TOPIC 4

Meeting the Need for Food and Fibre

Figure 2.40 Canadian food and fibre products are exported to countries around the world.

Canadians have used our tremendous natural resources and expertise in agriculture to become major world producers of food and fibre. Millions of people are employed producing, transporting, and processing agriculture and forestry products. We grow far more than we consume, so we export, or sell, our surpluses to other countries around the world. Canada is also a leader in agricultural and forestry science.

While Canada has earned a lot of its wealth from forestry and agriculture, this success has led to challenges and problems. For example, as you learned in Unit 1, much of the native prairie grassland has been changed into agricultural fields. How has this changed the native plants and animals that grew here before land was cleared for farms and cities? Harvesting timber from forests changes the nature of that ecosystem as well.

Figure 2.41 The organisms within a natural system live in a balance. When the timber was harvested from the area shown here, all of the organisms that lived there were affected.

Canadian scientists are working to understand more about how the complex natural systems work. Scientists, farmers, and foresters are developing practices that will reduce negative effects that sometimes occur when we harvest plants for food and fibre. We are concerned about **sustainability** — being able to grow food and fibre while keeping our natural systems healthy for the long term.

In this Topic you will learn about food and fibre plants that grow in Alberta, some of the practices used to produce them, and some of the problems we created in our attempts to produce more.

Agriculture in Alberta

Agriculture is an important but very new industry in Alberta today.

The first settlers from Europe found communities of Aboriginal people who had lived with nature for thousands of years. In general, the European pioneers cut the trees on large areas of forest and cultivated the grasslands so that they could grow crops. In the forests, the supply of wood seemed limitless, and it was used for construction, manufacturing, and fuel.

Figure 2.42 In less than 30 years after settlers arrived in Alberta, most of the native grassland was converted to cropland.

Pause & Reflect

When natural areas are cultivated to grow crops, native plants there are destroyed. What changes do you think might occur in soil underneath grassland when it is cultivated year after year? If you wanted to restore the cropland to the original grassland, what would you have to do? Record your answers in your Science Log.

In the late 1800s and early 1900s, thousands of settlers came to western Canada on the new railway. Early crops and prices were good, export markets were discovered, and farmers were encouraged to grow more and more grain. Within a period of 30 years, settlers occupied nearly all of the grassland in the prairie provinces and had ploughed up much of the native plants that had grown there for thousands of years.

As you can see in Figure 2.43, a large area of aspen parkland, grassland, and boreal forest in Alberta has been cultivated to grow crops. Of the 60 million hectare land area of Alberta, over 20 million is now managed as farmland.

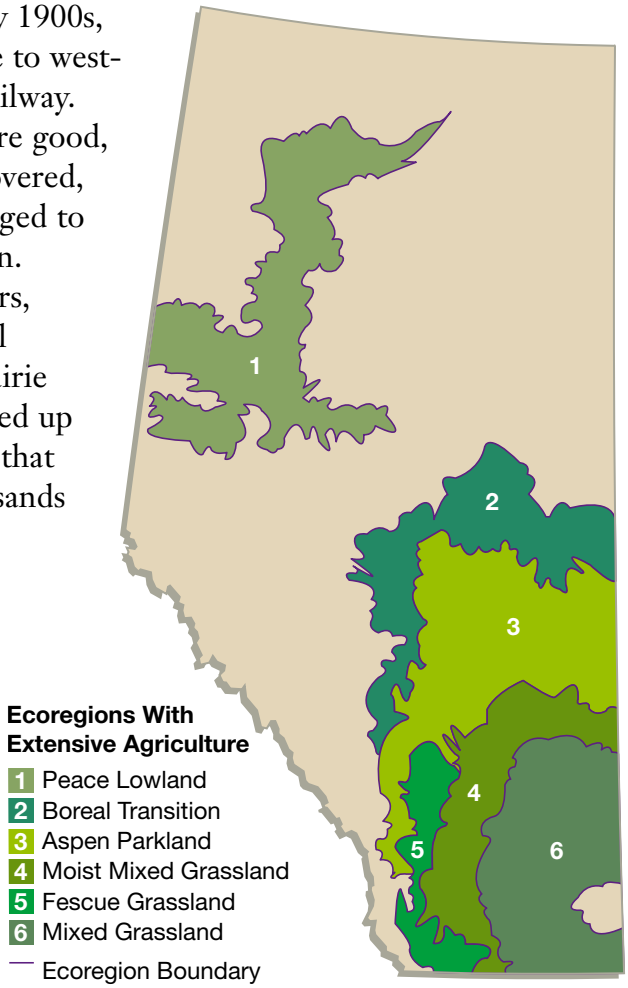


Figure 2.43 Native grassland and forest that has been cultivated and converted to cropland.

Who's Who in Crop Country?

If you were to travel from Athabasca to Lethbridge, you would drive all day and never leave fields producing food. Every year, Alberta farmers produce food crops worth almost $3 billion. The food industry is second only to oil and natural gas in terms of earnings. Wheat, canola, barley, and oats are all grown for their seeds and are the most common field crops in Alberta. These crops are also sold in large quantities to other countries.

Wheat

One-third of the world's people use wheat to make food. The seeds of this billion-dollar Alberta crop are ground to produce flour for making bread, pasta, and hundreds of processed products. Wheat seeds can tolerate cool soil and are planted early in the spring. The crop needs a long growing season, though, so it is most successful in the southern part of the province.

Oats

Most of the oats grown are fed to livestock. Horse trainers from Kentucky even request oats from Alberta. This grain is eaten by people, too. The oat plant is best adapted to the cooler and moister regions of Alberta. It also grows well in acidic or poorly drained soils. It is planted along the forests in the northern and western regions.

Canola

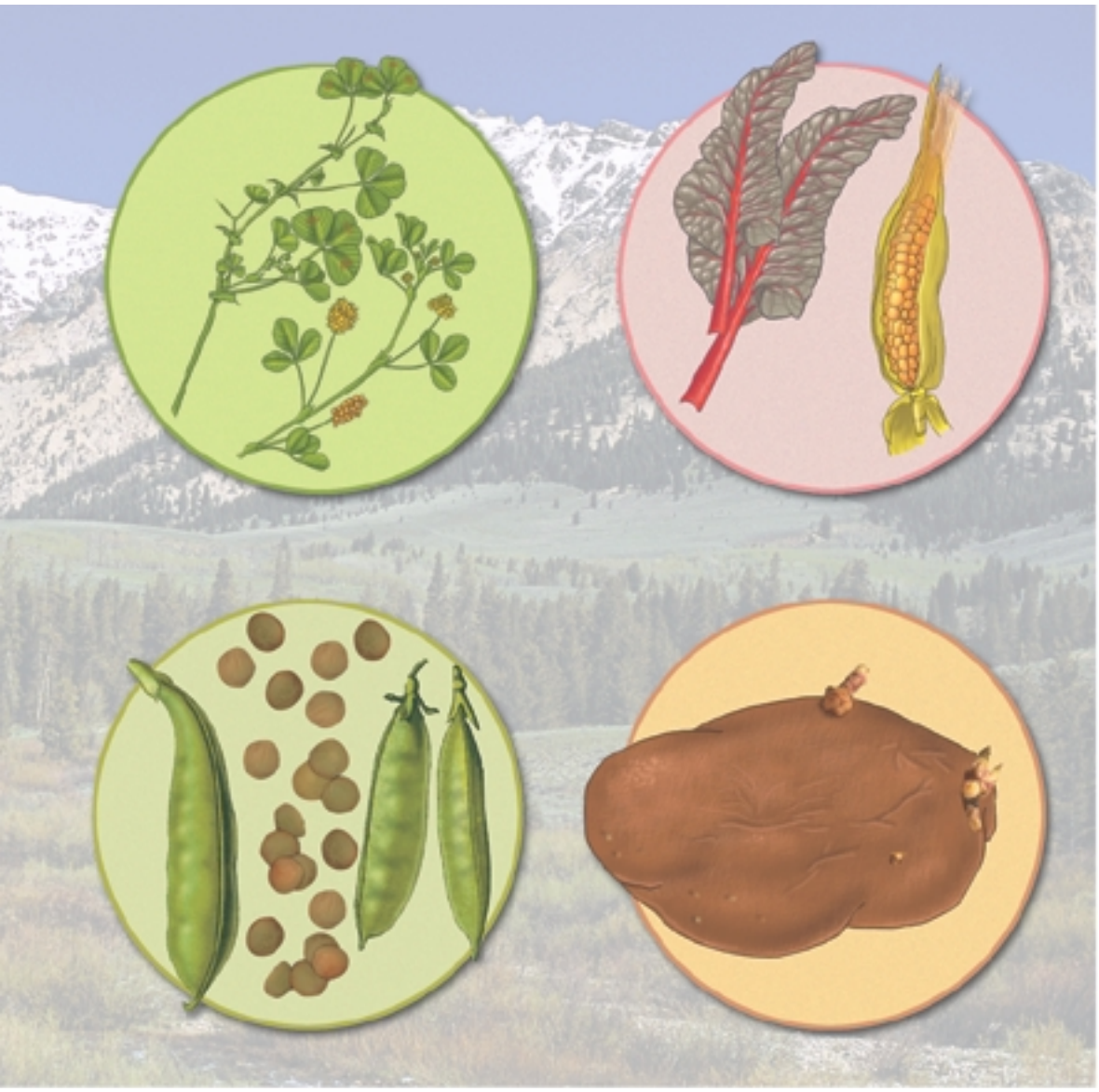
Canola is the second most valuable Alberta crop. Oil is pressed out of the seed and is used to make margarine, cooking oil, and salad dressing. Livestock and poultry eat the leftover "meal," which is high in protein.

Barley

The third most valuable crop in Alberta is barley. Barley can tolerate saltier soils and drier conditions than other crops. Most barley is fed to livestock and about one-quarter is used by humans for making malt flavouring for use in many foods.

DidYouKnow?

Field corn is a grain crop that is used to make silage to feed dairy cattle. (Silage is a finely chopped crop that is allowed to ferment.) Field corn has a higher yield per hectare than any other crop, and provides more energy per kilogram than any other type of silage. Older varieties of corn, however, needed quite a bit of heat to germinate and grow. For this reason, field corn could only be grown in southern Alberta. Recently, plant breeders created a variety that needs much less heat to grow. Now farmers in central and southern Alberta can grow field corn for silage, too.



Specialty Crops

The extra heat and irrigation available in parts of southern Alberta enable farmers to grow sunflowers and other crops that cannot be grown elsewhere. These specialty crops include beans, field corn, sugar beets, lentils, safflower, and spices.

Alfalfa

Some crops are not grown for their seeds, but for their leaves and stems. These crops are fed to livestock and are known as hay crops or forages. Alfalfa is the most common forage crop. It has a strong taproot that penetrates deep into soil in search of water and nutrients.

Legumes

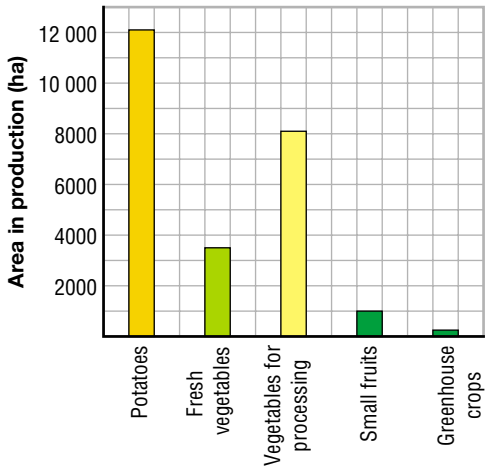
The Parkland and Peace River regions of Alberta have cool, wet growing seasons and are ideally suited to growing high-protein legume crops such as field peas, faba (or fava) beans, and lentils.

Potatoes

Much of Alberta has a cool climate that is ideal for growing potatoes. About half of Alberta potatoes are processed into frozen french fries and potato chips. Each year, about $20 million worth of potatoes are sold as seed to other farmers.

Fruit and Vegetable Crops

Vegetables and fruit crops are a multimillion-dollar industry in Alberta. Potatoes are the most valuable vegetable crop and are worth over $55 million each year. Alberta also grows a variety of vegetables that are sold fresh (including carrots, cabbage, onions, cauliflower) and others that are processed by canning or freezing (peas, beans, and corn). Market gardens grow specialty vegetables that are not generally grown in large crops, and also grow fruits such as raspberries, blueberries, and Saskatoon berries. Finally, tree and shrub nurseries, and commercial greenhouses are a small but important part of Alberta's agriculture industry.



Fresh vegetables = carrots, cabbage, cucumbers, cauliflower

Processed vegetables = peas, beans, corn, carrots

Greenhouse crops = bedding plants, potted plants, cucumbers, tomatoes, flowers, lettuce, peppers

Find Out ACTIVITY

Procedure

Performing and Recording
Analyzing and Interpreting

1. In southern Ontario and in the Vancouver area of British Columbia, fruits and vegetables are much more important crops than wheat, canola, and barley. The reverse is true in Alberta. In a small group, brainstorm the possible reasons for this difference.
2. Choose a fruit or vegetable crop and investigate how and where it is grown in Alberta. The Internet Connect on this page will also help you with your research.
3. Present your findings to your class.

What Did You Find Out

1. Where is the crop grown and why is it grown there?
2. What are some of the methods used to improve growing conditions for the crop?
3. Have new varieties of this crop been developed through selective breeding?

Extension

4. Look at the bar graph. One year the Alberta potato industry made $56 million and the greenhouse industry made $48 million. Compare the amount of land used for these two industries. Explain why they had similar incomes.

Skill FOCUS

For tips on doing Internet research, turn to Skill Focus 9.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

You can find out more information on crops grown in Alberta by going to the above web site. Click on **Web Links** to find out where to go next. Use this information to help you prepare a one-page report on an Alberta crop. Include information such as where the crop is grown and the overall economic importance of this crop.

DidYouKnow?

A hectare (ha) is an SI unit used for measuring land. It is equivalent to 10 000 m^2.

Math CONNECT

Calculate the yield per hectare of the following Alberta crops:

wheat: 8 716 000 tonnes harvested/ 2 897 652 ha planted

oats: 863 600 tonnes harvested/566 580 ha planted

barley: 5 987 400 tonnes harvested/1 922 325 ha planted

canola: 2 971 000 tonnes harvested/1 841 385 ha planted

Make a bar graph showing the yield per hectare of each crop.

Skill FOCUS

For tips on making bar graphs, turn to Skill Focus 10.

Growing Under Glass

All of the crops on pages 134–135 are grown outside in fields. The yield from these crops is very dependent on the particular growing conditions for that region. For example, the weather conditions, climate, and soil types will all affect yield. What specific growing conditions do you think could be controlled in a greenhouse environment? A wide range of warm-season crops, including seedless cucumbers, tomatoes, lettuce, peppers, house plants, and cut flowers, are grown in greenhouses.

Figure 2.44 Greenhouses allow warm-weather crops to be grown in Alberta.

Across Canada

Lois Hole

What do you do if you want to garden in a climate such as Alberta's where many varieties of plants are unable to grow? If you're Lois Hole, you don't give up; you meet the challenge by developing your own seed varieties. In 1952, Lois Hole and her husband bought a small farm property in St. Albert, Alberta, and gradually developed it into one of the largest garden centres in Canada. In the greenhouses at that garden centre, Lois helped to develop special hardy seed varieties that could thrive in the Alberta climate. In the process, Lois became a highly respected author, lecturer, and broadcaster all across the country.

Lois got her start in her mother's garden in Saskatchewan, the province of her birth. Her interest in gardening remained with her when she moved to Alberta and after she married (another gardening enthusiast) and had her family. Over the years, Lois amassed a tremendous amount of knowledge about plants and began to be sought out by people who wanted to learn to be successful gardeners. She also passed on her love of gardening to her children, involving them in the family business.

Lois has written a number of books, including a series of popular books that give advice on how to grow certain varieties of a particular type of plant such as roses or tomatoes. She has also been a regular newspaper columnist and popular guest on television gardening shows such as "The Canadian Gardener." Her contribution to Canadian gardening and to other aspects of Canadian life have won her many honours. For example, in 1998 she was elected to a four-year term as the sixteenth chancellor of the University of Alberta. In 1999 she was made a Member of the Order of Canada, the highest honour this country can confer. In February, 2000 she was installed as the Lieutenant Governor of Alberta. Not bad for a gardener from a place where things aren't easy to grow!

INQUIRY

INVESTIGATION 2-G

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Greenhouse Growing Conditions

Greenhouses help control the temperature for plants, but are designed to allow control of other growing conditions as well. Light can be increased or decreased. Water and nutrients can be added as required and adjusted to particular plants. The soil can be cooled or heated, or made more acidic or basic. What effect does a greenhouse environment have on the growth of various crops? Is this a sustainable way of growing plants for food and fibre?

Question

What effect does a greenhouse environment have on growth of various crops?

Hypothesis

Based on your understanding and observation of what plants need to grow, state a hypothesis about the effect of the greenhouse on crops growing indoors and outdoors.

Apparatus

thumbtack or pushpin
potting soil
4 trays or saucers for holding cups
scissors
clear adhesive tape
thermometer
plant grow lights (optional)
graduated cylinder
ruler
4 coloured pencils

Materials

8 paper or foam drinking cups
sprouted seeds
4 clear plastic drinking cups or plastic pop bottles
water

Procedure

1. Read through the investigation and **write your hypothesis**.
2. **Make a data table**.
3. Use the thumbtack or pushpin to put drainage holes in the bottom of eight paper or foam drinking cups.
4. Fill the cups with potting soil and plant one seed in each cup. Place two cups on each tray or saucer.

5. Your teacher will prepare the pop bottle by cutting the bottom off it. This will be your "greenhouse."

6. Your teacher will cut a small hole, or slit, in the drinking cup or clear pop bottle. Cover this hole with adhesive tape.

7. Place a clear plastic cup or clear pop bottle over each of the cups in two of the trays.

8. Place one tray with greenhouses and one tray without greenhouses outside (weather permitting).

9. Place one tray with greenhouses and one tray without greenhouses inside near a window. If a window is not available, place these greenhouses under grow lights.

10. Give your plants the same amount of water every two days.

11. At the same time each day, measure:
    - the air temperature in the greenhouse (put the thermometer through the opening you made) or around the plant if the plant is growing without a greenhouse
    - the soil temperature
    - the height of the plant
    - other observations such as colour

    Note: Handle the thermometer carefully. It is easily broken.

12. Plot the data on a line graph with the day on the *x*-axis and plant measurement on the *y*-axis. Use a different coloured pencil for each plant.

Skill FOCUS

For tips on writing a hypothesis, turn to Skill Focus 6.

For tips on making data tables and drawing line graphs, turn to Skill Focus 10.

Analyze

1. Compare the growth of each of the crops in the four environments.
2. Which growing conditions does a greenhouse improve?
3. Why did you use two seeds in each of the four environments?
4. Which was the manipulated variable? Which was the responding variable?

Conclude and Apply

5. Was your hypothesis supported by your investigation? Explain.
6. Are there any problems with growing plants in greenhouses? Explain. Could greenhouses be used to produce all our plants for food and fibre? Why or why not?

Extend Your Knowledge

7. How do actual greenhouses deal with low levels of heat, overheating, pests, and irrigation?

Pause& Reflect

Is a home vegetable garden a monoculture? Is a lawn a monoculture? In your Science Log explain the difference between caring for a monoculture and caring for an area planted with a variety of crops.

Farming Practices

In order to stay in business, farmers need to earn more money than they spend on growing crops. They have to produce each crop as efficiently as possible. Using large farm machinery enables farmers to grow crops over a larger area.

Figure 2.45 Farmers must ensure that their farming practices are sustainable, so that they can continue to grow crops for generations to come.

Adding nutrients to the soil helps the plants grow and produce more. Farmers also **irrigate**, or water, their crops using a system of large pipes and sprinklers. Most farmers grow their crops as a **monoculture**, only one type of plant in a field. Why might growing a crop as a monoculture be the most efficient use of a farmer's energy and equipment?

Farming Then and Now

In Alberta, farming practices changed from using human and animal power in the early 1900s to almost total mechanization by the 1950s. In the last 50 years, farm equipment has increased in size. Many farms now use computer controls on their machinery. The goal of farmers has stayed the same, but the way that they farm has changed dramatically. Look at Figure 2.46 to see how farmers grew crops in central Alberta in the early 1900s compared to today.

Activity	Technology of the Early 1900s	Technology of Today
1. Some farmers cultivate in the spring to loosen the soil for seeds. It also kills weeds. Other farmers use chemicals to kill weeds instead.	Oxen or horse-drawn cultivator	Machines called cultivators are used to prepare and fertilize soil.
2. Fertilizer is added to provide more nutrients for plants.	Manure was a common source of fertilizer.	
3. Fungi is controlled to protect plants when they are seedlings.	There were few controls for fungi in early years.	Special chemicals are used to control fungi.
4. Seeds are spread evenly to reduce competition for light and nutrients between crop plants.	Seeds were spread by hand.	Air seeders and seed drills are used to plant seeds.
5. Weeds and insects are controlled.	People, including children, pulled weeds by hand.	Crops are sprayed with chemicals to control weeds and insects. Other farmers use methods that do not use chemicals.
6. Grain is cut to allow it to dry and ripen.	Farmers used a scythe to cut crops.	Swathers are used to cut hay.
7. Grain is threshed. Threshing means separating the grain from the other plant material. Wind can help by removing the lighter stem and seed head (straw and chaff).	Grain was picked by hand. To separate grain from the rest of the plant, the grain was tossed in the air and caught in a basket. The wind carried straw away.	Combines are used to harvest grain and separate seeds.
8. Grain is hauled for storage or to market.	Horse-drawn carts were used.	Large trailer trucks are used.
9. Soil is turned and mixed to help kill weeds and disease organisms, to mix soil and plant matter, and to aid decomposition.	A horse-drawn plough was used (see Figure 2.46).	A modern plough is used (see Figure 2.46).

DidYouKnow?

The plough, invented in the Middle East, has been important to farmers for over 5000 years. It enabled early farmers to turn over the soil and bury weeds. This reduced the competition for the crop they wanted to seed, such as barley or wheat. Overploughing by farmers in the early 1900s, however, was partly responsible for the incredible loss of soil by wind erosion in "The Dirty Thirties."

Figure 2.46 Both of these ploughs were modern advances at one time. What do you think were the advantages and disadvantages of these two technologies?

Figure 2.47A Large "sprinklers" are used for irrigation.

Figure 2.47B Irrigation canals bring water to areas where it is in short supply.

Saving Soil Moisture

Farmers must try to make sure that the soil is moist enough for crop growth, even in dry weather. Moisture is lost through evaporation from the soil and also through transpiration in the leaves. Eventually, lack of moisture causes plants to stop growing. Field crops in the grasslands often run out of moisture and, as a result, do not produce as high a yield as they would in wetter conditions.

Farmers who live close to rivers and large lakes are able to add moisture using irrigation systems (see Figure 2.47A). Water from lakes, reservoirs, and rivers is channelled into large irrigation canals, such as those in Figure 2.47B. These canals have been built throughout southern and eastern Alberta to provide water to farms.

Maintaining Moisture

What are some ways to maintain soil moisture?

Find Out ACTIVITY

Materials

- foam meat trays, baking pans or other similar pans
- garden soil or potting soil
- organic material such as wood shavings, grass clippings, or leaves
- water
- fan (optional)
- grow light or heat lamp (optional)
- paper towel
- soil moisture metre (optional)

Procedure Performing and Recording

1. Add equal amounts of soil to each tray.
2. Cover the soil in one tray with organic matter. Mix the organic matter in with the soil in the second tray. Do not add organic matter to the third tray.
3. Dampen the soil in the trays using equal amounts of water. Do not saturate the soil.

4. Leave the trays in a warm area, under grow lights, or place them in front of a fan.
5. After several hours press a sheet of paper towel on the soil in each tray. Compare the amount of moisture on each paper towel. You can also use a soil moisture metre for this step.

What Did You Find Out? Performing and Recording

1. Which tray had the highest soil moisture?
2. How was the amount of soil moisture affected by placing the organic on top of the soil or mixing it?
3. What is another way you could measure soil moisture?

Fibre Plants and the Forestry Industry

Did you know that trees cover over 4.5 million square kilometres of land in Canada — an area larger than eastern and western Europe combined? Canada has about 10 percent of the world's forests, and produces many kinds of lumber and pulp and paper products. The wood fibre industry employs over 800 000 Canadians. British Columbia, Alberta, Ontario, and Quebec have vibrant forest industries. Alberta's forestry industry has grown considerably in the last ten years, and is now a very important industry in the northern part of the province.

In the next few pages, you will learn about the trees most desired for fibre, and how they are harvested. You will also learn about some of the practices that foresters use to improve growing conditions for trees.

A forest is much more than just the trees that live there. Forests have many types of trees, shrubs, and smaller plants. There are also many animals living in, around, and under these plants. The **diversity** or variety of plants and animals found in an ecosystem varies from one ecosystem to another. The presence of a large variety of organisms is often used as an indicator of a healthy ecosystem.

Like all natural systems, the species in a forest community are interdependent. When natural or human events disturb the balance, all the species are affected. Fire was a natural part of the process by which Alberta forests developed. This resulted in the emergence of species that required large amounts of light. As the forests grew, they became ideal for populations of species that require more shade. You can see how a cycle develops as a result of burning and/or cutting followed by regrowth. Forestry practices can increase the diversity of forest species by careful cutting that lets more light and air into the forest.

Pause & Reflect

In what ways do you think a mature forest would be different from a recently cut area? Examine these two photographs and think about the appearance of the forest, as well as the animals and the soil within it. Describe the differences in drawings and words.

Figure 2.48A A mature forest.

Figure 2.48B This forest has been logged and replanted.

Pause & Reflect

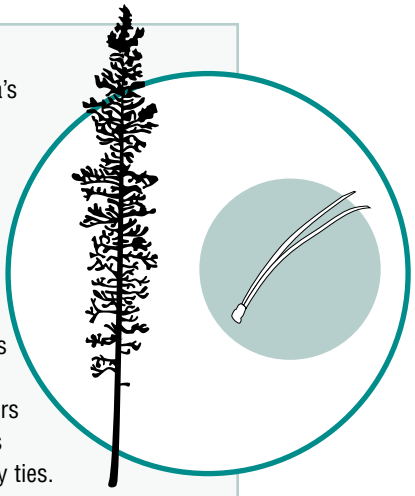
Do you play any role in how food and fibre is produced and harvested? Think of the food and fibre products that you need or want. Write your thoughts in your Science Log.

Who's Who in FibreSpace?

Some common Alberta tree species that are used for forest products are shown below. Which ones do you recognize? Which ones likely grow in your area?

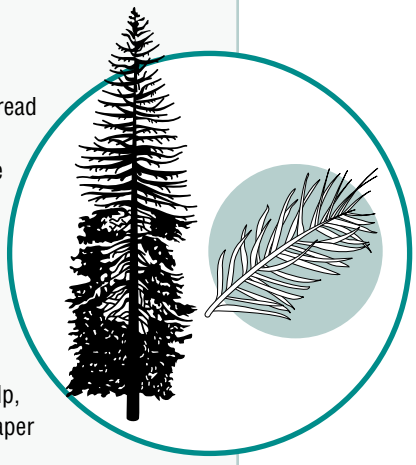
Lodgepole Pine

Lodgepole pine is Alberta's provincial tree. Its seeds are released by fire. The lodgepole pine's straightness and strength was highly valued. Aboriginal people used it to build their lodges, early settlers built fences and cabins with this pine, and builders of the first railway across Canada used it for railway ties. Today, carpenters use pine for building walls and roofs.



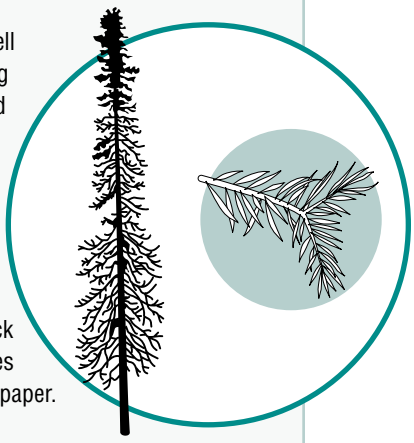
White Spruce

White spruce are widespread throughout the forested parts of Alberta. This tree takes over from aspen and pine as forests develop and mature. Spruce wood is light and soft, but strong and straight. It is valued for lumber, plywood, and pulp, which is used to make paper and paper products.



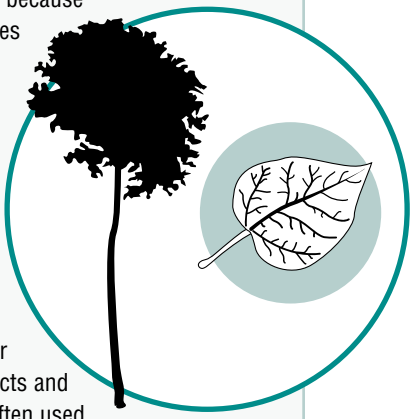
Black Spruce

Black spruce is well adapted to muskeg and poorly drained soils in western and northern Alberta. The wood is light and strong and is used for lumber and pulp. The black spruce's long fibres help make strong paper.



Aspen

This tree is also known as "trembling aspen" because of the way its leaves seem to shake or tremble in a breeze. It is the most widespread tree in Alberta and its range extends well into the grassland regions. Aspen is especially good for wood panel products and furniture, and is often used for pulp and paper.



Find Out ACTIVITY

Key It Out

Classification keys are used to help identify trees and other organisms. (You used a classification key to identify amphibians in Unit 1.) In this activity you will create an identification key for the six most common Alberta trees.

Materials

paper

pencil

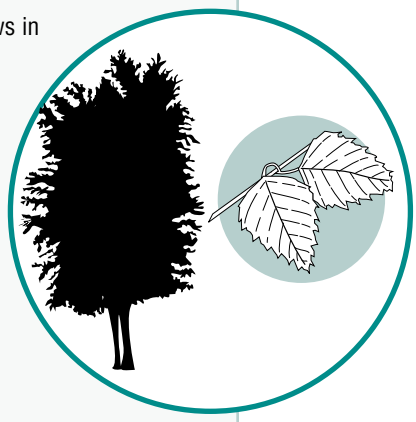
plant identification books (optional)

Procedure

Look at the leaves and needles of the trees on this page. Create an identification key to help someone identify the tree species. Look at examples of identification keys in plant books or review the amphibian key on page 73. You may use small illustrations in your key if you wish.

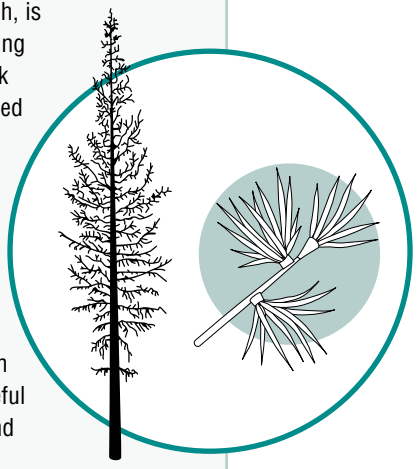
White Birch

White birch grows in moist areas and along rivers and lakes. Its heavy, strong wood is used to make furniture and cabinets, and is also considered to be one of the best woods for firewood.

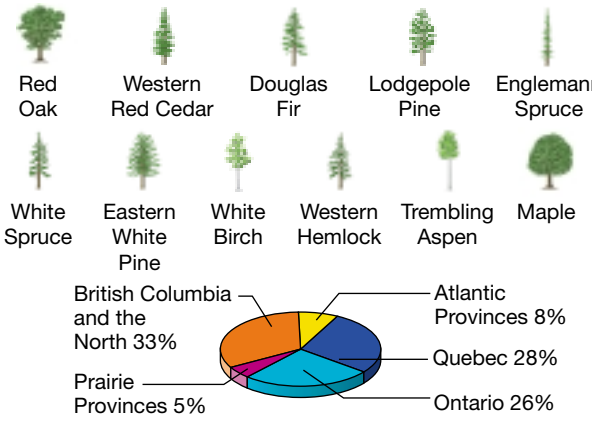


Tamarack (Larch)

Tamarack, or Larch, is another water-loving species. Like black spruce, it is adapted to cooler wet conditions such as muskeg. Tamarack grows slowly and has heavy wood. It resists fungi and the decay they can cause, so it is useful for fence posts and railway ties.



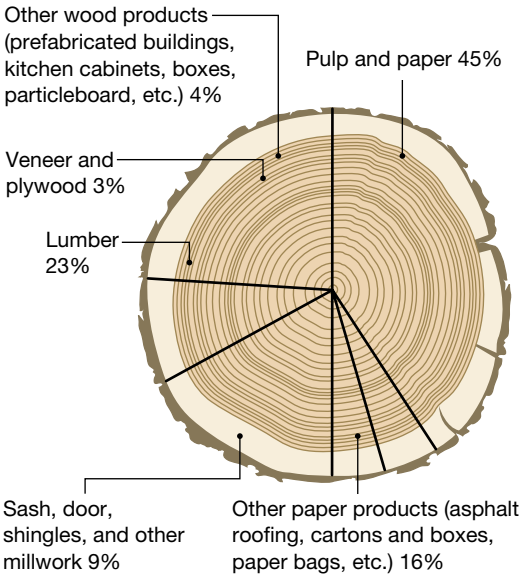
Some tree species harvested in Canada



Value of lumber shipments

Canada = 100%

Percentage Value of Forest Products



Forest Products in Canada

The forest industry is the largest industry in Canada and is a vital part of Alberta's economy. What processes does lumber from Alberta and other parts of Canada undergo in order to turn into finished products?

Procedure Performing and Recording, Communication and Teamwork

1. Examine the illustrations above. In which three provinces is forestry especially important to the economy?

Find Out ACTIVITY

2. How are the harvested trees used? If you do not understand any of the terms in the graphs, use a dictionary or encyclopedia to help you find a definition.
3. Choose one product made from wood and find out how raw lumber becomes a finished product.

Harvesting Trees

Before any trees are cut, foresters explore an area thoroughly. They make maps that outline the location of trees that will be cut and any special features they should consider. Then they create a plan for making a road and harvesting the trees. They also decide how they will cut the trees. For example, they may choose to clear-cut an area, where all of the trees are removed, or they may choose selective harvest, where only certain trees are removed. Some of the steps involved in harvesting trees include the following:

- planning the cut (based on a careful review of the site)
- building a road into the area
- felling (cutting down) and delimbing the trees
- dragging (or "skidding") the logs to a central loading point
- hauling the logs by truck to a saw mill or pulp mill
- preparing the site for reforestation (this step is called "scarification")
- reforestation (reseeding and replanting, if needed)

Figure 2.49 Feller-bunchers like this one are replacing the axe and chainsaw methods of the past. This machine quickly cuts down the trees. A separate machine called a de-limber and processor removes the branches and cuts them to log length. A powerful rotary (or circular) saw uses hydraulic technology to cut the trunk.

Reforestation

Like farmers, foresters are concerned about maintaining and improving growing conditions. They analyze conditions such as light, water, and nutrients when they plan forest management.

When trees are cut, some branches and fallen trees are left behind. In the past, burning this debris changed it to ash. The remaining bare soil provided poor habitat for wildlife. It also removed many starting materials needed for regrowth, so the area had to be reseeded by hand, as shown in Figure 2.50. Today, the leftover plant material stays, providing nutrients and starting materials for regrowth.

Figure 2.50 Tree planter

Figure 2.51 Fire tower lookout, and firefighter lowered into action.

On most sites, no manual replanting of trees occurs. Seeds left behind in the forest debris sprout naturally and become new trees. In the years after a forest is cut, the opening up of the area to light favours growth of plants that have strong needs for bright sunlight. These species grow rapidly. Tree species such as poplar and pine are especially favoured. They provide the shade in which other, more shade-tolerant species, will grow.

In Alberta forests, the nutrients for tree growth come from the recycling of materials in the forest soil, rather than use of chemical fertilizers. Pesticides are sometimes used to control insect infestations, but are used not nearly as much as in agriculture.

DidYouKnow?

Fire control is a major part of forest management. Most fires are caused by lightning strikes, but some are caused by human carelessness. People watch for fires from fire towers throughout Alberta. Firefighting measures are often taken as soon as possible after a fire is spotted. Sometimes a fire is allowed to burn in a controlled way, to open up and renew an area of forest.

Global Problems

One of the most serious problems worldwide is soil **erosion** (soil that is blown away by wind and water). North Africa once had very fertile land. Frequent and long-lasting droughts have resulted in desertification — a process in which the desert has taken over much of the agricultural land.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

How old do you think trees in Alberta are? What do you think might be the major factors that limit how old they become? Write your estimate of age and reasons in your Science Log. Then go the above web site to find out more. Click on **Web Links** to find out where to go next.

Figure 2.52 Drought-stricken area.

Where vegetation has been removed in Brazil and West Africa, soils became hard and useless for growing crops. In some areas of Europe and United States, high levels of agricultural chemicals in the water systems have caused serious pollution.

Irrigation in Pakistan helped to boost production at first. Excessive irrigation, however, brought salts to some areas, making it impossible for plants to grow.

It is possible to create sustainable systems, but scientists and community leaders must work closely together. Do ordinary citizens have a role, too? How do our demands for certain products help determine what kinds of crops are harvested and how they are produced? Producers and consumers both need to understand the complex web of life in which we live and respect the delicate balance that exists.

Find Out ACTIVITY

Media Monitor

What are some of the current issues related to agriculture and forestry where you live or in other parts of Canada?

Procedure Performing and Recording

1. Working alone or with a group, search various sources for current information on agriculture and forestry. Be sure to look at newspapers, news magazines, television guides, and the Internet.
2. Try to find articles related to the issues introduced in the last four Topics.
3. Post the information on a bulletin board.

What Did You Find Out?

Analyzing and Interpreting
Communication and Teamwork

From the information collected by the class, answer the following questions:

(a) Which issues seem to be receiving the most attention in the media?

(b) Why do you think that they are receiving so much attention?

(c) Do any of these issues relate to advances in food or fibre production? In sustainability?

Figure 2.53 In Nepal, wood needed for fuel and forests has been removed from hillsides, resulting in massive erosion.

TOPIC 4 Review

1. Describe three plants grown for food and three plants grown for fibre species in Alberta.
2. Explain what sustainability means.
3. Describe an example of modern technology that is used to help grow or harvest plants for food or fibre.
4. Explain how greenhouses modify the environment to improve growing conditions for plants.
5. Describe the advantages and disadvantages of growing crops as a monoculture.

TOPIC 5 Sustaining the Soil

Imagine what would happen if the soil suddenly disappeared. While animals run and leap, and plants dazzle with their bright colours, the soil often goes unnoticed. But healthy soil is critical in natural ecosystems and sustains our need to grow plants for food and fibre.

Figure 2.54 What might happen if we lost most of our soil?

Soil gives plants a place to sink their roots and anchor themselves. Without soil, strong winds and violent storms would tear plants out of the soil or tip them over. As well as being an anchor for plants, soil is an amazing natural community, with billions of residents per cubic metre. It is like a huge buffet table that stores nutrients, air, and water, and supplies them to plants as required. To lose the soil, or its ability to produce, would be a disaster. In some areas this has already happened (see Figure 2.55).

In this Topic, you will have an opportunity to examine soil closely and find out how it works. You will learn how soil is formed, how it matures, how it helps plants grow, and what it needs to stay healthy.

Figure 2.55 Severe erosion by water has removed topsoil. It dramatically reduced the productivity of this land, and will continue to do so for generations to come. What could be done to prevent such disasters?

DidYouKnow?

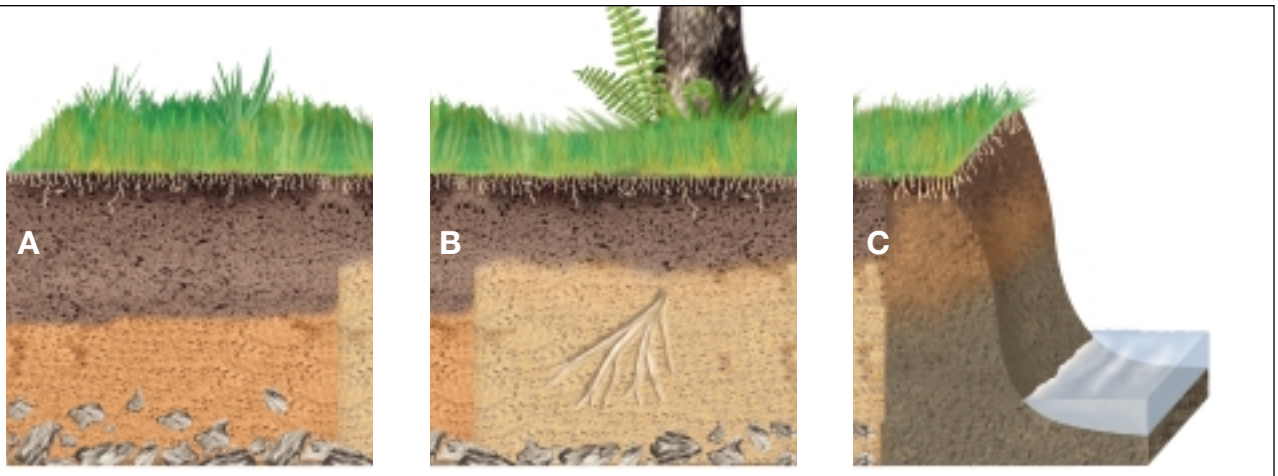
In Canada, much of the parent material was deposited by glaciers or glacial meltwater lakes and rivers relatively recently (10 000–12 000 years ago).

How Do Soils Develop?

Five major factors determine how soils develop: parent material, climate, vegetation, landscape (which affects the amount of water), and time.

- **Parent material** is the mineral (non-organic) matter (rock, soil, clay) from which the soil developed.
- Climate determines what kinds of plants will grow, and how fast they decompose. Warmth and moisture are required for soil organisms to break down plant and animal matter and change it to a rich, dark soil called **humus**. Humus holds nutrients and water for plants.
- The vegetation growing in the area determines the amount and type of organic matter in and on the soil. It also protects the soil from erosion.
- Water brings new soil and nutrients. In healthy soil, spaces between the particles hold water and air for roots. If soil is saturated with water, less oxygen is available.
- All of these processes happen over long periods of time.

Figure 2.56 shows how different soils might develop under different vegetation and water conditions. Time, climate, and parent material were the same for all three. Note how soil **horizons** (the layers in a cross section of soil) vary.



A In well-drained soils, roots are active throughout the upper layers of the soil. As roots die, bacteria decompose them. The resulting organic matter gives the upper horizon — **topsoil** — a brown or black colour. In general, the more moisture such grassland receives, the more organic matter there is, and the darker the topsoil.

B In well-drained soils under forests, most of the organic matter is added at the top as leaves, instead of below as roots, since tree roots live a long time. The soil remains grey-brown (the colour of the parent material or lighter). Fungi cause most of the decomposition of the leaves at the surface. The top horizon in this type of soil is quite acidic.

C Soils that are saturated with water have little oxygen available for any kind of decomposer to live and work. Organic matter does not decay, but collects on the soil surface. The parent material often changes little, except for the colour. Saturated soils often have a bluish tinge.

Figure 2.56 **A.** Soil under grassland **B.** Soil under forest **C.** Soil under water

Soil: A Lively Community

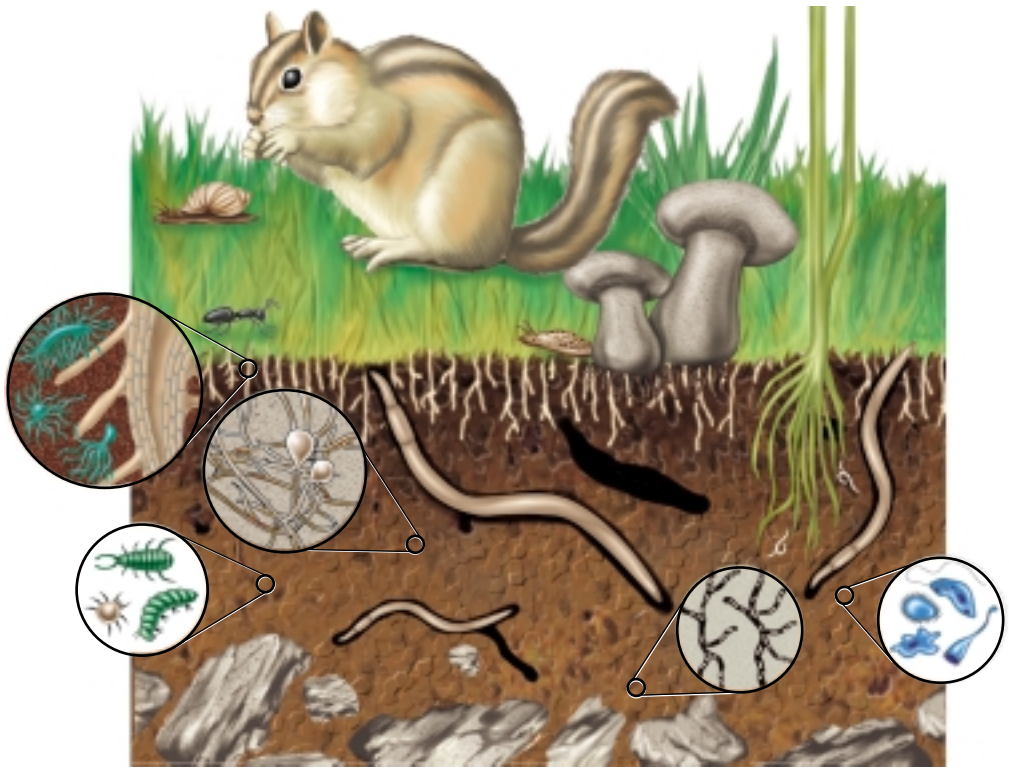


Figure 2.57 There's more to the soil than first meets the eye.

Healthy soil contains an amazing collection of creatures — gophers, earthworms, insects, and billions of microscopic bacteria and fungi. All are part of an ever-changing community. The decomposers break down plant and animal tissue, forming humus. This helps roots to move into the soil, and enables water and air to move more freely. The four key types of decomposers each work a little differently.

- Bacteria are the most diverse and numerous of all soil organisms. In healthy grasslands, billions of bacteria live in every kilogram of soil. A hectare could have up to 4 t of live bacteria, all actively breaking down dead plant and animal tissues.
- Fungi include moulds and mushrooms. These organisms are especially important in forest soils and where soils are cooler and more acidic. The fungi make nutrients available to the plants and receive carbohydrates in return.
- Microscopic actinomycetes are a special type of bacteria that also play a vital role in decomposing organic matter and forming humus.
- Soil that contains lots of earthworms is usually healthy. As earthworms eat the soil, they grind, digest, and mix it. They produce casts that are richer in nutrients and bacteria than the soil they took in! Earthworm tunnels help air and water move through the soil. The mucus that worms add helps stick soil particles together. Earthworms also bring up nutrients from lower levels of the soil as they tunnel through it.

DidYouKnow?

The earthworms in 1 ha (100 m x 100 m) of healthy soil grind, digest, and mix up to 30 t of matter per year. Charles Darwin honoured them by giving them the title "Intestines of the soil." Today, some people have special home worm composters to help digest fruit and vegetable waste in their homes.

DidYouKnow?

Soil organisms are often mixed in with seeds and seedlings to help improve growing conditions. For example, a special bacterium is mixed with alfalfa seed, and the two together produce nitrogen — a nutrient that alfalfa and other plants need. Many tree seedlings grown for reforestation are given a type of fungus called mycorrhizae to help them get nutrients from the soils in which they will be planted.

INQUIRY

INVESTIGATION 2-H

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Soil Sleuth

Use the following tests to learn about soil health by comparing potting soil with garden or yard soil.

Question

How do sand, potting soil, and garden (or yard) soil differ?

Hypothesis

Write a hypothesis about how sand, potting soil, and garden soil differ. Think about how each might differ in terms of organic matter, texture, and water-holding ability.

Safety Precautions

Apparatus

thumbtack
scissors
spoon
magnifying glass
ruler
microscope (optional)
balance
measuring cup or graduated cylinder
3 glasses or beakers (250 mL)
3 small jars with screw lids (250–500 mL)

Materials

6 disposable cups (250 mL)
labels
3 plastic lids (such as from a yogurt container)
water
sand
potting soil
garden or yard soil
3 cone-shaped coffee filters

Part 1

Texture Test Procedure

1. 1. Label each sample A, B, and C.

2. In your notebook, prepare an observation page, as shown here. Complete the "Sample source" section by indicating the brand of potting soil you are testing or the site of the soil sample.

Sample letter
Sample source

Particle size and texture tests
- crumble or clump
- formed ribbon (yes/no)
- length of ribbon
- rubbing test
- method used to estimate particle size
- estimate of average particle size

Organics
- evidence of organic material
- float test
- soup test

Drainage test
- start time for pouring
- time when water first drained
- stop time (no drips for 30 s)
- quantity of water drained

3. Squeeze test:
   - **(a)** Take a handful of moist soil (add a little water if it's dry), and squeeze it in your fist. Open your hand. Decide whether the soil formed a clump that holds together or crumbles when you press it.
   - **(b)** If you have a ball of soil, try to rub the soil between your index finger and thumb to form a ribbon. Soils with more clay will form longer ribbons.

   - **(c)** **Record** your observations.

4. Wet rubbing test:
   - **(a)** Add water to make a soupy mud. Rub the mud with the end of your finger.
   - **(b)** **Record** whether the mud feels mostly gritty, equally gritty and smooth, or mostly smooth.

5. Particle size:
   - **(a)** Use your observations to try to **predict** which soil sample has the largest particle size.
   - **(b)** **Examine** the soil and **describe** any evidence of particle size.
   - **(c)** **Record** any difficulty in estimating particle size. Don't worry if you have trouble; this task is not as easy as it may seem!

Part 2

Organic Matter Test

Procedure

1. Visual test:
   - **(a)** Pick apart the sample. Use your magnifying glass to search for any materials that you think might be organic.
   - **(b)** **Record** your observations.

2. Float test:
   - **(a)** Place about 10 mL of soil into a clear container full of water.
   - **(b)** **Observe** what floats on top. In natural soil, the material that floats is likely to be organic. In a potting soil mix, it may also include perlite or vermiculite.
   - **(c)** **Record** your observations.

3. Soup test:
   - **(a)** Place about 125 mL of soil in the small jar and half fill with water. Screw on the lid and shake well.
   - **(b)** Let the "soil soup" settle for 5 min. Then **draw** the layers you see.

4. Repeat these tests with the other two samples.

Part 3

Drainage Test

Procedure

1. Prepare the disposable cups as follows
   - **(a)** Label the cups as sand, potting soil, and (name of site of other sample).
   - **(b)** Using the thumbtack, punch 15 holes in the bottom of three of the cups.

CONTINUED

2. To hold each cup over the glass or beaker, cut a hole in a coffee-can or yogurt container lid so that the cup will just fit into the hole. Place a cup and lid over a glass or beaker.

3. Place the soil sample in the cup. Press it down firmly with your finger. Your soil should half fill the cup.

4. It is important to do this step *slowly*. Pour 100 mL of water into the cup.

5. **Record** the time when the water is first poured into the cup. **Record** the time when the water first drips from the cup.

6. Allow the water to drip for 20 min. Use the graduated cylinder to **measure** and **record** the amount of water that has collected in the glass or beaker.

7. **Repeat** the above steps with the other two samples.

8. Wash your hands thoroughly after completing this investigation.

Analyze

1. Read through the soil descriptions below. Which description best matches your soil sample?

Sandy soil	Clay soil
• has few or no lumps	• often has hard lumps that may be so hard you cannot break them with your fingers
• has lumps that crumble when you touch them lightly	• forms a sticky ball when water is added and ball is squeezed
• when wet, may clump together briefly, but will fall apart as soon as you try to pick it up	• may be difficult to wash off hands
• has particles of grains of sand that are easily seen with the magnifying glass	• has particles that are so tiny they cannot be seen under the microscope
• feels loose and grainy when dry, gritty when wet	• has small spaces between particles, so water cannot easily move through
• has a thick sand layer in the soup test	• expands when wet and shrinks when dry, causing large cracks to form in soil
• has large spaces between the particles that allow water to move through quickly	• can form a hard crust on top and prevent seedlings from emerging
• does not hold as much food or water for plants	• can be rich in nutrients

2. Use the chart below to locate the texture name of each sample.

Ribbon length	Mostly gritty	Both gritty and smooth	Mostly smooth
shorter than 2.5 cm	sandy and sandy loam	loam	silty loam
2.5–5 cm	sandy clay loam	clay loam	silty clay loam
over 5 cm	sandy clay	silty clay	clay

3. Which sample do you think has the greatest amount of organic matter? Which had the least?

4. How did the samples compare in their ability to hold water?

5. Which variable was controlled in this experiment?

Conclude and Apply

6. Which types of soil would be the best to grow vegetables in your garden? Why?

All You Can Eat!

Healthy, growing plants require large amounts of six nutrients: nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), and magnesium (Mg). Different parts of plants use different amounts of each of these. For example, nitrogen helps make leaves green. Newly planted seeds and stems need extra phosphorus for the best growing conditions, and flowers and seeds require phosphorus and potassium.

Sulphur, calcium, and nitrogen are usually present in the parent material of soil. Nitrogen, phosphorus, and potassium often need to be added in fertilizer.

Figure 2.58 The soil is like a buffet table that holds the water and nutrients that plants need.

What's in the Bag?

Find Out ACTIVITY

Plants often need more of the major nutrients, nitrogen, phosphorus, and potassium. A bag of fertilizer usually has three numbers that indicate the percentage of each of three nutrients. For example, a bag of fertilizer marked 12–14–18 contains 12 percent nitrogen, 14 percent phosphorus, and 18 percent potassium.

Procedure

Performing and Recording

Arrange to visit a garden store or nursery or speak with a knowledgeable resource person. Find answers to the following questions:

1. What formulations of fertilizer are available locally?
2. How is each formulation used? (For example, is it used for a specific crop, or applied at a certain stage of growth?)
3. Which fertilizer is used most commonly? (Which sells the best?)
4. What forms of fertilizer are popular, and how are they used? (For example, fish fertilizers might be used for plants, and slow-release nitrogen for lawns.)

What Did You Find Out?

Analyzing and Interpreting

Communication and Teamwork

1. Organize your findings in a table to present to your class.
2. What amount of fertilizer is best for a plant? (Can plants have too much fertilizer?) Rewrite this question so that you could test it.

Challenges and Solutions

Looking Ahead

Keeping soil healthy and understanding what type of fertilizer to use and how much to apply are important. Using the previous two activities as your basis, do some research to extend your knowledge of these aspects of plant growing. Discuss with your group how you can use what you learn in your Unit 2 Project, Get Growing!

Production practices have sometimes damaged large areas of soil in the prairie provinces. Here is a summary of the problems or challenges, and some of the solutions that are being used and developed. Over time, the practices will help soils become healthier and better able to resist damage.

Salinization: Salty Soil

Have you ever noticed a white crust on the soil surface like the one in Figure 2.59? Sometimes this white crust is in a ring pattern around a slough. The crust is salt that has collected on the surface of the soil. This condition is called **salinization**.

Figure 2.59 A white crust on the soil is evidence of salinization.

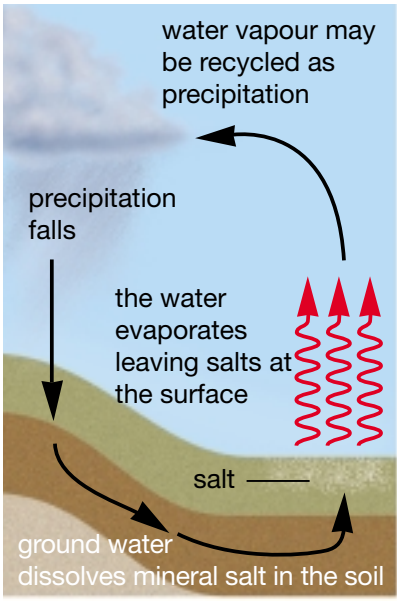


Figure 2.60 Ground water flows from higher elevations to lower elevations, carrying salts along with it.

High levels of salt in the soil have the same effect as dry conditions. Every year that salt collects in soil, the soil becomes less and less able to grow crops. In some areas, growing crops is now impossible.

Two factors lead to salinization: too little vegetation and too much water (excess irrigation). Look at Figure 2.60. When farmers cultivate land to grow field crops, they remove vegetation. Water enters the soil since there are no plants to absorb water. Irrigation brings even more water into the soil, adding to the ground water. The excess ground water dissolves minerals (salts) from the soil. Eventually, when the water evaporates the salts are left behind.

The problem of soil salinization can be solved by replanting the areas so that plants use up the water that falls before it has a chance to seep away. Farmers also monitor irrigation much more closely now, and have also lined water canals to stop the canal water from draining into the ground water.

Organic Matter and Erosion

Figure 2.61 Soil erosion is a serious problem in agriculture.

The most serious problem in soils is the loss of organic matter. This in turn leads to soil erosion (see Figure 2.61). It is estimated that, on average, 15–30 percent of organic matter — the work of earthworms and other soil organisms for over 10 000 years — has been lost in just a few decades of cultivation. Soil then is less able to hold nutrients, water, and air. This makes the soil poor for growing plants.

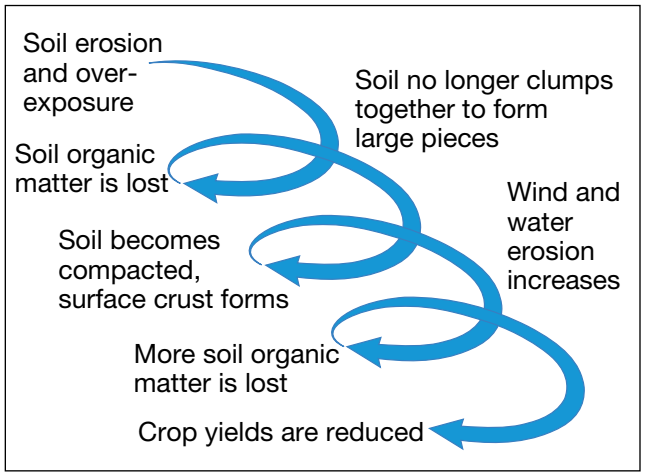


Figure 2.62 The common path to reduced soil quality.

Figure 2.62 shows how soil damage often begins. Natural vegetation was removed from prairie farms, exposing soil to Sun and wind. In an effort to control weeds and prepare perfect seedbeds, producers ploughed and cultivated the soil too much. Regular summer fallow was a common practice. (Summer fallow is the practice of cultivating land to control weeds but planting no crops.) This exposed the soil to sunlight and higher temperatures and encouraged bacteria to decompose the organic matter at a rapid rate. All of these practices depleted the soil.

Saving the Soil

What are some ways that farmers can help preserve the soil? Soil erosion can be solved by planting a cover of vegetation on the surface of the ground to slow the flow of water. This gives the soil more time to absorb the water. When more water soaks in, less will flow along the surface and cause erosion. Vegetation covers also protect soil from the wind.

Farmers, particularly those in drier areas, have realized how important it is to "keep the covers on" their fields. They need ways to keep protective vegetation on the field, while still being able to remove weeds. One solution is shown in Figure 2.63A.

Figure 2.63A In zero tillage, the stubble from last year's crop remains on the field. A zero-tillage seed drill, like the one shown here, plants the seeds through the stubble.

Figure 2.63B Some farmers cultivate less, and use a special wide-shovel cultivator which cuts weeds below the surface but does not disturb the surface soil too much.This cultivator keeps over 90 percent of the vegetation on top of the soil.

Instead of cultivating land some farmers use special seeding equipment, called seed drills (see Figure 2.63B). These drills push seed right through the stubble of the previous crop into the undisturbed soil. This technique, called zero-tillage, protects the soil from wind and water erosion. Other benefits are: lower tillage costs, improved soil structure, and more soil moisture for the next crop. Its disadvantages are that weeds and disease-causing organisms previously killed by cultivation can now be controlled only with pesticide sprays.

Other methods of saving soil are shown in Figure 2.64A, B, and C. Farmers plant **shelterbelts** (rows of trees) along the edges of fields. They also modify waterways, and they use crop rotation.

Figure 2.64A Shelterbelts reduce wind damage to crops, trap snow to increase soil moisture, and provide wildlife with habitat.

Figure 2.64B Many farmers have reshaped and seeded waterways to reduce erosion. Strong rains and spring meltwater can form small streams that wash away soils. These grassed waterways provide food, shelter, and travel corridors for many wildlife species.

Figure 2.64C Many farmers use forages (legumes and grasses) in a crop rotation to add organic matter and provide protection from wind and water erosion. Manure from livestock is often used to add organic matter, improve soil structure, and increase nutrients. Manure must be added carefully, however, in order to avoid adding weed seeds and disease organisms.

DidYouKnow?

Farming practices that increase soil organic matter take carbon "out of circulation" in the air and store it in the soil. This eventually reduces carbon dioxide levels in the air. Carbon dioxide is a greenhouse gas, so its removal from the air helps reduce global warming.

Pause& Reflect

The Soil Conservation Council of Canada's mission is "to promote the preservation and enrichment of Canada's soils and related water resources for the benefit of present and future generations." In your Science Log, list some ways that you could be part of this mission.

Hydroponic Technology

Figure 2.65 The yield and quality of vegetable crops under greenhouse hydroponic conditions can be far better than field production. It is expensive to grow plants this way, though, and the nutrients and other growing conditions must be closely monitored.

Hydroponics is a technique for growing plants without soil (see Figure 2.65). Plants are usually grown in a non-organic growing medium. Gravel or "rock wool" (rock that has been heated and spun) and nutrients are added to the water. In warmer parts of the world, farmers use hydroponic technology in their fields. In Canada, hydroponics is used in greenhouses. In the next investigation you will set up your own hydroponic system. There are many ways to do this. Below is the procedure that one student used.

1. Use a pencil to poke a large hole in the bottom of a foam cup.
2. Roll a 20 x 20 cm square of cotton cloth into a tight roll.
3. Push one end of the cloth through the hole in the cup until it is about three-quarters of the way into the cup.
4. Fill the cup around the cloth with peat moss, pressing it firmly.
5. Add fertilizer and water solution (mixed according to directions) to a large container.
6. Suspend the cup on a ring stand so that it is just above the level of the nutrient solution, with the rolled cotton cloth lowered deeply into the solution.
7. Plant seeds in the cup and set it under a grow light.

Ask an Expert

On page 176 you will meet Muhammad Younus, who will tell you more about hydroponics.

Word CONNECT

Hydroponics means growing plants without soil in a water solution. With a partner, write down as many "hydro" words as you can, then check a dictionary to find out how many there are.

Off the Wall

Aquaponics takes the idea of a "nutrient solution" one step further. This technology combines raising fish and growing plants in an aquaculture system. Water used by the fish provides nutrients for plants. The plants remove nutrients and clean up this water, which goes back to the fish. Aquaponics is becoming more common in northern greenhouses and could eventually become a significant source of fish and plants for food.

PROBLEM-SOLVING

INVESTIGATION 2-I

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Construct a Hydroponic Garden

Challenge

Design a model to show how you might grow plants using hydroponic technology.

Safety Precautions

Apparatus

container for the plants (Styrofoam™ cup, peat pot, plastic seedling container)

container for solution (large jar, aquarium, plastic tank, plastic pail)

a means of suspending the plant above the solution

source of light for the plants

a means of bringing the solution to the plant (cotton cloth, about 20 cm x 20 cm, to use as a wick; or a water pump)

Materials

selection of materials to choose from: non-organic medium (gravel, sand, peat, vermiculite, perlite, pumice)

sprouted seeds (radish, lettuce, peas, or beans) or seedlings (tomatoes)

hydroponic fertilizer

Design Specifications

A. Your model must demonstrate how nutrients and water can be supplied without soil.

B. Your model must enable plants to grow for two to three weeks.

C. Your model must be easy to monitor and maintain.

D. Your model must permit you to make best use of other growing conditions, such as temperature and light.

Skill FOCUS

For tips on scientific problem solving turn to Skill Focus 7.

Plan and Construct

1. With your group, discuss how you might create your hydroponic system.
2. Draw a labelled sketch of your model, indicating what materials you will use.
3. Obtain your teacher's approval. Then construct the model.
4. Improve the model until you are satisfied with the way it works, and feel confident that it can be used to grow plants for the required period.
5. Demonstrate your model to your class.
6. Wash your hands thoroughly after you have completed this investigation.

Evaluate

1. Did your model work as expected?
2. What adjustments did you make so that it would work better?
3. What scientific knowledge did you use to develop your model?
4. What knowledge did you gain from creating this model?
5. What ideas did other groups use that you would like to use?
6. How would you change your model if you wanted to actually produce food (for example, grow large tomato plants that would produce large fruit you could harvest)?

Saving Soil in Forests

Forestry can also have an impact on soils. When trees are cut and removed from an area, wind and water can erode the soil. To minimize damage, some trees and debris such as logs and stumps are left on cut areas. As the debris decays, it adds organic matter to the soil. Forests are also replanted with new trees shortly after they are harvested. As well, trees and shrubs are usually left around streams and gullies to minimize soil loss.

Figure 2.66 These erosion control methods slow the flow of water and enable trees and shrubs to take root in the gully again.

Looking Ahead

You are now ready to start your Unit 2 Project, Get Growing! Examine your Project Planning file and discuss ideas with your group. What else do you need to know before starting your project? Divide any tasks among your group members, and — Get Growing!

TOPIC 5 Review

1. What are the major factors that determine how soils develop?
2. What kinds of organisms live in the soil? What roles do they play?
3. Explain how soils that develop under grassland might be different from those that develop under forest vegetation. What causes them to develop differently?
4. Why is the loss of organic matter in soil so serious?
5. Name five farming or forestry practices that help prevent soil erosion or improve soil health.
6. What are the three major components of fertilizer?

TOPIC 6 Pests and Pest Control

Every year, tonnes of chemicals are used to control pest organisms that reduce plants' ability to produce food and fibre. What are the effects on our natural systems? Are there alternatives?

Pause & Reflect

Planting fields with single crops (monocultures) makes them attractive to pests. Do you think monocultures might also make it easier for farmers to control pests?

What Is a Pest?

What do you think a pest would say if you were to interview one?

From the point of view of a farmer or forester, a pest is any organism that is causing plants to die or produce less than they otherwise would. From a pest's point of view, though, things look different. Are bees pests? Are ants pests? When they are part of a natural system or are beneficial to people, no. When they annoy us or affect our ability to produce food and fibre, yes, they are pests. Insects are not the only types of pests, however. Fungi, weeds, and other animals such as slugs or birds can also be pests in certain situations.

Friend or Foe?

How would you define a pest? Is a bee a pest or an important pollinator? Perhaps it is both. What about the insects and other animals shown here? Are they pests? In small groups, brainstorm about pests.

Materials

large sheets of paper felt markers

Procedure

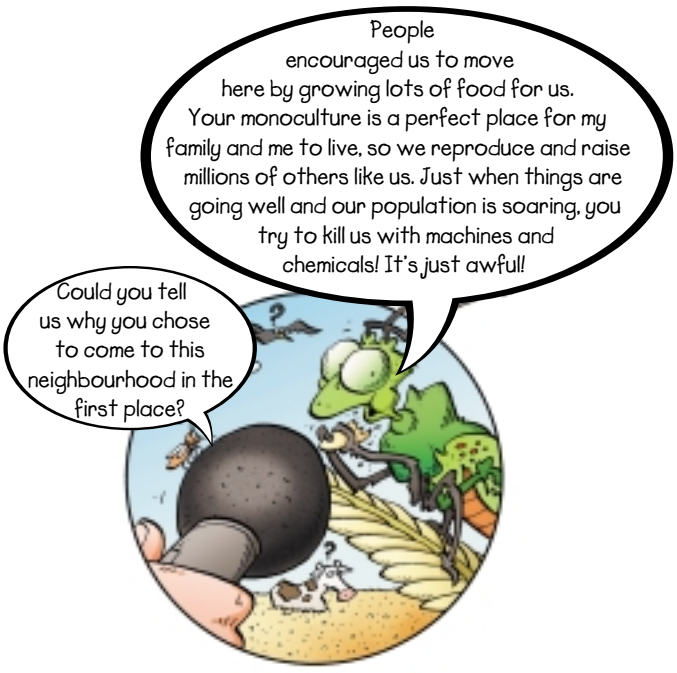
Performing and Recording
Communication and Teamwork

1. With your group, brainstorm a list of pests that affect you directly (for example, mosquitoes) or indirectly (for example, cabbage moth larvae that eat cabbage). Use the Internet, library, or other resources (such as employees of a garden centre or farm) to help you make your lists. Remember that pests are not only insects. They can also be weeds, fungi, or other animals.
2. Choose one pest and investigate the damage it does, and how it is controlled.
3. Are these control measures successful? Are other methods being tried?
4. Report your findings to your class in a 5 min presentation.

Find Out ACTIVITY

What Did You Find Out?

1. What kinds of technologies are used to control pests?
2. What concerns are there with the technologies that are used to control pests?



The Pest Problem

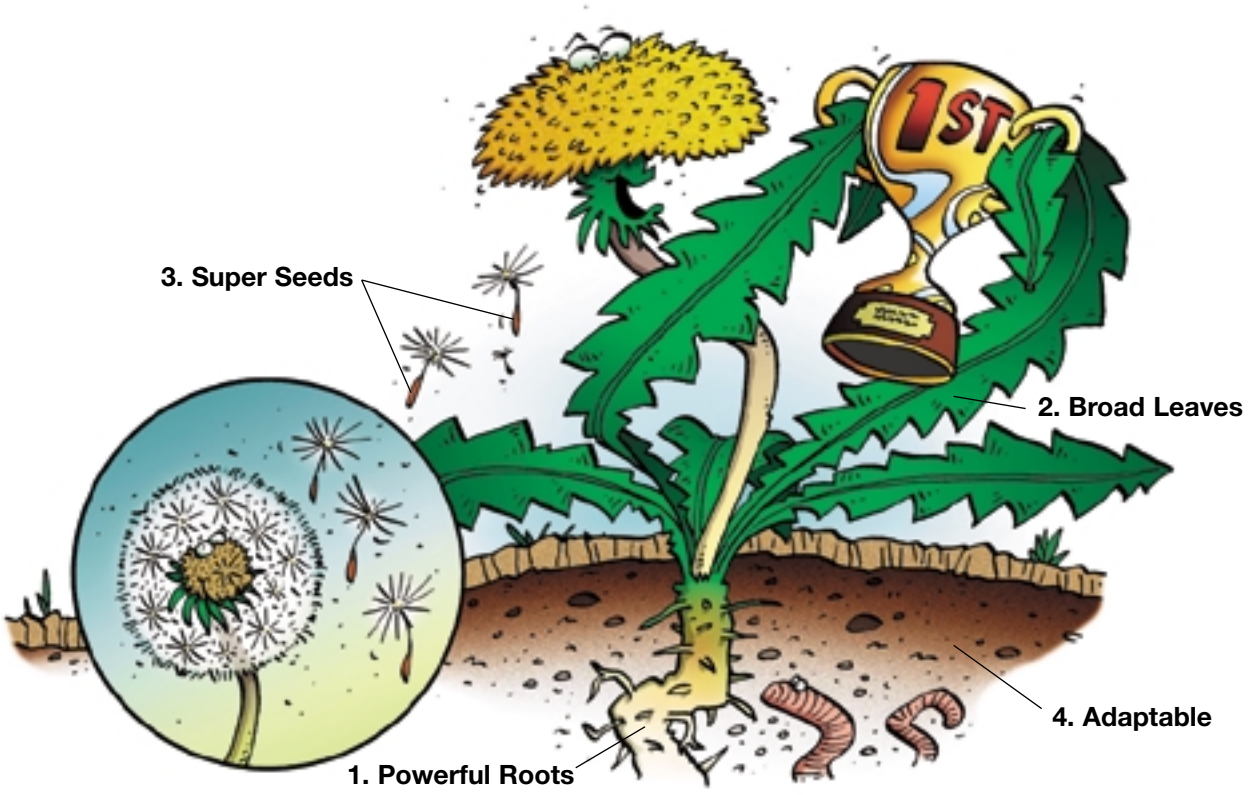
In natural systems, organisms have parasites, predators, or competing plants that help keep their numbers in check.

The pests that cause most damage are insects, fungi, and weedy plants. Weeds are "thieves"; they steal moisture, nutrients, space, or light from the crop. Insects usually eat some part of the plant, and fungi and bacteria can cause infections, destroying parts or all of the plant.

Insects and diseases consume over 50 percent of Canada's annual harvest. Farmers spend millions of dollars each year to control them and avoid food crop losses.

Dandelion: Profile of a Champion Competitor

What makes dandelions such successful weed pests?



1. **Powerful Roots** Dandelions have a long taproot that is anchored deep below the soil surface. If you try to pull up a dandelion, it usually breaks off near the surface, leaving most of the root in the soil. The root can grow new leaves and flowers. Dandelions store nutrients in their roots throughout the summer so that in early spring they can get a strong start and grow more quickly than the competition.

2. **Broad Leaves** Dandelions have long, wide leaves that shade out many nearby plants, making them strong competitors for light.

3. **Super Seeds** Dandelions are able to produce flowers and seeds all summer long. Each flower produces hundreds of seeds, which are carried a long distance on the wind.

4. **Adaptable** Dandelions grow well in all kinds of soil, including soil that is poor in nutrients. They also adapt quickly as a species to different situations because there is such a variety of these plants. For example, in a frequently mowed lawn, dandelions with very short flower stalks will survive because their flowers are missed by the lawn mower. Consequently, the homeowner will still have dandelions!

Chemical Weapons Dandelions release chemical agents to slow down the growth of grass and other plants nearby. This leaves more nutrients, water, and sunlight available for the dandelion plants.

Canola and Its Pests

Canola is popular with fungi, insects, and weeds. Here are some of the worst pests, and some of the strategies that make them successful.

DidYouKnow?

Technologists have developed new strains of canola that are resistant to herbicides. This means that a farmer can spray a field for weeds without killing the canola plants.

Introduced Species

Each food and fibre crop species has a set of pest weeds, insects, and fungi (see Figure 2.67). Many of the worst weed and insect pests are organisms introduced from other countries. They are called introduced, or exotic species. Introduced species become serious pests because they have few, if any, natural controls. Most of the weeds that cause crop losses (and increased expense) were accidentally introduced from Europe. Quack grass, thistles, and chickweed are examples (see Figure 2.68).

Figure 2.67 This picture was taken in July, when tree branches are normally covered in leaves. Tent caterpillars, however, have consumed almost every leaf. Aspen forests in Northern Alberta were severely affected by tent caterpillars in the 1980s.

Some of the foreign weed species came by accident, but others were introduced intentionally. Dandelions, for example, were brought from Europe to be used as a salad vegetable. Unfortunately, the set of insects and diseases that naturally control dandelion plants did not come with them.

Non-native insects also cause problems in fields and forests. The tiny European bark-boring beetle arrived in North America in 1940 with a shipment of elm logs from the Netherlands (see Figure 2.69). The beetle's damage to elm trees was relatively light. Unfortunately, it brought a fungus called Dutch elm disease that has since wiped out nearly all the native elm trees of North America.

Figure 2.68 Chickweed is a common weed pest that was introduced to Canada from Europe.

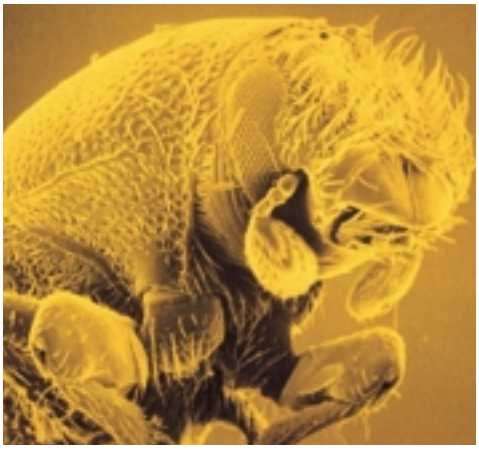


Figure 2.69 European bark-boring beetle

DidYouKnow?

The cane toad was released in many areas of Australia to control pests in sugar cane fields on farms. Unfortunately, the huge toads liked to live in cities too, and they became a major nuisance in both urban and rural areas.

DidYouKnow?

Plant diseases have been responsible for immigration. For example, the potato blight fungus in Ireland resulted in failure of potato crops and widespread hunger. Large numbers of Irish people came to North America and many settled in Alberta.

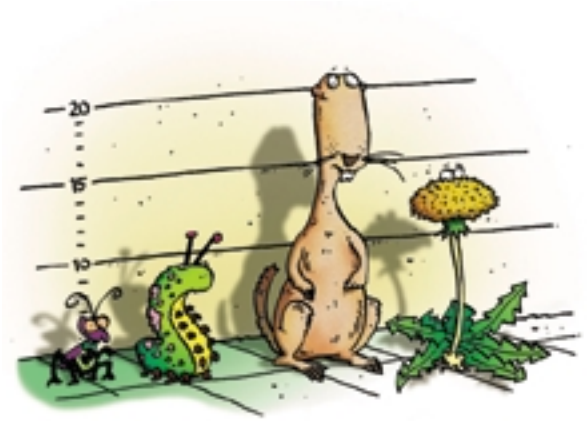


Figure 2.70 Pests come in all shapes and sizes.

Controlling Pests

Since people have been growing crops, they have tried different ways to control pests. Large pests could be chased or scared away, and smaller pests could be picked off plants by hand. Over the past 200 years, machines such as ploughs and cultivators have been developed to uproot or cut weeds at the soil surface (see Figure 2.71).

In the past farmers grew different crops each year as a way of controlling some weeds and diseases. In this practice of crop rotation, a field might grow wheat in the first year, barley in the second, potatoes in the third, and hay crops in the fourth, fifth, and sixth years. This system gave pests no opportunity to establish themselves since a new crop was grown each year. Regular summer fallow helped control a variety of weeds and crop diseases, but it led to soil damage.

As introduced species and other pests began to further threaten crops, chemical controls were developed. Chemical control seemed to be effective and relatively inexpensive. Herbicides, insecticides, and fungicides controlled weeds, insects, and fungi. These chemicals were simple to use, gave impressive results, and were considered safe. It took several decades of chemical use, however, before the major problems with the use of these controls became apparent.

DidYouKnow?

Up to about the 1930s, children were among the most common and effective forms of weed control. Families were large and children of all ages walked through the fields, pulled the weeds up, and brought them home to feed to the family's livestock.

Word CONNECT

Think of the words "herbicides," "insecticides," and "fungicides." What type of pest is each designed to control? What do you think the suffix *-cide* means? Use your dictionary to answer these questions.

Figure 2.71 Zero-tillage cultivators cut weeds near the soil surface, disturbing it as little as possible.

Concerns with Chemical Controls

Producers in Canada are becoming increasingly aware of long-term problems created by pesticides. Try the following activity to find one problem.

Find Out ACTIVITY

Passing on the Poison

How can chemicals that are meant to kill weeds or insects affect birds, fish, and mammals?

Materials

small squares of red and green paper

three different colours of ribbon

plastic bags

stopwatch

Procedure

Performing and Recording

Communication and Teamwork

1. Divide the class into producers, herbivores, and carnivores. Choose one top predator. Tie a different-coloured ribbon around the arm of each student to signify whether the student is a producer, a herbivore, or a carnivore. The top predator needs no ribbon.
2. In a large area, scatter the pieces of red and green paper. These are the plants in your food web.
3. Give the producers 1 min to collect as much "food" as they can. They can store the food in their "stomach" (the plastic bag).
4. After 1 min, stop the game and have each producer count and record the number of green and the number of red pieces of paper in each bag.
5. Now have the herbivores "eat" for 1 min. They eat by tagging the producers. If they tag a producer, the producer must hand over his or her stomach. Producers who are tagged are out of the game.
6. After 1 min, stop the game and have the herbivores count and record the number of green and the number of red pieces of paper in their bag(s).
7. Now have the carnivores "eat" for 1 min. Carnivores can tag only herbivores, and herbivores can tag only producers. If a herbivore is tagged, the herbivore passes *all* the bags to the carnivore and is out of the game.
8. After 1 min, stop the game and have each herbivore and each carnivore count and record the number of green squares and the number of red squares in the bag(s).
9. Now have the top predator "eat" for 1 min.
10. Stop the game. All remaining players count their red and green squares.

What Did You Find Out?

If the red squares represented chemically sprayed plants, explain how these squares got into the stomachs of predators that did not eat that food directly.

Bioaccumulation of Chemicals

As you saw in the previous activity, pollutants such as chemicals in pesticides can accumulate through the food chain. The pollutants move from level to level and get stored in organisms in the same way that food energy is stored. This effect is called **bioaccumulation**. Bioaccumulation is one of the primary concerns with the use of chemical pesticides. Animals at the top of the food chain, such as the bald eagle in Figure 2.72, are particularly affected by bioaccumulation.

Figure 2.72 Animals at the top of the food chain, such as bald eagles, are affected when chemical pollutants enter the food chain.

Soil Residue

Some of the chemicals wash off the plants and leave **residues** in the soil and water. If the pesticides are not easily decomposed, they can stay in the environment and remain poisonous. Toxic residues have been found in polar ice that is thousands of kilometres from the nearest source of the chemical.

Harming Non-Target Organisms

Pesticides are often toxic to more than one organism. In most cases, beneficial organisms, which are not the target of the chemical control, also die when pest organisms are killed. For example, earthworms are often non-target organisms that are affected by chemical controls. Killing non-target species often worsens the pest problem. For example, ladybird beetles eat aphids, but ladybirds are killed by an insecticide used to control aphids. The aphids soon return and, without the ladybirds present, their numbers and the damage they cause increase quickly.

DidYouKnow?

The use of chemicals to control pests is not new. By about 1000 B.C.E., sulphur was being used to kill insects. In 80 C.E., arsenic, an element known to be poisonous to humans, was used as an insecticide. Other toxic metals, including lead and mercury, were not known to be poisons. These popular pest controls were used in Roman times and poisoned many unsuspecting Romans.

Cool Tools

Two technologies — global positioning systems (GPS) and precision farming techniques — enable farmers to apply the right amount of chemicals to all areas of each field. GPS tells the farmer the exact position of the farm equipment. Precise measurements of soil and other factors are taken as the farm equipment moves across the field. A computer combines this information with other data about yield of the previous crop in that spot and adjusts the amount of fertilizer and pesticide for each part of the field.

Math CONNECT

The chemical DDT has been used to control insects carrying the fungal infection that causes Dutch elm disease. The elm leaves accumulated about 20 parts per million (ppm) of the DDT. Earthworms ate the leaves and accumulated over 80 ppm. After eating earthworms for the season, the bodies of robins had over 340 ppm.

A. Estimate the rate of increase of DDT in the first three species in the food chain above.

B. Suppose the concentration increased at a similar rate for the next species in the chain — the robins' predators. Estimate the concentration (in ppm) that you would expect in the tissues of the larger animals that prey on the robins.

Resistant Species

Scientists have discovered that, as pesticide use increases, the number of insect species that can withstand their effects (are **resistant**) is increasing as well. Target insects that survive have become naturally resistant to the chemical. Each generation of insects then becomes more and more resistant to the chemicals. The graph in Figure 2.73 shows how this can occur.

The only way to control these tough insects with chemicals is to use higher dosages and to develop new pesticides. These higher dosages could have even more harmful effects on the environment.

Pause & Reflect

If chemical controls have so many potential problems, why do you think they are so widely used? Discuss this question with a partner.

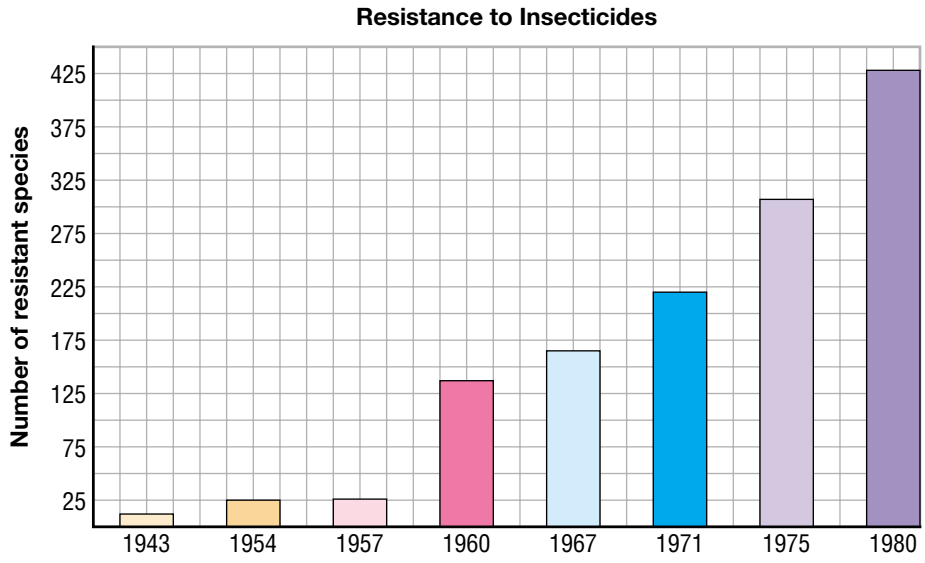


Figure 2.73 This graph shows how resistance to insecticides has steadily increased.

Pesticide Safety Labels

Find Out ACTIVITY

Universal symbols such as the ones below are used to indicate the dangers involved in handling pesticides and other hazardous chemicals.

Materials

instruction sheets photocopied from pesticides

Procedure

Performing and Recording

1. Choose a pesticide and prepare a brief report on the following questions:
   - **(a)** What is this pesticide used for?
   - **(b)** What safety precautions are necessary in order to apply the pesticide safely?
   - **(c)** What special equipment do you need?
   - **(d)** What conditions are required for safe storage and disposal?
   - **(e)** What action should you take if someone accidentally ingests or inhales this pesticide?

What Did You Find Out?

Analyzing and Interpreting

Are the instructions on the labels enough to keep all users and the environment safe? If not, what additional training or education should be required before people use pesticides?

Organic Food Production

Have you noticed foods labelled ORGANIC in grocery stores? **Organic** food is food that has been grown without the use of chemical fertilizers and chemical pesticides. Organic food growers use manure and compost to add nutrients to the soil. They fight weeds and other pests using a combination of methods such as tilling, crop rotations, mulching, planting their crop alongside plants that discourage insects (called companion planting), and removing insects by hand. Soaps can also be used to control many insect pests.

Figure 2.74A Organic food is grown without chemical fertilizers or pesticides.

Figure 2.74B An organic farm

Other practices that both organic and non-organic producers use to reduce the need for chemicals include:

- sowing good quality seeds
- removing weeds before their seeds mature by tillage or mowing
- cutting weeds along property edges
- cleaning equipment so that it doesn't transfer weeds from one field to another.

Many organic farmers also grow a variety of crops instead of monocultures. Increasing diversity helps reduce weeds, insects, fungal diseases, and the drain on some soil nutrients.

Producing without chemicals requires careful monitoring and extra work, so it can be expensive. Benefits include higher prices for produce, increased safety for the farmer, and less chance of residue buildup in the land. Consumers enjoy reduced chemical exposure, but must pay a little more for their food.

Pause & Reflect

Food produced organically presently costs more but it is safer for people and the environment. Would you be willing to pay more for food grown organically?

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7s

Meet some organic farmers by visiting the above web site. You can also find information about organizations that promote and support organic farming. Click on **Web Links** to find out where to go next. Prepare a mini-report about one organic farmer. How is food produced without chemical fertilizers or pesticides?

Find Out ACTIVITY

Controlling Slugs the Organic Way

Have you ever encountered a slug in a garden or on a vegetable or fruit? These members of the snail family feed on plants and can cause a lot of damage. How would you control slugs without using chemicals?

Procedure Initiating and Planning, Performing and Recording

1. Read the information about a slug's lifestyle below.

A Slug's Life

Slugs lay eggs on the surface of the soil in the fall. They like soil rich in organic matter. The eggs hatch in late spring and the growing slugs feed on almost any plant material within their reach. Slugs need to stay moist, so they do most of their eating during the evening and early in the morning. During the heat of the day, they hide under plants, rocks, boards, etc. These slippery visitors are attracted to liquids containing yeast and sugar.

2. Design a plan for reducing garden damage caused by slugs. What type of measures would you take to reduce damage by slugs?

What Did You Find Out? Analyzing and Interpreting

1. How do the strategies that you designed differ in terms of time and cost from simply using chemical pesticides to kill the slugs?
2. What are the advantages and disadvantages of using organic controls instead of chemical controls?

Biological Control

Biological control means using a pest's natural enemies to control it. It's like using one pest (insects, fungi, or bacteria) to control another. For example, the soil bacterium *Bacillus thuringiensis* (Bt) produces a toxin that is deadly to certain insects but is apparently harmless to humans and other animals (see Figure 2.75).

Some growers use ladybugs or predatory wasps to control insect pests such as aphids or white flies. In Unit 1 you learned how the black dot spurge beetle was successfully used to control the weed leafy spurge.

Figure 2.75 The bacterium *Bacillus thuringiensis* is commonly used as an insecticide.

Producers and Consumers — Partners in Sustainability

In Unit 1 you learned about producers and consumers in ecological systems. A similar relationship exists when we talk about growing plants for food and fibre. As you can see in Figure 2.76A, producing food and fibre has become increasingly complex. Farmers and foresters have to consider many factors in addition to conservation and sustainability. In the end, though, producers need to make a reasonable income. Are consumers willing to pay more for food and fibre products that are produced with less impact on the environment? We all have a part to play in the partnership between the plants we produce for food and fibre and the products we consume.

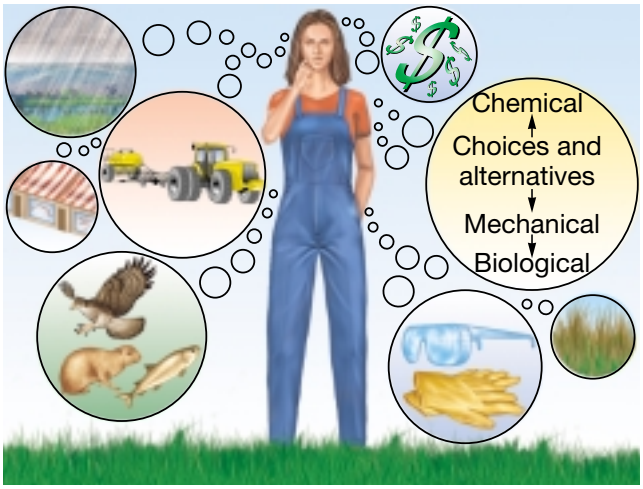


Figure 2.76A Farmers need to consider many factors in decisions about how and what to produce.

Figure 2.76B Consumers need to think about more than just the cost of their food. They are also partners in ensuring that the production of food and fibre is sustainable.

Pause & Reflect

What is your role in how plants for food and fibre are produced? Have you ever wasted products such as paper? Do you eat only food that is cheaper or that looks "perfect?" What is the cost, in terms of the sustainability of soil, water, and forests, of consumers' demands? Record your answers in your Science Log.

TOPIC 6 Review

1. What three kinds of organisms cause the greatest loss of food and fibre production? Give two examples of each, describing the crop species they prefer and how they cause crop loss.
2. Why are non-native pests sometimes so difficult to control?
3. If you were to design the ultimate weed, what features would you be sure to include?
4. **Apply** In a large garden, how might you apply simple, organic farming practices to control dandelions?
5. **Thinking Critically** Do you think the simple techniques described for controlling slugs could be applied in a large market garden? Why or why not? What further development of technology might make it cost effective?

Wrap-up TOPICS 4-6

If you need to check an item, Topic numbers are provided in brackets below.

Key Terms

sustainability
irrigate
monoculture
diversity
erosion
parent material
humus
horizons
topsoil
salinization
shelterbelt
bioaccumulation
resistant
organic

Reviewing Key Terms

1. In your notebook, match the description in column A with the correct term in column B.

A

- trees planted to reduce erosion from wind
- what a pest is when it becomes able to withstand chemicals and pesticides
- plants grown without soil
- dark, organic matter in soil that holds nutrients
- when only one type of plant is grown in an area
- non-organic material from which soil develops

B

- parent material (5)
- resistant (6)
- monoculture (4, 5)
- shelter belt (5)
- hydroponic (6)
- humus (5)

2. Explain the relationship between the following terms:

(a) diversity and monoculture (4, 6)

(b) irrigate and salinization (4, 5)

(c) erosion and topsoil (5)

Understanding Key Concepts

3. How are natural forests or grasslands different from agricultural fields or areas of forest that have been cut and replanted? (4)

4. Explain what is meant by sustainability. (4)

5. Explain why farmers should understand the climate and soil type for the area in which they farm. (4)

6. What are three economically important crops grown in Alberta? (4)

7. Describe one way in which farming technology has changed from 100 years ago? Is farming technology still changing? Explain your answer. (4)

8. Describe the practice of summer fallow. How did this practice damage the soil? (4, 5)

9. Describe some ways to save soil moisture. (4, 5)

10. How does the amount of organic matter and the amount of water in soil affect the ability of plants to grow? (5)

11. Why are earthworms sometimes referred to as the "intestines of the soil?" (5)

12. What do the numbers on this bag of fertilizer refer to? (6)

13. What characteristics of dandelions make them such successful plants? (6)

14. Describe three farming practices that reduce the need for chemical pesticides. (6)

UNIT 2

Ask an Expert

If you were a farmer trying to grow tomatoes in Canada in November, Muhammad Younus would be a very important person to know. Muhammad works for Alberta Agriculture, Food and Rural Development in the Greenhouse Crops division of Edmonton's Crop Diversification Centre North.

Q **What sort of work do you do?**

A I spend part of my day answering questions and giving advice to people who grow greenhouse crops such as tomatoes, cucumbers, and bedding plants. Sometimes they have a crop-related problem that they need solved, or they may need advice on setting up a new crop in a greenhouse. I get e-mails, letters, and telephone calls from growers all over Canada and sometimes as far away as Hawaii.

Q **What are the advantages of growing crops in greenhouses rather than outside?**

A Here in Canada the greatest advantage is that inside a greenhouse you can control the temperature, which means you can grow plants for a much longer period than you can in the natural environment. Most commercial greenhouses — those that grow food and plants to be sold in grocery stores and plant nurseries — are fully automated. A computer is programmed to control the temperature, light, and humidity in the building automatically. It also controls the amount of water and fertilizer that each individual plant will receive.

The black tubes visible in the photograph bring food and water to these young eggplant plants.

Q **So, growing in a greenhouse means your crop can't be damaged if there is too much rain, for example?**

A That's right. It also makes it easier to control disease and pest problems that can affect outdoor crops. Everything in the greenhouse environment is predictable. So, vegetable growers have a better idea of what their yield will be, and growers of container plants such as poinsettias and Easter Lilies can make sure that their plants are ready to bloom at the right time of year. Once they know what growing conditions work best, they can get a good product from every plant.

Q **But how do growers find out what growing conditions work best?**

A That's the other part of my job. I do research here in our greenhouses to develop techniques for successfully growing certain greenhouse crops. Once I've tested them, these techniques get passed along to the growers.

Q **So, you experiment with the ideal temperature and amount of water and so on?**

A Correct. I also try growing different crops in different artificial media to see how well they will grow.

Q **What do you mean by artificial media?**

A The medium is the material that the plant grows in. A plant outdoors usually grows in soil, but many greenhouse plants are grown in something different. It may be sawdust or peat, or it could be crushed Styrofoam™ or even glass beads. There is one medium called perlite, which is made from rock that has been blown like popcorn. Another, called rock wool, is rock that has been melted down and then spun into a mat of fibres, like fibreglass.

Q **But plants surely wouldn't get many nutrients from things like rock and Styrofoam™?**

A No, that's exactly the point. The media doesn't provide any nutrients to the plant. That way, the grower has complete control over what and how much the plant gets. This type of growing is called hydroponics. All of the food that the plant will get is delivered in the water-based feeding solution.

Q **How did you learn so much about growing plants?**

A I started out just by paying attention. When I was young, my paternal grandmother used many different plants to treat our illnesses. I found it fascinating. At about 16, I began making notes on the plants' names and what she used each of them for. Soon, people in the area were coming to me for information. In grade 12, my botany teacher made the study of plants sound so attractive, I decided it was for me. I got my masters degree in plant science from the Punjab University of Lahore, Pakistan, and after coming to Canada, began to work here at the Crop Diversification Centre North in 1988. And I continue to learn every day.

EXPLORING **Further**

So Much to Learn

Find out more about growing crops in a greenhouse. Visit some greenhouse web sites and maybe even grow a virtual greenhouse tomato! Go to **www.school.mcgrawhill.ca/resources/**.

Go to **Science Resources**, then to ***SCIENCEFOCUS™*** 7 to find out where to go next.

You can also find out more, at the same site, about the Crop Diversification Centre North where Muhammad Younus works.

UNIT 2 PROJECT

Get Growing!

Millions of people in Canada grow plants indoors or outdoors for a hobby or as a job. Do you have a "green thumb"? After completing this unit you should have a better understanding about the conditions in which plants grow best. Here is your chance to put all of that knowledge together to grow some great crops.

Challenge

You are part of a team that has been asked to design a way to grow the healthiest crop possible. How will you adjust the soil type, and the amount of water, light, and fertilizer to grow the best crop?

Apparatus

graduated cylinder

ruler

labels

felt marker

artificial growing lights (optional)

500 mL beaker

Materials

seeds (pea, radish, lentil, alfalfa, nasturtium, bean or other seeds of your choice)

3 clear plastic cups

paper towels

water

potting soil

growing mediums such as vermiculite, sand, perlite, peat moss, etc.

6 small paper cups or plant pots

500 mL of liquid fertilizer (mixed and provided by your teacher)

Safety Precautions

- Follow the instructions for safe disposal on the fertilizer package.
- Teachers should mix fertilizer for students.

Design Criteria

A. Choose two crops to grow. (You will receive 12 seeds of each crop and four seeds will be planted in each plant pot or "field".)

B. Sprout your crops in a germination chamber. (A plastic cup lined with a paper towel. Use one germination chamber for each crop.) Place the seeds between the paper towel and the outside of the cup so that you can see

them. Once seeds have sprouted plant four seeds in each of three "fields" (small plant pots). Label each pot.

C. You can vary the type of soil, and amount of light, water, and/or fertilizer in each field. All growing conditions must be recorded.

D. You will be given only 500 mL of fertilizer.

E. Plants will be grown and monitored for three weeks.

F. You must submit a summary outlining the growing conditions that resulted in the healthiest crop of plants. Include your criteria for determining plant health.

Plan and Construct 

1. As a class, decide on the criteria you will use to rate plant growth. For example, is the tallest plant the healthiest? Is it the plant with the most leaves or the best root growth? Or will this definition vary from species to species? Devise a system of scoring plant health.
2. In your group, review what you learned about plants and growing conditions in general in this unit. As well, review what you know about your two crops. (For example, did you use either of these varieties in an experiment earlier in this unit?)
3. Identify ways in which you could improve conditions for the roots, stems, and leaves of your crops.
4. As a group, decide on how you will vary the temperature, water, and/or light to encourage germination. (You do not have to vary all three.) Devise a way to measure and record seed growth.
5. As a group, decide on the type of soil or soil-less growing medium you will grow your crops in. You may use a different soil or growing medium (or a mixture) for each pot you will plant. The type of soil or growing medium used must be measured and recorded.
6. As a team, create the plan for growing your crops and recording your data. Make a list of materials you will need for your project.
7. Submit your group's final plan to your teacher. When you have received your teacher's approval, carry out your plan.
8. Monitor the growth of your plant for three weeks or more. (This includes germination time.)

Remember to wash your hands after handling potting soil, growing medium, or fertilizer.

Evaluate

1. At the end of three weeks, which plant was the healthiest? How did you determine plant health?
2. What condition(s) resulted in the best growing conditions in your experiment? Explain why you think these conditions improved the growing conditions for your plants.
3. What condition(s) resulted in poor plant growth? Explain why you think these conditions resulted in poor growth.
4. If you were to grow your crops again, what changes (if any) would you make? Why?
5. While increasing the amount of light, heat, or fertilizer may result in larger plants, there could be a cost to the environment. Explain this statement.

Would using a greenhouse change the results of your experiment? Devise a simple greenhouse and use it on one or more of your fields. Does a greenhouse improve the rate of growth? Does it improve the overall health of the crops?

UNIT 2

Review

Unit at a Glance

- Plants are critical to the environment and affect soil, water, and air. They cycle nutrients, create oxygen, and provide food and habitats.
- There are many kinds of plants, each adapted to particular growing conditions. Roots, stems, and leaves vary depending on these conditions.
- People use plants to meet their needs for food, medicines, and shelter. People also use plants as raw materials to manufacture many products.
- People have used our vast forests and grasslands, our knowledge of plants, and various technologies to become important producers of food and fibre.
- Plants reproduce sexually and asexually.
- Selective breeding can be used to create varieties of plants with desirable characteristics.
- Some farming practices have dramatically changed native forests and grasslands.
- It is important to grow plants for food and fibre in a sustainable manner so that natural systems remain healthy for future generations.
- Maintaining healthy soil is critical to sustainable harvesting of plants for food and fibre.
- Some agricultural crops can be grown in soil-less media.
- Some farming practices, for example, growing crops in monocultures, have resulted in problems such as the increased need for pest control.
- Alternative practices, such as organic farming and biological pest control, are being used to address the challenges of growing plants for food and fibre while still maintaining a healthy environment.
- Consumers also have a role to play in ensuring the sustainability of growing and harvesting plants for food and fibre.

Understanding Key Concepts

1. Describe two technologies that can be used to modify the growing conditions for a plant.
2. Describe a monoculture. How does this kind agricultural practice make production more efficient? What problems may result?
3. Describe five problems that have resulted from the widespread use of chemical controls.
4. Write a sentence using the words osmosis and diffusion to describe what happens when a tea bag and a spoonful of sugar are placed in a cup of hot water.
5. Name two common medicines that are produced from plants. Explain what each medicine is used to treat.
6. Describe the difference between annuals and perennials.
7. How is photosynthesis significant to the food chain?
8. How is seed dispersal important to the survival of plant species?
9. Describe the essential roles of plants in the environment.
10. Describe three ways that Aboriginal people use plants.
11. Compare the terms selective breeding and genetic modification.
12. Give three examples of characteristics that plants might be bred for. Provide a real example.

13. For each pair of terms below, explain what they have in common and how they differ.

(a) pistil and stamen

(b) flower and cone

(c) anther and stigma

14. Explain why seeds can be referred to as "plants in storage."

15. How are seeds adapted for dispersal by wind? By water? By animals?

16. Sketch this plant in your notebook. Label the plant parts and their function.

17. Explain what causes soil erosion and three ways in which it can be prevented.

18. Answer the following questions based on the photograph above.

(a) Explain what has happened in this photograph.

(b) Explain how this situation could be a problem for plants.

(c) How can farming practices be altered so that this does not happen?

Developing Skills

19. Make a diagram or a flowchart that demonstrates how photosynthesis works.

20. Use a graphic organizer of your choice to show the steps involved in changing a plant into a product. (For example, show the steps involved in processing trees into lumber.)

21. Use a labelled diagram to show how water enters and moves through a plant.

22. Design an experiment that would determine how different types of fertilizers affect plant growth.

23. Describe two ways to monitor plant growth.

24. Describe how you could monitor and describe plant health.

Problem Solving/Applying

25. During germination, the young plant parts inside the seed begin to grow. Explain why water is one of the most important requirements for germination to begin.

26. Many plants have adaptations that prevent them from self-pollinating. How does this benefit the species?

27. Imagine that you have been awarded the contract to introduce a biological control for dandelions. What factors would you need to consider as you search for the control? As you test it?

28. There are different challenges that arise when improving growing conditions in different settings. Choose one food plant. Compare the challenges one would face in optimizing the growing conditions for this plant in:

(a) a field

(b) a greenhouse

(c) your classroom

29. Over millions of years plants have adapted their structure to survive in their environment. Consider the following structures and describe what problems they solve for the plant.

(a) Lodgepole pine cones open only when there is intense heat.

(b) Dandelions have long taproots.

(c) Strawberry plants have horizontal runners.

(d) The leaves of the barrel cactus are modified into spines.

(e) Arctic lupine have seeds that can wait for centuries before sprouting.

(f) Milkweed seeds are light and feathery.

Critical Thinking

30. Why are many people concerned about the rapid loss of rain forests around the world?

31. In 1883 the tropical island of Krakatoa exploded leaving the entire island devoid of vegetation. It did not take long, however, for plants to begin growing again on this island. Describe three ways in which seeds might have reached the island.

32. There are many stages at which a new plant might have a problem that would prevent pollination or germination. For example, cool weather or lack of pollinators. What steps can growers take to try to ensure that plants successfully grow and reproduce?

33. A beech tree has small, green-coloured flowers. Explain why it is unlikely that beech flowers are pollinated by insects. Suggest the most likely method of pollination.

34. In many of the experiments in this unit you started with sprouted seeds. How is this important to achieving accurate results?

35. Explain why it is important to produce plants for food and fibre in a sustainable manner.

36. What are some factors that farmers or foresters need to consider before choosing a plant to grow in a certain area?

37. Name two plants grown in Alberta for food and/or fibre. Where do these plants grow? What make these plants well suited for growing in this province?

38. Imagine that you are an experienced field crop farmer. You are thinking about buying a particular parcel of land and want to check the soil. Answer the following questions.

(a) How could you test the soil for organic matter?

(b) Why would you be concerned about organic matter?

(c) If the soil is low in organic matter, how could you improve it?

39. Many people who are concerned about the environment would like to see hemp become an important source of fibre in Canada. They say that hemp fibre is more environmentally friendly than wood fibre. Explain the characteristics of hemp that support this position.

40. Why might a farmer decide to use chemical controls rather than other kinds of controls for an insect pest?

Pause & Reflect

1. People have always used knowledge and technology to help us produce useful products from plants. Give some examples of how our technology and knowledge have changed in the last 100 years.
2. Explain how it is sometimes a challenge to achieve a balance between the needs of people and a sustainable, healthy environment. Use examples that you learned about in this unit.
3. Now that you have completed this unit, go back to the Focussing Questions on page 90. Write answers to these questions in your Science Log.