Perhaps....Uh oh, let's get out of here quick!

Bug 1: What's the matter?

Bug 3: Look over there. A praying mantis. Run!

(The insects move to another part of the field.)

Bug 2: Phew! We were lucky to escape that time! That creature looked hungry!

Bug 3: Well, Increasing diversity in the field attracts all sorts of creatures.

Bug 1: Yeah, creatures that prey on the likes of us!

Bug 2: Talking of food. I'm hungry. Com'on. Let's find some stems to eat.

Bug 2: Okay.... Poooh! What's that stink?

Bug 3: It's coming from those herbs!

Bug 2: Let's get away from them!

Bug 3: But what if we have to get past those herbs to reach our food supply?

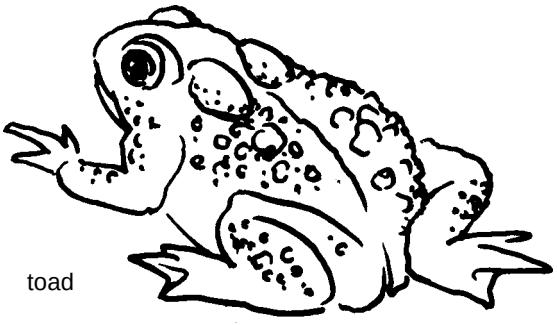
Bug 2: I don't care. I'm not going that way. Besides, the aroma is so strong, we wouldn't be able to detect our food supply anyway.

Bug 3: I bet this is another of the farmer's tricks to keep us at bay!

Bug 2: Shhhh. What's that sound? Those twigs are moving. I sense danger!

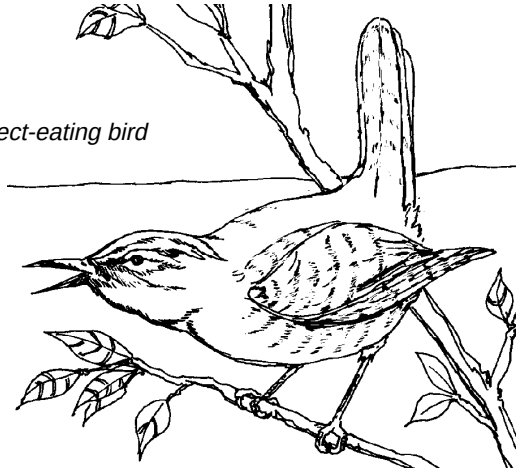
Toad: *(emerging from a small house made of twigs and leaves)* I'm a lucky old toad. What a lovely home the farmer's son made me out of twigs and leaves. It's so cool and shady here. Now I'll return the favour, and eat the farmer's insect pests. I'm so hungry! What's that? (*A bird flutters down to cling to a plant stalk.)* Oh, bird, you startled me. I was afraid you were going to try to catch me.

Bird: No, I'm searching among the crops for caterpillars to eat.



toad

insect-eating bird



Toad: How's life treating you?

Bird: Life is good now. Until I came here, I was struggling to find a safe place to live. Many of the wild places have become farmland. But now I've built a nest down by the stream on the land the farmer has left to grow wild. And I'm finding plenty of insects in the fields to eat. Looks like the farmer and I are helping each other!

Toad: Same goes for me, and just look at us! We both seem to be thriving! I'm so glad the farmer is trying to use nature to help protect his crops, instead of being so dependent upon poisons to keep the insect pests from damaging the plants.

Bird: Yeah, without poisons, it's safer for everyone. Goodbye. *(The bird flutters away.)*

Toad: I'd best be on my way, too. *(The toad disappears.)*

Bug 1: *(Emerges from his hiding place, in an indignant mood)* Safe! Did that bird say "Safe!"? It may be safer for them, but it's not safe for creatures who feast on crop plants!

Bug 2: Look! I see our farmer.... Oh no! He's talking to the farmer of this field...

Bug 3: Our future does not look bright, my friends!

The end

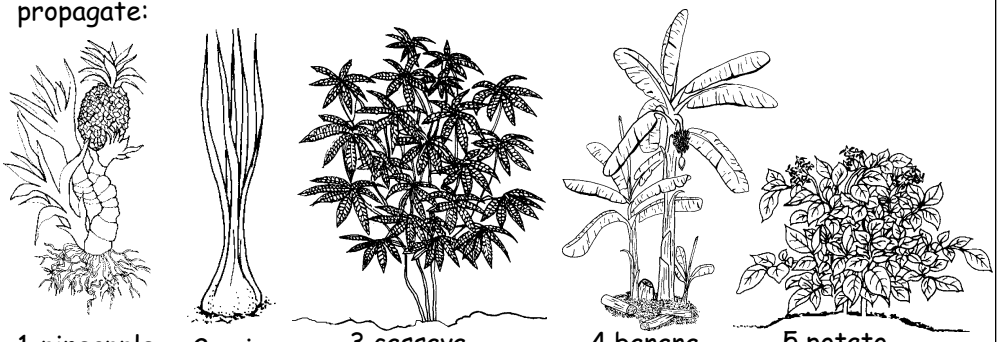
PUZZLES

SUGGESTIONS FOR USE:
Teachers, newspaper editors: *As entertaining ways to increase children's awareness of preserving genetic diversity in crop plants*

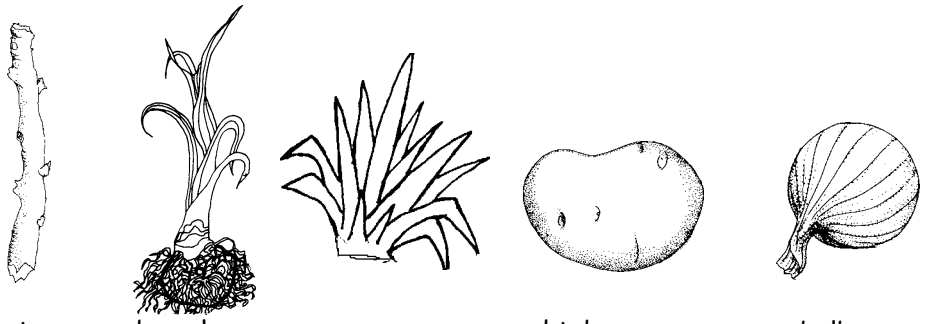
FUN PAGE

PLANT PARTS

When a plant is able to produce a new, complete individual from part of another one, it is capable of **vegetative propagation** or **asexual reproduction**. Most plants that naturally reproduce vegetatively will also reproduce from seed. Match each plant in the top row with the plant part by which it can vegetatively propagate:



1. pineapple 2.onion 3.cassava 4.banana 5.potato



a. stem b.sucker c. crown d. tuber e. bulb

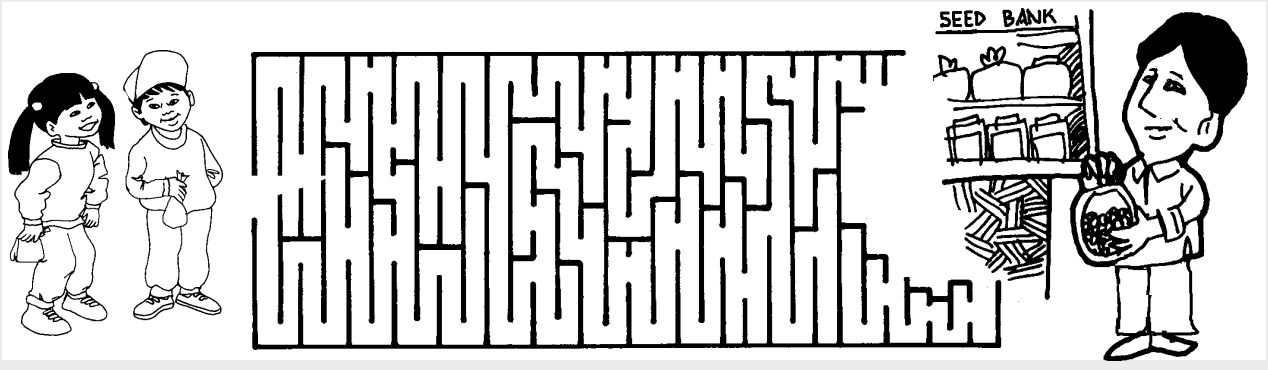
FROM SEED TO BANK

Try getting the SEED to the seed BANK in this puzzle. Start with the word SEED, then change one letter to make a new word. Keep changing one letter at a time to make new words until you have made the word BANK:

S E E D
_ _ _ _
_ _ _ _
_ _ _ _
B A N K

A-MAZE-ING SEEDS

Yu Li and Guo Yan want to get the seed they have collected to the community seed bank. Help them find their way through the maze.



Answers:
Plant parts: 1c and 1b (pineapples can be grown from suckers and crowns or tops); 2e; 3a; 4b (banana plants can also be vegetatively propagated by dividing their corms); 5d.
From SEED TO BANK: There is not just one answer. One way is SEED, SEND, SAND, SANK, BANK

QUESTIONS AND ANSWERS

SUGGESTIONS FOR USE:
Radio broadcasters, newspaper editors: *As the basis of a radio programme or article aimed at encouraging farmers and gardeners to begin experimentation with crop varieties and methods of crop cultivation.*
Teachers: *As an introduction to project work in crop breeding in school gardens.*

Garden And Field Trials

To do plant breeding or explore better ways to grow crops, you need to be able to set up garden/field trials to evaluate plant varieties or cultivation methods. This two-part series of scripts explains why garden trials are important, and some points to consider when you are designing, conducting and evaluating a trial.

PART 1: WHY CONDUCT GARDEN AND FIELD TRIALS?

Today, we are going to talk about why garden trials are important, and what you need to think about when you are designing one.

Q. Why should farmers and gardeners conduct trials?

A. For two reasons. Firstly, sometimes they may want to compare different varieties under the same conditions to find out which variety yields more, tastes better or has more resistance to pests or diseases. Secondly, farmers may want to find better ways to grow a specific crop or crop variety. In this type of trial, one variety is grown, and different cultivation techniques are compared.

Q. Can you grow as much food when you do garden or field trials?

A. Properly designed, a trial plot can produce nearly as much food as the same size plot planted in a single variety. After all, you can eat your trial results! And of course, trial plots yield more than just food - they provide information, too.

Q. How big does a trial plot have to be?

A. That depends on the crop and on what you want to measure. Sometimes you can get good results by planting just a few plants or a couple of rows of each new variety that you want to try.

Q. Does it take a lot of extra work to conduct a trial?

A. Not necessarily. A trial comparing two varieties of your usual crop usually yields good information for very little work. Such trials are very easy to set up, run and evaluate.

Q, Do you have to be a trained scientist to conduct trials?

A. No. Good plant research does require good design, execution and analysis of your trials. But good research is also just playing around, just trying things out to satisfy your own curiosity.

Q. So how do you set up a good trial?

A. Learning how to set up a successful trial comes with experience. The more you experiment, the easier it becomes. But there are a few key rules to follow. For a start, you need to be very clear about what question you are trying to answer by doing a trial. Do you want to know if one variety has a bigger yield than another? Maybe you may want to know if a new variety grows better at a higher or lower elevation. It's important to think about what kind of answer you are looking for.

Q. Why?

A. Because thinking of the answer you are looking for can help you design a good trial. It can help you decide what information you need to observe, record and evaluate.

Q. What else should you think about before you plant?

A. Where you should plant the trial crops. If your plants will need a lot of attention, then it makes sense to plant them closer to your home. You may need to grow the crop on land where you haven't grown a similar crop recently. If the same crop was planted the previous year, seed from the previous crop may still be in the soil, and may be confused with the new varieties. Also changing fields means that the new varieties are less likely to be affected by diseases that afflicted previous crops.

Q. How much space should you set aside for a garden trial?

A. Obviously, that depends upon on what kind of trial you are conducting, and how uniform your growing area is. If your growing area is not uniform, you probably need more replications of each variety or each cultivation method that you are testing. If you plan to save seeds from your trials, then you may have to be careful about

keeping apart varieties that can cross-pollinate.

Q. How many varieties or cultivation methods should you test at one time?

A. This may depend upon how many you can handle. The evaluation can take time. If you find you have tried to test more varieties or cultivation methods than you can handle, then just decide which are the most important, and then finish evaluating those particular trials. The simplest meaningful trial is one comparing a new variety or cultivation method with one that you know well.

Q. Why is this type of test meaningful?

A. Because if you grow a new variety with one (or better still, more than one) standard variety, then you have a control against which you can measure the new variety. By growing a control variety in the same garden plot, you can compare the growth of the two varieties. If the control variety grows well and the new variety does not, then you can assume the new variety does not suit your garden. If the control and the new variety grow poorly, then it is likely to be something other than the genetics of the plants that is hampering growth. For example, a prolonged dry spell could have affected the harvest, or maybe you could have fertilized the soil, but made it too rich in nitrogen, causing poor flowering and fruit yield.

Q. What varieties should you use to measure your new varieties?

A. It depends upon what you are trying to test. For example, if you are testing the resistance of a variety to a particular disease, you should try to compare it with a variety that is known to be resistant to the disease and a variety that you know is affected by the disease. If you are testing the result of a cross, it's good idea to grow a few plants of the original parents for comparison.

Q. What controls should you use if you are testing different cultivation methods rather than comparing different varieties?

A. The control would be the method you are currently using. For example, if you are trying to see if mulching would help your plants, and you currently do not mulch, then plants with no mulch would be your control. If you are assessing how much mulch would be most effective, if at all, then you would also include plots with different amounts of mulch around the plants.

We have talked about why garden trials are important, and how to make them meaningful. Next time, we will discuss conducting and evaluating garden trials.

excerpt from Issue Pack: Genetic Diversity and Food Crops, Activity Guide 1 Introduction to Genetics

ACTIVITY 1-3

Punnett Squares

SECONDARY LEVEL

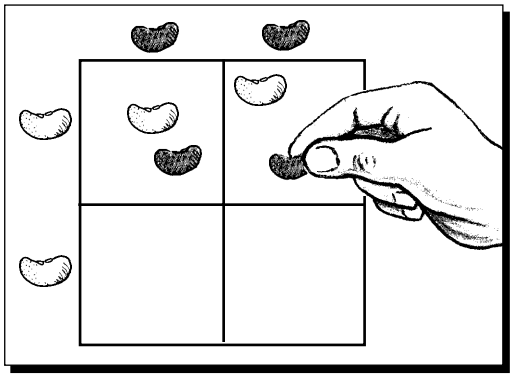
Objective:
To use a Punnett Square to demonstrate transfer of factors from one generation to another.

Materials:
- Paper and pencil
- Beans of two different colours, for example, red and white
- Red pencil or crayon

Place:
Inside or outside

An easier way to find the possible combinations of factors in the offspring of two parents is to use a diagram called a Punnett Square.

1 Draw a square with four boxes in it, as shown below.



2 Use two red beans to represent the two red factors in the male, and place them at the top of the square. Use two white beans to represent the two white factors in the female, and place them along the left side of the square.

3 Separate the two red beans, and place one at the top of each column to represent the kind of sex cells produced. Separate the two white beans, and place them at the left side of each row.

4 Now place all the possible combinations of red factors and white factors in the boxes. The combination of factors in each box of the square is found simply by

placing the column factor next to the row factor. Colour in the boxes that contain a factor for red flower colour. This represents the F_1 generation.

5 Repeat steps 1-4, but this time show a cross between two plants that each have one red and one white factor. This represents the F_2 generation.

Conclusions

1. Did you find it easier to find the possible combinations of factors in offspring using this method?
2. Instead of beans, you can use capital or lower case letters to represent factors. The Punnett Square on the right shows the cross between two parents that each have a short and a tall factor. The capital letter **T** stands for the dominant factor tall and the lowercase letter **t** stands for the recessive factor short. Draw Punnett Squares to show the crosses Mendel made between yellow-seeded plants and green-seeded plants; between round-seeded plants and wrinkle-seeded plants. Show the crosses that result in both the F_1 and F_2 generations.
3. In squash a factor for white colour (W) is dominant over the factor for yellow colour (w). Give the ratios for the results of each of the following crosses: WW x ww; Ww x ww; Ww x Ww.
4. Suppose you did not know if a squash had the factors Ww or WW. What cross could you make to find out?

Punnett Square

	T	t
T	TT	Tt
t	Tt	tt

excerpt from Issue Pack: Genetic Diversity and Food Crops, Activity Guide 2 What is Genetic Diversity?

ACTIVITY 2-3

PRIMARY LEVEL

SECONDARY LEVEL

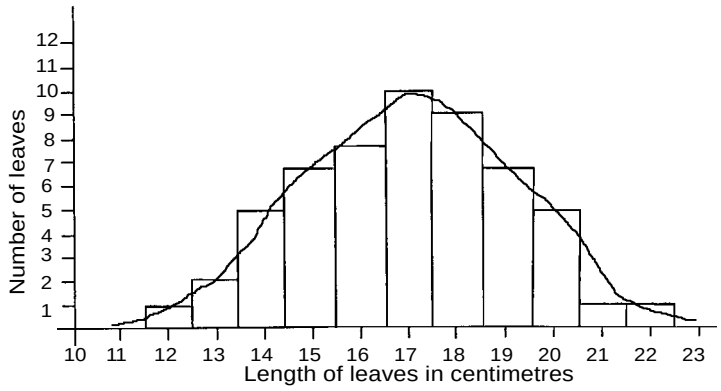
Measuring Variation In A Plant Population

Objective:
To measure variation in a plant popuation

Materials:
- Small ruler
- Paper and pencil

Place:
Garden or field

In this activity, you will measure the variation that exists within a plant population. For example, a population may consist of all the dandelions growing in a school lawn. They all belong to the same species, live in the same area, and can pollinate each other and make seeds. If the individuals in a plant population come in many different sizes, shapes, and colours, then there is probably a lot of genetic diversity within the population. On the other hand, if all the plants are uniform, then the genetic diversity of the population is probably small.



1. As a class, explore the school yard or a field for a plant population with an easily measurable trait. Examples might include the height of, or the size of, a certain kind of plant. Or, you might compare the average size of fruits or pods that grow on different plants of one species. Decide as a class what particular trait will be measured.
2. Find plant specimens with the largest and smallest measurements of the trait. Compare your specimens with ones found by classmates. Use the largest and smallest measurements as the values to set up the X and Y axes on the class graph that will be used to record results.

3. Randomly choose 10 of the plants to measure. Record your data, and that of other classmates, on a class graph like the one shown on the previous page. This particular chart measured the length of leaves of plant specimens.

Conclusions

1. What is the shape of your graph? Are most individuals in the middle of the graph? Are there fewer at the extremes of small and large?
2. Is there high or low genetic diversity within the population of plants you measured? Explain.
3. What other factors, besides genetic makeup, might affect the size of plants or plant parts?

excerpt from Issue Pack: Genetic Diversity and Food Crops, Activity Guide 3 Local Crop Diversity

ACTIVITY 3-1

PRIMARY LEVEL

SECONDARY LEVEL

Scavenger Hunt For Plant Varieties

Objective:
To discover crop biodiversity in the local area

Materials:
- pen and paper

Place:
local farms and gardens

CAUTION

If you would like to search for plants on private land, make sure you ask permission from the landowner beforehand. Tell him or her what you are doing, and if you are allowed on the land, be careful not to damage any crops or property.

You are going on a scavenger hunt to explore crop biodiversity in your area.

1. As a class, decide where the boundaries for your scavenger hunt should be. Draw a map of the area you are going to search. Mark the locations of farms and gardens you are going to visit.
2. Study the Scavenger Hunt List on the left, and discuss in class the deadline for the Scavenger Hunt.
3. In groups of 3-5 students, try to find as many pairs of plant varieties as you can. You can rely on your own observations, but you may also ask for help from farmers.
4. When you find a plant variety described in the list, ask the landowner/farmer for a sample leaf or fruit from the plant. Also ask for

Scavenger Hunt List

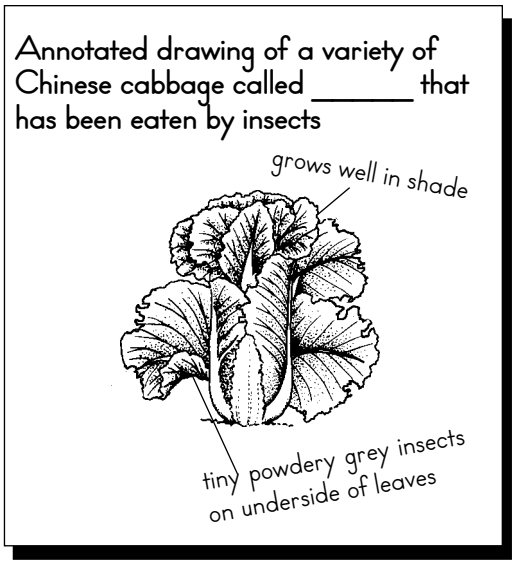
Look for two varieties of the same crop that fit the description of each of these pairs of plant varieties. For example, if you find a tomato variety that has small fruit, try to find a tomato variety that has large fruit, too. If you find a cassava variety growing well poor soil, try to find a variety that does not grow well in poor soil.

- A plant variety that shows signs of disease, and a variety of the same crop growing in the same area that is not diseased.
- A plant variety that is being eaten by insects or other pests, and a variety of the same crop in the same area that is pest–free.
- A plant variety that grows well in poor soil, and a variety of the same crop that does not grow well in poor soil.
- A plant variety that has large fruit, and a variety of the same crop that has small fruit.
- A plant variety that thrives in drought conditions, and a variety of the same crop that does not grow well in drought.
- A plant variety that thrives in wet soil, and a variety of the same crop that does not grow well in wet soil.
- A plant variety that has a long growing season, and a variety of the same crop that has a short growing season.
- A plant variety that has a high yield, and a variety of the same crop that has a low yield.
- A plant variety which is distinctly different in appearance from other plants of the same species.

collecting sample specimens from a farmer.

the name of the variety. Draw a picture of the plant, and mark its location on your map. Write down notes on the plant's important features (see picture).

5. Compare your findings with those of other groups in the class. Gather together information for each crop plant.
6. Create a class display showing the results of the scavenger hunt. Include in the display the maps and sample leaves and pictures of the different varieties of crops you have found.



Conclusions

1. Did you find an example of all the plants described in the list?
2. How many different varieties of each local crop did your class find?
3. From the scavenger hunt results, which crop has the greatest diversity? Why do you think this is so?

excerpt from Issue Pack: Genetic Diversity and Food Crops, Activity Guide 4 Biotechnology and Biodiversity

ACTIVITY 4-2

PRIMARY LEVEL

SECONDARY LEVEL

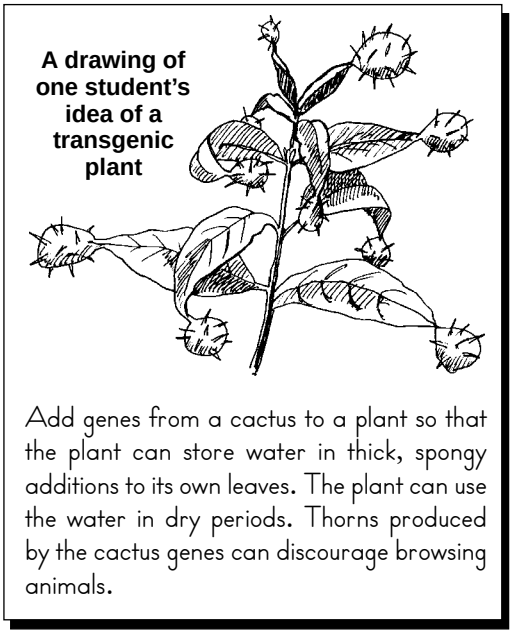
Design A Transgenic Species

Objective:
To imagine a transgenic species that contains genes from another existing plant or animal.

Materials:
- Paper and pencil;
- Materials for costume and props.

Place:
Inside or outside

1. Get your creative juices going in this activity! Think of a plant or animal that you would like to improve in some way. Decide what extra feature you would like to give it that will enable the plant or animal to do something better, or to do something it otherwise could not do. The catch is, the new feature has to be from another living thing. In theory, at least, the feature-creating genes must be taken from another living thing and inserted into your plant or animal.
2. Draw a picture of your "transgenic" plant or animal with its new feature. If the new feature is not visible, write notes to describe it. Explain which plant or animal the new feature came from, and how the new feature will help the transgenic species.
3. With a group of friends or classmates, create and present a humorous performance in which your transgenic plant or animal demonstrates its advantages.



ACTIVITY 1-1

PRIMARY LEVEL

SECONDARY LEVEL

Objectives:
To record growth of crops
To analyse which plants should provide seed for saving
To collect, dry and store seed

Materials:
- Paper and pencil
- Cloth strips
- Stakes

Place:
Garden or field

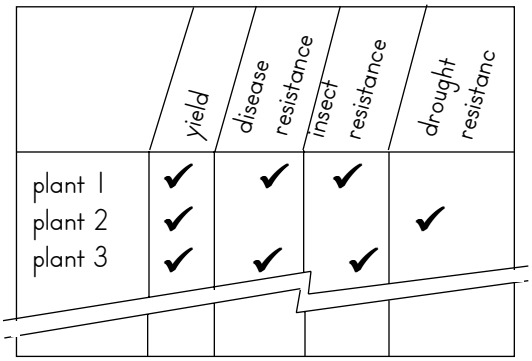
Saving Seeds

Selecting good plants is the key to any seed-saving effort. If you are careful in choosing the seed that you save, you can not only maintain your varieties, but also improve and refine them. You'll want to save seed from your best plants, but don't wait until harvest to make your selections. Watch your plants throughout the growing season, keeping in mind the traits you most want to encourage. It is the whole plant, rather than an isolated individual fruit, that you should consider in making your selections.

1. Choose a variety from which you wish to save seed. Review the list of plant qualities shown here. Choose the traits that are most important to you.

Plant Qualities:
Flavour and smell
Yield
Vigour
Colour
Size
Stature (tall or dwarf)
Storage life
Disease resistance
Insect resistance
Texture, tenderness or juiciness
Suitability for their purpose
Weather tolerance
Drought resistance

2. Make a chart listing those traits, and/or other desirable traits (see above right).
3. Watch the plants throughout the growing season, keeping in mind the qualities you most want to encourage. Stake those plants that have your desired traits. Tie a cloth around the stake or plant so the plants are easy to find. Write a number on each stake. On your chart write the numbers of the plants you have selected next to the plant qualities that it exhibits (see chart above).

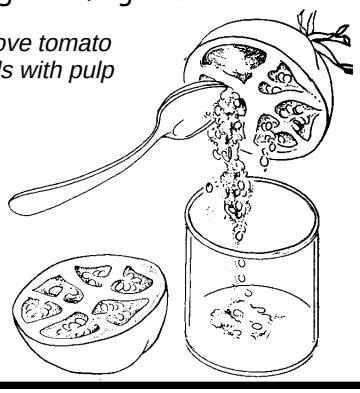


4. Wait for the seeds to ripen. Seeds picked too early, before they have time to mature, will not have had a chance to accumulate enough stored nourishment to get them off to a good start. Such seed will be thin and light in weight, and less likely to survive storage, germinate well, or produce strong seedlings. (Study the box on the next page for information on harvesting different types of seeds.)
5. Collect seeds from your chosen plants on a dry, sunny day after the dew has evaporated. Make sure to label each batch of seeds as soon as possible after collecting, so that you will know the desirable traits of each lot of seeds.
6. Clean and dry the seeds as described in the box on the next page.
7. Make sure seeds are thoroughly dry before storing them. Leave the seeds exposed in a dry room with good air circulation for several days. Heat and humidity can seriously damage seeds.
8. In order to remain viable as long as possible, seeds should be stored under cool and dry conditions. Store them in a house or shed shaded from the sun. Do not let moist air get to them. Put them in airtight jars or cans, except for beans and peas, which require open air. These can be stored in paper bags instead. To make a jar or can airtight, you can coat the rim of the opening with oil or grease to make an airtight

Harvesting, Cleaning and Drying Seeds

Plants with seeds encased in fleshy fruits, such as tomatoes, cucumbers and melons

1. Let the fruits turn a bit overripe before collecting seeds.
2. Do not let the fruit dry around the seeds.
3. Cut or crush to remove seeds with pulp.
4. Place in a small container and ferment 3-4 days at 60-70°F, until jelly-like pulp is gone and seeds feel rough instead of slippery.
5. Wash seeds by adding water, stirring, and allowing seeds to settle.
6. Floating seeds should be discarded.
7. Repeat as necessary, then dry seed for two days.
8. After drying, break apart seeds that stick together by gently rubbing with fingers.



Plants with fruits like squash or pumpkins

1. Seeds are mature when the fruit is ready to eat.
2. To harvest seed, scoop out seeds and pulp, and rinse.
3. Flattened or hollow seeds should be discarded.
4. Viable seeds may sink or float, so don't throw away floaters.
5. Spread seeds on paper or screen to dry.

Seed crops such as corn, beans, and wheat

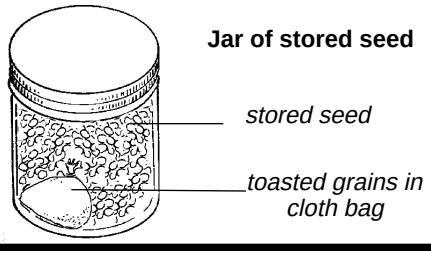
1. Let the seeds become thoroughly dry.
2. If the plants tend to bend in the wind or rain, cut and stack them in a dry place to cure and further dry them before removing the seeds.

Plants that have seed heads which drop seeds readily, such as onions and crops in the mustard family

1. As seeds ripen, place a paper bag securely around the seed head.
2. Shake the seed head vigourously into the bag several times over 1-2 weeks.
3. Winnow out the immature seeds by pouring from one container to another in a breeze.

seal, or think of some other way to seal the container.

9. To be sure the seeds stay dry, you can use a drying agent made of freshly toasted grains. Put some rice, wheat, maize or dried peas in a shallow pan over your stove to dry them completely. They should not be burned, only toasted a little. As soon as they have cooled down, put the toasted grains in a little cloth bag and put in the container with the seed. If you open the jart o take out seeds, replace the toasted seeds with fresh ones.
10. Label each bag or jar with the variety, date, and any other pertinent information.



Conclusions

Write a report about your results. The report should include information on:

1) the crops you cultivated;
2) the plant qualities you are trying to encourage;
3) the important observations you made over the growing season;
4) the crops from which you saved seeds and why;
5) when and how you harvested and stored your seeds.

GARDENING RESEARCH

To do plant breeding, you need to be able to set up garden trials to evaluate varieties. Garden trials are scientific research, and require good experimental design, execution and analysis. But gardening trials are also just playing around, just trying things out to satisfy your curiosity. And properly designed, a trial plot can usually produce nearly as much food as the same amount of space planted to a single variety. And it yields information as well as food. The checklist below gives some points to consider when designing a garden trial.

Checklist for Garden Trials

Keeping Records

1. Record things in a way that allows you to find all the information about one trial easily. For example, you could keep a separate file for each kind of crop.
2. Record dates, which often turn out to matter. Planting, flowering, and harvest dates are often useful.
3. Record the sources of all your seeds.
4. Record the weather, which can affect all your trials in a given year.
5. Record what you plant, both in the garden and on paper. Markers in the garden may get pulled up or fade, so you need something on paper to figure out what is in the garden.
6. Record anything that goes wrong as it happens.

DESIGNING AND CONDUCTING A TRIAL

Sample Plan for a Tomato Variety Trial

②	③	①	②	④
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
①	④	⑤	③	⑤
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X

In this plan, varieties were randomly assigned to plots. This was done by drawing their numbers from a hat.

X = location of plant in plot

No. 1 Tomato control: variety: Big Tom
No. 2 Tomato new variety: Cross 1x3
No. 3 Tomato control: variety: Hearty Red
No. 4 Tomato new variety: Cross 3x5
No. 5 Tomato control: variety: Wiltless Will

1. Decide what questions you are trying to answer and what the answers are likely to be.
2. Work out where you should plant, and how much space you will need, including space required to separate different varieties.
3. Decide how many varieties you want to test, and how many you can handle.
4. Remember to include controls. In the same garden patch where the new variety is growing you need to grow varieties of the same kind of plant that you are already familiar with - a standard with which you can compare the new variety. If you plant

a new variety and it does not do well, that means nothing without seeing how well the control plants grow under the same growing conditions.

5. Whenever you grow out the seeds from a cross, also grow out a little of each of the two original parents for comparison.
6. Whenever you evaluate the disease resistance of a new variety, try to include at least one variety known to be resistant to the disease and one variety known to be sensitive to it as controls.
7. Work out how many plants you need of each variety. If the growing area is not uniform, you probably need one or more replicas of each variety and control planted in different areas of the plot.

EVALUATING TRIALS

1. When evaluating trials, take the environment into account. For example, plants at the edges of patches are usually larger than those in the middle, so you may need to take edge effects into account. Or some areas of the patch may be more shaded than other areas.
2. Notice and record any evidence of variation within a variety. Do the plants that are supposed to be all the same variety look like it, or do they appear to be a mixture?
3. Take measurements of yield, because general impressions can be misleading.
4. As you record and evaluate your trials, ask yourself whether the results you got answered the questions you were asking.
5. Remember that all experiments are flawed. Record what the flaws or limitations are. For example, you might have planted later than the ideal planting date, or perhaps part of the planting was shaded.
6. Once you have your results, decide what to do with them. Usually your judgment is to grow something again or not, or to grow more of something or not, or to grow it a different way.